

Asking the Right Questions—the Impact of Critical Questioning Training on English Majors' Critical Thinking Development

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Abstract: This study investigates whether critical questioning training can enhance learners' questioning ability, critical thinking awareness, and regulate cognitive biases. Two groups of English major learners were involved, with the experimental group undergoing a 12-week critical questioning training program. The results showed that the questioning ability of the experimental group significantly improved after the training, as evidenced by a marked increase in the number of conceptual clarification and evidence-based questions posed. Before the experiment, a significant correlation existed between the degree of text agreement and questioning levels in both groups. After the experiment, the significant correlation between text agreement and questioning levels was still observed in the control group, but not in the experimental group. Moreover, the degree of text agreement in the experimental group decreased, indicating a stronger critical awareness. However, the score of critical thinking disposition questionnaire of both groups did not show significant improvement.

Keywords: critical questioning training; questioning ability; critical thinking awareness; cognitive bias

1. Introduction

Critical thinking, defined as a type of reflective thinking focused on deciding what to believe or do^[1], can prompt people to analyze and evaluate information gathered to make informed decisions. In the era of artificial intelligence, critical thinking skills not only assist individuals in identifying, assessing and selecting information but also enable them to effectively utilize diverse information to make optimal decisions, thereby mitigating or reducing the challenges posed by AI technology to employment and career development. The "Partnership for 21st Century Skills"^[2] and the "Basic Framework for the Development of Core Competencies of Chinese Students"^[3] have identified critical thinking skills as one of the key abilities for student education in the new era. The World Economic Forum (2020) also mentioned that high-order thinking skills, including critical thinking and problem-solving skills are exceedingly valued by businesses worldwide^[4]. However, researches indicate that Chinese college students do not excel in critical thinking skills and their critical thinking disposition is weaker than their international counterparts^[5]. Compared with students in other disciplines, English major students in China with their primary effort devoted development of language skills are even more insufficient in their critical thinking ability^[6]. In the face of the challenges posed by AI technology to English major learners, exploring effective critical thinking training strategies will not only enhance their analytical abilities but also hold significant importance for their long-term career development.

2. Literature Review

Among various strategies proposed for cultivating critical thinking, effective questioning stands out as a widely recognized approach. Depending on the questioner, questions can be categorized into teacher-initiated questions and learner-initiated questions. The impact of teacher-initiated questions on the development of learners' critical thinking skills are the primary focus in current research. Studies have shown that teachers' use of higher level questions, particularly Socratic questioning, positively promotes the development of students' critical thinking^{[7][8]}. As for learner-initiated questions, they are

mainly viewed as an effective learning strategy or meta-cognitive strategy believed to be able to deepen learners' understanding and mastery of learning content, and learner-initiated inquiry questions are found pivotal in promoting the generation of new knowledge^{[9][10]}. However, there are not many studies exploring the relationship between learners' questions and the development of their critical thinking skills. Only Ikuenobe has elaborated on the philosophical justification of promoting critical thinking development through learner-initiated questions^[11]. Seker & Komur and Liu investigated the correlation between learners' cognitive levels of questions and their critical thinking skills or dispositions^{[12][13]}.

Several findings emerge through the review and analysis of the current research status. Firstly, the importance of developing learners' critical thinking skills through learners' active question generation is somewhat neglected. The majority of relevant studies approach the topic from the teachers' perspective, emphasizing how teachers' high level questions help to promote the development of students' critical thinking. However, when teachers ask questions, the primary beneficiary may be teachers themselves, as asking questions is a manifestation of exploratory thinking, potentially more important than solving problems. According to constructivist theory of learning, the internalization of knowledge and development of abilities depend on learners' active exploration and practice. The process of asking questions and engaging in dialogue, or raising questions and seeking evidence to solve problems is an essential path for the development of critical thinking skills. One of the most notable characteristics of a critical thinker is the ability to actively pose questions and seek answers based on reliable evidence^[14]. Therefore, fostering students' initiative and teaching them to how to ask critical-thinking questions is crucial for turning them into real critical thinkers. Secondly, researches focusing on the relationship between learners' questions and the development of their critical thinking skills are primarily theoretical or correlational, with a lack of intervention studies. Ikuenobe et al. analyzed the logic between learner question-posing and critical thinking development from a philosophical perspective. Although the studies by Seker & Komur and Liu have examined the correlation between learners' levels of questions and their critical thinking skills or dispositions, they have not explored whether improving learners' questioning skills can effectively enhance their critical thinking level or disposition. Only DeWaelche's study showed that learners' questions improved the depth and rationality of learners' responses, and learners believed that the question-posing aided the development of their critical thinking skills^[15]. However, the evidence for the development of learners' critical thinking skills was based on subjective self-reports, hence lacking in strong evidence. Therefore, this study intends to use relatively more objective measurement tools to explore the impact of the training of critical questioning strategy on learners' questioning ability and critical thinking awareness.

3. Research design

3.1 Research Questions

This study aims to delve into the impact of critical questioning strategy training on learners' questioning levels and critical thinking awareness. To effectively prompt students' questions, argumentative essays will be used as reading materials as research indicates that compared with other genres of text, argumentative essays are more likely to trigger readers' critical thinking^{[16][17]}. However, when argumentative essays are utilized, the impact of cognitive bias on students' questioning levels should not be overlooked. Readers tend to accept and affirm information that aligns with their own views (confirmation bias) while critically examining and rejecting information that contradicts their views (disconfirmation bias)^[18]. In other words, when readers agree with viewpoint of the text, it is unlikely for them to pose critical questions; whereas when they disagree, they are more likely to raise more critical questions. So a significant negative correlation might be found between the readers' agreement with the text viewpoint and the level of the questions they raised. Yet critical questioning strategy training may have the potential to regulate these cognitive biases to some extent as learners with a strong critical thinking awareness are more open and reflective in their thinking. Potentially, they may question and reflect on viewpoints that align with their existing belief. Therefore, this study also intends to investigate whether questioning strategy training can mitigate learners' cognitive biases. Specifically, will the correlation between readers' level of agreement with the text viewpoint and their levels of questions undergo changes before and after the training? The study hypothesizes that before critical questioning training, there is a significant negative correlation between participants' level of questions and their degree of agreement with the text viewpoint in both experiment and control groups. However, after the training, participants' level of questions in the experimental group may no longer be closely correlated with their degree of agreement. Accordingly, the research questions for this study are

as follows:

- 1) Is there a significant change in the levels of two groups of students' questions before and after the training on critical questioning strategies?
- 2) Is there a significant change in the critical thinking disposition of the two groups of learners before and after the training on critical questioning strategies?
- 3) Is there a significant change in the types of critical questions asked by the two groups of learners before and after the training on critical questioning strategies?
- 4) Is there a significant change in the correlation between the levels of learners' questions and their agreement with the viewpoints in the two groups before and after the training on critical questioning strategies?

3.2 Research Participants

Participants in the study are learners from two intact English major classes aged 18-20 taught by the second author, with 25 females and 5 males in the experimental class and 23 females and 4 males in the control class. The two classes formed by evenly distributing students based on their College Entrance Examination scores are parallel in academic performance. Pre-tests showed no significant differences between the two groups of participants in terms of questioning skills and critical thinking disposition. Small amount of monetary rewards were given for their participation.

3.3 Research Instruments

To prompt students' questions, two Chinese argumentative essays around 500 words each on controversial topics were chosen as the reading material. One was about "Legalization of homosexual marriage in China", while the other was on "Female students' aptitude for studying science majors". The topics were chosen because they bear close relevance to the daily lives and were of interest to college students. The articles were downloaded from WebPages and are edited by using Baidu Company's Large Language Model "Wen Xin Yi Yan" for obvious coherence and grammar lapses, and therefore they are clear structured. Given that research has shown that language proficiency will affect readers' critical thinking performance^[19], the reading materials were provided in Chinese and students' question generation was also conducted in Chinese.

To measure students' critical thinking disposition, the Chinese version of the California Critical Thinking Disposition Inventory (CCTDI)^[20], consisting of 70 items, was used. The overall reliability of the questionnaire is 0.872, indicating good reliability.

3.4 Research Procedures

In the first week of the experiment, pre-tests were conducted on the participants' agreement with the viewpoint of the articles, students' question generation, and critical thinking disposition. The degree of agreement with the viewpoint of the articles was rated on a 5-point scale, ranging from "strongly disagree" (1) to "strongly agree" (5). After rating their agreement, participants were asked to pose 3-5 questions to the author of the article. To better understand the participants' intentions of the questions they raised, students were encouraged to provide brief answers to their questions. The reading and question generation for the two articles takes altogether approximately 25 minutes. Subsequently, participants completed the Critical Thinking Disposition questionnaire via an online survey platform (www.wjx.com) during class breaks.

From the 2nd to the 9th week, the experimental class received 15-20 minutes' training on critical questioning strategies based on Browne's suggestions about critical questioning techniques^[21]. The training content included: 1) identifying structure of argumentation (Is the text explanatory or argumentative? Are the sentences descriptive statements or normative statements?); 2) conceptual clarity (Are the core concepts of the article clear enough? Are there any inconsistencies in concepts throughout the text?); 3) awareness of evidence (What evidences support the conclusion? Is the evidence sufficient and reliable? Are there any counterexamples?); 4) implicit assumptions (What implicit assumptions underlie the argument? Are they reasonable?); and 5) argumentative fallacies (Is the argumentation process effective? Are there any fallacies?). To consolidate the training effects, in the 10th and 11th weeks, the experimental class practiced critical-thinking-question-raising using two additional articles on controversial topics (titled "Why Are Female Drivers Not as Good as Male

Drivers?" and "The Hazards of Smartphone"). Meanwhile, the control class followed the traditional reading procedure, completing reading assignments and discussions during their weekly reading classes, and they read one more textbook article than students in the experimental group each week.

In the 12th week, both groups of participants were re-tested on their agreement with the viewpoints of the reading material and question generation for the same articles used in the pre-test. They completed the critical thinking disposition questionnaire again during class breaks.

3.5 Data Analysis

Based on Bloom's cognitive level of questions, questions with answers that can be directly found in the reading materials were classified as low-level questions, scoring 1 point, and questions that cannot be directly answered from the reading of text as high-level questions, scoring 2 points. Among the high-level questions, questions that demonstrated students' critical thinking awareness according to Paul's criteria, were classified as critical thinking questions, scoring 3 points ^[22]. Critical questions can be further subdivided into concept clarification questions, evidence-related questions, argument perspective questions, and implicit assumption questions. Specific examples of each type of questions were listed in Table 1 as follows:

Table 1 Examples of different levels and types of students' questions

Level	Types		Examples
Low level	Memory and Comprehension questions		What are Chinese parents' attitudes towards homosexual marriage? What are the reasons why girls are not good at science and math?
High level	Non-critical Thinking questions	Open-ended	Why are homosexual marriages legalized in the UK and Netherlands? How can we change girls' disadvantages in learning science subjects?
	Critical thinking questions	Concept Clarification	What are the accepted conventional practices? Can you explain it clearly? What do you mean by saying that girls are not good at science? What are the evaluation criteria?
		Evidence-related	Are psychologists' research conclusions always reliable? Why do you think girls are not good at science? Is there any research data to support this?
		Argument perspectives	Are there any benefits to legalizing homosexual marriage, such as making marriage more stable? Could girls' meticulousness and perseverance be beneficial for learning science?
		Implicit assumptions	You said legalizing homosexual marriage would affect the birth rate. Does this assume that the number of homosexual has reached a certain size? Is it only girls who are affected by emotional issues in their studies? Won't boys be similarly affected?

The categorization of question types was independently conducted by two of the three researchers. The initial consistency coefficient between the two researchers was 0.823. After discussion and negotiation over inconsistent categorizations, the consistency coefficient between the two researchers reached 0.911. For questions that remained controversial, the third researcher was invited to jointly determine their classification.

4. Research results

4.1 Levels of students' questions, text agreement and Critical Thinking Disposition

In the pretest, there were no significant differences between the two groups in terms of agreement to the texts, levels of questions, and critical thinking disposition as shown in Table 2 (p-values were 0.831, 0.607, 0.811, 0.958, and 0.904 respectively, all>0.05). Compared with the pretest, the experimental group showed a significant improvement in their levels of questions for both Text 1 and Text 2 (p=0.000, 0.000<0.05) after the training on critical thinking questions in the posttest, but the control group exhibited no significant change in the levels of questions they generated (p-values were 0.196, 0.574>0.05). Additionally, compared with control group, there was significant improvement in levels of questions in the experimental group for both Text 1 and Text 2, with effect sizes (Cohen's d) of 1.002 and 1.134 respectively. Moreover, the level of text agreement for the experiment group was also much lower than that of the control group in the posttest. Additionally, although the critical thinking disposition scores of the experimental class improved slightly in the posttest, the improvement was not significant (p=0.686>0.05).

Table 2 Means and SD in Text Agreement and Level of Questions in Pre and Post test

Item	Control(N=27)		Experiment(N=30)	
	Pretest Mean(SD)	Posttest mean (SD)	Pretest Mean(SD)	Posttest mean (SD)
Agreement to Text 1	2.592(0.888)	2.518(0.802)	2.533(1.166)	2.400(0.932)
Question level of Text 1	2.219(0.512)	2.352(0.467)	2.294(0.517)	2.766(0.352)
Agreement to Text 2	3.000(1.037)	3.033(0.879)	3.067(1.048)	2.633(0.850)
Question level of Text 2	2.064(0.540)	2.123(0.516)	2.056(0.611)	2.638(0.382)
Critical thinking disposition	278.85(23.257)	279.518(17.140)	279.50(24.819)	281.567(20.51)

4.2 Changes in the Types of Critical thinking Questions in the two groups

Since this study primarily focuses on the effectiveness of training of critical thinking question generation, a comparison was made between the total number and different types of critical questions in the pre- and post-tests for both groups (see Table 3). Analysis showed that there was no significant change in the total number of critical questions in the control group ($X \approx 1.160$, $P=0.763$). Only the number of implicit assumption questions increased in the post-test, but this increase was not significant ($X \approx 0.854$, $P=0.356$). In contrast, there was a significant change in the total number of critical questions in the experimental group ($X \approx 12.021$, $P=0.007$). Specifically, there were significant increases in the number of Concept Clarification Questions ($X \approx 4.584$, $P=0.032$) and Evidence-related questions ($X \approx 3.809$, $P=0.051$). However, there were no significant changes in the number of Argument Perspective Questions and Implicit Assumption Questions.

Table 3 Number of Different Types of Critical Thinking Questions in Pre- and Post-test

Types of critical thinking questions	Control		Experiment	
	Pretest	Posttest	Pretest	Posttest
Concept Clarification	3	4	2	12
Argument Perspectives	9	10	13	10
Evidence-related	39	36	31	59
Implicit Assumption	19	26	28	23
Total number of Q	70	76	74	104

4.3 Correlation between Text Agreement and Questioning Level

As shown in Table 4, there was a significant negative correlation between text agreement and questioning level for both materials in both groups in the pretest. This means that participants who were less likely to agree with the article's viewpoint were more likely to pose critical questions. In the posttest, the control group still showed a significant correlation between text agreement and questioning level (-0.437^* , -0.481^*). However, this correlation was no longer significant in the experimental group (-0.126 , -0.228). This may indicate that even when participants in the experimental group had no obvious objections to the text view, they were still able to pose some critical thinking questions.

Table 4 Changes in Correlation between Text agreement and Level of Questions

Item	Control				Experiment			
	Pretest		Posttest		Pretest		Posttest	
	r	p	r	p	r	p	r	p
Text 1	-0.563**	0.002	-0.437*	0.023	-0.602**	0.000	-0.126	0.507
Text 2	-0.535**	0.004	-0.481*	0.011	-0.437*	0.016	-0.228	0.227

5. Discussion

Firstly, the study found that training on critical thinking question generation could significantly improve learners' questioning ability. After receiving the training, learners were able to pose more high-level critical thinking questions about reading materials, which is consistent with previous research conclusions on questioning strategy training. Graesser & Person believed that learners' inability to pose high-level questions stemmed from their lack of good questioning skills, and training in questioning strategies can help learners master effective questioning techniques [23]. This study not only provided learners in the experiment group with guidelines for raising critical thinking questions but also provided opportunities for them to practice, and therefore an apparent improvement was found after the training.

Secondly, the study revealed that there was little change in the total number and number of different

types of critical thinking questions in the control group before and after the experiment. In contrast, a significant increase was observed in the total number and the number of concept clarification and evidence-related questions in the experimental group, indicating a significant enhancement in their conceptual clarity and evidence awareness. In the pretest, both groups posed very few concept clarification questions, possibly because exploring the accurate definition of concepts required considerable cognitive effort. Typically, when dealing with abstract concepts in routine life, people tend to rely more on intuitive and less effortful heuristic thinking systems^[24], often satisfied with a vague understanding of concepts. At the same time, due to the influence of the typical eastern way of thinking, which focuses more on the relationship between things and emphasizes dialectics and flexibility of thinking^[25], much less emphasis was placed on conceptual clarity and certainty, especially for concepts in humanity studies^[26]. Therefore, Eastern learners lack sufficient attention to conceptual clarity and naturally cannot pose many related questions. During critical thinking training, the experimental group experienced the importance of clear concepts for effective argumentation, so they were able to pose more concept clarification questions in the posttest. Additionally, the awareness of evidence of the experimental group also significantly improved in the posttest. This may be partly because the teaching duration for evidence-related content was longer than for other content and partly because the pattern of critical thinking questions related to evidence are more readily applicable. Compared with other types of critical thinking questions, evidence-related critical thinking questions can be generated simply by learners identifying a statement as normative and applying the questioning pattern, "Why do you think...? Is your view well-grounded? Do you have any evidence for saying...?"

However, the number of argument perspective questions posed by the experimental group did experience much change even after the training, and this is possibly because argument perspectives involve extensive background knowledge of the topic. The more background knowledge learners have about a topic, the more likely they are to view it from different perspectives. Yet this study focused on questioning strategy training and did not involve additionally extensive discussions on related topics with learners. Therefore, it was difficult for learners to propose new perspectives on the argumentation of the topic without an increase in background knowledge.

It was also found that implicit assumption questions were the type of critical questions that learners were relatively good at. This may be because implicit assumption questions involve inferring the meaning of statements, which is an often-practiced reasoning technique in learners' reading comprehension exercises and exams. Bernard et al.'s research also showed that among the test score for five different dimensions of critical skills, the average score for understanding and identifying assumptions was higher than that of the other three dimensions^[27], indicating that identifying assumptions is not difficult for most learners, so the number of implicit assumption questions posed by participants in both groups was relatively higher than other types of questions.

This study hypothesized that the critical thinking disposition of the experimental group would improve with the training and enhancement of their questioning ability. However, the research results showed that the critical thinking disposition of the experimental group did not significantly improve compared with the control group. On the one hand, this may be because the experiment duration was not long enough, making it difficult to cover all aspects of critical thinking disposition, and what left a deep impression on learners was mainly the importance of evidence-based argument and concept clarity, so the overall improvement in critical thinking disposition was not significant. On the other hand, Hyytinen et al.'s research showed that there was a significant correlation between participants' critical thinking test performance and the time spent, with better performance associated with longer time spent^[28]. In this study, the average time taken by participants to complete the posttest of the critical thinking disposition questionnaire was about 97 seconds shorter than that of the pretest. The reduction in time spent on questionnaire completion may have also affected the valid measurement of critical thinking disposition of learners to some extent.

Meanwhile, the study also showed that after critical questioning training, the experimental group's agreement to text and level of questions were no longer significantly correlated in the posttest. Some learners might be able to pose certain critical thinking questions even when they had no obvious objections to the viewpoint of the reading material, indicating an improvement in their critical thinking awareness. This may be because critical questioning training made learners realize that argumentative essays are often composed of a series of viewpoints rather than facts, and these viewpoints cannot be easily judged as credible or convincing without thorough investigation and analysis. This improved critical thinking awareness allows some participants to maintain a reasonable skepticism even when faced with argumentative essays that they hold a neutral attitude. In fact, similar effects of questioning methods (i.e., Socratic questioning) have been achieved in psychotherapy. After receiving Socratic

questioning therapy, patients experienced a significant reduction in their certainty about their previous ungrounded beliefs^[29]. The improvement in the experimental group's critical thinking awareness is not only reflected in the significant increase in the number of critical thinking questions posed in the posttest but also in the decrease in their agreement to text in the posttest (see Table 2). In contrast, there was no significant change in the agreement to text in the control group.

6. Conclusion and Implications

Through 12 weeks' training of critical thinking questions generation, this study draws the following conclusions. Through questioning strategy training, the level of questions generated by the experimental group significantly improved, and they were able to pose more concept clarification and evidence-related questions. At the same time, before the experiment, there was a significant correlation between text agreement and levels of questions in both groups. After the experiment, text agreement and question levels remained correlated in the control group, but there was a reduction of text agreement in the experimental group and the correlations between text agreement and question levels in the experimental group were no longer correlated, indicating a heightened awareness of critical thinking awareness. However, the critical thinking disposition of the experimental group did not witness significant improvement compared to the control group.

This study has the following implications for critical thinking teaching. Firstly, when cultivating learners' critical thinking awareness, they should not only be encouraged to pose critical questions but also required to seek evidence and answers to the questions they have posed, which can better enhance the truth-seeking nature of their critical thinking. The formation of critical thinking begins with questioning, but after posing questions, the process of seeking evidence for answers, analyzing and judging, and clarifying thoughts may be even more important. As Ikuenobe stated, the process of actively asking questions and engaging in dialogue or self-questioning and seeking evidence to solve problems is the necessary path for the development of critical thinking skills^[30]. Through such a complete thinking process, not only can learners' critical thinking awareness be enhanced, but their inquiry spirit can also be cultivated, their knowledge reserves on related topics enriched, leading to a comprehensive and objective understanding of the topic.

Secondly, providing learners with more materials that align with their own viewpoints for critical thinking training may more effectively improve their openness and fairness in thinking. When processing information, people inevitably have confirmation bias and disconfirmation bias. Having learners practice posing critical questions about materials that align with their own viewpoints may be more challenging than questioning materials they disagree with. The cognitively disruptive activities of evidence collection and analysis after questioning will leave a deep impression on learners, resulting in better training effects. When providing learners with materials that do not align with their viewpoints, materials with strong argumentation should be appropriately selected. Through the process of questioning and collecting evidence, learners may be able to revise their previous one-sided perceptions and correct their disconfirmation bias.

This study draws the above conclusions based on a very limited number of English major learners. Due to the small sample size, the generalization of the research conclusions is somewhat limited. At the same time, the materials selected for this study were argumentative essays with obvious argumentation defects. Therefore, the study only found that some participants showed a heightened critical awareness of the agreed viewpoints after receiving critical questioning training. However, the study did not investigate whether participants could change their viewpoints after reading materials that did not align with their own but had strong argumentation. This issue will be further explored in future research.

Acknowledgment

This paper is funded by the Educational Research Project of Anhui Jianzhu University 2024, Project No.: 2024jy36.

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