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CRITICAL THINKING SKILLS FOR CHINESE TEACHERS: A STUDY OF MATHEMATICS TEACHERS' PERCEPTIONS

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Abstract

Critical thinking is a vital skill that promotes students' learning, enhances their creativity to solve problems, encourages them to seek new strategies and develops their thinking to a higher level. However, students cannot develop critical thinking by themselves, they need teachers' support and guidance. The aim of the research is to explore how Chinese mathematics teachers define critical thinking, and how their gender, teaching experiences and perceptions of critical thinking affect their mathematics class. Quantitative and qualitative methods were applied in the study. Data collected were analysed by deploying the statistics of mean, standard deviation, and Pearson's γ analysis at a 5% level of significance. Based on this paper, results revealed that gender and teaching experience are not significant variables but teaching experience and culture influence teachers' confidence and behaviour while teaching critical thinking. This study provided opportunities for future research, particularly in the area of closing the gap in mathematics teachers' perception of critical thinking

between China and Western countries, and how to support students develop critical thinking skills in their daily learning.

Keywords

Critical Thinking, Gender, Teaching Experience, Teachers' Perceptions

1. Introduction

Critical thinking dates back to Socrates in ancient Greece more than 2,500 years ago, from Socrates to contemporary scholars, as an educational ideal, critical thinking has long been recognized as a requirement for educational achievement (Liu, 2023). Critical thinking has been regarded as an important and necessary educational outcome because it helps students in the regulation of their study skills, and subsequently empowers them to effectively contribute to their future careers. Critical thinking has become an essential qualification a competency and a survival skill needed by students in facing the 21st century (Harjo et. al., 2019). for successfully competing in the global business market, demanded by employers (Bataineh & Alazzi, 2009). Thus, improving students' critical thinking skills has become a significant and vital task in the 21st century (Organisation for Economic Co-operation and Development, (OECD), 2018). Although the term critical thinking is widely used in Western countries, the definition of critical thinking has been subject to theoretical debates by many scholars from different cultural backgrounds and in different fields (Liu, 2023). For this particular study, the discussion and definition of critical thinking are in the strand of education.

2. Literature Review

As a vital skill, critical thinking has been emphasized by educators and scholars, the National Council for Excellence in Critical Thinking (NCECT) (2017) meets to discuss critical thinking every year. Critical thinking means making reasoned judgments that are logical and well-thought-out (Fisher, 2001; Heard et. al.,2020; Liu et. al., 2015). Within the mathematical content, students should be able to demonstrate logical, critical, analytical, creative and responsive skills in problem-solving (Afdareza & Yuanita, 2020). Critical thinking occurs when students are solving mathematics problems, as students are analyzing, evaluating, interpreting, and synthesizing information. Critical thinking is a way of thinking in which students do not simply accept all conclusions they are exposed to but have an attitude that involves curiosity and questioning.

Knowledge-based discussions can be more effective in developing an individual's critical thinking skills than a teacher who only transfers knowledge to students (Changwong et. al., 2018). When discussing with peers or teachers, students are required to provide factual inferences related to the topic, meaning students need prior knowledge on the topic, students also need the ability to clarify their ideas logically and be able to analyze and evaluate information. Individuals who think critically have the ability to understand logical connections between ideas, detect mistakes in inductions and deductions of issues, and come to a reasonable solution while problem-solving.

Thinking is a natural process, but without guidance, it can often be biased or uninformed (Duron et. al., 2006), therefore, teachers' perceptions of critical thinking may affect the enhancement of students' critical thinking abilities (Ozkan-Akan, 2003). Teachers who perceive that students can develop critical thinking skills demonstrate to students that there is often more than one solution to a problem. This actively encourages students to develop and apply critical thinking throughout their education (Choy, 2003). Teachers who provide questions that have obvious answers (Zohar et. al., 2001) may believe that problems that require high-order critical thinking are not suitable for low-achieving students, as those students are not equipped to understand them (Zohar et. al., 2001). Thus, teachers' perceptions or opinions on critical thinking affect students' development of their critical thinking abilities (Zohar et. al., 2001). It is hard for students to develop critical thinking skills naturally without a teacher's support and guidance throughout their learning (Ozkan-Akan, 2003).

With educational globalization, in the last two decades, the Chinese education system has increasingly attempted to assimilate Western education approaches and philosophies. For example, the recent curriculum reform addressed improving students' overall abilities in mathematical thinking ability, knowledge acquisition, problem-solving skills, and the process of mathematical modelling (Wang et. al., 2017). Scholars are experimenting with various methods which aimed to improve Chinese students' critical thinking skills (Chen, 2017). Most research studies are mainly about nursing and education (Liu et. al., 2015), and explore the reason why Chinese students have lower scores on critical thinking tests compared with other Western countries' students. For example, Cheng and Wan (2017) explored the effect of the classroom learning environment on critical thinking skills and pointed out that traditional Confucian values still exert influence. Cultural psychological studies remind us that critical thinking is absolutely culturally based and is a typical Western product, Asian cultures may demonstrate or value thinking skills in different ways (Chen, 2017). Paradoxically, Chinese students perform well in mathematics and other scientific subjects (Turner, 2006). For

example, Chinese students have higher achievement compared to US students in solving complex mathematical problems in International Mathematical Olympics, solving complex mathematical questions involves reasoning, decision-making, analysis and generalizing which are all critical thinking skills. So, if Chinese students are quiet and hesitant to ask questions in class does not mean that they are inevitably uncritical (Tian & Low, 2011). Recently, Liu (2023) adds that Chinese teachers' perceptions of critical thinking are influenced by their culture, therefore the possibility of cultural variability in critical thinking should not be ignored.

Since the research is all concerned with students' critical thinking ability or cultural influence, Chinese teacher, as a key factor affecting the development of student's critical thinking, is currently researched blank. When discussing the critical thinking ability of Chinese students, the understanding and definition of critical thinking by Chinese teachers is a crucial and unavoidable topic.

As a vital skill, critical thinking has been emphasized by educators and scholars, the National Council for Excellence in Critical Thinking (NCECT) (2017) meets to discuss critical thinking every year. Critical thinking is a western term, So

Teachers play an important role in supporting students to develop their critical thinking skills, before we discuss how Chinese students' critical thinking skills and their performance in International Maths competion, how Chinese teachers' definition and perceptions of critical thinking skills is vital will influence how they deliver these skills in their daily teaching, there is a research gap of this, how critical thinking is perceived in Chinese education is unexplored. Therefore, it is worth investigating these Two two research questions investigated within this study are:

- How do gender and teaching experience influence teachers' definitions of critical thinking?
- What are Chinese mathematics teachers' perceptions of their students' critical thinking?

This study examines critical thinking defined by teachers in China, to investigate how teachers' gender, teaching experience and perceptions of critical thinking skills affect their teaching. This is also expected to provide insight into how critical thinking is defined differently across different cultures.

3. Methods

Quantitative and qualitative research methods are used together in this study. Quantitative data were analyzed first, followed by qualitative data. The survey method was utilized to obtain a

representation of Chinese teachers' perceptions of critical thinking, and further exploration of the relationship between teachers' genders, teaching experience and their understanding of critical thinking was included. The qualitative method was used to obtain answers that provide further information surrounding Chinese mathematics teachers' perceptions of critical thinking. With the use of open-ended questions, teachers will have the opportunity to express their thoughts in specific detail. The qualitative data was obtained through in-depth interviews with participants.

To ensure the validity and reliability of the surveys, a pilot study was conducted in order to to decide whether the study was feasible and worthwhile.

The participants of this study were Chinese secondary school mathematics teachers. Through invitation emails and snowballing, the participants were recruited. In total, 98 secondary mathematics teachers responded to the survey.

In this study, gender was taken as a variable. There was a need for participants to define a different dimension of critical thinking, depending on their cultural background and belief system. When regarding the averages of individuals' critical thinking levels, their gender is considered. In this study, teaching experience was taken as a second variable. The more teaching experience a teacher has, the greater the possibility they have of generalizing and describing thinking skills, as well as addressing them in mathematics teaching and learning. Univariate analysis was applied to the analysis of one variable at a time (Bryman, 2016), and a bar chart was utilized to represent nominal or ordinal data, such as the percentage of the participants' ages and qualifications. Distribution of values, such as mean, median and mode were utilized to seek out the average of the distribution with SPSS. Pearson's γ was applied when examining relationships between interval variables.

4. Results And Discussion

How do gender and teaching experience influence teachers' definitions of critical thinking? The quantitative data obtained from the survey was used to collect Chinese secondary mathematics teachers' concepts of critical thinking across various genders, qualifications, and teaching experience. Coding took the form of identifying a participant by one digit number, for example, male-1, female-2. Qualification was coded as bachelor's degree-1, master's degree-2, and doctorate-3. The teaching experience was recorded in numbers, representing how many years of teaching experience; less than one year was coded as 1. Table 1 summarized the profile of participants from the survey.

Table 1: *Profile Of Participants*

Gender		
	N=51 Missing 1	
Male	16	31.4%
Female	35	68.6%
Qualification		
	N=41 Missing 11	
Bachelor's degree	32	78%
Master's degree	7	17.1%
Doctor degree	2	4.9%
Teaching Experiences		
(No. of years)	N=46 Missing 6	
1-4	5	10.9%
5-9	7	15.2%
10-14	7	15.2%
15-20	10	21.7%
>20	15	32.6%

(Source: Author's Own Illustration)

Table 1 showed that the data of 52 participants were used for the final data analysis, including 35 females (67.3%), and 16 males (30.8%), including one 1 participant with an undetermined gender. The majority of the participants had a bachelor's degree (78%, N=32), 17.1%(N=7) had a master's degree, and 4.9% (N=2) had a doctorate. About 54%(N=25) of participants had over 15 years of teaching experience.

Gender was taken as a variable. For participants, each one allowed their belief system to define skills within critical thinking. Table 2 shows the differences in perceptions of critical thinking among participants between genders.

Table 2: *The Different Perceptions Of Critical Thinking Between Genders*

Gender	N	t	Sig. (2-tailed)	
Analysis	Male	14	-1.096	.279
	Female	34	-1.076	.293

Reasoning	Male	15	-1.016	.315
	Female	35	-1.049	.303
Drawing Inferences	Male	15	-.981	.332
	Female	34	-.919	.367
Problem-Solving	Male	15	-.918	.363
	Female	35	-1.089	.283
Logical	Male	15	-.485	.630
	Female	34	-.571	.571
Clarifying Ideas	Male	14	-.569	.572
	Female	35	-.602	.552
Draw Conclusion	Male	15	-1.441	.156
	Female	35	-1.564	.128
Scepticism	Male	15	-.141	.888
	Female	35	-.154	.879
Inductive	Male	15	-.139	.890
	Female	35	-.147	.884
Deductive	Male	15	-.613	.543
	Female	35	-.667	.509
Application	Male	15	.172	.864
	Female	35	.190	.850
Self-Directed	Male	14	-.583	.563
	Female	35	-.608	.548
Evaluation	Male	14	-.048	.962
	Female	35	-.052	.959

$P<0.05$

(Source: Author's Own Illustration)

When the results in Table 2 were examined, it could be seen that($p>0.05$) there was no significant difference between males and females in their answers to the definition of critical thinking.

The findings were consistent with the other research experiments (Aktas & Ünlü, 2013), but were not in line with the findings of Ashraah, et. al. (2012) who highlighted that gender, length of experience and qualifications of Islamic teachers affect their definition of critical thinking skills.

The teaching experience was taken as a second variable. Table 3 shows the distribution of critical thinking skills based on teachers' teaching experience. The years of teaching experience were coded as group Group 1 (No. years of 1-5), group Group 2 (No. years of 6-10), group Group 3 (No. years of 11-15) and group Group 4 (No. years of 16-20). Independent samples t-test was applied to find out if there were any differences between teaching experience and teachers' answers to research questions. Results were compared between the two groups and were shown in Table 3.

Table 3: *The Different Perceptions Of Skills In Critical Thinking Based On Teaching Experience*

Teaching Experiences		N	t	Sig. (2-tailed)
Analysis	1-5 years	3	.543	.597
	6-10 years	11	.464	.678
Reasoning	1-5 years	3	-.735	.476
	6-10 years	11	-1.041	.335
Drawing Inferences	1-5 years	3	-.956	.358
	6-10 years	11	-1.075	.346
Problem-Solving	1-5 years	3	-.990	.342
	6-10 years	11	-.635	.584
Logical	1-5 years	2	-.177	.863
	6-10 years	11	-.232	.839
Clarifying Ideas	1-5 years	3	-.417	.684
	6-10 years	11	-.267	.812
Draw Conclusion	1-5 years	3	-3.549	.004
	6-10 years	11	-2.296	.135
Scepticism	1-5 years	3	1.566	.143
	6-10 years	11	1.997	.104
Inductive	1-5 years	3	-.388	.704

	6-10 years	11	-.399	.714
Deductive	1-5 years	3	-2.562	.025
	6-10 years	11	-2.746	.059
Application	1-5 years	3	-.956	.358
	6-10 years	11	-.971	.398
Self-Directed	1-5 years	3	-1.346	.563
	6-10 years	11	-.608	.203
Evaluation	1-5 years	3	.184	.857
	6-10 years	11	.148	.893

$p<0.05$

(Source: Author's Own Illustration)

From Table 3, data from group 1 and group 2 showed that there is a significant difference between teaching experience and their answers to 'drawing a conclusion'($p=0.04$) and 'deductive'($p=0.025$). Results from Table 3 showed that teachers who had 6-10 years of teaching experience agreed more on drawing conclusions and deductive skills than teachers who had 1-5 years of teaching experience. The results were similar to the findings of Innabi and Sheikh (2007) who found that 70% of Jordanian teachers misidentified a conclusion as critical thinking. Deductive skills are using the provided information to form general principles or conclusions. For example, since all squares are rectangles, and all rectangles have four sides; all squares have four sides. It seemed that if teachers misidentified 'deductive' skills as critical thinking, this would misidentify 'drawing a conclusion' because these two skills are connected to it. Compared to teachers who had rich teaching experience, teachers who had fewer years of teaching experience do not have as many strategies in their teaching method that incorporate critical thinking (Lauer, 2005).

What are Chinese mathematics teachers' perceptions of their students' critical thinking? The results were obtained from two categories: (a) the frequency of students' using critical thinking in Maths class and (b) the skills that students need to improve on.

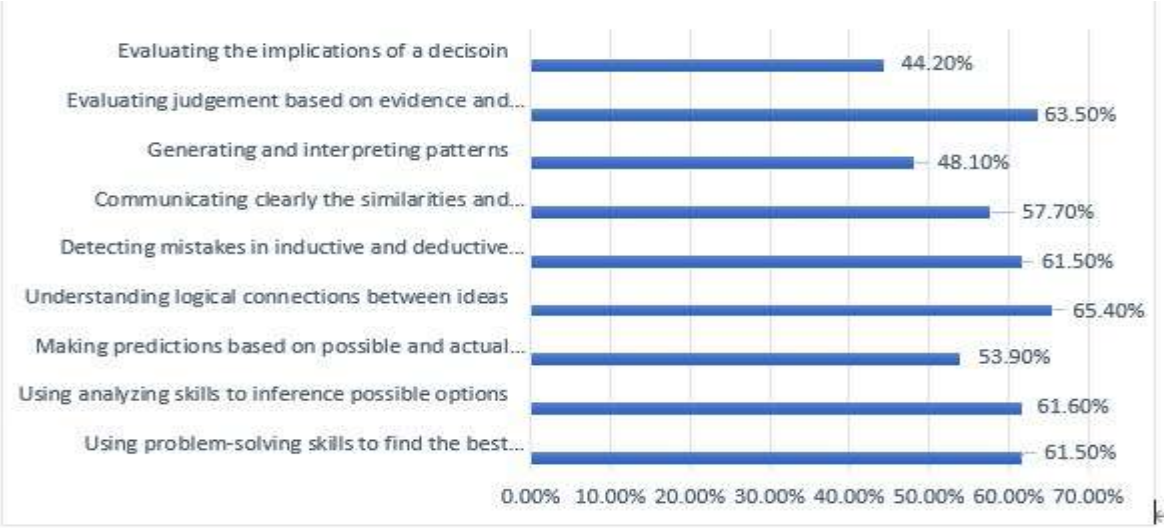

Figure 1: *Teachers' Perception Of Students' Demonstration Of Critical Thinking In Mathematics Class*

(Source: Author's Own Illustration)

Figure 1 showed that teachers valued 'understand understanding logical connections between ideas' (65.4%) and 'evaluate evaluating judgement based on evidence and assumptions'(63.5%) the highest. Teachers agreed that students strongly demonstrated 'detect[ing] detecting mistakes in inductive and deductive reasoning'(61.5%), 'using analyzing skills to inference possible options'(61.6%) and 'using problem-solving skills to find the best solution'(61.5%). Teachers agreed that students lacked in the 'evaluation evaluating of the implications of a decision' (44.2%).

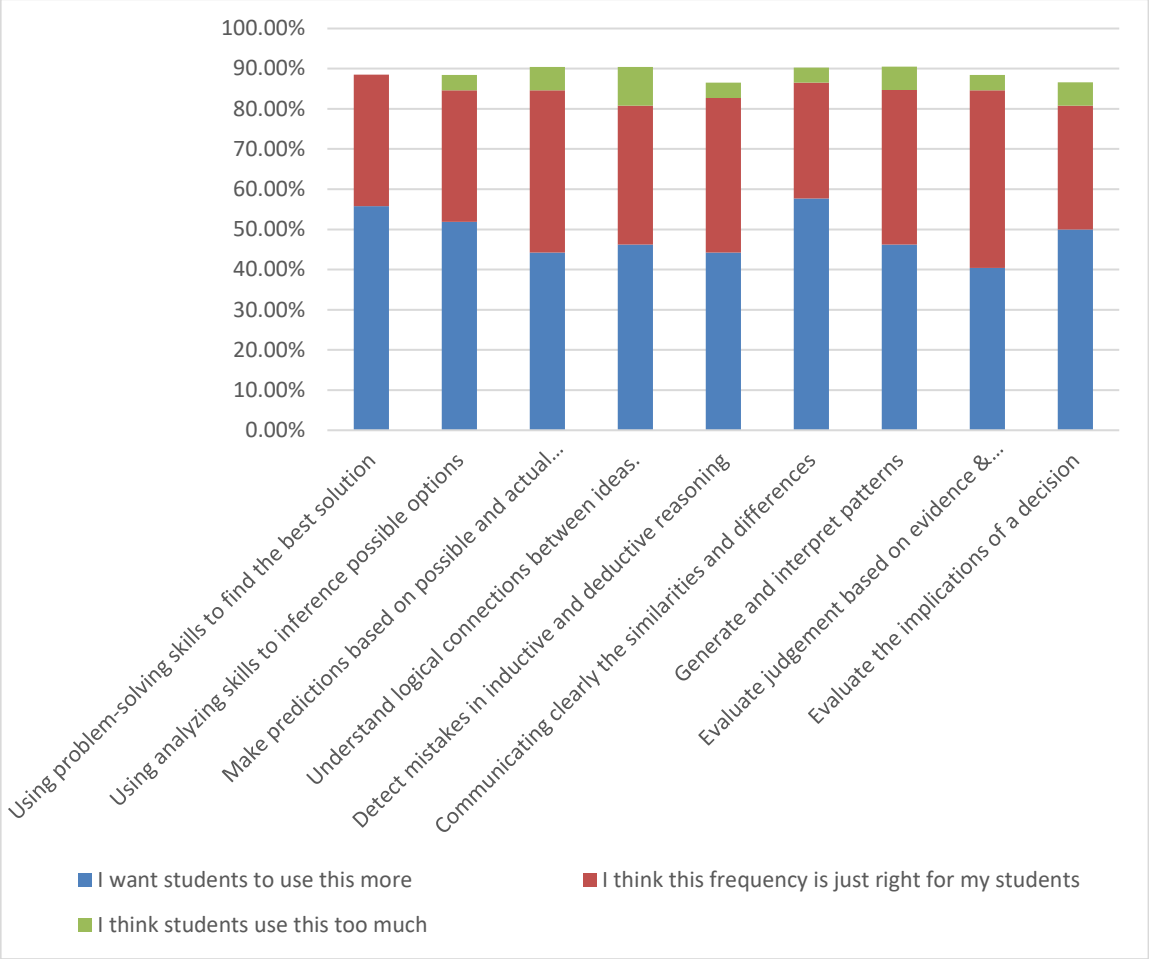

Figure 2: *Teachers' Evaluation Of Students' Critical Skills*

(Source: Author's Own Illustration)

Results from Figure 2 revealed that over half of teachers (57.7%, N=52) agreed that students need to apply 'clearly communicating the similarities and differences' more often. This reflected the view of Liu, He and Liu (2015)'s findings that Chinese classrooms are more teacher-guided, text-oriented, and exercise-based. This teaching and learning style influences teachers' perceptions of critical thinking, and the learning environment might restrict students' opportunity to articulate ideas surrounding their skills in problem-solving.

Figure 3 showed the correlations between teachers' perception of students' demonstrations of critical thinking in Maths class and teachers' evaluation of the skills that students need to improve on.

Table 4: *Correlation Of Teachers' Evaluation Of Students' Critical Skills*

		Q7#2_1	Q7#2_2	Q7#2_3	Q7#2_4	Q7#2_5	Q7#2_6	Q7#2_7	Q7#2_8	Q7#2_9
Q7#2_1	Pearson Correlation	1	.330*	.444**	.177	.437**	.312*	.616**	.316*	.613**
	Sig. (2-tailed)		.025	.002	.239	.003	.035	.000	.033	.000
	N		46	46	46	45	46	46	46	45
Q7#2_2	Pearson Correlation		1	.533**	.569**	.447**	.479**	.682**	.633**	.509**
	Sig. (2-tailed)			.000	.000	.002	.001	.000	.000	.000
	N			46	46	45	46	46	46	45
Q7#2_3	Pearson Correlation		*	1	.306*	.476**	.433**	.516**	.320*	.358*
	Sig. (2-tailed)				.036	.001	.002	.000	.030	.016
	N				47	45	47	47	46	45
Q7#2_4	Pearson Correlation		*		1	.513**	.646**	.439**	.537**	.441**
	Sig. (2-tailed)					.000	.000	.002	.000	.002
	N					45	47	47	46	5
Q7#2_5	Pearson Correlation					1	.455**	.475**	.274	.438**
	Sig. (2-tailed)						.002	.001	.069	.003
	N						45	45	45	44
Q7#2_6	Pearson Correlation						1	.395**	.518**	.355*
	Sig. (2-tailed)							.006	.000	.017
	N							47	46	45
Q7#2_7	Pearson Correlation							1	.601**	.572**
	Sig. (2-tailed)								.000	.000
	N								46	45
Q7#2_8	Pearson Correlation								1	.426**
	Sig. (2-tailed)									.004
	N									45
Q7#2_9	Pearson Correlation									1
	Sig. (2-tailed)									
	N									45

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

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

(Source: Author's Own Illustration)

Results from Figure 3 showed that r>0.1, which meant that there was some sort of correlation. This study followed Cohen's (1988) general guidelines, which stated that if 0.3>r>0.1 there is a small correlation. If 0.5>r>0.3 there is a moderate correlation, if r>0.5 there is a strong correlation. As r=0.177 means that there was a weak correlation between 'Using problem-solving skills to find the best solution' and 'Understanding logical connections between ideas. This revealed that Chinese teachers identified that problem-solving is a skill, they believed that understanding logical connections between ideas is related to analysis skills. There was a strong correlation (r=0.682) between 'Using analyzing skills to inference possible options' and 'Generate and interpret patterns.' The results revealed that Chinese teachers favored favoured analysis which was in line with the results in their responses to the research question. This result was consistent with the findings of Howe (2004) who pointed out that analysis requires careful examination, decomposition into separate elements, and the construction of well-thought-out judgments to draw a conclusion. As defined by these factors, analysis is an important component of fostering critical thinking.

5. Conclusion

This study found that gender and teaching experience were not significant variables in influencing a teacher's perception of critical thinking, but teachers who have less teaching experience have a lack of confidence and strategies in teaching critical thinking.

In terms of students' critical thinking levels, teachers agreed that students need more opportunities to articulate their ideas. Chinese education culture may influence teachers' behaviour in supporting students' learning and development of critical thinking skills, such as teacher-centered teacher-centred lectures or activities.

The study involved a few limitations. First, it was a small scale of the survey, the sample size was not larger enough to do other related statistical analysis with SPSS, like a Chi-Square test. Second, it was an online survey, so it was hard to know which district the participants come from, as there might differences among teachers' programs or curricula in different districts in China. Third, though the open questions provided some information about teachers' perception of critical thinking, it was hard to incorporate the depth of investigation of the reason or more related details about the research questions. The limitations assisted with explaining and providing boundaries, for example, exploring urban/suburb secondary school mathematics teachers' perceptions about incorporating critical thinking skills within mathematics classes.

This study provided opportunities for future research, particularly in closing the gap between mathematics teachers' perception of critical thinking within China and western Western countries. For future research, there is a need to explore Chinese mathematics teachers' knowledge of critical thinking, and how they teach critical thinking skills in mathematics classes. Moreover, there is a need to examine obstacles within critical thinking in China and how to implement critical thinking across the curriculum. Through this, we can explore the relationship between mathematical achievement and critical thinking.

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