Research on Pre-service Mathematics Teachers' Mathematical Critical Thinking Ability in China

Abstract

As the pre-service mathematics teachers, their mathematical critical thinking ability influences students' mathematical learning and innovative thinking. So, more and more researchers have begun to pay attention to the research on pre-service mathematics teachers' mathematical critical thinking ability in China. With the summary of the relevant results, the following conclusions are drawn~~–~~: ~~(1)~~ firstly, the research on pre-service mathematics teachers' mathematical critical thinking ability mainly focuses on the concept of mathematical critical thinking, the current situation of pre-service teachers' ability, the influencing factors, and the cultivation measures. ~~(2)~~ Secondly, the influencing factors and cultivation measures of mathematical critical thinking ability are the hot issues of current research. ~~(3)~~Thirdly, the research method is single. Most researchers just use theoretical thinking to analyze the influencing factors and cultivation measures. ~~(4)~~Fourthly, the suggestion about improving pre-service mathematics teachers' mathematical critical thinking is a blank spot. Therefore, it is suggested to use more research methods on mathematical critical thinking ability to find more comprehensive influencing factors and more reasonable enhancement measures.

Keywords: Pre-service Mathematics Teachers, Mathematical Critical Thinking, Thinking Ability

~~1.~~ Introduction

For mathematics education, the training of mathematical critical thinking is beneficial to improve students' ability to ask questions and solve problems (Pei, 2022). Teachers can influence students' thinking ability which requires mathematics teachers to have strong mathematical critical thinking ability. As future educators, pre-service mathematics teachers' critical thinking ability not only affects the thinking ability of future students but also affects the professional development of teachers themselves (Li, 2017). In recent years, scholars have paid attention to the area of pre-service teachers' mathematical critical thinking ability. However, there is no collation of relevant research findings, so this paper intends to review the existing relevant literature and systematically analyze the current research status and shortcomings. This research can provide a reference to improve pre-service mathematics teachers' mathematical critical thinking ability. In addition, it can help researchers grasp the characteristics and status of current research to promote further research by scholars.

Research Questions

The following are the research questions of this paper ~~is~~

Formatted: Font: 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering, Tab stops: Not at 0.55 cm

Formatted: Font: 12 pt, Not Bold

"1. What is the current status of the research on pre-service mathematics teachers' mathematical critical thinking ability?" ~~The following specific questions are included:~~

~~(1)~~2. What research has been done on pre-service mathematics teachers' critical mathematical thinking ability?

~~(2)~~3. What are the main areas that scholars have been studied?

~~(3)~~4 What are the main research methods on mathematical critical thinking ability?

~~(4)~~5. What are the blank spots in the current research on pre-service mathematics teachers' mathematical critical thinking ability?

~~2.~~ Methods

~~2.1.~~ Source of Information

This article adopts the literature method and uses the China National Knowledge Infrastructure (CNKI) documents as the data source. CNKI is the most authoritative document retrieval tool for national academic journals, which includes all the contents of journals in China. This paper chooses this database to ensure the persuasiveness and reliability of the research.

~~2.2.~~ Data Collection

A total of 12 articles were retrieved using "critical thinking" and "pre-service teachers" as the topic words. A total of 29 articles were retrieved using "critical thinking" and "teacher educators" as the topic words. A total of 150 articles were retrieved using "critical thinking ability in mathematics" as the topic words. Considering the research questions and the number of citations in the literature, 39 references and 5 related books were finally selected.

~~3.~~ Results

Through collation, ~~we~~ the researchers found that scholars' research on pre-service mathematics teachers' mathematical critical thinking ability focuses on four aspects: the concept of mathematical critical thinking, the current situation of pre-service mathematics teachers' mathematical critical thinking ability, the influencing factors, and the cultivation measures.

~~3.1.~~ The Research on Concept

~~3.1.1.~~ The Concept of Critical Thinking

Dewey first clearly defined critical thinking, introducing the term "reflective thinking", stating that reflective thinking is the continuous reflection on an issue (Dew~~ae~~y ~~and~~ & Wang, 2001 p?). Dewey viewed critical thinking as a thought process, and later scholars have viewed critical thinking as a cognitive process. The American Psychological Association (APA) provided an authoritative definition of critical thinking in 1990: critical thinking is the thought process of making self-regulating judgments about the processes, theories, methods, contexts, evidence, and criteria for evaluating knowledge that produces knowledge (Wu, 2004). According to He (year), critical thinking is the process of understanding in which our thinking is examined comprehensively to deepen

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering, Tab stops: Not at 0.55 cm

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering, Tab stops: Not at 0.55 cm

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Comment [AK1]: This part should come immediately after research question

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

understanding (He, 2000). Du (year) considers critical thinking as a process in which students correctly analyze thinking materials, examine thinking processes, make comprehensive and correct analyses in their thinking activities (Du, 2012). According to Huang (year), critical thinking is the process of operating critical thinking about one's knowledge or opinions, and it is the process of concluding through questioning and argumentation (Huang, 2020).

According to Zhu and Lin (year), critical thinking is the intellectual quality of critically evaluating the thinking material and examining the thinking process in the thinking activity (Zhu ~~and~~ & Lin, 1986). Luo and Yang pointed out that critical thinking is a personality quality in which individuals make self-regulating judgments about the process of knowledge generation (Luo ~~and~~ & Yang, 2002).

Some scholars consider critical thinking as an ability, represented by Ennis (year), who believes that critical thinking is the ability of individuals to make rational decisions about what to do and what to believe (Ennis ~~and~~ & Du, 2016). Gu (year) thinks critical thinking is the ability to ask appropriate questions and present sound arguments (Gu ~~and~~ & Liu, 2006). Wen refers to critical thinking as the ability to think critically and considers it as the ability to make purposeful and informed judgments about things based on criteria (Wen et al., 2011).

~~3.1.2.~~ The Concept of Mathematical Critical Thinking

Regarding the criticality of mathematical thinking, Cao believes students' critical mathematical thinking is manifested by having an interest and ability to be willing to test in various ways (Cao, 1990). According to Li, the criticality of mathematical thinking is demonstrated by not trusting blindly to general conclusions or others' opinions, having a solid intention to check, and being good at finding and correcting errors (Li, 1994).

Scholars have also analyzed mathematical critical thinking based on the concept of critical thinking combined with the characteristics of the mathematics discipline. According to Liu, mathematical critical thinking refers to the quality of closely examining the correctness and truthfulness of the information. It is expressed as the ability to give one's own opinion about existing mathematical representations and to use known conditions comprehensively for self-feedback (Liu, 2014). According to Xiong, mathematical critical thinking is a quality of thinking that refers to students who are good at examining the thinking process in their thinking activities (Xiong, 2012).

Zeng regards mathematical critical thinking as a kind of mathematical analysis ability and believes that mathematical critical thinking is not an independently existing form of thinking (Zeng, 2017). That is an integrated mathematical analysis ability supported by various basic knowledge. Other scholars believe that mathematical critical thinking is a kind of thinking process. Xiao believes that mathematical critical thinking refers to the thinking process in which college students purposefully reexamine, defend and rethink the mathematical theories they have learned (Xiao ~~and~~ & Dai, 2010). According to Liu, in terms of the object of thinking, mathematical critical thinking is the process of reflecting, questioning, clarifying, and independently analyzing one's thinking (Liu, 2007).

Comment [AK2]: This citation is obsolete

Comment [AK3]: The names of these authors should be put as they were initially, say, they are five. All of them should be written and then et al should be used in the subsequent citations

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Comment [AK4]: Too old

~~3.1.3.~~ The Concept of Mathematical Critical Thinking Ability

There are relatively few studies on the concept of mathematical critical thinking ability. Huang considers critical thinking ability as a stable psychological characteristic of individuals (Huang, 2016). It is expressed in the individual's judgment of the accuracy and value of various relevant knowledge to make rational decisions about what to believe and choose. Jia believes that mathematical critical thinking ability is an important part of mathematical thinking, mainly critically examining the correctness and truthfulness of information (Jia, 2020). Specifically, mathematical critical thinking ability is concentrated in the qualities of not blindly following the crowd, not blindly believing in the knowledge in mathematics textbooks, daring to question books and teachers, and being good at identifying problems and actively adjusting one's thinking. Ji considers the ability of mathematical critical thinking as a comprehensive ability that involves the ability to analyze, judge and ~~evaluate,~~evaluate reason, explain, and self-monitor in mathematical activities (Ji, 2021).

~~3.2.~~ The Research on Status

Zhou and Song believe that mathematics teacher-training students do not show the advantage of critical thinking in college, and there is still much room for improving their critical thinking ability (Zhou and Song, 2017). Yan believes that the traditional teacher training education model ~~is~~ & mainly reflected in straightforward teaching methods. Teachers instill knowledge through lectures, and students receive knowledge through rote memorization (Yan, 2017). Under such a teaching model, pre-service teachers' understanding of teaching can only be a superficial understanding, and critical reflection is impossible to arise. Through a survey comparison, Ma found that the level of critical thinking of senior students in teacher training colleges is significantly lower than that of junior students (Ma et al., 2015). Zhang also concluded through a survey study that college students' critical thinking does not become stronger with increasing grades (Zhang, 2016). These studies show that pre-service mathematics teachers' mathematical critical thinking ability is weak and that current teacher education colleges do not significantly improve pre-service mathematics teachers' mathematical critical thinking ability.

In addition, scholars have made a more in-depth investigation on the current situation of college students' critical thinking ability. The research results of Ye and Yin showed that the cognitive characteristics of college students' critical thinking process are mainly: thinking indifference, thinking compromise, thinking conformity, and thinking fixation (Ye ~~and~~ & Yin, 2019). Xia and Zhong believed that the overall level of critical thinking among college students is ~~average,~~average; the depth of reasoning ability is not strong. So cultivating critical thinking among college students is relevant and urgent (Xia ~~and~~ & Zhong, 2017). The results of a study by Li showed that some students lacked systematization and organization in analyzing and dealing with problems, and they did not know how to find the causes (Li et al., 2019). Zhao believes that teacher training colleges and universities students often lack questioning spirit and reflective consciousness (Zhao, 2009).

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

~~3.3.~~ The Research on Influencing Factors

~~3.3.1.~~1.1.1. Pre-service Teachers

Li analyzed the influencing factors in terms of the personal affective traits of college students. He concluded that the factors of the student subject, the student's gender, chosen profession, and evaluative ability significantly influence their critical thinking ability (Li ~~and~~ & Li, 2014). Li pointed out that mathematical critical thinking depends on mathematical knowledge, the level of development of the subject's thinking, and the psychological quality of the student in terms of thinking content (Li, 2004). Qiu argued that extracurricular learning and college students' study engagement status significantly affect students' critical thinking ability (Qiu, 2021). The stronger the extracurricular learning and research atmosphere, the better the critical thinking level of students. A good level of engagement in learning helps students be more proactive in their thinking and exploration, which promotes the improvement of critical thinking (Cao, 2016).

~~3.3.2.~~ Normal University

As for the influencing factors at the school level, Zhao and Cao analyze them from the aspects of cultivation objectives and the cultivation mode of universities (Zhao, 2009; Cao, 2016). They believe that at the current stage, many colleges and universities in China generally deviate seriously from the scientific and human-oriented principles in terms of cultivation objectives. In terms of cultivation mode, universities continue the traditional memory-indoctrination teaching mode. Zhang and Xia analyzed the faculty level of universities. Zhang argues that university teachers' teaching philosophy, teaching content, teaching assessment, and teaching methods affect the cultivation of critical thinking (Zhang et al., 2016). Xia argues that some university teachers do not have high expectations of their teaching effectiveness and only stay at the level of regular teaching maintenance. There is a problem of their lack of teaching responsibility and their attitude and ability to deconstruct and innovate existing subject knowledge and concepts (Xia, 2014). Cao et al. argue that external factors such as classroom culture can also affect the critical thinking ability of college students. Education in China has emphasized the absolute obedience of students to teachers since ancient times (Cao, 2016; Yang, 2013; Xia, 2020). The suppression of students' critical thinking makes students subordinate to their teachers. Qiu analyzes the academic assessment from the perspective of academic assessment (Qiu, 2021). She argues that assessment is a test of teaching effectiveness and supervision of learning to think. The setting of assessment affects students' way of thinking and habits.

~~3.3.3.~~ Family Environment

Family environment is also an essential factor influencing pre-service teachers' critical thinking ability. Chen argues that objective factors such as parental literacy and family economic background affect college students' critical thinking ability (Chen, 2018). Yu and Shen found that family income significantly impacts college students' critical thinking ability (Yu and Shen, 2019). More and more sustained financial investment is needed to guarantee that children can have greater competence through higher education, especially higher-order competencies represented by critical thinking ability.

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Heading 1, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

~~3.4.~~ Research on Training Measures

~~3.4.1.~~ Normal University

Cao (year) analyzes the curriculum from the perspective of curriculum development and argues that the curriculum should be reformed to train students' critical thinking ability(Cao, 2016). Schools can set up a set of interdisciplinary core courses to broaden students' horizons and improve their scientific and rational critical thinking ability (Xia,2014). Xia and Zhou analyze the school's teaching objectives at the setting level. Xia argues that schools should establish a view of knowledge based on the cultivation of critical thinking and the value of knowledge for creativity (Xia, 2020). Zhou argues that when schools work on critical thinking development, they should first adjust the goals of talent development in a targeted way according to the principles of individualization, diversity, and internationalization (Zhou, 2013). This will allow students' autonomy and individuality to be fully developed under the school's critical thinking cultivation goals.

~~3.4.2.~~ College Teachers

Xia believes that university teachers should have profound knowledge and have humble qualities and broad-mindedness (Xia, 2014). Teachers should be open and tolerant to students' questions and criticisms in teaching practice. Teachers can encourage students to reconstruct the existing conceptual knowledge system in many forms. Zhou suggests that university teachers plan more opportunities and time for students to think for themselves and do bold challenges and explorations (Zhou, 2013). Sun argues that teachers should change the traditional one-way injection teaching mode and adopt heuristic and discussion teaching mode to effectively play the leading role of teachers (Sun, 2012). Li suggested that teachers in higher education institutions should consciously guide students to think and make judgments in teaching to train students' critical thinking (Li, 2017). Each pre-service teacher must carefully observe other pre-service teachers in the classroom and give feedback on the teaching of fellow lecturers at the end of the class.

~~3.4.3.~~ Teaching Environment

Some scholars suggest creating a teaching environment at the level of teaching atmosphere. Ye suggests building a learning environment conducive to cultivating critical thinking among college students (Ye, 2019). According to Qiu, a student-oriented classroom teaching atmosphere that focuses on inspiration and guidance should be created to build an extracurricular learning and research environment conducive to developing students' critical thinking (Qiu, 2021).

~~4.~~ Discussion

From the above studies, scholars mainly focus on four aspects: the concept of mathematical critical thinking, the current situation of pre-service mathematics teachers' mathematical critical thinking ability, the influencing factors, and the cultivation measures. Among them, the influencing factors and cultivation measures of mathematical critical thinking ability are the hot spots of current research. That is

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Heading 1, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 2, Line spacing: single, No bullets or numbering

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering, Tab stops: Not at 0.55 cm

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

consistent with the conclusions reached in Jiang's study (Jiang, 2021). However, there are few studies on the concepts of mathematical critical thinking ability and the current situation of pre-service mathematics teachers' ability.

Specifically, researchers mainly defined mathematical critical thinking as the quality of thinking or a thinking process. Some researchers defined it as an ability. Many scholars confused the concepts of mathematical critical thinking and mathematical critical thinking ability. Therefore, future research is better to distinguish the two concepts. This was also mentioned in Zhai's study (Zhai, 2014).

From the viewpoint of research subjects, scholars mainly analyzed the influencing factors of college students. There are few studies specifically for pre-service mathematics teachers. In terms of research methods, scholars mostly used theoretical thinking to analyze the influencing factors, lacking empirical analysis. That leads to the intense subjectivity of the research results and the lack of comprehensive analysis of the influencing factors. Scholars Qiu and Chen also pointed out that the research methods of the relevant studies were relatively single (Qiu, 2021; Chen, 2018). Therefore, future research is better to use more comprehensive research methods and conduct a more objective analysis of the factors affecting pre-service mathematics teachers' mathematical critical thinking ability.

In addition, scholars mostly make suggestions based on their own experiences or with reference to previous studies, which makes the credibility and feasibility of the suggestions not convincing. Therefore, subsequent research can be conducted from a broader perspective to make more comprehensive suggestions to develop pre-service mathematics teachers' mathematical critical thinking ability.

~~5.~~ Conclusion

Through summarizing the previous studies, it can be seen that scholars focus on the concept of mathematical critical thinking, the current situation of pre-service mathematics teachers' mathematical critical thinking ability, the influencing factors, and the cultivation measures to enhance pre-service mathematics teachers' mathematical critical thinking ability.

The following conclusions can be drawn by summarizing the related studies: (1) The influencing factors and cultivation measures of mathematical critical thinking ability are the hot issues of current research. (2) The research method is single. Most researchers just use theoretical thinking to analyze the influencing factors and cultivation measures. (3) The suggestion about improving pre-service mathematics teachers' mathematical critical thinking is a blank spot.

Therefore, future research is better to use more comprehensive research methods and conduct a more objective analysis of the factors affecting pre-service mathematics teachers' mathematical critical thinking ability. And subsequent research can be conducted from a broader perspective to make more comprehensive suggestions to develop pre-service mathematics teachers' mathematical critical thinking ability.

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, Line spacing: single, No bullets or numbering, Tab stops: Not at 0.55 cm

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

References

Cao, C. H. (1990). *Introduction to secondary school mathematics teaching*. Beijing: Beijing Normal University Press.

Cao, Y. H. (2016). Cultivation of critical thinking among college students. *Education and Career*, 100(15), 118-120.

Chen, T. (2018). *Research on critical thinking of teacher-training students.* (Master's thesis, Shanxi Normal University, Taiyuan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201901&filename=1019021468.nh&uniplatform=NZKPT&v=dwZInYi1C2o_uRbf_3trJsxWmCu7Ki9oaDNmcqhQoVXz2R-FIcUCixIbYIktS2X-

Dewey, J., & Wang, C. X. (2001). *Democracy and education*. Beijing: People's Education Press.

Du, Y. W. (2012). *The development of mathematical critical thinking ability teaching*. Proceedings of International Conference on Engineering and Business Management.

Ennis, R., Du, J. Y., & Li, X. (2016). Critical thinking test. *Industrial and Information Technology Education*, 4(06),8-17.

Gu, Z. Y., & Liu, Z. H. (2006). *Critical Thinking Tutorial*. Beijing: Peking University Press.

He, Y. F. (2000). On critical thinking. *Journal of Social Science*, 22(11) ,10-16+92-93.

Huang, D. Y. (2020). *An investigation of pre-service mathematics teachers' critical thinking about teaching*. (Master's thesis, Huazhong Normal University, Wuhan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD202101&filename=1020114626.nh&uniplatform=NZKPT&v=RmIlpznXIyxfkgBsbUdfcmGXyDq8jazPIjn_JLOTXxgJnLXvJbphcCCmpYrqDQlf

Huang, H. E. (2016). How to implement the cultivation of critical thinking ability in elementary school mathematics teaching. *Examination Weekly*, 10(27), 76.

Ji, H. Q. (2021). *Research on the current situation of mathematical rational thinking of high school students and the cultivation strategies.* (Master's thesis, Shandong Normal University, Jinan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFDTEMP&filename=1021106973.nh&uniplatform=NZKPT&v=JHzLJe5yQfVPsMvDW2yM2Z53Tb8wCroUmfhBrE7tPpRPfDEbRFk6S9XjvOE2KZig

Jia, Z. W. (2020). Strategies for cultivating critical thinking ability in high school mathematics. *Secondary School Curriculum Counseling (Teacher Newsletter)*, 10(07), 70-71.

Jiang, J. (2021). *Research on the cultivation of critical thinking of teacher-training students in mathematics courses*. (Master's thesis, Shanghai Normal University). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD202102&filename=1021590310.nh&uniplatform=NZKPT&v=PhCNy-4tsUrVZM1UxwnBXv8LBbSf6g65yTPkVPQYt33gw79goTsxwLGmdci-sKVe

Formatted: Font: (Default) Times New Roman, 12 pt, Font color: Auto

Formatted: Heading 1, First line: 0 ch, Tab stops: Not at 0 cm

Formatted: Font: (Default) Times New Roman, 12 pt, Not Bold

Li, J. J., Pan, S. D., & Liao, Y. X. (2017). Insights from foreign critical thinking research. Educational Science Research, 28(09), 81-87.

Li, N., Han, Q. E., & Zhong, W. X. (2019). Analysis of the current situation and differences in critical thinking quality of college students--a survey study based on Shandong Province. *China Higher Education Research*, 35(02), 49-52.

Li, W. J. (2004). *Mathematical critical thinking and its teaching*. (Master's thesis, Shandong Normal University, Jinan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD0506&filename=2004124903.nh&uniplatform=NZKPT&v=oLUZgaP846JwRZADWx7bSE-5iooHaj_mlj8u5a6-T2E_Ouc5iHcc-Gk6zA5i2UX1

Li, Y. Q. (1994). *Introduction to mathematics education.* Beijing: China Science and Technology Press.

Li, Z. S., & Li, Y. X. (2014). Implications of the cultivation of critical thinking in American universities for English teaching in China. *China Foreign Language*, 11(06), 14-20.

Liu, M. (2014). The way to cultivate "critical thinking quality" in mathematics for secondary school students. *Teaching and Management*, 31(36), 139-141.

Liu, Q. Z. (2007). *Exploration of critical thinking and trial-and-error teaching in mathematics.* (Master's thesis, Hebei Normal University, Shijiazhuang). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD2008&filename=2007150982.nh&uniplatform=NZKPT&v=B5e6JmXsrkLXd0SsH5ybMaaJKHE4dMyVPsMyme1-pGxp8WNH_epdkaFmg2Qz21aG

Luo, Q. X., & Yang, X. H. (2002). A preliminary revision of the California Critical Thinking ability Test. *Psychological Science*, 39(06), 740-741.

Ma, J. Y., Zhao, Q., & Zhang, Y. (2015). An investigation study on the tendency of critical thinking among teacher-training students in colleges and universities. *Journal of Mathematics Education*, 24(06), 21-25.

Pei, C. G. (2022). The development of mathematics critical thinking disposition questionnaire and its reliability analysis. China Examination, 32(03), 44-50.

Qiu, L. (2021). *An empirical study on the factors influencing the level of critical thinking of master students.* (Master's thesis, Nanchang University). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFDTEMP&filename=1021797872.nh&uniplatform=NZKPT&v=5YqBP0CoiKyA7KTWUTCKLIQiH1WbWYBRr9D-GhpBZ4eNgbB6_Rppm3tRGMNSlq0l

Sun, L. (2012). The importance of cultivating critical thinking ability of college students and the analysis of countermeasures. *China Adult Education*, 21(08), 51-53.

Wen, Q. F., Wang, J. Q., & Zhao, C. R. (2011). A Study on the Reliability of the Discursive Tendency Scale for Chinese College Students. *Foreign language E-Learning*, 33(06), 19-23.

Wu, Z. H. (2004). On critical thinking. *Journal of Guangzhou University (Social Science Edition)*, 3(11), 10-16+92-93.

Xia, H. (2014). Critical thinking of students in university teaching and the cultivation path. *Education and Career*, 98(18), 185-187.

Xia, H. H., & Zhong, B. L. (2017). Research on the influencing factors and cultivation strategies of critical thinking development of college students. *Educational Research*, 39(05), 67-76.

Xia, Q. (2020). The Nurturing Value of Critical Thinking. *Educational Science Research*, 36(08), 18-24+30.

Xiao, Y. H., & Dai, Y. X. (2010). An analysis of college students' mathematical critical thinking survey. *Henan Education(Mid)*, 58(04), 52-53.

Xiong, Q. J. (2012). The development of mathematical critical thinking by "media". *New Course (Comprehensive Edition)*, 6(02), 10-11.

Yan, D. (2017). Cultivation of pre-service teachers' critical thinking under the perspective of transformative learning. *Education Observation(First Half of the Month)*, 6(17), 60-62.

Yang, X. (2013). *Critical thinking development of college students: a perspective of classroom culture.* (Master's thesis, Shandong Normal University, Jinan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201302&filename=1013216389.nh&uniplatform=NZKPT&v=exLpdfBqS6_uitmoEkxTUCi-ifEJ2XWiBdABLfMAwYaZNxFYixrTHcl04NTZgG-F

Ye, Y. H., & Yin, Y. M. (2019). Exploring the cognitive characteristics and cultivation strategies of college students' critical thinking--an empirical study based on cooperative group inquiry. *Educational Development Research*, 40(11), 66-74.

Yu, G. X., & Shen, H. (2019). The effect of family income on undergraduate students' critical thinking ability-an empirical study based on institution-level mediating effects. *China Higher Education Research*, 35(02), 41-48.

Zeng, L. Y. (2017). How to develop students' mathematical critical thinking. *Mathematical and Rational Problem Solving Research*, 10(03), 11.

Zhai, F. F. (2014). *Teaching research on the cultivation of mathematical critical thinking for senior students*. (Master's thesis, Shandong Normal University, Jinan). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD201402&filename=1014192743.nh&uniplatform=NZKPT&v=EwLegnHU9homQDEYuaN9HIkhsF39PqtEPdV-ZaOn1M3FsHxx-I5QNk8NeSV_Joof

Zhang, M., Ru, J. F., & Yin, Y. (2016). A study on the current situation and causes of critical thinking among college students. *Journal of Chongqing University (Social Science Edition)*, 22(03), 202-207.

Zhao, J. T. (2009). *Research on the cultivation of critical thinking among college students*. (Master's thesis, Dalian University of Technology). Retrieved from https://kns.cnki.net/kcms/detail/detail.aspx?dbcode=CMFD&dbname=CMFD2010&filename=2010021495.nh&uniplatform=NZKPT&v=7Y4IsxJNsII9UE5zHJfT7Yw9YxWDBETJrViFwwLBKeorz_fgrTieQPO2J5XVgogP

Zhou, J. (2013). Empirical insights into the development of critical thinking ability in the United States. *Curriculum Education Research*, 4(04), 19.

Zhou, Y. J., & Song, Z. Z. (2017). A comparative study of mathematics teachers' and college students' tendency of critical thinking. *Reference for Teaching Secondary School Mathematics*, 46(Z3), 121-124.

Zhu, X. P. (2007). On the cultivation of critical thinking traits in college students. *Higher Education Exploration*, 23(03), 44-46.

Zhu, Z. X., & Lin, C. D. (1986). *The psychology of thinking development*. Beijing: Beijing Normal University Press.

Comment [AK5]: Recent APA referencing style should be consulted and use accordingly