Journal of Autonomous Intelligence (2024) Volume 7 Issue 5
doi: 10.32629/jai.v7i5.916

ORIGINAL RESEARCH ARTICLE

A systematic review of critical thinking for Engineering Students in Chinese classrooms

Zhiying Liu[1,2], Sook Jhee Yoon[1,*], Maoxing Zheng[3,*]

[1] *Faculty of Education, Language & Psychology, SEGI University, Kota Damansara 47810, Malaysia*

[2] *School of Humanities & Teacher Education, Wuyi University, Wuyishan 354300, China*

[3] *School of Computer Sciences, Baoji University of Arts and Sciences, Baoji 721007, China*

*** Corresponding authors:** Sook Jhee Yoon, yoonsookjhee@segi.edu.my; Maoxing Zheng, morse2000@163.com

ABSTRACT

As a result of fast technical breakthroughs, globalization, a customer-centric emphasis, and team-based design techniques, 21st century workplace expectations for engineers have evolved. These changes need that engineering graduates possess highly developed critical thinking abilities in order to work at a high level in the engineering field. Critical thinking has been introduced as a fundamental ability in the new Skills Framework. Countries from all over the globe have taken steps to foster the development of critical thinking skills in their citizens, and researchers from a variety of fields pay attention to and conduct critical thinking research. However, comprehensive research on the teaching and learning of critical thinking in the Chinese setting is scarce. This study examines the research literature on critical thinking in Chinese classrooms in order to discover which theories and research methodologies are applied in critical thinking research. By scanning the CNKI and Web of Science databases, 63 Chinese and English publications were discovered using the PRISMA model. The analysis demonstrates that Chinese schools lack theoretical applications of critical thinking research. In the meanwhile, three distinct research techniques are used, however quantitative research approaches have the most papers. According to research, anyone interested in studying critical thinking should be familiar with its theory. In addition, researchers must use a range of study methodologies to guarantee that the results give information beyond summaries of critical thinking. Finally, Chinese researchers on critical thinking need greater exposure to qualitative data sources in order to modify their data gathering procedures.

Keywords: critical thinking; CNKI; Web of Science databases; PRISMA

ARTICLE INFO

Received: 6 July 2023
Accepted: 19 July 2023
Available online: 14 March 2024

1. Introduction

Due to globalization and transdisciplinary design alternatives, the 21st century has brought about a shift in the expectations put on the engineering profession[1]. The need to work in teams and with clients to optimize technological solutions has accompanied the traditional conception of an engineer as an individual who brings original ideas to address isolated problems. This has led to a departure from the conventional viewpoint of an engineer. Therefore, the highly technical skills obtained via postsecondary engineering education alone are inadequate for success in engineering careers.

The development of students' intrapersonal and interpersonal abilities has become a crucial component of an engineering education leading to professional success. In spite of this, there continues to be a skills gap between engineering graduates and employers' needs. Employers believe that the majority of social and emotional abilities required of entry-level engineers have not been attained to a sufficient

level. This is particularly true with communication abilities. Students have the chance to boost their employability by acquiring critical thinking skills through internship programs provided by engineering companies.

Critical thinking is one of the talents listed in the framework for 21st century competencies. Students of engineering must be adept at independently considering all material elements, making decisions, asking questions, expressing viewpoints, and avoiding jumping to conclusions[2]. As a result, critical thinking has become a focal point of engineering curricula globally in order to prepare students for the information economy. While colleges in the United Kingdom have changed their emphasis from critical thinking to other qualities such as collaboration and leadership, critical thinking is still a vital component of higher education in the United States. Critical thinking is strongly emphasized at all educational levels in China. The China Education Innovation Institute of Beijing Normal University established the 5C Framework for 21st Century Key Competencies, which comprises five core competencies: creativity, cooperation, critical thinking, communication, and cultural competence. The four components of critical thinking are questioning and critique, analysis and argumentation, synthesis and generation, and reflection and assessment.

A literature search revealed that there are few systematic reviews of the teaching and learning of critical thinking in Chinese contexts. The review by Tian and Low[3] that focuses on Chinese higher education students concludes that culture is not the primary cause for engineering students' lack of critical thinking. There is a more recent evaluation by Fan and See[4]; however, they focused on Chinese students studying abroad and concluded that there is insufficient evidence to suggest that Chinese students have worse critical thinking abilities than their peers. In addition to engineering students' learning of critical thinking, the teaching of critical thinking by instructors is another subject that has quietly garnered interest over the last decade. They found, for instance, in Zhang et al.[5] that the instructors' lack of professional expertise hindered their adoption of critical thinking. Concerning research methodologies, Tian and Low[3] advocated for an increase in context-sensitive research and qualitative studies in order to better comprehend the problem. In a similar spirit, Fan and See[4] advocated for additional large-scale empirical investigations to comprehend the critical thinking of Chinese learners. Therefore, it is essential to perform a systematic study to determine how far the teaching and learning of critical thinking have advanced in China. This analysis sought to address two questions: What theories are utilized to investigate critical thinking in Chinese classrooms? What research methodologies are utilized to investigate critical thinking in Chinese classrooms?

2. Related work

One of the early works on critical thinking was How We Think by Dewey, which introduced the notion of reflective thinking (1933). Additionally, other fields have sought to define critical thinking. The psychological approach emphasizes cognitive ability and thinking. The philosophical approaches emphasize the need to be rational, skilled, and deliberate while making decisions. The sociological approach emphasizes how an individual's connections with the community affect his or her thinking[5]. In education, Bloom's Taxonomy and its subsequent revision are emblematic of critical thinking[6]. Bloom's Taxonomy's educational goals include six levels of cognitive abilities, and the three higher-level talents of analysis, assessment, and creativity are termed "critical thinking"[7]. In teaching and learning, educators have used a variety of frameworks. In their book, Moseley et al.[5] classified frameworks into four primary groups. First, frameworks that may assist educators in establishing instructional activities Second, structures that emphasize both thought and action Third, cognitive development incorporating intelligence-focused frameworks Fourth, all-encompassing frameworks for instruction, behavior, and cognition.

In ancient China, ancient sages emphasized the significance of critical thinking in the learning process, according to historical documents. For instance, the Doctrine of the Mean (Zhongyong) advised a thorough

learning process consisting of broad study, accurate inquiry, thoughtful reflection, clear discrimination, and diligent practice. This ancient Chinese method of education is one of the most significant historical examples of critical thinking. Confucius, a revered Chinese sage, emphasized the need to promote critical thinking in the educational process and the value of independent thought in learning. Confucius said in the Analects of Confucius (Lunyu) that learning without thinking leads to misunderstanding, while thinking without learning leads to danger. As a result, traditional Chinese critical thinking places more emphasis on action. To establish the unity of knowledge and action after inquiring, thinking, and judging, one must apply the conclusion or belief to everyday life. These first works in China demonstrate that the development of critical thinking among students in Chinese society has long historical roots.

In contemporary China, the government has placed an emphasis on teaching students to think critically. The government put up regulations to guarantee that critical thinking was included in the curricula of schools and universities. Under the first policy, the Core Competencies and Values for the Development of Chinese Students, logical thinking, critical questioning, and an eagerness to investigate are recognized as the fundamental criteria for judging the scientific spirit of engineering students. Second, in 2018, a new policy, Education for the Future: Global Experience, Developing 21st Century Skills and Competencies was implemented in an effort to increase the teaching of essential concepts. Lastly, critical thinking is one of the seven basic characteristics of individuals in the 21st century that are highly appreciated by nations and international organizations (China Education Innovation Institute of Beijing Normal University, 2018). Also, Chinese colleges have emphasized critical thinking. In the fall 2003 class at Peking University, for instance, Logic and Critical Thinking was established as an optional course[8]. In recent years, additional empirical research on the teaching of critical thinking in English as a foreign language (EFL)[9], nursing education[8], and teacher training[10] has been done, among others.

3. Proposed method

3.1. Search strategy

Figure 1 depicts the procedure for choosing papers for this systematic review. The Web of Science database was searched using keyword combinations ("critical thinking" AND China OR Chinese AND education) in the title of English-language articles. The search returned 768 matches for English-language articles. This assessment was done in June 2022, using data from the Web of Science database that was last updated on June 22, 2022. Using CNKI, a search was run using the terms "critical thinking" as a topic. Initial searches yielded a total of 768 English-language articles and 888 Chinese-language pieces, for a grand total of 1656 items.

The second screening phase consisted of two stages. Firstly, the titles and abstracts of the articles were read to identify studies that met the inclusion criteria[11]. **Figure 1** demonstrates the inclusion and exclusion criteria. The screening produced a total of 733 articles. The second step of screening included reading the whole document. At this stage of screening, the criteria for inclusion were that the research techniques must be described in the publications, the study participants must be Chinese engineering students or instructors, and the research location must be China. Journal articles without a description of study methodology, review articles, abstracts, and conference papers were excluded. After the second phase of screening, 28 Chinese articles and 35 English pieces fulfilled the selection criteria, bringing the total number of articles to 63.

3.2. Information sources

The purpose of this study is to examine critical thinking in the Chinese environment between 2012 and 2022. The articles considered for this analysis were published in both Chinese and English. The identification of the items included two steps: searching and filtering. First, to assure the quality, papers were picked from the Science Citation Index (SCI), Chinese Social Science Citation Index (CSSCI), Chinese Science Citation

Database (CSCD), and Peking University core journals based on the division of China's journal index. The CNKI database in China was queried for articles published in Chinese.

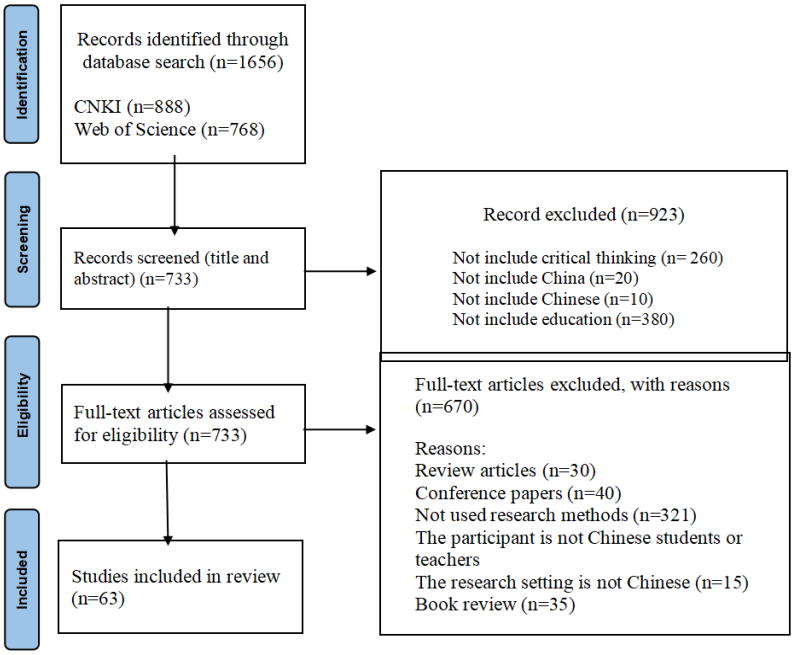

Figure 1. Flow diagram based on PRISMA guidelines.

3.3. Inclusion criteria

Four inclusion criteria were established before conducted the review: (1) published journal articles; (2) written in Chinese and English; (3) participants are teachers or students; (4) The research setting is in China.

3.4. Exclusion criteria

In this systematic review, exclusion criteria: (1) review article; (2) dissertation; (3) conference articles; (4) book review; (5) abstract; (6) non-Chinese and non-English articles.

4. Result

Figure 1 depicts the process of article evaluation for this systematic review. This section starts with a description of the chosen articles' demographics. The results for the two research questions are then provided. Moher et al.[12] advocated that, when analyzing the data, the search variables should be put first. For data analysis in this assessment, MAXQDA 2020 software was employed. Prior to analyzing the 63 publications, the researchers assigned codes to research questions, research methods, research hypotheses, study participants, research instruments, and research outcomes. The researchers then analyzed and categorized all the data to present an overview of studies on critical thinking in Chinese education over the last decade. Following this rule, the researchers carefully reviewed each manuscript in search of codes and to establish distinct groups and subjects. The outcomes of this analysis are provided in the next section.

4.1. Descriptive information

The review focuses on Chinese and English-language journal papers published between 2012 and the present (i.e., the past 10 years). The yearly trends of Chinese and English journal papers are identical, as illustrated in **Figure 2**. The data indicates that the greatest number of publications were published in 2020. As seen in **Figure 2**, the number of Chinese articles published has been on the increase since 2016, but will decline in 2021 relative to the two preceding years. From 2018 to 2021, the number of articles published in English

skyrocketed. Since the data search was completed in June of 2022, it is probable that the number of articles published in 2022 will be comparable to that of 2021.

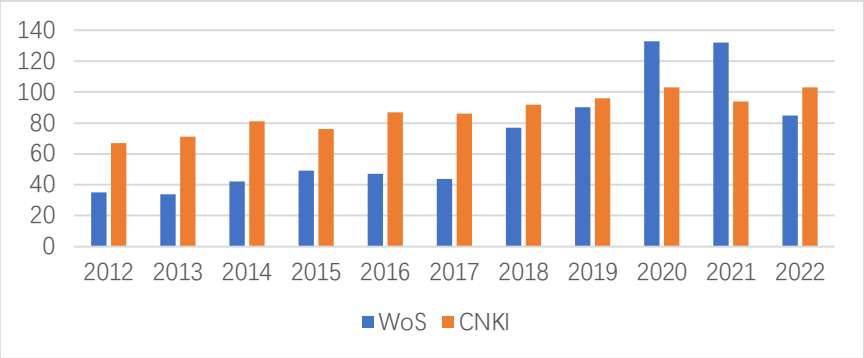

Figure 2. Publications per year.

As indicated in **Table 1**, 74.6% of the total chosen papers included college engineering students as participants. There were eight studies on teachers, including four on college English instructors (n = 4), two on high school teachers (n = 2), and one on middle school teachers (n = 1), but none on elementary school or preschool teachers. In addition, one article's participants comprised elementary, middle, and high school principals. Participation by middle school students (n = 4) and high school students (n = 2) in articles represented just 9% of the total. However, there are few publications that involve elementary and preschool pupils.

Table 1. Study participants.

Participants	Number of articles	Percentage
Teachers and students	2	3%
Teachers only	7	11%
School leaders	1	1.5%
College students only	47	73.4%
High school students only	2	3%
Middle school students only	5	8%
Primary school students only	0	0
Preschool children only	0	0

[a] Not equal to 100% as a result of rounding.

4.2. Researching critical thinking in the Chinese classrooms

Only ten of the sixty-three papers analyzed used critical thinking ideas in their study. These ideas come from many angles, with sociological theories appearing in three of the articles. Student engagement theory and the community of inquiry framework have each been used in two papers, while the other theories indicated in **Table 2** have been utilized in just one research. In their investigation, only Qin and Lyu[13] used both the theory of moral growth and the student engagement theory. The other nine investigations used just a single hypothesis.

Table 2. The theories used by researchers of the 10 articles.

Perspective	Theory used	Author using the theory	Language of article
Psychology	Theory of moral development	Qin and Lyu[13]	Chinese
	Student involvement theory	Qin and Lyu[13]; Mei et al.[14]	Chinese
Philosophy	Five Dimensions of Epistemological Beliefs of Schommer	Xia and Zhong[15]	Chinese

Table 2. (*Continued*).

Perspective	Theory used	Author using the theory	Language of article
Cognitive	Piaget's cognitive development theory	Bi et al.[16]	Chinese
Sociological	Vygotsky's sociocultural theory	Ma and Luo[11]	English
	McIntyre's Notion of Rationality	Tan[17]	English
	Community of Inquiry Framework	Wu[18]; Yuan et al.[19]	Chinese
Social psychology	Positioning theory	Pu and Evans[20]	English
Social cognitive	Four-stage content analysis framework model	Ye and Yin[21]	Chinese

4.3. Research designs used in researching critical thinking in Chinese classrooms

According to an analysis, there are four kinds of research designs used to study critical thinking in China. With 23 publications, survey design was the most prevalent, followed by experimental design with 16 articles. A comprehensive study of the articles revealed that their purpose was to highlight the critical thinking of pupils. The purpose of these articles is also to assess students' critical thinking abilities and inclinations. In addition, there are papers that investigate the link between students' critical thinking and other pertinent aspects (learning styles, social factors). 64 was the lowest sample size, while 46820 was the largest. Experiments designed to determine the efficacy of different critical thinking development strategies Problem-based learning[22], task-based learning[23], group study[21], philosophy for children[1], online teaching methods[24,25], blended teaching methods[26], and service learning activities were among the treatments included in **Table 3**.

Table 3. Research designs used in researching critical thinking in China.

Research design	Author	Sample size
Survey	Lu et al.[27]	103 undergraduate students
	Huang et al.[28]	1075 medical students
	Cheng and Wan[29]	3869 high school students
	Huang et al.[30]	1,338 medical students
	Wu and Wu[31]	64 nursing students
	Pu et al.[32]	130 undergraduate medical students
	Ma et al.[33]	46,820 students under 547 physics teachers
	Zhang et al.[34]	157 senior undergraduate nursing students
	Yang and Mohd[35]	542 EFL university students
	Lu and Chen[36]	437 engineering college students
	Li et al.[37]	1075 college students
	Qin and Lyu[13]	1610 top-notch college students
	Mei et al.[14]	1060 college students
	Xia and Zhong[15]	1049 college students
	Shen et al.[38]	1833 college students
	Wu[39]	350 college students
	Zheng et al.[40]	504 medical students
	Zhang et al.[41]	385 medical students
	Gao[42]	489 college students
	Mao and Xu[43]	115 high school teachers

Table 3. (*Continued*)

Research design	Author	Sample size
Experimental	Zhou et al.[44]	119 high school students
	Hwang et al.[45]	40 middle school students
	Huang and Ning[28]	430 engineering students
	Chen and Hu[24]	60 freshmen English majors
	Qin et al.[46]	229 undergraduate nursing students
	Bi et al.[16]	100 middle school students
	Wu[28]	76 college students
	Han and Wei[47]	78 middle school students
	Qiao[48]	33 college engineering students
	Nie et al.[49]	82 college engineering students
	Wu[1]	178 middle school students and 2 teachers
	Ye and Yin[50]	30 college engineering students
	Yuan et al.[51]	44 undergraduate students
	Ma et al.[52]	75 undergraduate psychology students
Explanatory sequential	Huang et al.[53]	1241 medical students
	Ng et al.[54]	178 college students
	Liang and Fung[55]	125 primary school students, 5 English teachers
	Wang and Seepho[56]	50 English majors
	Chiu[57]	45 English majors
	Liao et al.[58]	118 nursing undergraduates
	Du and Zhang[59]	156 English majors
	Ma and Liu[60]	186 teachers
	Liu and Jin[61]	23 English majors
	Leng et al.[62]	55 college engineering students
	Zhang et al.[41]	57 college engineering students
	Mao and Xu[63]	115 high school teachers
Case study	Pu and Evans[20]	29 postgraduate students
	Zhao[64]	8 middle school teachers
	Li and Pan[65]	4 high school teachers

4.4. Data sources in researching critical thinking in Chinese classrooms

Analysis revealed that both quantitative and qualitative data were obtained to investigate critical thinking in Chinese schools. The most prevalent source of numerical data was critical thinking tools. In the papers, a total of 18 instruments were used. The most popular tool was the Chinese version of the California Critical Thinking Disposition Inventory (CTDI-CV). This instrument appears in seventeen articles. In seven papers, the California Scale of Disposition for Critical Thinking (CCTDI) was the second-most-used instrument. Among the instruments, there are a few that are based on Chinese culture. There were several papers that used quantitative research methodologies. The goal of the papers was to examine the critical thinking of Chinese students or instructors or to evaluate the efficacy of utilizing certain teaching techniques or tactics to foster critical thinking in engineering students. The CCTDI is designed to assess the personality components of critical thinking. The questionnaire is intended to assess cognitive capacity and is relevant to those aged 15 and older. Using CCTDI, a number of scholars[13] have advocated localizing the questionnaire. As stated in

Table 4, we redesigned the CCTDI and released the Chinese version of the Critical Thinking Disposition Inventory (CTDI-CV).

Table 4. Instruments used in researching critical thinking in Chinese classrooms.

Instruments	Author
The Chinese version of Watson Glaser Critical Thinking Appraisal (CWGCTA);	Pei et al.[66]
California Critical Thinking Disposition （CCTD）	Chiu[57]
Learning Environment Affordance Survey Critical Thinking (LEAS_CT),	Du and Zhang[59]
University of Florida Critical Thinking Inventory（UFCTI）	Lu et al.[10]
The Scale of the Critical Thinking Tendency	Hwang et al.[45]
The Critical Thinking Skills Survey (CTSS)	Chen and Hu[24]
The Critical Thinking Disposition Assessment (CTDA),	Cui et al.[67]
The Program for Regional Assessment of Basic Education Quality (PRABEQ)	Ma et al.[68]
Cornell Critical Thinking Tests-Level X,	Bi et al.[16]
The Chinese College Students' Cognitive and Creativity Development Questionnaire	Mei et al.[14]
ETS Proficiency Profile (EPP), Educational Testing Service	Xia and Zhong[15]
Watson-Glaser Critical Thinking Appraisal	Wu[26]

Critical thinking research in Chinese classrooms also gathered non-numerical data. **Table 5** shows the non-numerical data sources. These sources included semi-structured interviews, observations, focus group discussions, open-ended questionnaire and reflective log. Semi-structured and focus group interviews were the most common data sources.

Table 5. Non-numerical data sources.

Sources of Data	Author
Semi-structured interview	Ma and Luo[11]; Pu and Evans [20]; Huang and Wu[69]; Zhao[64]; Yuan and Stapleton[70]; Chen[71]; Li and Pan[65]
Observation	Ma and Luo[11]; Huang and Wu[69]; Zhao[64]; Li and Pan[65]
Open-ended questionnaire	Tan[72]
Reflective log	Wei[73]
Group discussion	Wei[73]; Yuan and Stapleton[70]; Leng and Guo[62]

Researchers utilize a mixture or combination of quantitative and qualitative techniques, tools, or ideas in a single study or set of linked studies, as shown in **Table 6**. The qualitative and quantitative components of research may be conducted concurrently or sequentially to answer a research topic or a set of interrelated questions. Since the 1990s, the intricacy of research issues has necessitated that researchers answer queries using more than just words and statistics.

Table 6. Mixed-methods studies included in review.

Source	Language	Sample size	Instruments/Sources of data
Wu[1]	English	178 middle school students and 2 teachers	Questionnaires designed by scholars on the basis of three questionnaires: CAT, the Cornell Test Level, and the Watson Glasser test; Classroom observation; informal interview
Ma et al.[52]	Chinese	75 undergraduate psychology students	Student reflection journal; coding Table of critical thinking performance in problem solving
Yuan et al.[51]	Chinese	44 undergraduate students majoring in educational technology	Learner Text Interactive Content; Newmen's Critical Thinking Depth Measurement Model

Table 6. (*Continued*).

Source	Language	Sample size	Instruments/Sources of data
Ye and Yin[50]	Chinese	36 college engineering students	Critical issues for group inquiry; group works
Xu[22]	Chinese	88 college students	The Chinese version of Critical Thinking Disposition Inventory (CTDI-CV); interview; student logs
Liang and Fung [55]	English	125 primary school students, 5 English teachers	The California Scale of Disposition of Critical Thinking (CCTDI); audio-recording of group discussion; classroom observation, students' written work; semi-structured interviews with teachers.
Wang and Seepho[56]	English	50 English majors	Learner voice questionnaire; semi-structured interviews
Chiu[57]	English	45 English majors	California Critical Thinking Disposition (CCTD); the summative assessment reflection; student focus group
Liao et al.,[58]	English	118 nursing undergraduates	Chinese version of the Critical Thinking Disposition Inventory (CTDI-CV)

5. Discussion

Teachers and engineering students in China have paid greater attention to critical thinking during the last decade. However, the evaluation revealed that the breadth of the research was more focused on the setting of higher education. Preschool and elementary school pupils must get enough attention. Critical reasoning is not a natural talent. At its 45th Anniversary Conference in 1995, UNESCO stated that education should aid in the development of autonomous judgment, critical thinking, and moral reasoning among young people. The development of critical thinking is a continuous process, and research demonstrates that even toddlers may benefit from instruction in this area. The use of tangible objects (tales, images) to establish favorable circumstances for teaching critical thinking may increase the development of thinking abilities in preschool children aged 5 to 6.

The analysis revealed that not all papers used relevant theories in their research. Despite the fact that there is more research on critical thinking in Chinese classrooms, it is concerning that a huge majority of these studies disregard theoretical grounding. In planning a study, rookie researchers may rely only on their intuitive understanding, resulting in a lack of theoretical foundation[74]. The significance of the theory cannot be disputed. Theoretical frameworks in qualitative research communicate researchers' core principles and offer a clear signal or lens for how new information should be handled in a study. Similarly, theories define a range of phenomena worthy of investigation and how to observe and comprehend them[75]. noted that publications in Chinese social science journals are often replete with assertions, general norms, or emotive anecdotes but lack proper research procedures. According to Sun[76], the research approach of developing a theoretical framework through evaluating literature is no longer enough to meet China's present educational research demands. In this review, it was determined that surveys were the method of choice among Chinese researchers. Because the findings of quantitative research techniques are thought to be more objective and scientific, surveys were frequently employed in China. Experiments were the second-most-favorite kind of design. Using specific instructional approaches, experiments were done to evaluate the students' critical thinking. The duration of the trials did not exceed one semester (12–16 weeks). In a mixed-methods study, for instance, individuals were treated for just four weeks. The growth and training of critical thinking is a long-term, continuing process[17]. Instructors adapt new teaching techniques or tactics in the classroom as a result of experimental research, which is a significant issue for both teachers and engineering students. Zhou et al.[77] stated that the duration of the classroom experiment may have been insufficient to synthesize the impacts of the novel technique. It is considered that the 12-week intervention time on student learning may not be sufficient to make meaningful effects. Longer-term or longitudinal studies may thus serve to characterize the development of engineering students' critical thinking abilities in more detail. Regarding instrumentation, the instruments used in these

investigations were created outside of China. Certain aspects of cultural heritage impact critical thinking. Confucianism has the greatest effect on Chinese culture. The culture of Confucius promotes peace and zhongyong. Moreover, the Chinese possess a collective attitude. It is proposed that the critical thinking test scale now used in China was designed in the past and, hence, cannot be utilized to represent current developments in the area of critical thinking. There are few studies that utilize methods other than instruments to obtain data about critical thinking. There are only eleven papers with qualitative data. As opposed to qualitative data, quantitative conclusions are more frequently acknowledged as scientific. This likely explains why there are so few studies adopting qualitative data collection methodologies in critical thinking research. In addition, it was suggested that cultural, political, and ethical concerns added to the complexities of qualitative research in China.

Regarding the research participants, the analysis revealed that they were virtually exclusively students and teachers in higher education. Similarly, researchers in higher education are instructors. Universities at China's higher education level employ general education to foster critical thinking among engineering students. However, the quality and substance of courses, as well as the teaching philosophy and practices of professors, are crucial aspects that have a direct impact on critical thinking education. Similarly, in the 21st century learning environment, knowledge is continuously updated and created, and the advancement of science and technology has a direct impact on the transmission and interchange of information. These have presented the school's purpose and function with unprecedented obstacles. Therefore, more emphasis should be placed on technology and instructional approaches for teaching and researching critical thinking. Although higher education stresses the significance of the intellectual, moral, and skill development of engineering students, there is always room for improvement. In order for engineering students to gain key 21st century competences and prosper in a diversified and global information economy, elementary and secondary schools must place more focus on cognitive development.

6. Conclusions

The purpose of this study was to determine how much critical thinking research has advanced over the previous decade. The review assessed the chosen publications' ideas, study designs, and data sources. The study highlights three significant consequences. Those interested in exploring critical thinking must first be familiar with critical thinking ideas. In addition, researchers' abilities in study design must be enhanced to guarantee that their studies are anchored in applicable ideas. Second, researchers must use a variety of study designs, such as action research, causal research, and cross-sectional designs, to guarantee that the findings of their studies give information beyond the profiles of critical thinking. Thirdly, people doing research on critical thinking in China need more exposure to qualitative data sources. Researchers might use qualitative data sources such as content analysis and photovoice to diversify their data gathering tactics.

Future studies on critical thinking in Chinese classrooms must concentrate on various phases of formal education, such as early childhood, preschool, elementary, and secondary. The absence of critical thinking in early life and preschool education necessitates additional study in these areas. The study also merits a request for further qualitative research to unravel the intricacies of critical thinking instruction and learning.

Author contributions

Conceptualization, ZL; methodology, ZL; data curation, ZL and MZ; writing—original draft preparation, ZL and MZ; writing—review and editing, ZL and MZ; visualization, SJY; supervision, SJY; project administration, SJY; funding acquisition, SJY. All authors have read and agreed to the published version of the manuscript.

Funding

This work was supported by the Institute of Educational Sciences of Fujian Province under Grant No: FJJKBK21-098.

Conflict of interest

The authors declare no conflict of interest.

References

1. Wu C. Training Teachers in China to Use the Philosophy for Children Approach and Its Impact on Critical Thinking Skills: A Pilot Study. Education Sciences. 2021; 11(5): 206. doi: 10.3390/educsci11050206
2. China Education Association. Core competencies and values for Chinese students' development. 2016; Available online: http://www.scio.gov.cn/37236/37262/Document/1602754/1602754.htm(accessed on 8 December 2023).
3. Tian J, Low GD. Critical thinking and Chinese university students: a review of the evidence. Language, Culture and Curriculum. 2011; 24(1): 61-76. doi: 10.1080/07908318.2010.546400
4. Fan K, See BH. How do Chinese students' critical thinking compare with other students: A structured review of the existing evidence. Thinking Skills and Creativity. 2022; 46: 101145. doi: 10.1016/j.tsc.2022.101145
5. Moseley D, Baumfield V, Elliott J, et al. Frameworks for Thinking. Published online December 1, 2005. doi: 10.1017/cbo9780511489914
6. Jarrett RF, Thorndike RL, Hagen E. Measurement and Evaluation in Psychology and Education. Journal of the American Statistical Association. 1956; 51(275): 560. doi: 10.2307/2281462
7. Lewis A, Smith D. Defining higher order thinking. Theory Into Practice. 1993; 32(3): 131-137. doi: 10.1080/00405849309543588
8. Gu Z, Liu Z. A Course of Critical Thinking. Peking University Press; 2006.
9. Zhang H, Yuan R, He X. Investigating University EFL Teachers' Perceptions of Critical Thinking and Its Teaching: Voices from China. The Asia-Pacific Education Researcher. 2020; 29(5): 483-493. doi: 10.1007/s40299-020-00500-6
10. Liu T, Yu X, Liu M, et al. A mixed method evaluation of an integrated course in improving critical thinking and creative self-efficacy among nursing students. Nurse Education Today. 2021; 106: 105067. doi: 10.1016/j.nedt.2021.105067
11. Ma L, Luo H. Chinese pre-service teachers' cognitions about cultivating critical thinking in teaching English as a foreign language. Asia Pacific Journal of Education. 2020; 41(3): 543-557. doi: 10.1080/02188791.2020.1793733
12. Moher D, Liberati A, Tetzlaff J, et al. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. Annals of Internal Medicine. 2009; 151(4): 264. doi: 10.7326/0003-4819-151-4-200908180-00135
13. Qin, X, Lyu, L. Learning involvement and critical thinking in the cultivation of top-notch innovative personnel: An empirical study based on12 universities with top-notch talent cultivation project in China. Jiangsu Higher Education 2022; 1, 73–82
14. Mei H, Si R, Wang J. On the Relationship Between College Students' Diversity Experiences and Their Critical Thinking Disposition. Journal of Northeastern University (Social Science) 2018; 20(4). doi: 10.15936/j.cnki.1008-3758.2018.04.013
15. Xia H, Zhong B. On Influencing Factors and Cultivation Strategies of University Students' Critical Thinking. Eucational Research. 2017; 5: 67–76.
16. Bi J, Dong Y, Han Y. An Empirical Study on the Development of Critical Thinking of Junior High School Students: From the Perspective of Learning Activity Design. Curriculum and Teaching. 2018; 7: 9–25. doi: 10.13811/j.cnki.eer.2018.07.012
17. Tan C. Conceptions and Practices of Critical Thinking in Chinese Schools: An Example from Shanghai. Educational Studies. 2020; 56(4): 331-346. doi: 10.1080/00131946.2020.1757446
18. Wu Y. Research on the Relationship of Critical Thinking and Community of Inquiry Model. Research on Modern Distance Education. 2017; 4. doi: 10.3969/j.issn.1009-5195.2017.04.012
19. Yuan M, Yu S, Nie, S, et al. Online Learning Activities Character Design to Promote the Development of Critical Thinking. Research on Modern Distance Education. 2017; 2: 76–82.
20. Pu S, Evans M. Critical thinking in the context of Chinese postgraduate students' thesis writing: a positioning theory perspective. Language, Culture and Curriculum. 2018; 32(1): 50-62. doi: 10.1080/07908318.2018.1442473
21. Ye Y, Yin Y. Cognitive characteristics and cultivation strategies of college Students' critical thinking: Empirical research based on group cooperation. Research on Educational Development. 2019; 11. doi: 10.14121/j.cnki.1008-3855.2019.11.011
22. Xu HY. A study of content-based teaching approach to students' critical thinking ability. Foreign Language and Literature.2015; 31(4): 151–156.

23. Theory and practice of education. Choice Reviews Online. 2008; 45(09): 45-5122-45-5122. doi: 10.5860/choice.45-5122
24. Chen J, Hu J. Enhancing L2 Learners' Critical Thinking Skills Through a Connectivism-Based Intelligent Learning System. International Journal of English Linguistics. 2018; 8(6): 12. doi: 10.5539/ijel.v8n6p12
25. Yuan MX, Yu SY, Nie SX, et al. Online learning activities character design to promote the development of critical thinking. Modern Distance Education. 2017; 2: 76–82. doi: 10.13927/j.cnki.yuan.2017.0019
26. Wu, Y. R. An empirical study on blended learning to promote the development of college students' critical thinking ability. Curriculum and Teaching. 2014; 8: 83–88. doi: 10.13811/j.cnki.eer.2014.08.013
27. Lu P, Burris S, Baker M, et al. Cultural Differences in Critical Thinking Style: A Comparison of U. S. and Chinese Undergraduate Agricultural Students. Journal of International Agricultural and Extension Education. 2021; 28(4): 49-62. doi: 10.5191/jiaee.2021.28449
28. Huang Y, Ning C. RETRACTED: Enhancing critical thinking in Chinese students in physical education through collaborative learning and visualization. Thinking Skills and Creativity. 2021; 42: 100958. doi: 10.1016/j.tsc.2021.100958
29. Cheng MHM, Wan ZH. Exploring the effects of classroom learning environment on critical thinking skills and disposition: A study of Hong Kong 12th graders in Liberal Studies. Thinking Skills and Creativity. 2017; 24: 152-163. doi: 10.1016/j.tsc.2017.03.001
30. Huang L, Liang YL, Hou JJ, et al. General Self-Efficacy Mediates the Effect of Family Socioeconomic Status on Critical Thinking in Chinese Medical Students. Frontiers in Psychology. 2019; 9. doi: 10.3389/fpsyg.2018.02578
31. Wu HZ, Wu QT. Impact of mind mapping on the critical thinking ability of clinical nursing students and teaching application. Journal of International Medical Research. 2020; 48(3): 030006051989322. doi: 10.1177/0300060519893225
32. Pu D, Ni J, Song D, et al. Influence of critical thinking disposition on the learning efficiency of problem-based learning in undergraduate medical students. BMC Medical Education. 2019; 19(1). doi: 10.1186/s12909-018-1418-5
33. Ma X, Zhang Y, Luo X. Students' and teachers' critical thinking in science education: are they related to each other and with physics achievement? Research in Science & Technological Education. 2021; 41(2): 734-758. doi: 10.1080/02635143.2021.1944078
34. Zhang C, Fan H, Xia J, et al. The Effects of Reflective Training on the Disposition of Critical Thinking for Nursing Students in China: A Controlled Trial. Asian Nursing Research. 2017; 11(3): 194-200. doi: 10.1016/j.anr.2017.07.002
35. Yang L, Mohd RBS. The relationship between critical thinking and the community of inquiry model: a quantitative study among EFL university students in China. International Journal of Adolescence and Youth. 2020; 25(1): 965-973. doi: 10.1080/02673843.2020.1814359
36. Lu ZH, Chen JW.Critical thinking tendency and learning engagement of college students: The mediating role of achievement goal orientation and academic self-efficacy. 2017; 38(7): 69-77.
37. Li, N, Han, et al. The General Situation and Variation Analysis of Undergraduates' Critical Thinking: Based on an Investigation in Shandong Province. Higher Education Research in China. 2019; 2. doi: https://doi.org/10.16298/j.cnki.1004-3667.2019.02.09
38. Shen XJ, Hu H, Zhang BJ, et al. The development status of college students' critical thinking and learning style and its relation research. XDJYJS. 2021; 31(2): 48–57. doi: 10.3969/j.issn.1009-8097.2021.02.007
39. Wu Y. Research on the Relationship of Critical Thinking and Community of Inquiry Model. Research on Modern Distance Education. 2017; 4. doi: https://doi.org/10.3969/j.issn.1009-5195.2017.04.012
40. Zheng YN, Li XY, Gong, Q, et al. The mediating role of empathy between critical thinking and perseverance among senior medical students in Ganzhou City. Medicine and Society. 2021; 34. doi: 10.13723/j.yxysh.2021.02.020
41. Zhang T, Zhang S, Gao Q, et al. Study on the development of critical thinking of learners in online peer assessment. Research on Qudio-Visual Education. 2022; 06: 53–60.doi: https://doi.org/10.13811/j.cnki.eer.2022.06.008
42. Gao ZY. A survey on the current situation of critical thinking tendency of applied undergraduate students. Higher Education Exploration. 2013; 2: 129–133.
43. Mao WJ, Xu CY. Chinese high school teachers' conceptions and teaching practice about critical thinking. Research on Educational Development. 2018; 1: 75–84. doi: https://doi.org/10.14121/j.cnki.1008-3855.2018.20.013
44. Zhou Q, Huang Q, Tian H. Developing Students' Critical Thinking Skills by Task-Based Learning in Chemistry Experiment Teaching. Creative Education. 2013; 04(12): 40-45. doi: 10.4236/ce.2013.412a1006
45. Hwang G, Huang H, Wang R, et al. Effects of a concept mapping-based problem-posing approach on students' learning achievements and critical thinking tendency: An application in Classical Chinese learning contexts. British Journal of Educational Technology. 2020; 52(1): 374-493. doi: 10.1111/bjet.13007

46. Qin H, Ge W, Sun, et al. Application of PBL teaching method in cultivation of critical thinking ability of students in experimental teaching. Experimental Technology and Management. 2013; 30(6): 121–123. doi: 10.16791/j.cnki.sjg.2013.06.037
47. Han Q, Wei XP. The experimental study of task-situational teaching on the development of junior high school students' critical thinking. Theory and Practice of Education. 2014; 34(10): 62–64. doi: 10.5860/choice.45-5122
48. Qiao AL. A Study on the Influence of Learning Style on College Students′ Critical Thinking Development—An Empirical Study based on Online Teaching Environment. Modern Distance Education. 2020; 5: 89–96. doi: 10.13927/j.cnki.yuan.20201109.002
49. Nie X, Yu Y, Yuan X, et al. An Empirical Study on Promoting Critical Thinking through Asynchronous Interactive Learning Activities. Modern Distance Education. 2016; 3: 60–67. doi: 10.13927/j.cnki.yuan.2016.0031
50. Ye H, Yin M. Cognitive characteristics and cultivation strategies of college students' critical thinking: Empirical research based on group cooperation. Educational Development Research. 2019; 11. doi: 10.14121/j.cnki.1008-3855.2019.11.011
51. Yuan MX, Yu SY, Nie SX, et al. Online learning activities character design to promote the development of critical thinking. Modern Distance Education. 2017; 2: 76–82. doi: 10.13927/j.cnki.yuan.2017.0019
52. Ma H, Yao ML, Tong, LJ. Enhancing critical thinking of college students: Intervention study of service learning. Psychological Development and Education. 2013; 5: 515–524. doi: 10.16187/j.cnki.issn1001-4918.2013.05.007
53. Huang L, Fan APC, Su N, et al. Chinese medical students' disposition for critical thinking: a mixed methods exploration. BMC Medical Education. 2021; 21(1). doi: 10.1186/s12909-021-02801-w
54. Ng SY, Cheung K, Cheng HL. Critical Thinking Cognitive Skills and Their Associated Factors in Chinese Community College Students in Hong Kong. Sustainability. 2022; 14(3): 1127. doi: 10.3390/su14031127
55. Liang W, Fung D. Fostering critical thinking in English-as-a-second-language classrooms: Challenges and opportunities. Thinking Skills and Creativity. 2021; 39: 100769. doi: 10.1016/j.tsc.2020.100769
56. Wang S, Seepho S. Facilitating Chinese EFL Learners' Critical Thinking Skills: The Contributions of Teaching Strategies. SAGE Open. 2017; 7(3): 215824401773402. doi: 10.1177/21582440177340244
57. Chiu, J. Flipping silence to coffeehouse chat: Developing Chinese students critical thinking. The Asian Journal of Applied Linguistics, 4(1), 89–101.
58. Liao Y, Wang S, Weng D, et al. Impact of a case-based-team-based learning model on critical thinking and self-efficacy of nursing undergraduates in China. Indian Journal of Continuing Nursing Education. 2020; 21(2): 159. doi: 10.4103/ijcn.ijcn_51_20
59. Du X, Zhang L. Investigating EFL Learners' Perceptions of Critical Thinking Learning Affordances: Voices From Chinese University English Majors. SAGE Open. 2022; 12(2): 215824402210945. doi: 10.1177/21582440221094584
60. Ma L, Liu N. Teacher belief about integrating critical thinking in English teaching in China. Journal of Education for Teaching. 2022; 49(1): 137-152. doi: 10.1080/02607476.2022.2044267
61. Liu, H., & Jin, L. M. An empirical study of English debate and the development of college students' critical thinking. Foreign Languages and Their Teaching, 5, 24–28. https://doi.org/10.13458/j.cnki.flatt.003825
62. Leng J, Guo RF. Research on Discourse Analysis of Critical Thinking in Online Collaborative Platform. Audio-Visual Education Research. 2018; 2. doi: 10.13811/j.cnki.eer.2018.02.004
63. Mao WJ, Xu CY. Chinese high school teachers' conceptions and teaching practice about critical thinking. Research on Educational Development. 2018; 1: 75–84. doi: 10.14121/j.cnki.1008-3855.2018.20.013
64. Zhao W. Epistemological flashpoint in China's classroom reform: (How) can a 'Confucian do-after-me pedagogy' cultivate critical thinking? Journal of Curriculum Studies. 2019; 52(1): 101-117. doi: 10.1080/00220272.2019.1641844
65. Li JJ, Pan SD. Analysis of classroom dialogues among high school physics teachers—Based on the perspective of critical thinking teaching. Educational Science Research. 2019; 6.
66. Pei Z, Zheng C, Zhang M, et al. Critical Thinking and Argumentative Writing: Inspecting the Association among EFL Learners in China. English Language Teaching. 2017; 10(10): 31. doi: 10.5539/elt.v10n10p31
67. Cui L, Zhu Y, Qu J, et al. Psychometric properties of the critical thinking disposition assessment test amongst medical students in China: a cross-sectional study. BMC Medical Education. 2021; 21(1). doi: 10.1186/s12909-020-02437-2
68. Ma L, Luo H. Chinese pre-service teachers' cognitions about cultivating critical thinking in teaching English as a foreign language. Asia Pacific Journal of Education. 2020; 41(3): 543-557. doi: 10.1080/02188791.2020.1793733
69. Huang Y, Wu B. Developing Critical Thinking Skills in Stratified College English Courses: Experiences of Teachers in a Large University in China. Creative Education. 2020; 11(07): 1042-1046. doi: 10.4236/ce.2020.117075
70. Yuan R, Stapleton P. Student teachers' perceptions of critical thinking and its teaching. ELT Journal. 2019; 74(1): 40-48. doi: 10.1093/elt/ccz044
71. Chen L. Understanding critical thinking in Chinese sociocultural contexts: A case study in a Chinese college. Thinking Skills and Creativity. 2017; 24: 140-151. doi: 10.1016/j.tsc.2017.02.015

72. Tan C. Conceptions and Practices of Critical Thinking in Chinese Schools: An Example from Shanghai. Educational Studies. 2020; 56(4): 331-346. doi: 10.1080/00131946.2020.1757446
73. Wei Y. CULTIVATING CRITICAL THINKING ABILITY IN BTI IN CHINA. Indonesian EFL Journal. 2018; 4(2): 90. doi: 10.25134/ieflj.v4i2.1380
74. DiSessa AA, Cobb P. Ontological innovation and the role of theory in design experiments. Journal of the Learning Sciences. 2004; 13(1): 77-103. doi: 10.1207/s15327809jls1301_4
75. Collins CS, Stockton CM. The Central Role of Theory in Qualitative Research. International Journal of Qualitative Methods. 2018; 17(1): 160940691879747. doi: 10.1177/1609406918797475
76. Sun M. Educational research in Mainland China: current situation and developmental trends. Comparative Education. 2011; 47(3): 315-325. doi: 10.1080/03050068.2011.586764
77. Zhou Q, Huang Q, Tian H. Developing Students' Critical Thinking Skills by Task-Based Learning in Chemistry Experiment Teaching. Creative Education. 2013; 04(12): 40-45. doi: 10.4236/ce.2013.412a10066