The Effects of Collaborative Argumentation on Learning Engagement and Critical Thinking: An Empirical Study of Processes and Outcomes

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ABSTRACT

This study explored the effects of collaborative argumentation activities on university students' learning engagement and critical thinking, and further analyzed the relationship between critical thinking processes and learning outcomes. A one-group pretest-posttest quasi-experimental design was used. 28 students participated in an eight-week collaborative argumentation teaching intervention. The results showed that: (1) collaborative argumentation significantly improved students' learning engagement and critical thinking dispositions, with all students showing positive improvement; (2) the frequency of critical thinking processes was significantly and positively correlated with improvement in learning engagement, but not significantly related to improvement in critical thinking disposition; (3) improvement in learning engagement was strongly and positively correlated with improvement in critical thinking disposition, suggesting that learning engagement may play a mediating role in the development of critical thinking. The results confirmed the multidimensional and complex nature of critical thinking development. The study also highlights that teachers should not only focus on training students' critical thinking skills, but also pay attention to promoting the internalization of thinking dispositions by increasing learning engagement, in order to cultivate students' critical thinking more comprehensively.

Keywords: collaborative argumentation; critical thinking; learning engagement; critical thinking process; critical thinking disposition

INTRODUCTION

In the context of 21st-century education, which emphasizes the development of students' higher-order thinking skills, critical thinking has become a core competency (Thornhill-Miller et al., 2023). Collaborative argumentation is a teaching strategy that deeply integrates social interaction and cognitive construction. It is widely recognized as an effective way to promote deep learning and improve students' critical thinking (Stegmann et al., 2012).

However, in the complex process of collaborative argumentation, the performance and development mechanisms of students' critical thinking are still unclear. The relationship between students' internal thinking dispositions and their external thinking processes also needs further exploration (Sönmez et al., 2020).

At the same time, how students engage in collaborative argumentation activities and the role of learning engagement in this process are not yet well understood. Especially, there is a lack of systematic empirical research on the complex interactions among critical thinking processes, critical thinking dispositions, and learning engagement (Demircioglu et al., 2022). These issues are important topics that need further investigation in current educational research.

Therefore, this study aims to review relevant literature, clarify the achievements and gaps in existing research, and propose new research perspectives and frameworks based on this analysis.

Specifically, the study has three main objectives:

1. To examine the effect of collaborative argumentation on improving students' learning engagement.

2. To evaluate the effect of collaborative argumentation on enhancing students' critical thinking dispositions.

3. To explore the relationships among critical thinking processes, improvement in learning engagement, and improvement in critical thinking dispositions during collaborative argumentation.

LITERATURE REVIEW

Collaborative argumentation refers to the learning process where students work in groups to build, evaluate, and revise arguments together (Giri & Paily, 2020). This concept combines theories from argumentation and collaborative learning, highlighting how social interaction can promote higher-order thinking. Toulmin's (1984) argumentation model provided a theoretical framework for collaborative argumentation. It included six elements: claim, data, warrant, backing, qualifier, and rebuttal. In education, collaborative argumentation was widely used in fields such as science education (Osborne et al., 2004), mathematics education (Ferrari, 2024), and language education (Rismanto et al., 2021).

Critical thinking is a complex, multi-dimensional concept. Scholars generally agree that it includes two core aspects: skills and dispositions (Facione et al., 1994) This study used a two-dimensional approach, distinguishing between external critical thinking processes and internal critical thinking dispositions. External critical thinking processes refer to the observable cognitive behaviors students show during argumentation activities. Perkins and Murphy's (2006) framework included four dimensions: Clarification, Assessment, Inference and Strategies. This framework was widely used to assess critical thinking in online discussions and collaborative learning (Chan et al., 2021; Perkins & Murphy, 2006). Internal critical thinking dispositions reflect an individual's willingness and mental readiness to use critical thinking. Facione et al. (1994) developed the California Critical Thinking Disposition Inventory (CCTDI), which measures seven dimensions: truth-seeking, open-mindedness, analyticity, systematicity, critical thinking confidence, inquisitiveness, and maturity. These dispositions were considered the "emotional" or "motivational" part of critical thinking, influencing whether a person is willing and able to keep using critical thinking skills (Facione & Facione, 1994).

Learning engagement is the physical and mental energy that students put into learning activities, reflecting the quality and intensity of their learning (Heilporn et al., 2021). The three-dimensional model by Fredricks et al. (2004) was widely used: Behavioral engagement, Emotional engagement, Cognitive engagement. Dixson (2015) developed the Online Student Engagement (OSE) scale, applying this framework to online learning. It included skills, emotions, participation, and performance. Reeve & Tseng (2011) further proposed agentic engagement as a fourth dimension, emphasizing students' active role in shaping their learning environment. These tools helped measure learning engagement in collaborative argumentation.

Many studies showed that collaborative argumentation can effectively improve students' critical thinking and learning engagement. First, argumentation tasks require students to go beyond simple repetition of information and think deeply about problems, which directly increases their cognitive engagement (Tsai & Tsai, 2014). At the same time, to persuade others, students must collect evidence and organize logic, which trains their external critical thinking processes (Chi et al., 2018).

Second, the interactive nature of argumentation meant students must listen to, understand, and respond to their peers' ideas. This social interaction increased students' sense of participation and belonging, boosting behavioral and emotional engagement (Mitchell, 2019). It also helped students encounter different perspectives. When their own ideas are challenged, students were more likely to reflect, which supported the development of internal critical thinking dispositions such as open-mindedness (Chen et al., 2024).

Through literature analysis, we found two research gaps:

1. Most studies use only one measure or a static approach to critical thinking. They focus either on external performance (such as argument quality) or on internal dispositions, and often only use simple pre- and post-tests. This approach lacks dynamic tracking of the development of critical thinking and may miss its complexity (Berland & Reiser, 2009).

2. Although learning engagement is seen as a key factor linking teaching activities and learning outcomes (Fredricks & McColskey, 2012), the relationships among critical thinking processes, dispositions, and learning engagement in collaborative argumentation have not been fully examined. Especially, the possible mediating role of learning engagement between collaborative argumentation and critical thinking still needs empirical study.

Therefore, this study used collaborative argumentation tasks to examine whether collaborative argumentation can promote students' critical thinking processes, critical thinking dispositions, and learning engagement, as well as explore the relationships among these three aspects.

RESEARCH METHODOLOGY

This study used a quantitative research design, specifically a one-group pretest-posttest quasi-experimental design. Through eight weeks of collaborative argumentation intervention, the study examined changes in students' critical thinking and learning engagement, as well as the relationship between them. Although the research involved collecting discussion texts, these qualitative data were converted into frequency data through coding, and then used as variables for quantitative analysis. Therefore, this study was essentially quantitative, and all data were finally analyzed using numerical statistics.

A. Research Procedure:

The research was conducted in three sequential phases:

1. Pretest stage (beginning of week 1)

Before starting the collaborative argumentation intervention, all 28 students completed the online Learning Engagement Scale and the CCTDI questionnaire. This collected the baseline data.

2. Intervention and process data collection stage (week 1 to week 8)

The eight-week collaborative argumentation teaching intervention took place. During this period, all online discussion texts and recordings of offline discussions were systematically collected and transcribed in a timely manner to ensure the completeness of qualitative data.

3. Posttest stage (end of week 8)

After all intervention activities were finished, all students will again completed the online Learning Engagement Scale and CCTDI questionnaire to assess the changes after the intervention.

B. Research Hypotheses:

Based on the literature review and research questions, this study proposes the following three core hypotheses to be tested by later data analysis:

• H1: The improvement in students' learning engagement is significantly and positively related to the frequency of their external critical thinking processes during collaborative argumentation.

• H2: The improvement in students' critical thinking dispositions is significantly and positively related to the frequency of their external critical thinking processes during collaborative argumentation.

• H3: The improvement in students' learning engagement is significantly and positively related to the improvement in their critical thinking dispositions.

C. Research Instruments:

1. Online Learning Engagement Scale:

This study used the scale developed by Dixson (2015), with appropriate translation and adjustments to fit the research context. The scale measures students' learning engagement in three areas: behavioral, emotional, and cognitive.

2. California Critical Thinking Disposition Inventory (CCTDI):

The study used the Chinese version of the CCTDI to assess students' internal thinking dispositions, including truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness, and maturity.

3. Collaborative Argumentation Process Records (Discussion Transcripts):

During the eight-week intervention, all written discussion records from the online collaboration platform and the transcribed recordings of offline group discussions were collected. These served as the original data for analyzing students' external critical thinking processes.

D. Participants:

Participants were selected through purposive sampling based on the following criteria:

1. The accounting major is one of the largest majors in the School of Economics and Management, making it representative.

2. The students had some experience with online learning and could adapt to the online collaboration environment required for the study.

According to the sampling criteria, this study selected 28 students. The participants were first-year accounting students from the School of Economics and Management at a university in China.

Table I Participant Information

Gender	Number	Percentage
Male	10	35.7%
Female	18	64.3%

E. Data Analysis:

1. Step 1: Quantitative Analysis of Questionnaire Data

Before starting the collaborative argumentation intervention, all 28 students completed the online Learning Engagement Scale and the CCTDI test.

2. Step 2: Quantifying Qualitative Data from Discussion Texts

Based on the framework of Perkins & Murphy (2006), a coding system was developed. The discussion transcripts were analyzed and coded for different types of critical thinking behaviors, and the frequency of each type was calculated. Cohen's kappa coefficient was used to check coding reliability. In this way, qualitative discussion texts were turned into quantitative frequency data.

3. Step 3: Integrated Analysis of the Three Variables

The improvement scores for each student's learning engagement and critical thinking disposition (posttest minus pretest) were calculated. Spearman rank correlation analysis was used to explore the relationships among the frequency of critical thinking processes, the improvement in learning engagement, and the improvement in critical thinking disposition.

RESULTS

This study used empirical analysis to examine the effects of collaborative argumentation activities on students' learning engagement and critical thinking dispositions, as well as the relationships between critical thinking processes and these two variables. The participants were 28 students who took part in collaborative argumentation activities. A pretest-posttest design was used. The data were analyzed using descriptive statistics, the Wilcoxon Signed Rank Test, and Spearman correlation analysis.

1) Analysis 1: Effect of Collaborative Argumentation on Students' Learning Engagement

This study first conducted descriptive statistical analysis of the pre-test and post-test scores on learning engagement for 28 students who participated in the collaborative argumentation activities. Then, the Wilcoxon Signed Rank Test was used to compare the average scores before and after the intervention. Table II and Table III show the overall trend of students' scores in the two tests. In general, all students showed positive changes in their learning engagement, with clear increases in the post-test average, median, and lower quartile scores compared to the pre-test.

Specifically, there was a significant increase in the average score. The average learning engagement score rose from 49.96 in the pre-test to 67.54 in the post-test, an increase of 17.58 points. The median score also improved notably, from 48.5 to 69.5, indicating that the collaborative argumentation activities had a positive impact on most students. Additionally, the pre-test scores showed a positive skew (skewness = 0.913), meaning that most students had lower scores, with a few high scorers raising the average. In contrast, the post-test scores showed a negative skew (skewness = -0.939), suggesting that most students reached a higher level of learning engagement after the intervention. Moreover, the standard deviation decreased from 9.061 (pre-test) to 7.110 (post-test), showing that the gap in engagement levels among students became smaller. This is also reflected in the score ranges. In the pre-test, scores ranged from 35 to 74 (a 39-point gap), while in the post-test, scores ranged from 50 to 80 (a 30-point gap). The lowest score increased from 35 to 50, meaning even the least engaged students showed noticeable improvement. Table 5.3 shows that students' learning engagement scores improved at all levels after the intervention, with higher 25th, 50th, and 75th percentile scores compared to before.

Table II Descriptives of Learning Engagement Scores

		Statistic	Std. Error
Pre-Learning Engagement Score	Mean	49.96	1.712
	Median	48.5	
	Variance	82.11	
	Std. Deviation	9.061	
	Minimum	35	
	Maximum	74	
	Range	39	
	Skewness	0.913	0.441
Post-Learning Engagement Score	Mean	67.54	1.344
	Median	69.5	
	Variance	50.554	
	Std. Deviation	7.11	
	Minimum	50	
	Maximum	80	
	Range	30	
	Skewness	-0.939	0.441

Table III Percentile Comparison of Learning Engagement Scores

	Percentiles		
	25	50	75
Pre-Learning Engagement Score	42.5	48.5	55.75
Post-Learning Engagement Score	65.25	69.5	72.75

Then, the Wilcoxon Signed-Rank Test was conducted using SPSS software, with the significance level set at 0.05. As shown in Table IV and Table V, all students (N = 28) showed improvement in their learning engagement scores after the intervention.

In summary, every student showed improvement in learning engagement after the collaborative argumentation. This result provides statistically significant evidence that the intervention had a positive effect. Therefore, the collaborative argumentation approach used in this study effectively enhanced students' motivation and participation in learning.

Table IV Rank of Pre-Post-Learning Engagement Test

		N	Mean Rank	Sum of Ranks
Post-Learning Engagement Score - Pre-Learning Engagement Score	Negative Ranks	0[a]	0	0
	Positive Ranks	28[b]	14.5	406
	Ties	0[c]		
	Total	28		

a. Post-Learning Engagement Score < Pre-Learning Engagement Score

b. Post-Learning Engagement Score > Pre-Learning Engagement Score

c. Post-Learning Engagement Score = Pre-Learning Engagement Score

Table V The Wilcoxon sign-rank Test for Learning Engagement Test

	Post-Learning Engagement Score - Pre-Learning Engagement Score
Z	-4.626[b]
Asymp. Sig. (2-tailed)	<.001

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

2) Analysis 2: Effect of Collaborative Argumentation on Students' Critical Thinking Dispositions

The CCTDI (California Critical Thinking Disposition Inventory) scores of all 28 students were first analyzed using descriptive statistics, followed by a Wilcoxon Signed Rank Test to compare the differences between pre-test and post-test scores.

Table VI and Table VII present the overall changes in students' CCTDI scores before and after the intervention. The results show that all students demonstrated a positive improvement in critical thinking disposition during the experiment. First, the average CCTDI score increased from 68.18% in the pre-test to 78.51% in the post-test. Second, the pre-test scores showed a slight negative skew (skewness = -0.214), indicating that most students had a moderately high level of critical thinking disposition. The post-test scores had a stronger negative skew

(skewness = -0.463), suggesting that a greater number of students achieved a higher level after participating in the collaborative argumentation activities. Third, the standard deviation decreased from 4.79% to 4.33%. This suggests that not only did students' critical thinking disposition improve overall, but the performance gap between students also decreased. Fourth, the range of CCTDI scores shifted upward. The pre-test scores ranged from 57.62% to 78.57% (range = 20.95%), while the post-test scores ranged from 65.95% to 86.67% (range = 20.72%). Although the range remained nearly the same, the entire distribution shifted upward. This indicates that the improvement was not limited to low-performing students — students across all performance levels benefited from the intervention. The percentile results also confirm the overall improvement in students' critical thinking disposition.

Table VI Descriptives of CCTDI Scores

		Statistic	Std. Error
Pre-test Score （%）	Mean	68.18	0.90611
Median		69.05	
Variance		22.989	
Std. Deviation		4.79471	
Minimum		57.62	
Maximum		78.57	
Range		20.95	
Skewness		-0.214	0.441
Post-test Score （%）	Mean	78.51	0.81761
Median		78.57	
Variance		18.718	
Std. Deviation		4.32639	
Minimum		65.95	
Maximum		86.67	
Range		20.72	
Skewness		-0.463	0.441

Table VII Percentile Comparison of CCTDI Scores

		Percentiles		
		25	50	75
Weighted Average	Pre-test Score （%）	64.11	69.05	71.8425
	Post-test Score （%）	75.6575	78.57	81.9625

The results of the Wilcoxon Signed-Rank Test showed a significant difference between students' pre-test and post-test CCTDI scores ($Z = -4.623$, $p < 0.001$), with post-test scores being significantly higher (see Table VIII and Table IX). This indicates that the collaborative argumentation intervention effectively improved students' critical thinking dispositions.

In summary, the study shows that students' CCTDI scores significantly improved after participating in the collaborative argumentation activity, indicating an effective enhancement in their critical thinking dispositions.

Table VIII Rank of Pre-Post-CCTDI Test

		N	Mean Rank	Sum of Ranks
Post-test Score （%） - Pre-test Score （%）	Negative Ranks	0[a]	0	0
	Positive Ranks	28[b]	14.5	406
	Ties	0[c]		
	Total	28		

a. Post-test Score （%） < Pre-test Score （%）

b. Post-test Score （%） > Pre-test Score （%）

c. Post-test Score （%） = Pre-test Score （%）

Table IX The Wilcoxon sign-rank Test for CCTDI Test

	Post-test Score (%) - Pre-test Score (%)
Z	-4.623[b]
Asymp. Sig. (2-tailed)	<.001
a. Wilcoxon Signed Ranks Test	
b. Based on negative ranks.	

3) Analysis 3: Relationships Between Critical Thinking Processes, Learning Engagement, and Critical Thinking Dispositions

To investigate the development of students' critical thinking processes during collaborative argumentation, data were collected from collaborative argumentation tasks. Based on Perkins and Murphy's critical thinking framework, the critical thinking processes were coded into four categories: Clarification, Assessment, Inference, and Strategies.

This study conducted a correlation analysis on three key variables: the total number of critical thinking processes, the improvement score in learning engagement and CCTDI (California Critical Thinking Disposition Inventory) improvement score. Since the sample size was 28 and the data did not follow a normal distribution, the Spearman rank correlation method was used. Table X presents the correlation results among these three variables.

First, there was a significant positive correlation between the total number of critical thinking processes and the improvement in learning engagement ($\rho = .555$, $p = .002$). This supports H1 and means that students who showed greater improvement in learning engagement also tended to have more critical thinking behaviors during the collaborative argumentation tasks. This result suggests a close connection between students' learning engagement and their critical thinking performance in the activity. In other words, if we want students to perform better in critical thinking, improving their learning engagement might be an important step.

In contrast, the total number of critical thinking processes was not significantly correlated with the CCTDI improvement score ($\rho = .303$). This result does not support H2. It indicates that how actively students expressed critical thinking during the tasks was not necessarily linked to their CCTDI test results or how much their thinking disposition improved. This statistical result suggests that the "observable behavior" of critical thinking and the "internal disposition" of critical thinking are two relatively independent aspects.

Third, there was a strong and significant positive correlation between learning engagement improvement and CCTDI improvement ($\rho = .671$, $p < .001$). This supports H3 and shows that students who improved more in learning engagement also tended to have higher improvement in critical thinking disposition. This suggests that during the collaborative argumentation process, students' improvement in learning engagement and their development in critical thinking disposition happened at the same time.

Table X Spearman Correlation Matrix among Critical Thinking Process, Learning Engagement, and CCTDI Variables

		Change-Learning Engagement Score	Change-CCTDI Score(%)	Critical Thinking Process
Change-Learning Engagement Score	Correlation Coefficient	1	.671**	.555**
	Sig. (2-tailed)	.	<.001	0.002
	N	28	28	28
Change-CCTDI Score(%)	Correlation Coefficient	.671**	1	0.202
	Sig. (2-tailed)	<.001	.	0.303
	N	28	28	28
Critical Thinking Process	Correlation Coefficient	.555**	0.202	1
	Sig. (2-tailed)	0.002	0.303	.
	N	28	28	28

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

The results of this study provide important insights for understanding how collaborative argumentation activities promote students' learning engagement and the development of critical thinking. The findings not only confirm the educational value of collaborative argumentation, but also reveal some interesting phenomena in the process of developing critical thinking.

A. The Effect of Collaborative Argumentation on Learning Engagement and Critical Thinking Disposition

This study found that collaborative argumentation activities significantly improved students' learning engagement (an increase of 17.58 points) and critical thinking disposition (an increase of 10.33%), with all participating students showing positive improvement. This result is important for education. First, as an active learning strategy, collaborative argumentation requires students to actively express their ideas, evaluate evidence, and defend their arguments. This deep involvement naturally promotes higher learning engagement. Second, the cognitive activities in argumentation, such as questioning, rebutting, and reconstructing ideas, provide practical opportunities for developing critical thinking.

It is also worth noting that the post-test results showed a decrease in the standard deviation among students (for learning engagement, from 9.061 to 7.110; for CCTDI, from 4.79% to 4.33%). This means that collaborative argumentation had a compensatory effect and was especially helpful for students who started at a lower level. This may be because the collaborative environment gave weaker students peer support and cognitive scaffolding, allowing them to gradually internalize critical thinking through social interaction.

B. The Separation Between Critical Thinking Process and Critical Thinking Dispositions

An unexpected but important finding of this study is that the number of critical thinking processes students showed during collaborative argumentation was not significantly related to the improvement in their critical thinking disposition ($\rho = .202$, $p = .303$). This separation reveals the complexity of developing critical thinking. Critical thinking processes reflect students' observable behaviors in specific tasks, while critical thinking disposition represents deeper cognitive habits and thinking qualities.

This finding suggests that cultivating critical thinking should not focus only on training observable behaviors, but also on developing internal dispositions. Some students may show many critical thinking processes under the pressure of collaboration, but these actions may not yet become stable thinking habits. On the other hand, some students may speak less during discussions, but might achieve deep changes in their thinking quality through listening and reflection. Therefore, educators should use a variety of teaching strategies—not only providing opportunities for students to practice critical thinking skills, but also promoting the internalization of thinking dispositions through activities.

C. The Mediating Role of Learning Engagement in the Development of Critical Thinking

The study found a strong positive correlation between improvement in learning engagement and enhancement in critical thinking disposition ($\rho = .671$, $p < .001$), and also a significant correlation between improvement in learning engagement and critical thinking behaviors ($\rho = .555$, $p = .002$). This suggests that learning engagement may act as a bridge between critical thinking behaviors and the development of critical thinking disposition. Students who were highly engaged were more likely to use critical thinking strategies actively during collaborative argumentation, and this ongoing cognitive involvement further helps form critical thinking dispositions.

The practical implication of this finding is that increasing learning engagement may be an effective way to cultivate critical thinking. Teachers can enhance students' engagement by designing interesting and challenging argumentation topics, creating a safe discussion environment, and providing timely feedback. When students are fully engaged emotionally, behaviorally, and cognitively, they are more likely to turn critical thinking from a classroom exercise into an everyday habit of mind.

CONCLUSION

This study investigated how collaborative argumentation activities influence students' learning engagement and critical thinking disposition, as well as the relationship between critical thinking processes and these two variables. The findings led to three main conclusions.

First, collaborative argumentation activities had a significant positive effect on improving students' learning engagement and critical thinking disposition. Second, the study revealed the multidimensional and complex nature of critical thinking development. There was no significant correlation between critical thinking behaviors (processes) and internal dispositions, which shows that these two represent different dimensions of critical thinking development. Teachers need to use more detailed approaches to help students develop critical thinking, and should not simply equate observable behaviors with the development of internal abilities. Third, learning engagement plays an important role in the development of critical thinking. Higher learning engagement was not only significantly related to critical thinking behaviors, but also strongly related to the improvement in critical thinking disposition. Cultivating students' learning engagement may be a key way to promote the development of critical thinking and provides clear guidance for instructional design.

However, this study also has some limitations. The sample size was relatively small (N=28) and there was no control group, which may affect the generalizability of the conclusions. In addition, the research period was short, making it difficult to assess the long-term effects of collaborative argumentation activities. Future studies are recommended to use larger sample sizes, adopt randomized controlled experimental designs, and conduct follow-up research to examine the sustainability of the effects.

In summary, this study provides empirical support for the educational value of collaborative argumentation activities and contributes to the development of theory and practice in critical thinking education. As 21st-century skills become increasingly important, continuing to deepen research on collaborative learning and critical thinking cultivation is essential for improving education quality and developing innovative talent.

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