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The Effects of Blended Learning Environment on University Students' Critical Thinking Dispositions in College English Course

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Abstract

This research aims to introduce and examine the effects of blended learning on learners' critical thinking dispositions for undergraduate students of business major at North China University of Science and Technology in China. The participants are 28 freshmen from College English Course. The research tools are Critical Thinking Dispositions Inventory Chinese Version and Blended Learning Environment Questionnaire. The findings show that blended learning environment is beneficial for improving Chinese students' critical thinking dispositions. The students are willing to take part in the learning activities both online and offline. They find out it is most difficult part is to understand the teacher's English instructions. Majority of students' critical thinking dispositions is significantly improved after one semester learning in the blended learning environment. Open-mindedness, self- confidence, and inquisitiveness of critical thinking dispositions are correlated with students' gender, English scores of college entrance exam, and science and liberal arts respectively.

Keywords: Blended Learning, Critical Thinking Dispositions, College English Course, Correlation

Introduction

In the 21st century, propelled by information technology, the cultivation of talents who possess critical thinking has become indispensable. Society demands high cognitive workers who are thoughtful, and employers prefer prospective employees who can keep pace with changes in their respective fields, highlighting the necessity for critical thinking skills (Rios et al., 2020). However, the development of critical thinking in Chinese higher education encounters numerous challenges. Hu and Sun (2006) emphasized the importance of nurturing students' critical thinking, extensive knowledge, significant humanistic values, and proficient, sophisticated English language skills. They advocated for an educational approach that integrates these elements to prepare students for the dynamic demands of the modern workforce. Qu et al. (2013) noted an emerging consensus among Chinese foreign language educators about the critical thinking deficit among Chinese English learners. They observed that many non-native English speakers often convey their thoughts with ambiguity and a paucity of logical and critical rigor in both speech and writing. Zhang and Fu (2018) reported

that the critical thinking of foreign language students do not significantly improve during their college education. This finding underscores the need for pedagogical interventions that specifically target the enhancement of critical thinking skills. Tian et al. (2020) conducted a survey at a Chinese university, revealing that over 26% of students lacked the attitudes and temperament essential for critical thinking. The study highlighted a concerning trend among students, suggesting a widespread need for educational strategies that can cultivate these attributes. Liu (2020) identified a negative tendency among students in embracing the seven characteristics of critical thinking dispositions, including truth-seeking, confidence, systematic ability, analytical ability, and intellectual curiosity. This calls for a reevaluation of educational practices to better support the development of these dispositions.

Reflecting on the current talent development models in Chinese institutions, Chen and Wang (2021) argued that the absence of critical thinking, coupled with limited subject knowledge and inadequate reading competencies, has significantly impaired the quality of graduates. They called for the creation of an innovative, information technology-rich learning model designed to foster critical thinking in Chinese university students, aligning with the aspirations of the nation, society, and the individual's growth.

Literature Review

Blended Learning

Blended learning is defined as the application of relevant learning technologies at appropriate times for appropriate learners to impart appropriate information and capabilities, thereby producing a learning method that optimizes learning results (Garrison & Vaughan, 2008). Dziuban et. al. (2018) propose blended learning as the new normal in higher education. Because of this, instructors, students, and educational institutions are increasingly embracing blended learning, which successfully combines the benefits of both online and in-person learning (Shen, 2021). There are three primary points of view regarding what blended learning means (Cronje, 2020). The first relates to combining various teaching methodologies; the second refers to integration of various teaching modes or delivery devices; and the third is combining online and face to face learning. In order to achieve flexible and effective quality learning, blended learning in this study refers to a learning method that organically integrates online and face-to-face learning. On the online learning, learning management is used and on fact-to-face learning, interactive classroom is adopted.

Blended Learning Researches

The academic pursuit is increasingly oriented toward curriculum innovation guided by contemporary theories, reflecting a trend that promises to enhance educational management. With the advancement of new technologies, an expanding array of content is being seamlessly woven into the educational tapestry. Blended learning emerges as an encompassing framework, much like a vast umbrella, capable of integrating diverse elements and leveraging their collective strengths (Graham, 2021). Jou et al. (2016) have demonstrated that within a knowledge transformation model, blended learning can significantly enhance students' critical thinking and knowledge conversion abilities. Moreover, students have shown positive attitudes toward this pedagogical approach, which in turn stimulates their motivation to learn. Zhang (2021) discovered that interactive activities within a blended learning context are positively correlated with the development of students' critical thinking dispositions. Alamri (2021) further supports this, indicating that blended learning not only hones cognitive skills

such as self-regulation, critical thinking, and creative thinking but also facilitates the integration of learning with practical work applications.

Ma (2020), emphasizes the effectiveness of innovative teaching methods like blended learning in substantially improving students' critical thinking. Building on this, Zhang and Tang (2021) present a ranking of course structures based on their efficacy in fostering critical thinking, with comprehensive, integrated, and independent courses being the most beneficial. The cultivation of critical thinking is identified as a vital strategy for elevating language proficiency, particularly in the context of language output (Sun & Yu, 2015). Ma (2020) reveals a consensus among English as a Foreign Language educators in China, who strongly advocate for the integration of critical thinking within the College English Curriculum and its classroom instruction. In light of these findings, it is an appropriate moment to explore the cultivation of critical thinking within the CEC, aiming for an integrative approach that harmonizes critical thinking with English language learning in a holistic manner. Thus The purpose of this study was to ascertain the degree to which freshmen at North China University of Science and Technology (NCUST) had developed their critical thinking and English performance in College English Course (CEC) in the context of blended learning environment.

Blended Learning in China

Blended learning has risen to prominence as a teaching and learning modality in China's higher education sector, particularly during the pandemic. Its swift development and adoption have catalyzed a transformation and innovation in the higher education instructional model (Wang & Li, 2020). Despite the surge in blended learning initiatives, a significant proportion has yet to achieve a truly integrated and effective instructional design. Instead, many merely juxtapose online learning with traditional face-to-face instruction without a cohesive strategy (Zhu & Zhang, 2021). While information technology is increasingly present in educational practices, Xiong (2017) has observed a dearth of successful cases where blended learning has markedly enhanced teaching quality within university settings. Peng and Yang (2017) echo this concern, noting that some implementations of blended learning may disrupt the clarity and structure of knowledge, potentially leading to superficial learning. This can stem from a variety of factors, including a paucity of theoretical research, educator incompetence, misapplication of technology, and an inadequate institutional framework. Jing and Shen (2019) identify three principal challenges associated with blended learning: the ineffective delivery of online and offline information, a lack of complementary design in learning activities, and a weak integration between learning and communication frameworks. Consequently, the inadequate systematic execution of blended learning has been linked to low learning outcomes (Shen, 2021).

In light of these findings, this paper poses three questions aimed at assessing the impact of blended learning on students' critical thinking dispositions (CTD) within the context of the CEC:

1) Can a blended learning environment enhance students' CTD?
2) What factors influence students' CTD within a blended learning context?
3) What are students' perceptions of the blended learning environment in CEC?

Methods and Instruments

Participants

The participants in this study comprise a cohort of 28 first-year undergraduate students majoring in business, all of whom have enrolled in CEC. To establish a baseline measure of their CTD, an initial assessment was conducted at the outset of the study. This was followed by a subsequent assessment at the semester's conclusion to determine the impact of the blended learning environment. The evaluation of CTD was facilitated through online questionnaires, allowing for a robust and accessible method of data collection.

Furthermore, to gauge the students' perceptions of the blended learning environment, their attitudes were evaluated at the term's end. This assessment aimed to capture insights into the learning environment's effectiveness and the students' overall receptiveness to the educational modality employed. The study's design ensures a comprehensive examination of the influence of the blended learning environment on both the development of critical thinking dispositions and student satisfaction with the learning context.

Research Tools

There are two research tools in this study which includeds:

Critical Thinking Dispositions Inventory Chinese version (CTDI-CV) by (Wen et al., 2009). It contains 50 items and are classified into two categories, four levels and eight dimensions. The two categories are social category and academic category. The two categories have four levels. Social category includes rationality and morality. Academic category contains intellectualness and emotionality. The four levels can be further divided into eight dimensions. Analyticity and inquisitiveness are classified as intellectualness; systematicity and self-confidence are classified as emotionality; truth-seeking and cognitive maturity are classified as rationality; open-mindedness and justice-orientedness are classified as morality. The scale's Cronbach alpha coefficient is 0.87, and the eight dimensions' values all fall between 0.50 and 0.73. Overall, the scale's dependability is satisfactory for statistical purposes (Wen et. al., 2009). Students are asked to select only one response for each item, ranging from "totally disagree" to "totally agree," depending on how they feel about the claim. When "totally disagree" was selected, they may receive one point, while "totally agree" would be worth six points. Therefore, the possible total scores are between 50 and 300. It is important to note that 27 of the items are negative questions. There are four categories for students CTD scores: greatly positive inclination (overall scores≥250), positive inclination (overall scores of 200~249), ambivalence (overall scores of 151～199), and negative disposition (overall scores≤150) (Lu, 2018).

Blended Learning Environment Questionnaire (BLEQ). The questionnaire was adapted from the WEBLEI questionnaire, which was designed by Chang and Fisher in 1999 with the aim of understanding students' perceptions of web-based learning environments and was further modified and refined by Chang and Fisher in 2003. They concluded that the questionnaire was suitable for both fully online and partially online blended courses, which makes it appropriate for the blended learning environment designed for this study. Chang and Fisher (2003), test the reliability of the questionnaire and find that it had high reliability both overall and in terms of individual dimensions. The WEBLEI questionnaire is translated into Chinese and some of the questions were removed or modified to suit the needs of blended learning environment. After the modifications are completed, Chang and Fisher (2003), re-ran the reliability test and

find that the modified questionnaire still maintained a high reliability. According to the Cronbach's alpha reliability coefficient, alpha ranged from 0 to 1, and when alpha was >0.8, it indicated good reliability; alpha ranged from 0.7 to 0.8, indicating an acceptable reliability coefficient. The reliability coefficient of the questionnaire is 0.86, which means that the reliability of the questionnaire is very good. The questionnaire altogether have 19 questions and each question is tested by Likert scale from 1 to 5.

Results and Discussion

Students' Critical Thinking Dispositions

Reliability of CTDI-CV: At the commencement and conclusion of the academic term, a set of 28 questionnaires was distributed via an online platform to each participant. This resulted in a collection of 26 completed questionnaires for both the initial and final surveys, reflecting a response rate of 93%. Prior to the administration of the questionnaires, Cronbach's alpha was employed to evaluate their reliability, a standard measure in assessing the internal consistency of the survey instrument. The results, as presented in table 1, indicate that the questionnaire yielded a Cronbach alpha of 0.887. In the context of reliability assessment, a coefficient ranging from 0.7 to 0.8 is generally regarded as acceptable, while a score of 0.8 or above is indicative of excellent reliability. With a reliability coefficient of 0.887, the questionnaire demonstrates a high degree of internal consistency and, consequently, is deemed to be a reliable tool for measuring the intended constructs.

Table 1
Reliability of CTDI-CV by Chang and Fisher (2003)

Cronbachα		
Items	N	Cronbach α
50	26	0.887

Effectiveness of blended learning environment on students' CTD:Table 2 presents the findings of the study, indicating that students' CTD were assessed both prior to and following a term of blended learning. The initial assessment yielded an average score of 180.05. Subsequent to the blended learning intervention, the CTD was reassessed using identical questionnaires, resulting in an increased average score of 219.31. To determine the statistical significance of the observed changes, the data were analyzed using a paired t-test. The mean difference between the pre- and post-intervention scores was calculated to be 39.25. The t-value obtained from the test was 7.406, and the corresponding p-value was 0.000. Based on these results, it is concluded that the blended learning environment has a statistically significant impact on the development of students' CTD. The substantial increase in scores, coupled with the highly significant p-value, answers the research question 1 that blended learning contributes positively to the enhancement of critical thinking dispositions among students.

Table 2
Paired- t test on students' CTD

Paired t test					
Items	Paired (M±SD)		Mean difference(Paired1-Paired2)	t	p
	Post-study	Pre-study			
Pre-study Paired Post-study	219.31±21.01	180.05±11.73	39.25	7.406	0.000**
* p<0.05 ** p<0.01					

Table 3 delineates the distribution of CTD levels among the participants. According to the data, among the 26 participants, a single student achieved a score of 250 or above, indicating that approximately 3.8% of the participants exhibit a very strong inclination toward CTD. Furthermore, 23 individuals obtained scores ranging from 200 to 249, signifying that 88.5% of the participants possess a positive disposition toward CTD. Additionally, 2 students got scores within the 151 to 199 range, which corresponds to 7.7% of the participants falling into the lower to moderate category for CTD. It is noteworthy that there were no participants with negative CTD, as no scores of 150 or below were recorded. Consequently, it can be inferred that the majority of participants, exceeding 90%, demonstrate a positive CTD. The absence of negative CTD among the subjects is an encouraging finding, suggesting an overall positive engagement with critical thinking within the students.

Table 3
Distribution of Different Levels of Participants' CTD

Total scores	≥250	200~249	151~199	≤150
N	1	23	2	0
Percent	3.8	88.5	7.7	0

Table 4 presents the data revealing that among the eight dimensions of CTD, cognitive maturity attains the highest mean score. The findings unequivocally indicate that participants excel in the area of cognitive maturity. With a mean score of 29.9, truth-seeking ranks as the second-highest dimension, closely followed by justice-orientedness at a mean score of 29.5, suggesting a strong alignment between the participants' inclinations toward truth-seeking and justice-orientedness. Self-confidence, inquisitiveness, and open-mindedness exhibit very similar mean scores ranging from 27 to 29, slightly lower than the top three dimensions but indicative of a consistent performance across these areas. This similarity underscores the participants' relatively uniform engagement with these dimensions of critical thinking.

In contrast, the mean scores for analyticality and systematicity are 22.6 and 19.2, respectively. These scores are notably lower than the majority of the dimensions' mean scores, suggesting a need for enhancement in participants' dispositions toward these two characteristics. The distribution of total scores among the learners, as illustrated in the table, extends from 173 to 264, with an average score of 219. This indicates that the students' CTD are generally inclined towards a positive spectrum. This finding contrasts with previous research; for instance, Tian et al. (2020) reported a general deficiency in CTD among Chinese university

students. Additionally, Liu (2020) observed that there was no significant improvement in CTD for Chinese university students during their university tenure.

The strong performance in cognitive maturity is corroborated by previous studies, including those of Wen et al. (2009) and Lu (2018), and is consistent with the current findings. However, some outcomes are unexpected when compared with past research. Wen's research indicated superior performance in the analytical and inquisitive dimensions, with notable deficiencies in truth-seeking and self-confidence—findings that diverge from the present study's results. According to Lu (2018), there was a need for improvement in justice-orientedness and analyticity, yet the current study reveals that analyticality and systematicity got the lowest scores among the eight dimensions.

Table 4
Students' Eight Dimensions of CTD

Dimensions	Number of students	Minimum	Maximum	Mean
Analyticity	26	13	30	22.6
Inquisitiveness	26	18	36	27.4
Systematicity	26	8	28	19.2
Self-confidence	26	17	41	28.3
Truth-seeking	26	13	42	29.9
Cognitive maturity	26	14	47	34.7
Open-mindedness	26	8	36	27.8
Justice-orientedness	26	14	36	29.5
Total scores	26	173	264	219

Factors' Influence on Students' CTD: Research Question 2 is explored through the lens of gender, English scores on the college entrance examination, and types of university majors.

The correlation between gender and CTD: The analysis of the correlation between gender and CTD is presented in Table 5. It reveals that gender significantly influences responses to eight survey items: questions 20, 24, 31, 34, 36, 43, 48, and 50. All these items exhibit a negative correlation with gender. Specifically, questions 20, 24, 31, and 36 have p-values below 0.05, indicating a statistically significant association, while questions 34, 43, 48, and 50 have p-values below 0.01, suggesting an even stronger association. Among the eight dimensions of CTD, open-mindedness is found to be the most significantly affected by gender. Cognitive maturity and truth-seeking follow as the second and third most influenced dimensions, respectively.The current findings diverge from those of Marni et al. (2020) and Boonsathirakul and Kerdsomboon (2021), who concluded that there is no significant relationship between gender and CTD. In contrast, our results resonate with the research conducted by Barta et al. (2022), which suggests a correlation between gender and CTD.

Table 5
The Correlation between Gender and CTD

20. I will stand by my ideas even when there is evidence that I am wrong.(truth-seeking)	Coefficient	-0.395*
	p value	0.046
24. The best way to solve problems is to get answers from others.(cognitive maturity)	Coefficient	-0.411*
	p value	0.037
31. I don't mind seeing people cheat in exams. (justice)	Coefficient	-0.465*
	p value	0.017
34. Life experience has taught me that I don't have to pay too much attention to logic in doing things.(cognitive maturity)	Coefficient	-0.623**
	p value	0.001
36. Having to seek the truth about many issues scares me.(truth-seeking)	Coefficient	-0.430*
	p value	0.029
43. I stand by my opinions and no one else has the right to ask me to give reasons.(open-mindedness)	Coefficient	-0.499**
	p value	0.009
48. Being open to different world views is not as important as people think.(open-mindedness)	Coefficient	-0.507**
	p value	0.008
50. People have the right to stand by their opinions, but I don't have to listen to them. (open-mindedness)	Coefficient	-0.585**
	p value	0.002

The correlation between English scores in college entrance exam and CTD: As demonstrated in Table 6, five survey items exhibit a significant correlation with students' English scores on the college entrance examination. These items are question numbers 1, 10, 13, 15, and 48. Notably, questions 1, 10, and 13 display a negative relationship with English scores, whereas questions 15 and 48 show a positive correlation. Among the eight dimensions assessed, self-confidence is found to be the most significantly influenced by English proficiency. The data indicate that students with higher English scores tend to exhibit a robust sense of self-confidence, a strong inclination towards justice, and a pronounced open-mindedness. These findings stand in contrast to those of Wang and Shen (2022), who reported no association between CTD and learners' English proficiency levels.

Table 6
The Correlation between English Scores in College Entrance Exam and CTD

1.I may appear to have logical and analytical skills, but in reality I am not. (self- confidence)	Coefficient	-0.466*
	p value	0.016
10. It is fun to try to solve complex problems. (inquisitiveness)	Coefficient	-0.438*
	p value	0.025
13. I think I am capable of dealing with complex problems.(self-confidence)	Coefficient	-0.491*
	p value	0.011
15. I feel indignant when I encounter injustice in the treatment of others. (Justice-orientedness)	Coefficient	0.488*
	p value	0.011
48. Being open to different world views is not as important as people think. (open-mindedness)	Coefficient	0.474*
	p value	0.015

The correlation between majors and CTD: Table 7 in this study delineates a significant relationship between five survey items and the students' academic major, categorized as either science or liberal arts. These items correspond to questions 25, 33, 35, 41, and 42, all of which exhibit a negative correlation with the field of study. Specifically, questions 25 and 35 have p-values below the threshold of 0.05, indicating a statistically significant association, while questions 33, 41, and 42 have p-values below 0.01, denoting a highly significant association. Within the eight dimensions of CTD evaluated, inquisitiveness is identified as the dimension most profoundly affected by the students' choice of major. These results corroborate the findings of Liu and Pásztor (2022), who reckoned that academic majors exert an influence on students' CTD.

Table 7
The Correlation between Arts Major or Science Major and CTD

25.I am interested in learning more about any subject that is being discussed. (inquisitiveness)	Coefficient	-0.403*
	p value	0.041
33. Even though I don't know when it will be useful, I strive to study as much as I can. (inquisitiveness)	Coefficient	-0.505**
	p value	0.009
35. People expect me to come up with appropriate criteria while making decisions.(open-mindedness)	Coefficient	-0.439*
	p value	0.025
41. I still want to learn new things at the age of 60. (inquisitiveness)	Coefficient	-0.648**
	p value	0.000
42. I favor assessments that call for analytical thought over ones that only rely on memorization. (Analyticity)	Coefficient	-0.503**
	p value	0.009

Students' experiences and attitudes towards the blended learning environment:Research Question 3 is addressed through a multifaceted analysis of BLEQ, which was administered to students in the experimental group upon completion of the course.

Reliability of Blended Learning Environment Questionnaire: The BLEQ encompasses four dimensions: students' attitudes towards the course and its activities, their attitudes towards the blended learning environment itself, their overall perceptions of the blended learning environment, and their perceptions of the difficulties encountered within this environment. Prior to the study, the BLEQ's reliability was assessed using Cronbach's alpha (α). As depicted in Table 8, the Cronbach α for the questionnaire is 0.883. A value of α greater than 0.8 is indicative of excellent reliability deeming it suitable for further data analysis.

Table 8
Reliability of Blended Learning Environment Questionnaire by Lu (2018)

Cronbach α		
Items	N	Cronbach α
19	28	0.883

Learners' attitudes to course and activities: Learners' attitudes towards the course and its activities were assessed based on questions 1 through 9, as detailed in Table 9. Regarding the course aspect, students generally expressed satisfaction with the overall teaching approach. The majority found that lesson objectives and assignments were clearly articulated, that the instructional activities were suitable, that the pace of instruction was well-structured, and that they comprehended the rationale for the teacher's integration of offline and online activities. In terms of activities, students exhibited a positive attitude towards both classroom and online learning activities, and perceived a balanced integration of online activities with classroom instruction.

A comparative analysis of the data highlights two intriguing observations. Firstly, approximately 75% of students endorsed online learning activities, whereas 64% favored classroom learning activities, indicating a preference for online learning experiences over in-person ones. This preference contrasts with the findings of Lu (2018), who reported that approximately 60% of students approved of online learning activities, compared to 80% who favored classroom learning activities, suggesting a preference for face-to-face learning. Secondly, between 10% and 30% of students chose the median response option for all nine items, indicating that a significant proportion of students hold a moderate stance on these aspects of learning.

Table 9
Learners' Attitudes to Course and Activities

Items	Completely disagree (%)	Disagree (%)	Not sure(%)	Agree(%)	Completely agree(%)	Mean	SD
1. I like online activities.	3.57	0	21.43	46.43	28.57	3.964	0.922
2. I like classroom activities.	0	10.71	25	46.43	17.86	3.714	0.897
3. There is a good balance between online and classroom activities.	0	3.57	35.71	32.14	28.57	3.857	0.891
4. Online activities and classroom activities matches well.	0	3.57	25	42.86	28.57	3.964	0.838
5. I understand that why this course will combine online activities with classroom activities.	0	3.57	10.71	32.14	53.57	4.357	0.826
6. The learning objectives for each lesson are very clear	0	0	28.57	53.57	17.86	3.893	0.685
7. It was easy to follow the schedule.	0	3.57	32.14	42.86	21.43	3.821	0.819
8. The expectations of the tasks are stated very clear.	0	3.57	25	53.57	17.86	3.857	0.756
9. Activities are carefully planned carefully.	0	0	21.43	53.57	25	4.036	0.693

Learners' attitudes to the online and offline learning: Learners' attitudes toward the blended learning environment were evaluated based on questions 10-11, as presented in Table 10. The mean scores for student preferences indicated that the classroom environment was favored, with a mean score of 4.036, while the computer-based learning environment received a mean score of 3.571. Approximately 46% of the students expressed a preference for online learning, while an equal proportion, 46%, indicated uncertainty. Conversely, 79% of the students favored traditional classroom learning, with 21% expressing uncertainty. Although discernible differences exist in student attitudes towards the two learning environments—online and traditional classroom—the data indicate a growing positivity towards online learning. This finding aligns with the research of Ferrer et al. (2022), who also reported that students hold a positive attitude towards online learning. Furthermore, the notable proportion of students who are undecided ('not sure') reflects a dynamic and evolving preference for online learning. This observation is consistent with the results reported by Zhu et al. (2020).

Table 10
Learners' Attitudes to the Online and Offline Learning

Items	Completely disagree (%)	Disagree (%)	Not sure(%)	Agree(%)	Completely agree(%)	Mean	SD
10. I like to learn online	0	7.14	46.43	28.57	17.86	3.571	0.879
11. I like to study in the classroom	0	0	21.43	53.57	25	4.036	0.693

Learners' overall perceptions to the blended learning environment: Learners' overall perceptions of the blended learning environment were assessed using questions 12-16, as presented in Table 11. Approximately 70% of students reported consistently feeling satisfied, successful, enjoyable, and interested in the learning environment. Furthermore, 77% of learners indicated that they can often or occasionally learn more in the blended learning environment. Notably, 95% of students rarely or never felt bored with the course. These findings suggest several implications: first, the blended learning environment demonstrates the potential to motivate students and stimulate their interest, a finding that corroborates the research conducted by Peng and Fu (2021). They reported similar observations regarding the positive impact of blended learning on students' motivation. Second, the need for students to undergo a period of adaptation to become fully comfortable with this learning modality is consistent with the conclusions drawn by Mali and Lim (2021), who emphasized the importance of an adaptation phase for students in new educational settings. Finally, the necessity to refine the design of the blended learning environment to better meet the needs of students aligns with the findings of Ustun and Tracey (2021), who highlighted the importance of refinement of educational design.

Table 11
Learners' Overall Perceptions to the Blended Learning Environment

Items	Always (%)	Often (%)	Occasionally (%)	Seldom (%)	Never (%)	Mean	SD
12. I feel satisfied and successful in a blended learning environment	14.29	21.43	35.71	25	3.57	2.179	1.090
13. I enjoy learning in a blended learning environment.	10.71	32.14	28.57	28.57	0	2.250	1.005
14. In a blended learning environment, I can learn more.	10.71	35.71	32.14	17.86	3.57	2.321	1.020
15. Blended learning environment aroused my interests to the project	10.71	28.57	32.14	21.43	7.14	2.143	1.113
16. At the end of the semester, I was bored with the course.	0	3.57	21.43	39.29	35.71	4.071	0.858

Learners' perceptions to the difficulties of the blended learning environment: Learners' perceptions regarding the challenges of the blended learning environment are evident in their responses to questions 17-19, as detailed in Table 12. A majority of students, 74%, reported finding the information technology requirements for the course to be easy, relatively easy, or expressed uncertainty. However, the mean score of 2.429 suggests that students still encounter significant difficulties in understanding the information technology involved. The instructions for online activities were perceived as even more challenging, with a mean score of 2.036, indicating a general struggle to comprehend them. The most problematic area was found to be the teacher's instructions, with a particularly low mean score of 1.857.

Table 12
Learners' Perceptions to the Difficulties of the Blended Learning Environment

Items	Easy (%)	Relatively easy (%)	Not sure (%)	Relatively difficult (%)	Difficult (%)	Mean	SD
17. The language of the instructions for the online activities is...	10.71	7.14	60.71	17.86	3.57	2.036	0.922
18. the information technology required by this course for me is...	21.43	25	28.57	25	0	2.429	1.103
19. Understand the teacher's instructions in class is...	7.14	7.14	50	35.71	0	1.857	0.848

Three primary factors contribute to the difficulties students experience in the blended learning environment: First, the necessity for students to adapt to the information technology integral to blended learning activities is consistent with the findings of Rasheed et al. (2020), who emphasized the need for a transition period to familiarize oneself with new technologies. Second, the activities are intentionally designed to develop critical thinking, which by design, elevates the complexity of the learning tasks. This result aligns with the perspective of Rasheed et al. (2020), who underscored the significance of thoughtfully designing learning tasks beforehand to relieve learners' pressure on comprehension. Third, the use of English, in contrast to Chinese, by instructors when explaining activities introduces an extra dimension of complexity. This observation is in line with Bruggeman et al. (2021), who highlighted the vital role of clear teaching instructions in facilitating students' understanding.

Conclusion

The blended learning environment has demonstrated benefits for enhancing Chinese students' CTD. Students have shown a willingness to engage in both online and offline learning activities. However, they have identified understanding the teacher's instructions in English as the most challenging aspect. After one term of blended learning in CEC, the majority of students exhibit a positive CTD. Specifically, dimensions such as open-mindedness, self-confidence, and inquisitiveness have shown significant correlations with gender, English scores on the college entrance exam, and students' majors, respectively. The study, while informative, has several limitations that suggest directions for future research. First, the participant pool is not sufficiently large; future studies could extend the investigation to encompass a more diverse range of university majors. Second, incorporating qualitative research methods could provide deeper insights into students' perceptions of CTD and their experiences with blended learning. Third, a comparative analysis between the blended learning model and other educational paradigms could provide valuable insights. Such a comparison could identify the unique strengths and areas for improvement within the blended learning environment, thereby contributing to its ongoing evolution and optimization.

Research Limitations and Suggestions for Future Researches

The current study has certain limitations that provide avenues for future research. Firstly, the sample size is constrained, which may affect the generalizability of the findings. Subsequent studies should consider expanding the sample to encompass students from a variety of academic majors to enrich the diversity of perspectives and increase the representativeness of the research outcomes. Secondly, the scope of the study is primarily centered on the assessment of critical thinking dispositions. Future investigations could benefit from broadening the scope to include critical thinking skills, which are equally important in understanding the holistic development of students' cognitive abilities.

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Authors' Contributions

Li Li is responsible for designing the research and drafting the manuscript; Shaharuddin Bin Md Salleh is responsible for supervise the writing process. Both of them have agreed the publication of the paper in this journal.

Conflicting Interests

There is no any financial or non-financial competing interests.

Ethics Approval and Consent to Participate

Every individual involved in the research has acknowledged that they could drop out of the study at any time, and their participation was completely optional. Since the students were adults with the ability to choose whether or not to participate in the study, the institution where they studied did not need to obtain approval from the ethics committee.

Availability of Data and Material

The corresponding author can provide the datasets used and analyzed for this study upon reasonable request.

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