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Generative AI-Enabled Design of Logic-Oriented English Reading Homework for Senior High Schools

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Abstract

The Senior High School English Curriculum Standards (Ministry of Education, 2017 Edition, 2020 revision) identifies "thinking quality" as one of the four core competencies in English language education, with logical thinking serving as its foundational component. In practice, however, senior high school English reading homework has largely remained at lower-order cognitive levels such as vocabulary memorization, grammar drills, and literal comprehension, failing to provide systematic training in logical reasoning. Drawing on Du Guoping's five-dimensional framework of logical thinking, this study employs a mixed-methods approach to examine the distribution of logical thinking dimensions in current reading homework. The findings reveal a significant imbalance across the five dimensions: foundational dimensions such as clarifying concepts and making accurate judgments are relatively well represented, whereas higher-order dimensions including rigorous reasoning, constructing sound arguments, and identifying fallacies are critically underrepresented. To address this issue, the study proposes four AI-empowered pathways: intelligent item generation, chain-of-thought-driven reasoning visualization, tiered task adaptation, and precision feedback aligned with logical dimensions. A case study using the reading text "Travel Peru" illustrates the practical application of these pathways. The study offers a theory-grounded framework and practical routes for the systematic integration of generative AI into reading homework design as an effective vehicle for fostering logical thinking.

Keywords

Generative AI, Logical Thinking, Senior High School English Reading Homework, Homework Design

1. Introduction

The *Senior High School English Curriculum Standards* (Ministry of Education, 2017 Edition, 2020 revision) identifies "thinking quality" as a key dimension of the core competencies in English language education, requiring students to "discriminate among various phenomena in language and culture; classify and summarize information, construct new concepts; and analyze and infer logical relationships in information." Thinking quality manifests itself through three interrelated facets—logical, critical, and innovative thinking—among which logical thinking occupies a foundational position. In teaching practice, however, reading homework, as an essential extension of classroom instruction, has long been confined to low-order cognitive operations such as vocabulary retention, grammar exercises, and detail-oriented comprehension questions. Previous studies have pointed out that current English reading instruction still suffers from problems such as superficial text interpretation, fragmented processing of textual information, and insufficient exploration of deeper meaning (Lin, 2021; Chen, 2021). Homework design, in particular, is generally characterized by mechanical repetition, uniform formats, and a lack of competency orientation.

In the meantime, generative AI technologies represented by ChatGPT and DeepSeek have undergone rapid development. Existing research has confirmed that AI tools can significantly improve the efficiency of text adaptation and the scientific rigor of assessment design. Generative AI offers new possibilities for personalized learning by generating context-sensitive feedback, adapting instructional support to learners' needs, and facilitating more individualized learning experiences (Morris et al., 2025). Nevertheless, most existing studies have focused on language skill training, leaving a gap in the systematic application of generative AI to logic-oriented reading homework design.

Against this background, the present study addresses two core research questions. The first concerns the distribution characteristics and deficiencies of current senior high school English reading homework across the various dimensions of logical thinking. The second explores how generative AI can support the design and feedback of logic-oriented reading homework on the basis of a five-dimensional logical thinking framework.

2. Literature Review

2.1. Logical Thinking

The term "logic" originates from ancient Greek, with its original meaning encompassing speech, thought, concept, and reason. From the late 1950s onward, foreign scholars began large-scale investigations into thinking theories related to logicality. The development of students' thinking requires attention not only to the acquisition of knowledge but also to the development of logical thinking and the ability to analyze and reason. Piaget (1970) emphasized that advancing educational reform in the epistemological sense requires focused efforts on cultivating students' logical reasoning abilities, enabling them to gradually master complex abstract conceptual structures. Subsequent research has continued to refine and expand the connotation of logical thinking. Inhelder and Piaget (1958) viewed the development of logical thinking as a gradual transition from concrete operations to formal operations, with the latter enabling increasingly abstract and systematic reasoning.

In China's educational context, logical thinking did not receive widespread attention until the promulgation of the Senior High School English Curriculum Standards (2017 Edition), which explicitly incorporated "thinking quality" into the core competency framework and identified logical thinking as one of its fundamental components. Logical thinking is also closely related to foreign language learning, as learners need to identify relationships, generalize linguistic patterns, and apply rules in new contexts.

To construct a more systematic and operational theoretical framework, Du (2018) proposed a five-dimensional structure of logical thinking, comprising clarifying concepts, making accurate judgments, rigorous reasoning, constructing sound arguments, and identifying fallacies (**Figure 1**). This framework is closely aligned with the objectives of China's basic education and possesses strong practical guidance value.

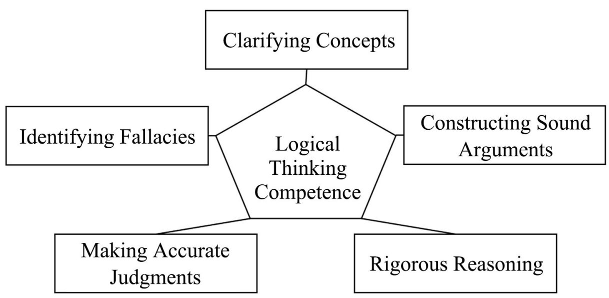

Figure 1. Five-dimensional structure of logical thinking competence.

2.2. Logical Thinking in English Reading Instruction

Logical thinking is closely connected to reading comprehension because understanding a text requires learners to go beyond surface-level information and engage in processes such as analysis, inference, evaluation, and meaning construction. Empirical research has shown that integrating critical-thinking-oriented instruction into EFL reading can significantly improve students' reading com-prehension, suggesting that higher-order thinking plays an important role in deeper engagement with texts (Bakhtiari Moghadam et al., 2023).

However, despite the increasing sophistication of theoretical frameworks for logical thinking, their systematic integration into senior high school English reading homework remains underdeveloped. Existing research on logical thinking cultivation has largely concentrated on classroom questioning, writing instruction, or comprehensive learning activities, with relatively few studies approaching homework design from the full spectrum of logical thinking—concept clarification, judgment formation, reasoning development, argument construction, and fallacy identification. For example, although tiered homework cases have been designed to attend to differences in thinking levels, they do not always align closely with the core elements of logical thinking (Wang, 2024); Moreover, current research generally lacks homework feedback mechanisms grounded in logical frameworks, leaving students without precise guidance on their logical thinking processes after completing assignments. This theory-practice gap creates room for generative AI to play a role in personalized feedback.

2.3. Generative AI in Homework Design and Feedback

Generative AI is increasingly moving beyond its role as a language learning tool and showing potential to support a broader range of learning activities. In reading and language learning, large language models can facilitate interaction with texts and provide learners with context-sensitive explanations and feedback. In homework design and feedback, generative AI can also assist teachers in generating learning materials and providing individualized formative support. Steinert et al. (2024), for example, developed an LLM-based learning assistant that provides formative feedback designed to stimulate students' cognitive and metacognitive processes. Similarly, Morris et al. (2025) demonstrated the feasibility of using large language models to provide real-time formative feedback on students' summaries, particularly for assessing reading comprehension. In EFL writing, Khojasteh et al. (2025) found that AI-based feedback could improve aspects of learners' writing performance, although a hybrid model combining teacher and AI feedback produced the strongest overall gains.

Furthermore, researchers have begun exploring the technical potential of generative AI in promoting student thinking training. The "chain-of-thought" prompting technique proposed by Wei et al. (2022) enables models to present complex problem-solving and reasoning steps, providing a technical foundation for cultivating logical reasoning ability. Building on this, Liu et al. (2023) further enhanced the model's logical judgment capability through instruction fine-tuning on logical chains, enabling it to analyze students' reasoning processes, identify points of logical breakdown, and present argument structures. Generative AI thus demonstrates educational value worthy of continued exploration in assisting students to construct clear logical thinking and enhance metacognitive abilities.

In summary, although progress has been made in five senior high school English reading homework, logical thinking cultivation, and educational applications of generative AI, several deficiencies remain. First, senior high school English reading homework design generally lacks systematic integration of logical thinking components, with current reform efforts remaining at a macroscopic level without decomposing logical thinking into its specific constituent elements. Second, logical thinking theory has not been effectively translated into an operational reading homework design framework, with its application in the homework domain still limited. Third, educational applications of generative AI have largely remained at the language training level, without providing in-depth support for systematic logical thinking cultivation. The present study addresses these gaps by exploring how generative AI can be leveraged for logic-oriented reading homework design.

3. Theoretical Framework

3.1. The Five-Dimensional Structure of Logical Thinking

This study adopts Du (2018) five-dimensional structure as its core analytical and design framework. The theoretical contribution of this framework lies in decomposing the abstract construct of "logical thinking ability" into five observable, measurable, and trainable dimensions. The ability to clarify concepts is the starting point of logical thinking—concepts are the basic units of thought, and conceptual clarity is the most fundamental requirement of rational thinking. In reading, this manifests as whether students can accurately understand key terms in the text, distinguish between similar concepts, and grasp the extensional relationships among concepts. The ability to make accurate judgments is the form of thinking that involves making determinations about states of affairs—in reading, this manifests as whether students can make appropriate judgments about the truth of propositions, the relevance of information, and the reasonableness of viewpoints based on textual evidence. The ability to engage in rigorous reasoning is the thinking process of deriving new judgments from known premises, including induction, analogy, and deduction—in reading, this manifests as whether students can derive new conclusions through reasonable logical deduction from known textual information, and this dimension serves as the key bridge connecting "understanding" and "creation". The ability to construct sound arguments is the process of using evidence to support claims—in reading, this manifests as whether students can identify the author's thesis and supporting evidence while also constructing persuasive argument structures for their own viewpoints. The ability to identify fallacies is the capacity to recognize logical errors in arguments, including common fallacies such as equivocation, circular reasoning, hasty generalization, and false cause—this is a higher-order ability in logical thinking and an important manifestation of critical thinking.

This five-dimensional framework is suitable for reading homework design for three reasons. First, the five dimensions exhibit a clear progression from concept to judgment, from judgment to reasoning, from reasoning to argumentation, and from argumentation to fallacy identification, corresponding to a complete cognitive path from foundational understanding to higher-order critique, which facilitates the design of tiered homework. Second, each dimension has corresponding manifestations in reading contexts, enabling the design of specific task types. Third, each dimension possesses observable behavioral indicators, facilitating homework feedback and ability assessment.

3.2. Deep Learning-Oriented Homework Design Principles

Four core characteristics of deep learning-oriented reading homework can be distilled from a systematic review of the relationship between deep learning and homework design (Long & Huang, 2026). The first is the deepening of text reading, which requires reading homework to move beyond superficial information extraction and guide students to understand the text's structural logic, argumentative logic, and intellectual lineage, rather than stopping at word-level checks. The second is the advancement of cognitive levels, requiring reading homework to cover a full spectrum of cognitive objectives ranging from memorization, comprehension, and application to analysis, evaluation, and creation—this aligns closely with the progression of the five-dimensional logical thinking structure. The third is the cultivation of critical thinking, requiring homework to guide students in questioning textual viewpoints, identifying argumentative flaws, and forming independent judgments. The fourth is the occurrence of knowledge transfer, requiring homework to create new contexts that allow students to transfer acquired knowledge and thinking methods to solve new problems. These principles provide directional guidance for AI-empowered homework design.

3.3. Construction of the "Logic Dimension–AI Empowerment" Integrated Analytical Framework

Drawing on the above theories, this study constructs an integrated analytical framework structured around four components: "logic dimensions—homework task types—AI empowerment approaches—specific examples" (Table 1). This framework serves three functions. First, it functions as a tool for textual analysis, used to code collected reading homework samples and reveal the distribution characteristics and gaps across the five logical dimensions in existing homework. Second, it serves as a guide for design generation, providing dimensional references for subsequent AI prompt design and teacher review. Third, it serves as a basis for feedback evaluation, offering a five-dimensional diagnostic framework for analyzing student responses.

Table 1. Analytical framework for logic-oriented senior high school English reading homework design.

Logic Dimension	Core Ability	Homework Task Types	AI Empowerment Approaches	Specific Examples
Clarifying Concepts	Identifying concept connotations and extensions, distinguishing similar concepts	Concept definition, concept discrimination, classification and induction	Automatically generate concept definition and discrimination items; provide sets of near-synonym comparisons	Compare the similarities and differences between "globalization" and "modernization" in the text
Making Accurate Judgments	Making sound determinations based on textual evidence	Fact judgment, opinion discrimination, true/false judgment	Generate true/false judgment items; automatically locate textual evidence	Determine whether "the author believes cultural diversity is worth protecting" aligns with the text and find supporting evidence
Rigorous Reasoning	Deriving new conclusions from known premises	Causal analysis, inductive reasoning, deductive reasoning	Display chain-of-thought reasoning steps; generate causal relationship diagrams	Summarize commonalities among three country cases and infer a conclusion not explicitly stated in the text

Continued

Constructing Sound Arguments	Identifying argument structure, building logical chains between claims and evidence	Thesis identification, evidence analysis, argument evaluation	Automatically annotate argument structure; generate argument framework diagrams	Identify the author's main thesis and supporting evidence; complete an argument structure table
Identifying Fallacies	Recognizing logical errors and cognitive biases	Fallacy identification, critical reflection, counter-argumentation	Point out logical flaws; generate counter-argument examples	Identify the logical problem in the statement "globalization is inevitable, so there is no need to protect local culture"

4. Research Methods

This study employs a mixed-methods approach combining a teacher questionnaire survey and textual analysis of reading homework. The questionnaire targeted English teachers from five senior high schools in Shaoxing City. A total of 60 questionnaires were distributed, with 52 valid responses received, yielding an effective response rate of 86.7%. Among the 52 teachers, 15 had teaching experience of less than 5 years, 22 had 6 to 15 years, 10 had 16 to 25 years, and 5 had more than 26 years. The teacher questionnaire comprised 21 items across four dimensions (**Table 1**): teachers' basic information (4 items), cognition and attitudes toward logical thinking cultivation (6 items), the types and frequency of logical thinking tasks they design in reading homework (7 items), and the challenges they face as well as their awareness of generative AI (4 items). The questionnaire employed a five-point Likert scale and was administered and collected through the Wenjuanxing platform. The questionnaire items were developed with reference to Du's (2018) five-dimensional framework of logical thinking and were further adapted to the context of senior high school English reading homework. All items employed a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). To establish content validity, the initial pool of 25 items was reviewed by a panel of three experts in English education and logic, resulting in the final 21-item version. The content validity index (CVI) at the item level (I-CVI) ranged from 0.83 to 1.00, and the scale-level CVI (S-CVI/Ave) was 0.92. Internal consistency was assessed using Cronbach's alpha, yielding a coefficient of 0.85 for the total scale, indicating good reliability.

For textual analysis, one component of this mixed-methods design, 100 reading-homework texts were collected, with 20 samples drawn from each of the five participating schools. The grade-level distribution included 34 samples from Grade 10, 33 from Grade 11 and 33 from Grade 12; detailed sample counts by school and grade are presented in **Table 2**. The corpus consisted of after-class reading-comprehension exercises, continuation-writing tasks, reading reflection journals and other common reading-homework formats. The researcher and a senior high school English teacher with seven years of teaching experience independently coded these 100 texts following the five-dimensional analytical framework in **Table 3**. Prior to formal coding, the two coders had in-depth discussions over the definitions of the five dimensions and their corresponding task categories. After trial coding of selected texts achieved inter-coder reliability above 85%, they proceeded to complete independent coding for the full dataset. The coding unit was defined as an individual homework item (e.g., a single question or task prompt), rather than the entire homework text. A single item could be coded as addressing one or multiple dimensions of logical thinking, as some complex tasks may simultaneously tap into, for example, both concept clarification and judgment. The percentage reported for each dimension, therefore, represents the proportion of the total number of homework items that involved that particular logical thinking dimension.

Table 2. Distribution of reading homework samples by school and grade.

School	Grade 10	Grade 11	Grade 12	Total
School A	7	7	6	20
School B	7	6	7	20
School C	6	7	7	20
School D	7	7	6	20
School E	7	6	7	20
Total	34	33	33	100

Table 3. Questionnaire framework for investigating logical thinking cultivation in senior high school English reading homework.

Dimension	Focus Area	Number of Items	Specific Content
Dimension 1	Teachers' basic information	4	Gender, teaching experience, professional title, educational background
Dimension 2	Cognition and attitudes	6	Familiarity with the concept of "logical thinking"; perceived importance of logical thinking cultivation for senior high school English reading instruction; perceived correlation between logical thinking cultivation and thinking quality improvement; perceived correlation between logical thinking cultivation and reading comprehension ability; attitude toward integrating logical thinking training into English reading homework; familiarity with Du Guoping's five-dimensional structure
Dimension 3	Types and frequency of logical thinking tasks in homework design	7	Frequency of assigning: concept comprehension and discrimination tasks; opinion judgment tasks; causal analysis tasks; inductive reasoning tasks; argument structure identification tasks; logical fallacy identification tasks; open-ended reflection and evaluation tasks
Dimension 4	Challenges and AI awareness	4	Greatest challenges in cultivating students' logical thinking; awareness of generative AI's applicability to homework design; prior use of AI tools to assist homework assignment; attitude toward AI-assisted logical thinking homework design

5. Results and Discussion

5.1. Current State of Logical Thinking Cultivation in Reading Homework

Teachers' Cognition and Attitudes toward Logical Thinking Cultivation

The questionnaire results indicate that teachers generally recognize the importance of logical thinking cultivation. Specifically, 88.5% (n = 46) of the teachers considered logical thinking cultivation "important" or "very important" (ratings of 4 or 5 on the 5-point scale). A one-sample t-test against the scale midpoint (3) confirmed that this perception was significantly positive (M = 4.21, SD = 0.78, t (51) = 11.2, $p < 0.001$). Furthermore, 84.6% (n = 44) of teachers believed that logical thinking cultivation is closely related to both the improvement of students' thinking quality and reading comprehension ability. Over 73% (n = 38) of teachers held positive attitudes toward integrating logical thinking training content into reading homework.

However, teachers' understanding of the specific connotations remained superficial. Approximately 59.6% (n = 31) indicated that they had "heard of, but are not familiar with" Du Guoping's five-dimensional structure, and less than 19.2% (n = 10) were able to clearly describe the connotations of each dimension in an open-ended follow-up question. This finding is consistent with the "high recognition, low cognition" pattern regarding emerging educational concepts identified in existing research. In terms of attitudes toward AI-assisted homework design, teachers with longer teaching experience demonstrated more positive attitudes compared to their less experienced counterparts, while some younger teachers expressed reservations about potential over-reliance on AI tools, which they feared might weaken their own capabilities in question design over time.

5.2. Coding Results from Homework Text Analysis

To validate the reliability of teachers' self-reported data, this study conducted coding analysis on 100 reading homework texts based on the five-dimensional structure. The results are presented in Table 4.

The textual analysis results largely align with the questionnaire data. Over 70% of homework items included concept clarification tasks, approximately 60% included judgment tasks, but only around 30% involved reasoning tasks, approximately 20% involved argumentation tasks, and less than 10% of items involved fallacy identification. A notable discrepancy emerged: while approximately half of the teachers self-reported "frequently assigning inductive reasoning tasks" in the questionnaire, textual analysis revealed that only about 30% of homework items actually contained such tasks. This discrepancy may reflect a misunderstanding of "reasoning-type items"—some teachers may have misidentified detail-extraction tasks such as "answer questions based on the article content" as reasoning training. In terms of grade-level distribution, the proportions of items addressing clarifying concepts and making accurate judgments were relatively similar across grades 10 through 12, with little variation. However, for rigorous reasoning and constructing sound arguments, grade 12 slightly outperformed grades 10 and 11, while all three grades remained at low levels for fallacy identification. This suggests that examination pressure does not automatically translate into more systematic logical thinking training—teachers at higher grade levels still predominantly used traditional question types.

Table 4. Distribution of the five-dimensional logical thinking structure in reading homework texts.

Logic Dimension	Number of Homework Items Involving the Dimension	Percentage
Clarifying Concepts	74	74%
Making Accurate Judgments	62	62%
Rigorous Reasoning	32	32%
Constructing Sound Arguments	22	22%
Identifying Fallacies	9	9%

5.3. Pathways for Generative AI-Empowered Logic-Oriented Reading Homework Design

To address the problems of weak higher-order logical dimension training in current reading homework and the gap between teachers' cognition and practice, this study takes the reading text "Travel Peru" from Unit 2, Travelling Around, in the People's Education Press Senior High School English Compulsory Book 1 as a case study to present specific pathways for generative AI-empowered logic-oriented reading homework design across four levels. This text is a magazine-style travel introduction, rich in geographical and cultural information, containing multiple comparisons, recommendations, and other discursive content, making it suitable for multi-dimensional logical training including concept discrimination, reasoning and judgment, and argument evaluation.

5.3.1. Pathway 1: Intelligent Item Generation Based on the Five-Dimensional Structure

The survey found that when designing logical thinking tasks, teachers predominantly concentrated on relatively manageable question types such as concept comprehension and judgment, while showing markedly insufficient effort on higher-order dimensions including reasoning, argumentation, and fallacy identification—attributable in part to a lack of reference question examples and design approaches. AI can quickly generate initial drafts of items covering all dimensions based on the five-dimensional structure, effectively compensating for teachers' experience gaps in higher-order logic item design.

Teachers can input the reading text together with the five-dimensional structure requirements into DeepSeek, which then automatically generates items covering all five logical dimensions. Below is a sample instruction and its generated results for the "Travel Peru" text.

AI instruction:

Based on the following reading text, please generate two items for each of the five dimensions—Clarifying Concepts, Making Accurate Judgments, Rigorous Reasoning, Constructing Sound Arguments, and Identifying Fallacies—with one foundational level and one challenge level item per dimension, and provide answer keys with brief reasoning steps.

Table 5. AI-Generated logic-oriented reading homework items (Travel Peru).

Logic Dimension	Foundational-Level Item	Challenge-Level Item
Clarifying Concepts	The text mentions that Machu Picchu is a UNESCO World Heritage site. Please explain in your own words what "World Heritage" means.	What is the difference between the concepts of "off-the-beaten-path" and "popular tourist destination" in the text? For which aspects of Peru does the author use each term?
Making Accurate Judgments	Determine whether the following statement aligns with the text: "You can only reach Machu Picchu by train." Find textual evidence to support your judgment.	Which travel route do you think the author recommends more? Support your judgment with at least two pieces of textual information.
Rigorous Reasoning	Based on the text's descriptions of Peru's coastal, mountainous, and rainforest regions, complete the causal inference: Because ______, tourists need to acclimatize to the high-altitude environment in advance.	The text states that "Peru offers something for every type of traveler." Please summarize the three types of travelers mentioned in the text and their corresponding travel styles, then infer a plausible conclusion not explicitly stated in the text.
Constructing Sound Arguments	What is the core thesis of the text's recommendation of Peru as a travel destination? What factual evidence does the author use to support it? (Fill in the table.)	If you wanted to refute the view that "traveling to Peru is too expensive," how would you construct a brief argument using information from the text?
Identifying Fallacies	A classmate says: "Because the text only introduces Peru, Peru must be the best travel destination in South America." What is the problem with this reasoning?	Analyze the logical flaw in the following argument: "Peru has World Heritage sites, so traveling to Peru will definitely offer more cultural gains than traveling to other countries."

To evaluate AI-generated content, a review protocol was established. A senior teacher with seven years of teaching experience assessed all ten AI-generated items (two per dimension) according to three criteria: 1) textual relevance, 2) alignment with the targeted logical dimension, and 3) prompt clarity. The results indicated that 100% of items for the Clarifying Concepts and Making Accurate Judgments dimensions satisfied all three criteria and were adopted directly. Half (1 out of 2) of the items under the Identifying Fallacies dimension failed the textual-relevance criterion and required substantial revision. Overall, 75% (7 out of 10) of the AI-generated outputs were retained following teacher review and modification. Further analysis revealed considerable quality variation among AI-generated items for the Identifying Fallacies dimension: although the model could detect common fallacies such as hasty generalization effectively, it performed poorly in judging fallacy types shaped by specific cultural contexts, which calls for ongoing teacher oversight.

5.3.2. Pathway 2: Chain-of-Thought-Driven Reasoning Visualization

Most students, when completing reasoning-oriented homework, tend to provide only the final answer while concealing the thinking process, making it difficult for teachers to determine whether their reasoning paths are correct, let alone provide targeted process-oriented guidance. Chain-of-thought technology can externalize implicit reasoning processes. For reasoning-type items, teachers can instruct AI to generate detailed reasoning steps as a thinking scaffold for students' reference.

Taking the challenge-level item from the Rigorous Reasoning dimension in Table 5 as an example—summarize the three types of travelers mentioned in the text and their corresponding travel styles, then infer a plausible conclusion not explicitly stated in the text—the AI generated the following reasoning chain:

- Step 1: Extract key information about the three types of travelers from the text—history enthusiasts correspond to historical-cultural routes such as Machu Picchu, nature enthusiasts correspond to natural adventure routes such as the Amazon rainforest, adventure enthusiasts correspond to outdoor activities such as trekking and mountain biking;
- Step 2: Identify commonality—all three types of travelers can find suitable travel styles in Peru, indicating the diversity of Peru's tourism resources;
- Step 3: Inductive conclusion—Peru can meet the differentiated needs of diverse tourists;
- Step 4: Infer an unstated conclusion—Peru's tourism development strategy may emphasize differentiated positioning to attract diverse international tourists.

This step-by-step presentation transforms implicit thinking processes into explicit text, helping students understand the derivation pathway of the answer rather than merely knowing the final conclusion. Teachers can attach such reasoning steps as thinking visualization tools to homework, which is particularly beneficial for weaker students to imitate and learn normative reasoning processes.

5.3.3. Pathway 3: Tiered Variations and Personalized Adaptation

Students' logical abilities within a class vary considerably, making it difficult for teachers to simultaneously address differentiated learning needs. AI's batch generation capability can rapidly produce multiple difficulty-graded variations of items. Teachers can instruct AI to generate three difficulty versions for the same logical dimension. Taking the Constructing Sound Arguments dimension as an example, AI generated the following tiered scheme:

- Foundational level: Provide an argument framework table (including thesis column, evidence column, supporting sentence column); students only need to extract keywords from the text to fill in;
- Standard level: Students independently identify the author's thesis and evidence, completing an argument structure analysis table independently;
- Challenge level: In addition to identifying the argument structure in the text, students write an argument paragraph on whether one should travel to Peru, containing at least one thesis, two pieces of evidence, and one reasoning connective.

Such tiered design enables teachers to assign differentiated homework to students at different levels, ensuring both the completion feasibility for weaker students and providing expansion space for more capable learners.

5.3.4. Pathway 4: Precision Feedback Based on Logical Dimensions

Feedback on current reading homework largely focuses on the correctness of language forms—such as vocabulary spelling and grammatical accuracy—with relatively little attention to diagnosing and guiding thinking processes, resulting in students completing homework without being able to identify their own thinking biases. AI can analyze open-ended responses based on the five-dimensional structure. The following demonstrates the AI's five-dimensional feedback framework using the challenge-level item from the Constructing Sound Arguments dimension—construct a brief argument using information from the text to refute the view that "traveling to Peru is too expensive"—as an example.

Student response:

Traveling to Peru is not necessarily very expensive. The text says Peru has accommodation and transportation options at various price points. Moreover, many natural attractions are free, such as beaches and hiking trails. So I think traveling to Peru is not expensive.

AI feedback across the five dimensions:

- Concept Clarification: The response does not define what "too expensive" specifically means—does it refer to expensive flights, expensive accommodation, or high overall budget? It is suggested to first clarify the scope of discussion.
- Accurate Judgment: The response mentions "accommodation and transportation options at various price points" and "many natural attractions are free," but does not cite specific textual information as evidence. It is suggested to locate the original textual statements that mention specific prices or free attractions.
- Rigorous Reasoning: The reasoning jumps directly from "having various price options" to "not expensive"—the existence of low-cost options does not equate to low overall cost. It is suggested to supplement: precisely because low-cost options exist, tourists can flexibly arrange according to their budgets, thereby controlling total expenditure.
- Constructing Sound Arguments: Two reasons are proposed, but clear logical connectives are lacking. Consider adding relational expressions such as "although international flights may not be cheap, …"
- Identifying Fallacies: Equating "having free attractions" with "traveling to Peru is not expensive" oversimplifies—free attractions are merely one component of travel expenses and cannot represent all expenditures.

This feedback model transforms general evaluation into detailed diagnosis across logical dimensions, helping students identify exactly where their deficiencies lie. It should be noted that AI feedback must undergo teacher review—in this case, the teacher removed one inaccurate judgment from the AI-generated five feedback items, as the AI believed the student had not cited textual information whereas the student had actually implied textual content, thereby ensuring feedback quality.

6. Conclusion

This study set out to investigate the current state of logical thinking cultivation in senior high school English reading homework and to explore how generative AI can be leveraged to address its deficiencies. The findings from the teacher questionnaire and the textual analysis of 100 homework samples reveal a significant gap between intention and practice. While teachers recognize the importance of logical thinking, the homework they assign predominantly focuses on foundational levels—clarifying concepts and making accurate judgments—while neglecting higher-order abilities such as rigorous reasoning, constructing sound arguments, and identifying fallacies.

To bridge this gap, this study proposed a theoretical framework integrating Du Guoping's five-dimensional structure with deep learning principles, and subsequently demonstrated four practical AI-empowered design pathways: intelligent item generation, reasoning visualization via chain-of-thought, tiered task adaptation, and precision feedback aligned with logical dimensions. The case study on "Travel Peru" illustrated how AI, acting as a co-pilot, can assist teachers in designing diverse, cognitively demanding tasks and providing targeted, process-oriented feedback, thereby moving reading homework beyond mere language practice to become a vehicle for genuine intellectual growth.

This study has several limitations. The sample is limited to five high schools in a single city, and future research should expand to a larger, more diverse sample of schools and students. Future studies should also empirically test the effectiveness of the proposed AI-empowered homework pathways in improving students' logical thinking over time, possibly through a controlled experimental design. In addition, investigating teachers' professional development needs in effectively collaborating with AI for this purpose would be a valuable area of inquiry.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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