



## Research Article

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# No College Students Left Behind: Writing Module Incorporating Critical Thinking Skills for the National Postgraduate Entrance Examination in China

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## Abstract

*In recent years, Chinese universities and scholars have recognised the significance of critical thinking. Despite this growing awareness, integrating critical thinking skills into the curriculum remains a challenge in China. To gain entry to postgraduate programmes, students majoring in management in the country are required to take a National Postgraduate Entrance Examination (NPEE) that emphasises logical knowledge related to critical thinking and writing. Hence, this study aims to develop a writing module that incorporates critical thinking skills for college students in China. To achieve this, a mixed methods approach was employed. Firstly, a prototype writing module was created using the Analyse, Design, Develop, Implement and Evaluate (ADDIE) Model and verified by content experts for content validity. Subsequently, the module was implemented in a traditional classroom setting. For the pilot study, a pilot sample of 50 students was randomly chosen from a training centre in China that assists college students to prepare for the examination. For the next stage, 100 students were selected as the study sample. After implementing the writing module, both quantitative and qualitative analysis were conducted. The results indicated a significant improvement in participants' scores in the pre-test and post-test, demonstrating the effectiveness of the writing module in fostering critical thinking skills. The writing module developed by the researchers will have a profound effect on Chinese teachers' teaching in the future. It will provide them with clear instructional materials to cultivate Chinese students' critical thinking abilities, ensuring that no college students will be left behind.*

**Keywords:** ADDIE Model, critical thinking skills; instructional materials; logical knowledge; writing module

## 1. Introduction

Critical thinking (CT), defined as an ability to objectively analyse and evaluate information (Ennis, 2018), holds profound significance for individuals' professional and academic trajectory in the contemporary landscape. Many scholars argue that critical thinking can benefit college students.

They believe that college students who have undergone critical thinking training perform better than those who have not (Hasruddin & Rezeqi, 2015). Critical thinking has been shown to enhance the academic performances of students from various majors, such as business (Guo et al., 2020) and engineering (Tapper & Poth, 2017). Furthermore, some scholars suggest that college students with stronger critical thinking abilities tend to have brighter career prospects after graduation (Halpern, 2014; Paul & Elder, 2006).

The relevance of writing in critical thinking has been demonstrated by many scholars. Critical thinking is often considered the foundation for effective writing (Fisher, 2011), and writing is seen as an expression of critical thinking (Paul & Elder, 2006). Tapper and Poth (2017) argue that writing promotes critical thinking by necessitating individuals to formulate clear arguments, provide evidence, and identify logical fallacies. Several universities, including Harvard University, Northwestern Polytechnical University, and some universities in Singapore, have incorporated the development of critical thinking skills into certain writing courses (Johnson & Smith, 2021; Smith & Chen, 2019; Tan et al., 2020).

In China, the importance of logical knowledge related to critical thinking in academic life has been steadily increasing. This is particularly evident in the National Postgraduate Entrance Examination (NPEE) for management majors, which now comprises two sections. One section consists of 30 logic questions, while the other section involves a written task known as "Argumentation Validity Analysis," designed to evaluate candidates' logical reasoning abilities and critical thinking skills (Ministry of Education of China, 2022). For students pursuing degrees in management-related disciplines, passing this examination is a prerequisite for obtaining their master's degrees and subsequently pursuing further academic endeavors.

However, Chinese students seemed to lack the capacity for critical thought and have an inclination to mindlessly follow their teachers' instructions (Li, 2016; Luo, 2001; Zhu, 2009). Chen (2017) has identified factors such as rote learning, teacher-centered instruction, and cultural differences in learning styles that contribute to the lack of critical thinking courses in Chinese universities. Some other scholars argue that critical thinking is frequently seen as not keeping in line with traditional Chinese cultural values (Kim, 2018), which emphasize guiding individuals in their personal, social, and political behavior. This is in contrast to the Western definition of critical thinking, which emphasizes students' ability to make informed decisions (Ennis, 1997).

Although several Chinese universities have taken steps to integrate critical thinking and writing courses into their curriculum, acknowledging the importance of nurturing these skills (Wang & Li, 2020), the majority of Chinese educational institutions still lack comprehensive programmes in these areas (Wang & Li, 2020). Furthermore, Sun (2004) highlighted that constraints related to course objectives, class hours, teaching philosophies of instructors, and other factors pose challenges to effectively merge writing instruction and critical thinking in the Chinese context. Writing has always been one of the most complex language skills (Boumediene et al. 2017). Hence, the development of a writing module that incorporates critical thinking holds significant importance for Chinese students.

In addition, one of the researchers has vast experiences in developing and cultivating critical thinking and writing skills in Chinese college students for over a decade. He has helped thousands of students successfully enter graduate programmes, and he possesses a deep understanding of the shortcomings of Chinese students in critical thinking and writing, along with extensive teaching experience. Consequently, the researchers believe that by developing a Writing Module Incorporating Critical Thinking Skills, it would help to resolve the problems faced by Chinese college students. They based the module on the ADDIE Model (Watson, 1981), a widely utilised instructional design development method consisting of five steps: Analyze, Design, Develop, Implement, and Evaluate. The objective of this module was to assist Chinese college students not only in passing the crucial entrance examination but also in enhancing their critical thinking and writing skills.

## 2. Literature Review

To optimise the efficacy of the developed writing module, the researchers conducted a thorough review encompassing previous related studies and theories centered on integrating critical thinking skills within the writing modules. We strategically integrated a selection of these theories into the developmental process of the module. This section aims to introduce previous studies and the relevant theories pivotal to the writing module's development.

### 2.1 Previous Related Studies on Writing Modules Integrating Critical Thinking Skills

The integration of critical thinking into writing modules has become a significant focus for researchers globally. Some scholars have aimed to create various writing modules to improve students' critical thinking skills. For instance, Niati et al. (2023) developed an essay writing module designed to stimulate students' critical thinking. They applied their module in online teaching materials and conducted both pre-test and post-test, revealing a substantial improvement in students' critical thinking abilities. Abdelmohsen (2020) developed a module for college students in Oman, intending to enhance collaboration, critical thinking, and writing skills. Abdelmohsen's (2020) research demonstrated significant score improvements among participants after conducting the writing lesson using the developed module, affirming its reliability and effectiveness. Similarly, Lestari et al. (2018) addressed higher-order thinking assessment challenges by introducing a project-based writing assessment module, resulting in noticeable improvements in students' writing, critical thinking, and creativity skills.

Nejmaoui's (2019) research also focused into Argumentative Writing, aligning with similar expectations in the National Postgraduate Entrance Examination (NPPE) in China. In Nejmaoui's study, participants were evenly divided into experimental and control groups, both received instruction in Argumentative Writing, and underwent pre-test and post-test assessments. The results indicated an improvement in participants' critical thinking abilities through their engagement with Argumentative Writing.

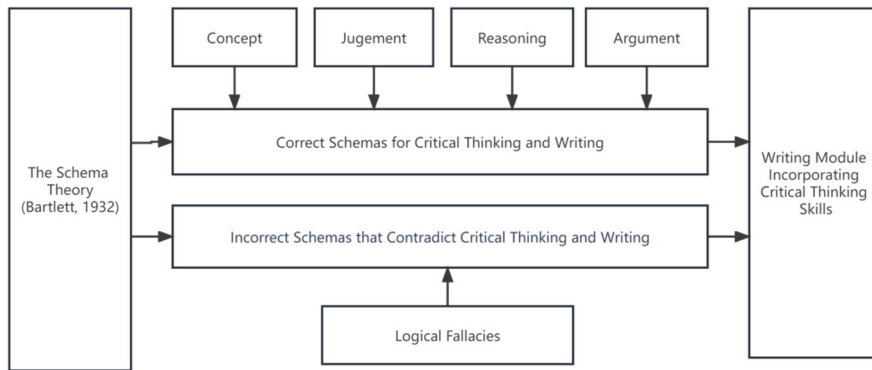
There were also several other studies that explored the pedagogical approaches, including integrating reading and writing (Turuk Kuek, 2010), teaching critical thinking in English as a Foreign Language (EFL) contexts (Mehta & Al-Mahrooqi, 2015), and using non-traditional writing tasks (Sinaga & Feranie, 2017). All these studies illustrated improvements in students' critical thinking and writing abilities. Additionally, Schmidt (1999) emphasized the mutual relationship between writing and critical thinking, highlighting how teaching writing contributes to the development of critical thinking skills.

Generally, these studies emphasise the effectiveness of integrating critical thinking into writing modules, showcasing enhancements in students' critical thinking abilities, writing proficiency, logical reasoning, and overall academic performance in various educational settings.

### 2.2 The Schema theory (Bartlett, 1932; Bransford & Johnson, 1972)

Schema theory is a psychological theory that was first proposed by Frederic Bartlett in the 1930s (Bartlett, 1932). The theory explains how our brains organise information into mental frameworks or schemas that help us make sense of the world around us. Bransford and Johnson (1972) conducted a study on the impact of prior knowledge on comprehension and problem-solving and they found that individuals with relevant prior knowledge were more likely to comprehend and solve problems related to the domain than those without prior knowledge. The study highlights the importance of activating relevant schemas and integrating new information into existing knowledge structures.

As is shown in Figure 1, the researcher attempted to teach students the correct schemas for critical thinking and writing, such as proper judgment, reasoning, and argumentation, and to teach students to resist incorrect schemas that conflict with critical thinking and writing, such as overly emotional thinking and common logical fallacies.



**Figure 1 :** Application of Schema Theory in the Writing Module

2.3 *The Gestalt theory (Wertheimer, 1938; Koffka, 2013)*

The Gestalt theory emphasises the importance of perception and its impact on human behaviour. Wertheimer (1938) asserts that humans have an innate tendency to perceive objects as holistic entities rather than separate components. This concept, known as the law of simplicity, suggests that the human mind naturally organizes visual stimuli into the simplest form possible. In this study, the researchers' use of Gestalt theory was demonstrated in three aspects. First, the principle of similarity and proximity in Gestalt theory was applied to construct a knowledge system for modules. Second, the researchers hope that students can learn the logical knowledge related to critical thinking as a whole, rather than looking at it in isolation. The principle of Continuity in Gestalt theory was used to guide students in understanding that the four parts of knowledge required by the outline, namely, concept, judgment, reasoning, and argumentation, are not isolated but organically combined. Third, the principle of Continuity in Gestalt theory was used to guide students to understand that critical thinking and critical writing are combined as a whole, rather than isolated as two separate parts.

2.4 *Piaget's Theory of Constructivism (Piaget,1977; Paul & Elder, 2006)*

Jean Piaget's theory of constructivism is a well-known framework in educational psychology that emphasises the importance of active learning and cognitive development.

Many scholars have suggested that utilising constructivism in teaching can help students better develop their critical thinking skills (Paul & Elder, 2006). Therefore, in this study, the researchers aimed to use the basic principles of constructivism to design the writing module and organise teaching activities. These principles included four aspects, as shown in Table 1.

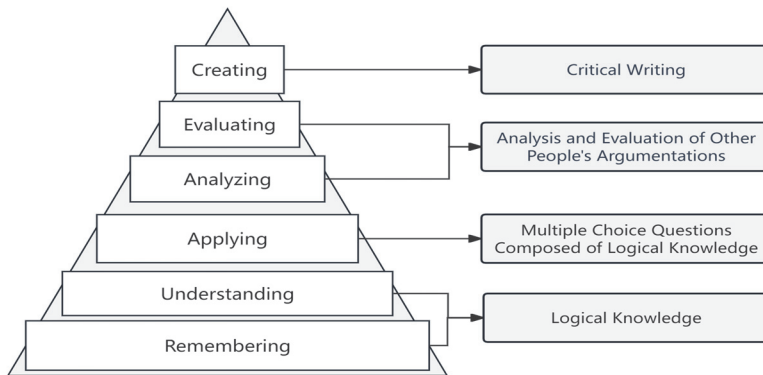
**Table 1:** Module design using principles of constructivism

Principles	Module Design
Learner-centered	The design of the writing module places the learner at the center, with a focus on actively constructing their own understanding of critical thinking and writing.
Active learning	The writing module encourages learners to actively engage in problem-based learning, inquiry-based learning, and collaboration.
Authentic assessment	The assessment tasks in the writing module are designed to be authentic, relevant to real-world situations, and to evaluate learners' ability to apply critical thinking skills in practical contexts.
Reflection	Reflection is an essential element of the writing module, where learners are motivated to reflect on their own learning and critical thinking processes.

### 2.5 Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001)

The revised Bloom's Taxonomy by Anderson and Krathwohl in 2001 is a framework commonly referred to as "21st Century Bloom's Taxonomy" and is applied in the design of the writing module, as illustrated in Figure 2.

- 1) Remembering and Understanding  
In the writing module, students should first remember and understand the logical knowledge related to critical thinking ability. They learn the logical knowledge of concept, judgment, reasoning and argumentation in detail.
- 2) Applying  
In the study, students' ability to apply critical thinking is reflected in the multiple choice questions which are composed of logical knowledge.
- 3) Analysing and Evaluating  
In the writing module, students' ability to analyse and evaluate is reflected in whether they can find logical fallacies in others' arguments and make correct analysis and evaluation.
- 4) Creating  
Creating means students should form their own ideas by using critical thinking skills. In the writing module, students read a given article as required by the entrance examination. After reading the article, they need to identify the possible logical fallacies in its argumentation. Next, students need to do 'Argument Validity Analysis'.

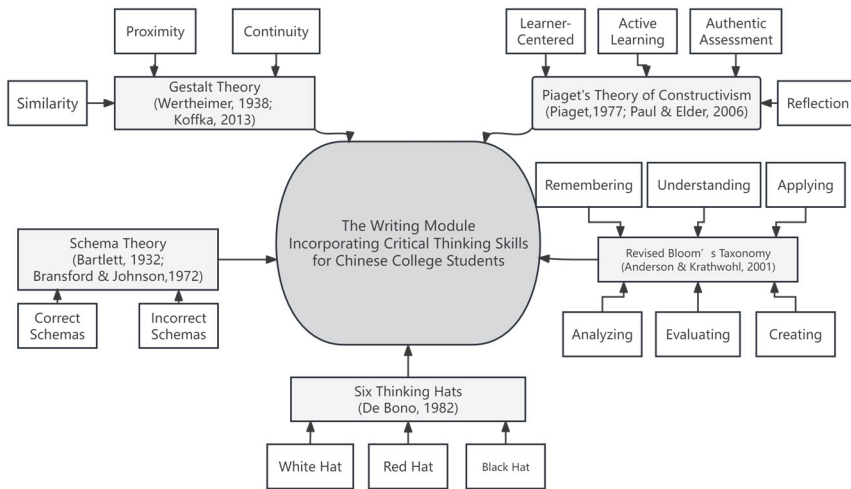


**Figure 2:** Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001) Applied in the Writing Module

### 2.6 The Six Thinking Hats (De Bono, 1982)

The "Six Thinking Hats" is a creative problem-solving technique developed by Edward de Bono in 1982 (De Bono, 1982). The theory proposes that people think in different ways and that each way can be symbolised by a coloured hat. Each hat represents a different way of thinking and approaching a problem, allowing individuals to explore multiple perspectives and ideas. Several studies have investigated the relationship between critical thinking and the "Six Thinking Hats". According to Setyaningtyas and Radia (2019), incorporating the "Six Thinking Hats" as a tool has significant potential in assisting students to develop their critical thinking skills.

In this study, the researchers utilised the 'White hat,' which entails concentrating on objective information, and the 'Black hat,' which involves examining the negative aspects of an idea and employing criticism to identify potential weaknesses. They aimed to reduce 'Red Hat' thinking among students, characterised by the use of intuition, emotions, and feelings to explore a problem.



**Figure 3:** Theoretical Framework of the Study

In summary, the researchers utilised a multitude of theories and technique to guide the development of the writing module, as illustrated in Figure 3.

### 3. Methodology

#### 3.1 Participants

During the implementation phase of this study, two groups of samples participated in the experiment. In the first stage, a pilot sample of 50 students was randomly selected from a Chinese training center that helps college students prepare for the postgraduate entrance examinations. In the second stage, 100 students were chosen as the study sample.

#### 3.2 Research Design

This study employed the mixed-method approach, which is a valuable research methodology combining both qualitative and quantitative data collection and analysis techniques (Johnson & Onwuegbuzie, 2004). In this approach, qualitative and quantitative findings are integrated to offer a more comprehensive and robust perspective on the research topic (Creswell & Plano Clark, 2018). Researchers can leverage the strengths of both methods, thereby enhancing the validity and reliability of their results and addressing a wider range of research objectives. The mixed-method approach is increasingly acknowledged as a versatile and powerful tool in various fields of study.

#### 3.3 Research Instruments : Pre-test and Post-test

The researchers aimed to develop the writing module to enhance the critical thinking and critical writing skills of Chinese college students and to assist them in passing the National Postgraduate Entrance Examination (NPEE). Questions from the 2020 and 2021 past year examinations were used for the pretest and post-test questions. Both the pretest and post-test consisted of 30 logic multiple-choice questions, with a time limit of 60 minutes, as well as one essay (Argumentation Validity Analysis) with a time limit of 30 minutes.

#### 4. Module Development Process

In order to develop the writing module, the researchers chose the ADDIE model for the construction, which consists of five different phases, namely Analysis, Design, Develop, Implement and Evaluation as illustrated in Figure 4.

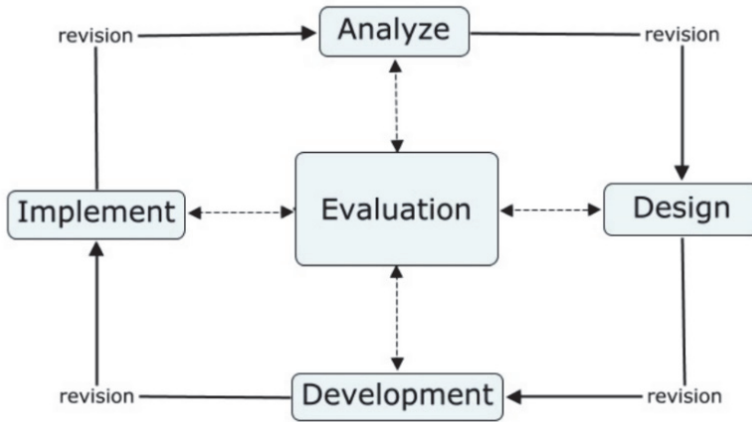


Figure 4: ADDIE Model (Watson, 1981)

##### 4.1 Analysis

This study aims to align with the requirements of the National Postgraduate Entrance Examination (NPEE), providing undergraduate students with the opportunity to obtain a master's degree and continue their academic careers. In the analysis phase, the researchers primarily focused on analyzing the examination syllabus to understand the expectations for candidates.

According to the "Syllabus of National Master's Entrance Examination of Management Professional Degree" (Ministry of Education of China, 2022), specific requirements have been outlined in the examination syllabus for postgraduate entrance examinations in China. These exam requirements can be summarized as follow:

- 1) *The logical reasoning section of the comprehensive abilities exam primarily evaluates candidates' skills in understanding, analysing, and synthesising various types of information. It also assesses their logical thinking abilities in judgment, reasoning, and argumentation.*
- 2) *The writing section of the comprehensive abilities exam chiefly measures candidates' capacities to analyse, reason, and express their ideas in writing.*

##### 4.2 Design

According to the ADDIE model, the Design phase encompasses several key tasks, which include identifying learning objectives, creating course frameworks, formulating teaching strategies, selecting appropriate instructional materials, and designing assessment and feedback methods (Molenda, 2003).

In the Design phase of this study, as depicted in Table 2, the researchers undertook the following tasks: defined the objectives of the writing module, designed the Framework of the writing module, designed classroom activities, designed the Evaluation System.



**Table 2:** Tasks and Outcomes of the Design Phase

Tasks	Outcomes
<b>Defined the Objectives</b>	Objectives : 1) To enable students to understand the requirements of the entrance examination syllabus for their abilities, and to understand the requirements of the syllabus for the content of the examination. 2) To help students master Logical Knowledge related to critical thinking, including concepts, judgment, reasoning, and argumentation. 3) To teach students how to identify logical fallacies and analyze the common ways of logical fallacies. 4) To equip students with the skills of critical writing, especially the writing skills of the "analysis of argumentation effectiveness" short essay required by the examination syllabus.
<b>Designed the Framework</b>	Framework : Unit 1 Interpretation of the syllabus Unit 2 Logical Knowledge Related to Critical Thinking Unit 3 Identification and analysis of logical fallacies Unit 4 Critical Writing: Argumentation Validity Analysis
<b>Designed Classroom Activities</b>	Types of classroom activities : 1) Problem-based learning 2) Formative & Summative Assessments: exercises

### 4.3 Development

The Development phase's primary focus was on completing the development of the module, conducting pilot testing, and making essential modifications. This section presents the process of developing the writing module and its exercises.

#### a. Development of the Writing Module and Its Exercises

The researchers developed a writing module consisting of four units aligned with the framework. Unit 1 primarily addresses syllabus interpretation and does not require additional exercises. Therefore, exercises were created for Unit 2 to Unit 4, which cover various aspects of logical knowledge, including critical thinking, identification and analysis of logical fallacies, and critical writing, particularly in the context of argumentation and validity analysis.

As recommended by Almanasreh et al. (2019), a content validity assessment was conducted following the module's development. The researchers followed their suggestion by assembling an expert panel to evaluate content validity. In this study, once the prototype writing module was created, every section and its exercises were assessed by all the three content experts using a scale ranging from 1 to 5. To establish inter-rater reliability, the researchers utilised SPSS to calculate Cronbach's Alpha (Cronbach, 1951) for the ratings provided by the three inter raters. The computed Cronbach's Alpha value was determined to be 0.839, exceeding the 0.7 threshold. These findings robustly confirm the high reliability and dependability of the experts' content evaluations.

According to the three content experts, the majority of the content received average scores of 4.0 or higher, signifying strong validity. The researchers made adjustments to the relevant content of the writing module based on content experts' recommendations. The modified content of the module is presented in Figure 5.



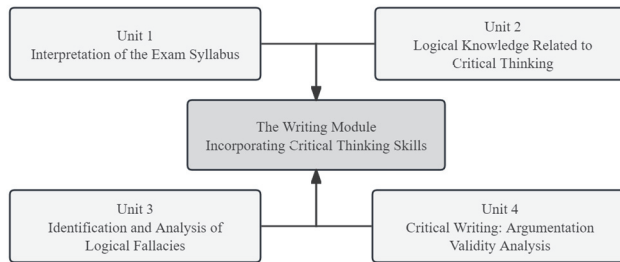


Figure 5: Content of the Writing Module

b. **Piloting the Writing Module**

The researchers selected 50 Chinese college students as the pilot sample to conduct a pilot test of the writing module prototype. Based on the feedback from these 50 participants, the researchers made secondary revisions to the items of the Multiple Choice Questions in the related exercises which are either too difficult or too easy.

Table 3: Difficulty Level of the Exercises for Unit 2

Difficulty Index	Difficulty Level	No. of Items	Percentage
0.3 and below	High	3	10.00%
0.30 ~ 0.7	Moderate	16	53.33%
0.7 and above	Low	11	36.67%

Specifically, the exercises for Unit 2 consisted of 30 multiple-choice questions related to logical knowledge associated with critical thinking. According to Wang & Gao (2018), assessing the difficulty level of an exam is important as it provides valuable insights into the quality of the exam and the performance of test-takers. Items with a difficulty index of less than 0.3 are considered difficult, those with a difficulty index between 0.3 and 0.7 are considered moderately difficult, and those with a difficulty index greater than 0.7 are considered easy (Wang & Gao 2018). Applying this criterion, it can be observed from Table 3 that, apart from three challenging questions (10.00%), the remaining questions in Unit 2 exhibit moderate difficulty (53.33%) or relatively low difficulty (36.67%).

According to Fredricks et al. (2004), the Discrimination Index is a statistical measure used to assess a test's ability to differentiate between high- and low-performing students based on their test scores. According to Barkley et al.'s (2014) approach, examinees were categorised into upper and lower groups based on their scores, with the top 27% in the upper group and the bottom 27% in the lower group. The Discrimination Index can range from -1.00 to +1.00. Items with a Discrimination Index less than 0.20 are considered poor, those between 0.20 and 0.35 are considered good, and those above 0.35 are considered excellent (Mertler, 2016). The researchers analysed the Discrimination Index of the multiple-choice questions in Unit 2, as presented in Table 4. Among the 30 items, 11 demonstrated good discrimination (36.67%), 17 showed excellent discrimination (56.67%), and 2 had poor discrimination (6.67%).

Table 4: Discrimination level of the Exercises for Unit 2

Discrimination Index	Discrimination Level	No. of Items	Percentage
less than 0.20	poor	2	6.67%
0.20 ~0.35	good	11	36.67%
greater than 0.35	excellent	17	56.67%

Based on the Difficulty Index and Discrimination Index data, the researchers made adjustments to the exercises. While Q6 and Q7 were very easy (>0.80), their discrimination indices were good (0.46

& 0.31), so they were retained. However, Q25 and Q27 were extremely difficult (<0.2) with poor Discrimination Indices, leading the researchers to replace these two items.

In order to evaluate the scoring of essay exercises in Unit 3 and Unit 4, three raters assessed them in accordance with the grading standards outlined by the Ministry of Education of China (2022) for the National Postgraduate Entrance Examination (NPEE). To measure the reliability of the three raters' essay scoring, the researchers opted for the Intraclass Correlation Coefficient (ICC), as recommended by Shrout and Fleiss (1979), rather than Cronbach's Alpha.

According to the findings of Koo and Li (2016), ICC values below 0.50 suggest poor reliability, values between 0.50 and 0.75 indicate moderate reliability, and values exceeding 0.75 demonstrate excellent reliability. For Unit 3 and Unit 4, the ICC values obtained from the three raters were 0.938 and 0.953, respectively, showcasing excellent reliability. This also implies that the same scoring method can be used for both the pre-test and post-test.

#### 4.4 Implementation

In this study, the writing module was utilised to instruct students on the integration of critical thinking skills into their writing over a total of 32 classes. The instructional timeline was structured as shown in Table 5.

**Table 5:** Timetable of the Implementation

Unit	Topic	Week	Class (45mins per class)
1	Interpretation of the syllabus	1	2 classes
2	Identification and Analysis of Logical Fallacies Related to Critical Writing	2~4	16 classes
3	Identification and analysis of logical fallacies	5~6	6 classes
4	Critical Writing: Argumentation Validity Analysis	7~8	8 classes

#### 4.5 Evaluation

As part of the diagnostic evaluation, the researchers administered a pre-test to assess students' critical thinking abilities and critical writing levels before the course commenced. This pre-test served a dual purpose: it provided a foundation for teachers' subsequent instruction and established baseline data for comparison with post-test results. To evaluate students' performance in the pre-test, the researchers applied the evaluation criteria outlined in the National Postgraduate Entrance Examination (NPEE) (Ministry of Education of China, 2022).

According to these criteria, each correct response in the logic multiple-choice questions was awarded 2 points, allowing for a maximum score of 60 points.

As for critical writing, specifically Argumentation Validity Analysis, the scoring criteria were divided into two segments. In the first part, candidates were required to identify four logical fallacies within a provided argument, with each correctly identified fallacy earning 4 points, resulting in a maximum score of 16 points.

In the second part, raters evaluated the quality of arguments or rebuttals, the structural soundness, organisation clarity, and language conciseness and fluency to determine the remaining score (out of 14 points). Essays demonstrating strong arguments or rebuttals, a rigorous structure, clear organisation as well as concise and fluent language are classified as Class I, receiving scores ranging from 12 to 14 points. Class II essays are awarded scores between 8 and 11 points, Class III essays are awarded scores from 4 to 7 points, and Class IV essays are awarded scores between 0 and 3 points. The total score for each student is the sum of these two dimensions.

At the end of the courses, the researchers conducted post-test examination for the students. The post-test has the same format and scoring criteria as the pre-test. The students' scores in the

post-test were recorded by the researchers for comparison and analysis with the pre-test. The performance of the students in the pre-test and post-test were as follow:

a. **Analysis of Total Scores in Pre-test and Post-test**

As shown in Figure 6, this study included a total of 100 samples for research, with survey indicators including multiple choice questions scores (Part1: Logical Reasoning), writing scores (Part2: Argumentative Validity Analysis), and total scores. Specific analysis reveals that the mean percentage of Part I in the pre-test was 46.97% out of 60 points, while the mean percentage of Part I in the post-test was 66.93%. The difference in mean scores (post-pre) was 19.97%. Additionally, the mean percentage of Part II in the pre-test was 44.80% out of 30 points, while the mean percentage of Part II in the post-test was 68.90%. The difference (post-pre) was 24.10%. Overall, the pre-test percentage totalled to 46.24% out of 90 points, the post-test percentage totalled to 67.59%, and the difference was 21.34%. The difference between the pretest and post-test scores indicates that the participants' mean scores in logical reasoning and the effectiveness of argument analysis significantly improved through the writing module's instruction. This implies a significant enhancement in participants' critical thinking and writing abilities.

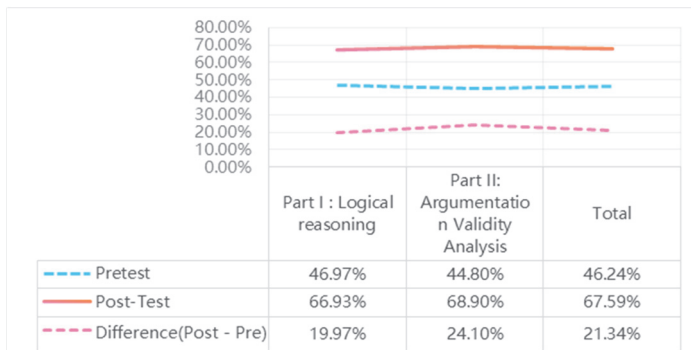


Figure 6: Comparison of Total Scores in Pretest and Post-test

b. **Analysis of Logical Question Scores in Pre-test and Post-test**

As mentioned earlier, in the National Postgraduate Entrance Examination (NPEE), Logical Knowledge related to critical thinking is categorized into four types: concepts, judgments, reasoning, and argumentation (Ministry of Education of China, 2022). Therefore, conducting a categorical analysis of participants' scores in the pre-test and post-test can provide a better understanding of whether students' abilities have improved effectively during the implementation of the writing module.

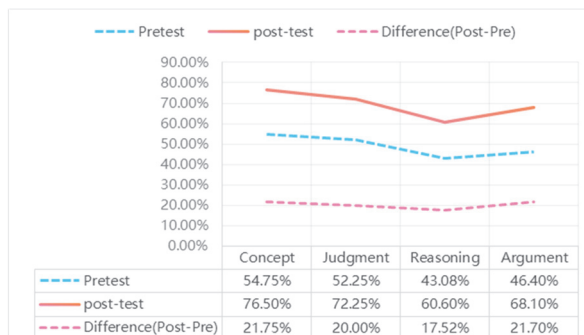
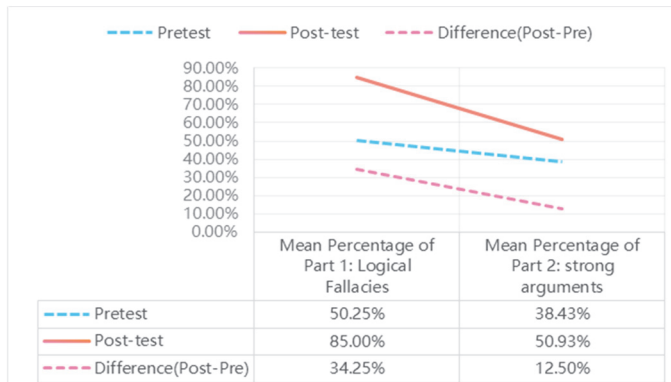


Figure 7: Comparison of Logical Question Scores in Pre-test and Post-test

Figure 7 provides a visual representation of the differences between the pre-test and post-test. As shown in Figure 7, the performance of the students on concept-related items increased from 54.75% in the pre-test to 76.50% in the post-test, showing an improvement of 21.75% while the performance for Judgment-related items increased from 52.25% in the pre-test to 72.25% in the post-test, showing an improvement of 20.00%. Participants demonstrated improvement in both of the categories. In this study, knowledge related to concepts and judgments primarily requires "Remembering" and "Understanding," with less emphasis on "Applying," which is in accord with Krathwohl (2002), who categorises them under the "Remembering" domain in the Revised Bloom's Taxonomy and is considered as foundational while the "Understanding" and "Applying" domains involve higher-level requirements, emphasising comprehension and the ability to use knowledge in familiar situations. The results from the post-test revealed that the participants achieved a mean percentage exceeding 72% while the performance for the Judgment-related items recorded a percentage of only 60.60% and 68% which is consistent with the explanations provided in the Revised Bloom's Taxonomy.

**c. Analysis of Writing Scores in Pre-test and Post-test**

As mentioned earlier, the evaluation of the writing section, as per the Evaluation Criteria established by the Ministry of Education of China (2022), comprises two components. Three inter raters conducted detailed evaluations of the participants' writing, and the mean percentage for these two components are depicted in Figure 8. As shown in Figure 8, participants correctly identified an average of 50.25% for logical fallacies (out of 4 fallacies) and received corresponding scores in the pre-test. In the post-test, participants identified an average of 85.00% for logical fallacies. Therefore, compared to the pre-test, participants were able to identify an average of 34.25% more for logical fallacies. In comparison to the pre-test, the scores of the participants in the post-test exhibited significant improvement. This indicates a notable enhancement in students' ability to recognise and analyse issues in argumentation within critical writing.



**Figure 8:** Comparison of Writing Scores in Pre-test and Post-test

In the second part of grading, which assesses the degree of argumentation, article structure, language expression, and other aspects, the average percentage of the participants in the pre-test was 38.43% out of 14 points, while in the post-test, the average percentage was 50.93%. The difference was 12.50%. Compared to the pre-test, the percentage of the participants in the post-test showed a good improvement. These data indicate improvement among the participants in the assessed aspects, although the magnitude of improvement is not as high as in the case of identifying logical fallacies. In the critical writing under "Argumentation Validity Analysis," students are initially tasked with analysing and evaluating the arguments of others to identify logical fallacies, which aligns with Part 1

of the scoring criteria mentioned above. According to the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001), "Analysing" and "Evaluating" fall under the Higher Domains (Krathwohl, 2002). As evident in this study, participants achieved an average percentage of 85.00% in this aspect during the post-test. This indicates that instructing the participants making use of the module for both the correct and incorrect schemas of logical knowledge is congruent with the Schema theory (Bartlett, 1932; Bransford & Johnson, 1972) and, exhibiting a remarkably significant effect on the identification of logical fallacies.

However, the participants did not attain a high level of proficiency in the writing tasks, specifically in areas such as argument sufficiency and the fluency of text expression, which correspond to Part 2 of the scoring criteria mentioned above. This section demands that participants creatively articulate their viewpoints, and their challenges in this regard also demonstrate the difficulty they encountered in achieving the highest level of "creating," as outlined in the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2001).

### 5. Thematic Analysis of the Participants' Feedback in the Interviews

After completing the post-test, the researchers randomly selected 2 participants from each of the high-scoring, mid-scoring, and low-scoring groups for interviews. The interviews were coded as shown in Table 6.

**Table 6:** List of Codes for the Interviews

Types of data	Individuals	Time/Date
Formal interview - FOI IQ1~10 - interview questions Unit1~4 - the four Unit of the module	R - Researcher of this study HSP1~2 - High-score participants(more than 70 points) MSP1~2 - Medium-score participants(50~70points) LSP1~2 - Low-score participants(less than 50 points)	Eg. 15/4/2023

The researcher conducted a thematic analysis of the interview content of the participants. Thematic analysis is a qualitative research method used to identify, analyse, and report patterns (themes) within the data (Braun & Clarke, 2006). In this study, the thematic analysis encompassed the benefits and challenges encountered by the participants while using the module.

#### a. Benefits Gained Using the Writing Module

This section presents the interviewees' feedback after using the Writing Module to develop critical thinking skills in writing. The interviewees expressed how they incorporated critical thinking into their writing. The interviewees indicated that they can remember and understand logical knowledge as the correct schema for critical thinking and writing, and they also recognise logical fallacies as the incorrect schema. This enables them to utilise the analytical skills related to logical fallacies acquired from the module in their critical writing, specifically in Argumentation Validity Analysis. Furthermore, one participant expressed that through learning from this module, she became more focused on analysing facts and questioning arguments besides reducing emotional judgments and becoming more rational. This aligns with the aim of this research, that is, to decrease the "red hat" thinking and increase "white hat" and "black hat" thinking, based on The Six Thinking Hats framework (De Bono, 1982).

*"Sure, I can remember and understand the logical knowledge. Let's talk about concept and argumentation. Concept refer to the fundamental attributes of things, while argumentation involves using established, true facts to demonstrate the correctness of a viewpoint." (FOI-HSP2-17/7/2023)*

*"I identify the logical fallacies in the other person's argument and then refute them." (FOI-LSP2-17/7/2023)*

*"I think I can apply critical thinking skills in writing. For example, when I question an argument, I use critical thinking. If someone makes an absolute statement, I analyze whether it's too absolute. If there's a survey, I analyze the reliability of the sample, and so on."*(FOI-MSP1-17/7/2023)

*"It had a significant impact. Initially, I lacked direction and structure in my writing. However, after taking our classes, I gained a clear sense of direction. I learned how to structure my essays and enrich their content. Previously, I focused on emotions in my writing, but now I place a greater emphasis on rationality."* (FOI-MSP2-14/7/2023)

All the six interviewees unanimously stated that the module enhanced their exam scores, thereby contributing to their performance in the exam.

*"One benefit is the development of critical thinking skills. Another benefit is that my scores have improved compared to before."* (FOI-MSP1-17/7/2023)

*"I think, first and foremost, it significantly improved my logic and writing skills. Second, it helped me understand how various logical fallacies are presented. Third, it deepened my understanding of critical thinking. Of course, it also improved my scores in exams."* (FOI-MSP1-17/7/2023)

*"It has had some improvement, but I feel that my study habits are not up to par, so the score improvement didn't meet my expectations"*(FOI-LSP1-15/7/2023)

#### **b. Challenges Faced Using the Writing Module**

Two interviewees from the high-scoring group indicated that they did not encounter significant challenges, as the writing techniques from the module made the process easier.

*"Not many challenges, really. Because when it comes to writing argumentative essays based on logical analysis, once you understand the method and know how to write, it becomes relatively easy."*(FOI-HSP1-17/7/2023)

Conversely, interviewees from the mid-scoring and low-scoring groups reported facing various challenges such as lack of background knowledge, limited experience in critical writing, the influence of prior mindsets, differences in learning approaches, and inadequate study habits.

*"Because sometimes my background knowledge base is not sufficient. Like I mentioned earlier with equivocation, the first scenario is that I may not notice it, and the second scenario is that even if I notice it, my knowledge may not be extensive enough to clearly explain the differences between the two concepts."*(FOI-HSP1-15/7/2023)

*"There are challenges. Firstly, I didn't write much before, and I had never encountered critical writing before, so it was a new concept for me. Secondly, critical thinking is different from the habitual thinking patterns I had developed in daily life, so it required a shift in my traditional thinking. Thirdly, the learning approach was different from what I was used to. Previously, we mainly received knowledge through lectures, and critical reflection was less emphasized. Lastly, if the writing involves subjects like management or economics, I find it challenging due to my background knowledge."*(FOI-MSP2-14/7/2023)

*"For me, my current learning state is not optimal. I had poor study habits before, and I tend to be lazy. Additionally, I have some fixed incorrect ways of thinking from the past, and it's challenging to change them to the correct way of thinking."*(FOI-LSP1-15/7/2023)

## **6. Findings and Discussion**

Based on both the pre-test and post-test results, as well as students' feedback in interviews, it is

evident that the developed module has enhanced students' critical thinking and writing skills, potentially preparing them for success in China's graduate entrance exams. The module, specifically Unit 2, concentrates on imparting logical knowledge while Unit 3 is dedicated to fostering critical thinking, and Unit 4 instructs participants in the art of critical writing. A comparison of the pre-test and post-test scores indicates a significant improvement in participants' logical reasoning that is associated with logical knowledge, with an average increase of 19.97%. Similarly, the participants' scores in critical writing improved by an average of 24.10% which is directly linked to the development of critical thinking. This suggests that, in this study, enhancing critical thinking through the teaching of logical knowledge is a valid strategy. This to a certain extent challenges McPeck's (2016) perspective, which posits that critical thinking is best cultivated through domain-specific content and problem-solving activities, rather than solely focusing on logic.

However, from the interviews conducted, several participants expressed that a lack of background knowledge in relevant fields presented challenges to their critical thinking and writing abilities. This indicates that critical thinking is not an isolated body of knowledge or skill but rather it has correlations with knowledge in other domains, aligning with McPeck's (ibid) perspective. As such, the researchers of this study advocate for a multifaceted approach to critical thinking instruction. This involves considering two primary methods: specialized critical thinking courses that emphasise logical reasoning supplemented by systematic and in-depth training in critical thinking skills (Bailin & Siegel, 2003), and the integration of critical thinking into other academic disciplines. This integration underscores the practical application of critical thinking skills in real-world contexts specific to particular fields of study (Paul & Elder, 2006). These two approaches should be viewed as complementary rather than mutually exclusive in enhancing students' overall critical thinking abilities.

## 7. Limitations of the Study

This study encountered potential limitations. Firstly, among the participants, variations existed in their prior knowledge of critical thinking. While some participants had previous exposure to critical thinking concepts, others lacked experience in this domain. These differences in knowledge levels might have led to varying needs and acceptance of the learning materials, potentially influencing their learning outcomes (Wade, 2019; Gurlitt & Renkl, 2010).

Secondly, the study did not explore the pivotal role and significance of teachers in fostering students' critical thinking skills. Previous researches have emphasised the crucial role of teachers in guiding students' development of critical thinking (Behar-Horenstein & Niu, 2011; Choy & Cheah, 2009). Training and support provided to teachers play a pivotal role in enhancing students' critical thinking abilities (Brookfield, 2011). However, this study did not offer specialised materials or professional training tailored for teachers. These potential limitations underscore the importance of future research prioritising the role of teachers in nurturing students' critical thinking abilities. Future studies should focus on providing increased support and training for teachers to facilitate the comprehensive development and application of critical thinking skills in teaching.

Another limitation concerns the ability of the potential users of the module to assess the composition using the official assessment standards for the National Postgraduate Entrance Examination (NPEE). The users might not be able to assess and provide feedback adequately and accurately. The reliability of the assessment might be affected to some extent even though the official assessment standards for the National Postgraduate Entrance Examination (NPEE) were employed in the evaluation of the composition evaluation. Furthermore, scholars advocate diversified approaches in essay grading and feedback. For instance, integrating teacher and peer feedback methodologies has been proposed to enhance students' writing capabilities (Gielen et al., 2010; Strijbos et al., 2010; Ruru & Sulisty, 2020). However, this approach was not incorporated in this study, presenting a challenge for future consideration and resolution.



## 8. Conclusion

The developed writing module delves deep into critical aspects of Logical Knowledge, forming the bedrock of critical thinking. It meticulously explores a wide spectrum of elements, encompassing conceptual understanding, judgment, reasoning, and argumentation, while simultaneously addressing the prevalent logical fallacies relevant to critical writing, as mandated by the syllabus outlined for the National Postgraduate Entrance Examination (Ministry of Education of China, 2022). Moreover, this pioneering study charts unexplored territory for future researchers due to the scarcity of studies comprehensively integrating writing and logic skills within the context of China's educational landscape (Li et al., 2019). Simultaneously, the judicious use of questions from the examinations in both the pretest and post-test phases provides substantial grounds for optimism regarding this writing module's potential to significantly enhance students' performance in the actual postgraduate entrance examination. With a conspicuous absence of such programs in the majority of Chinese universities, this research holds the promise of fostering substantial educational advancement.

This developed writing module extends its reach beyond students preparing for the National Postgraduate Entrance Examination (NPEE). Its significance is underscored by the pivotal role that critical thinking plays in the postgraduate entrance examination, its lasting impact on college students' future academic and professional trajectories, and the current inadequacy of relevant critical thinking and writing courses in Chinese universities. The development of a writing module that seamlessly integrates critical thinking skills addresses these pressing concerns. This writing module holds the potential for widespread implementation in Chinese universities, ensuring that every college student, regardless of their academic path, can partake in a more holistic and sustainable educational experience and to make sure that no college students are left behind.

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