Exploring Chinese Secondary Teachers' Perception of Critical Thinking in Mathematics Teaching

Wei Liu, Hillcrest Christian College–VIC, Australia

Abstract

The significance of developing students' critical thinking has been widely recognized by educators. Critical thinking has been regarded as an important and necessary educational achievement as it empowers students to creatively contribute to their future chosen careers. Quantitative and qualitative methods are used in this study to examine the definition of critical thinking espoused by teachers in China. This study aims to further investigate teachers' perceptions of critical thinking skills within their teaching, and how they promote critical thinking among their students. This study expects to provide significant insight into critical thinking within different educational cultures.

Keywords: Critical Thinking, Critical Thinking in China, Chinese Education Culture

Introduction

Critical thinking

The history of critical thinking

Critical thinking can be traced back to Socrates, over 2500 years ago in ancient Greece. By a method of probing questions, Socrates demonstrated that people could think profoundly before they accept ideas and can justify their claims of knowledge by asking deep questions. In the 20th century, William Graham Sumner recognized the urgent need for critical thinking throughout life and education. In her book, *Folkways* (1906), Sumner stated: "Education in the critical faculty is the only education of which it can be truly said that it makes good citizens" (Paul, Elder, & Bartell, 1997, p.633). Early philosophers did not form a formal definition of critical thinking, however, contemporary scholars have since developed their own. Contemporarily, strands of critical thinking are defined differently in different fields, such as philosophy, psychology, and education (Coney, 2015). For this particular study, the discussion and definition of critical thinking are in the strand of education.

Recent development in critical thinking

From Socrates to contemporary scholars, critical thinking as an educational ideal has been consistently regarded as essential and necessary for educational achievement (Forawi, 2016; Howe, 2004; Siegel, 2010). Although the term critical thinking is widely used in Western countries, the definition of critical thinking is an ongoing theoretical debate amongst many scholars of different cultures. Dewey (1938) argued that learning to think is the fundamental objective of education. Critical thinking is reflective thinking—the thinker determines the implication of ideas after actively questioning and considering them (Dewey, 1938). Ennis (1962) initially defined critical thinking as "the correct assessing of statements" (p. 83). Later Ennis was critical of his early work (Ennis,1996) in which he modified the definition to "critical thinking is reasonable reflective thinking focused on deciding what to believe or do" (Ennis, 1993, p. 180). Dewey (1938) and Ennis (1996) addressed that critical thinking is reflective thinking, but the weakness is that the definitions do not point out how to process information before making a decision. Glaser (1941) ascribed three main elements of critical thinking: considering issues and concerns within one's experiences, knowing how to reason, and using reasoning methods for problem-solving. Facione (1990, p.6) defined critical thinking as "purposeful, self-regulatory, judgment, which results in interpretation, analysis, evaluation, and inference, as well as an explanation of evidential, conceptual, methodological, or contextual considerations upon which that judgment is based." Facione (2013) later distinguished the definition of critical thinking using six core skills: interpretation, analysis, explanation, evaluation, self-regulation, and inference. Frequently, the notion of critical thinking is defined as the development and evaluation of arguments (Facione,1984). Critical thinking through "purposeful, reflective judgment, increases the chances of producing a logical conclusion to an argument or solution to a problem" (Dwyer, Hogan & Stewart, 2014, p.13). Critical thinking includes abilities such as applying available information to new situations, analysing causes or motives for situations, and evaluating opinions on subjects (Cheng & Wan, 2017). Considering definitions of critical thinking that Facione (1984), Dwyer et al. (2014), and Cheng and Wan (2017) formulated, in this study, critical thinking is understood as skills that make individuals think, question and challenge ideas, generate solutions to problems and make intelligent decisions based on analysis and evidence. In mathematics, critical thinking may involve logical reasoning and skills while

separating facts from opinions. Individuals who think critically can understand logical connections between ideas, detect mistakes in induction and deduction reasoning, and come to a logical decision while solving problems.

Chinese culture and critical thinking

In this section, two contradictory opinions about how to develop critical thinking skills in students are discussed. Some scholars agreed that critical thinking is a western cultural term and is not adapted to Chinese culture, while others believe that rather than culture, nurturing is a more impactful method of developing these skills.

According to Ku and Ho (2010), cultural heritage is a great obstacle while nurturing critical-minded citizens. In the Western context, diversity in opinion is respected and valued, judgment is characterized as analysis. Contrasting, traditional Chinese Confucian ideas place a higher value on respect towards authority, tradition, and harmony (Chen, 2017). Under this educational culture, students tend to prioritize consensus and avoid arguments (Liu, He & Li, 2015). Although researchers and scholars do not explicitly claim that Chinese culture lacks elements of critical thinking, their arguments suggest that critical thinking is culturally based and a typically Western term (Tian & Low,2011). For example, multiple scholars (McBride, Xiang, Wittenburg, & Shen, 2002; Tiwari, Avery, & Lai, 2003) have demonstrated that Chinese students scored lower than Western students in most dispositions of critical thinking through the use of the California Critical Thinking Dispositions Inventory (CCTDI). As education in the Chinese classroom is heavily teacher-guided, students are thought to be rote learners. Therefore, those researchers (Clark & Gieve, 2006; Heng, 2016, as cited in Chen, 2017) question whether critical thinking can be applied to Chinese educational culture.

Tian and Low (2011) expressed different opinions. They pointed out how CCTDI was developed in the United States, so it is impossible to eliminate social and cultural prejudice within it. Hence, test results may undervalue Chinese students because the results are paradoxical to the finding that show Chinese students perform better in mathematics and other scientific subjects (Cai & Hwang, 2002; Turner, 2006). For example, Chinese students have higher achievement scores compared to US students in solving complex mathematical problems (Cai & Hwang, 2002). Complex mathematical problems need students to have the ability to draw inferences and evaluate the judgements and methods they use while solving problems. All these skills are attributes of critical thinking. Also, high-ability students can deal with complex problems and tasks in flexible and creative ways, and cannot be considered rote learners (Wolfle,1986). Critical thinking is an unconsciously developed social product, it is related to cultural thinking and is a kind of social practice (Atkinson,1997). If Chinese students are quiet, and hesitant to ask questions in class, this does not mean that they are inevitably uncritical in the way they think (Tian & Low, 2011).

Nurture

According to Paton (2005), rather than culture, nurturing is a larger key factor that affects Chinese students' critical thinking. Kenney (2013,) further echoed that critical thinking is not an inherent skill but is an inclusion of both skills and habit (Cheng & Wan, 2017). For this reason, not only Chinese students but also students from all countries need to be nurtured to be able to apply critical thinking skills (Tian & Low, 2011). Both Bruner and Vygotsky (Wood, Bruner, & Ross, 1976) emphasize a child's environment, particularly social environments. Both agree that adults should play an active role in assisting a child's learning.

Schools, colleges, and universities are the main educational environments that develop these skills in students (Alwadai, 2014). Developing students' critical thinking requires teachers who possess critical thinking skills themselves and are well-educated in terms of content knowledge and pedagogical skills (Aktaş & Ünlü, 2013). For example, teachers who possess advanced critical thinking strategies may, in turn, improve the critical analytical skills of their students (Mei-Yun, Swee, Jung, & Leah, 2003; Paul et al., 1997).

Many studies show that teachers who understand the concepts and teaching strategies of critical thinking perform better in teaching critical thinking skills (Onosko,1992; Semmar & Fakhro, 2009; Zhang, 2001). Onosko (1992) found that teachers who reflect on their practice, value their thinking, and emphasize the depth of content often create a thought-provoking atmosphere in the classroom. Onosko (1992) suggested that investigating how teachers think about critical thinking may provide data for teaching theory, which in turn can provide information for pedagogical practices Zhang (2001) found a relationship between teaching methods and the way of thinking in teaching. Teachers who value and commit to critical thinking within teaching are more likely to demonstrate reflective teaching methods. Studies that collected teachers' perceptions of critical thinking found that although most teachers indicated that critical thinking was a part of their teaching, many people could not express how to effectively teach it (Howe, 2000; Paul et al.,1997). Since there is a lack of explanation of, and guidelines on critical thinking for both teachers and students (Bissell & Lemons,2006; Turner,2006), the method of teaching critical thinking is repeatedly reported as a concern. In this case, teachers are advised to use different teaching methods to support and enhance students' critical and logical thinking, as well as problem-solving skills. To meet this requirement, teacher education programs should aim to improve these skills for teacher candidates (Incikabi, Tuna, & Biber, 2013). Teachers need the training to be more effective as they teach critical thinking skills (Innabi & Sheikh, 2006). In this context, to support teachers that are infusing critical thinking skills within mathematics, future teacher education programs should allocate more courses for critical thinking. In this way, prospective teachers can become models of critical thinking and make the subject easier and more understandable for the students.

Research questions

As critical thinking is a western expression, are Chinese teachers committed to thinking critically to the same degree as western teachers? How do Chinese mathematics teachers define critical thinking? How do those teachers promote critical thinking in their mathematics lessons? These research questions attempt to investigate critical thinking within the Chinese educational culture and explore how teachers in Chinese mainland schools interpret critical thinking. This will provide a springboard for future discussion and research, such as teaching approaches, pedagogies, curriculum, and policy reform within China's education.

Methods

Quantitative and qualitative research methods are used collaboratively in this study. Quantitative data was collected via survey. The survey method was utilized to obtain a representation of Chinese teachers' definitions of critical thinking. Distribution of values, such as mean, median and mode were utilized to seek out the average of the distribution with SPSS. Qualitative data was collected via questionnaires and interviews. The importance of critical thinking was explored through a questionnaire to collect a broad range of perceptions

of critical thinking within mathematics. Data were categorised based on skills. An in-depth interview was applied to obtain further details about participants' responses, which highlights information about their understanding of critical thinking.

The participants of this study are all secondary school mathematics teachers from China. An invitation email and snowballing were used to recruit participants. Eventually, 98 secondary mathematics teachers responded to the survey, but 46 were excluded due to missing data. Therefore, only the data of 52 teachers were included in the final analysis.

Results and discussion

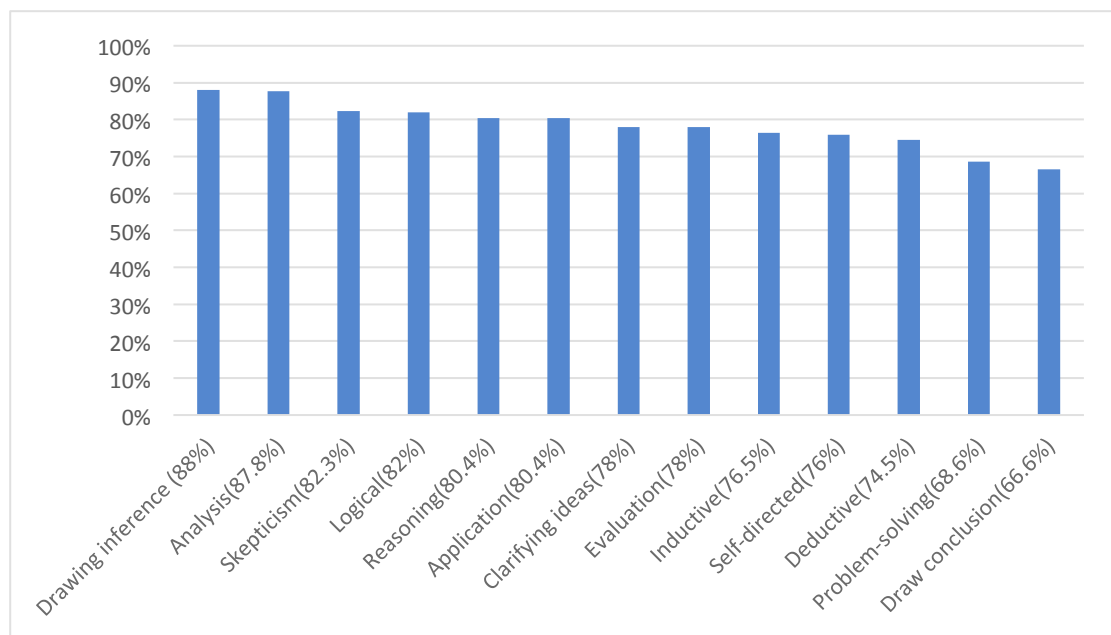*1: How do Chinese mathematics teachers define critical thinking?*

Figure 1. Chinese secondary mathematics teachers' definitions of critical thinking

Figure 1 shows the different definitions of critical thinking that teachers in China value. Each of the definitions is sorted in descending order. The top five definitions were drawing inferences (88%), analysis (87.8%), scepticism (82.3%), logical (82%), reasoning(80.4%) and application (80.4%).

Table 1 Mean and Standard Deviation (SD) of definitions of critical thinking

		Analysis	Reasoning	Drawing inferences	Problem-solving	Logical	Clarifying ideas	Draw conclusion	Scepticism	Inductive	Deductive	Application	Self-directed	Evaluation
N	Valid	49	51	51	50	50	50	51	511	51	51	51	50	50
	Missing	3	1	1	2	2	2	1	1	1	1	1	2	2
Mean		4.18	3.98	4.14	3.90	4.02	3.98	3.71	4.16	3.96	3.92	4.10	3.98	3.94
Std. Deviation		.755	.812	.670	.831	.820	.937	.965	.857	.891	.891	.878	.915	.913

As can be seen from Table 1, participants expressed their strong agreement (M=4.18) with the definition 'analysis', with the second highest mean (M=4.16) being for the definition 'scepticism'. With a high mean score of (M=4.14), participants agreed with 'drawing inferences'. In addition to this, a high agreement (M=4.10) was recorded for 'application.'

Chinese secondary mathematics teachers were found to hold positive opinions on critical thinking. Chinese teachers' definitions of critical thinking are consistent with the definitions of Facione's (1990), they tended to emphasize skills that incorporate deeper understanding such as drawing inferences, and reasoning. This analysis supports the view of Howe's (2004) study that shows Japanese teachers' conceptions of critical thinking correlate with concrete learning outcomes. Chinese teachers also endorse scepticism and logic while defining critical thinking, showing that Chinese mathematics teachers encourage probing questions and critical responses.

The qualitative data from subsidiary question one was collected regarding teachers' opinions on the importance of critical thinking (Innabi & Sheikh,2006., Howe,2004).

A broader view of their opinion could be obtained by investigating the ranking of the top 5 definitions. Results were sorted into four categories as shown in Table 2.

Table 2 Teachers' explanation of the importance of critical thinking

Category	Board understanding	Themed phrases
Thinking	Helps to develop students' logical thinking Improves mathematical thinking ability Practice independent thinking Can cultivate the ability to think independently Practice independent thinking This is an important indicator of rational thinking Can improve the quality of students' thinking To guide students to think creatively Helps develop students' divergent thinking skills Improve students' thinking ability With critical thinking, we can start solving problems Solve problems independently	logical thinking mathematical thinking independent thinking rational thinking creative thinking thinking skills thinking ability problem -solving
Processes	Cultivate students' logical thinking Improved ability to analyse problems Draw inferences about other cases from one instance Study the issue from all sides Questioning, analyzing, and concluding are the most important learning skills Critical thinking is the process of questioning and demonstrating unity	logical analysis drawing inferences drawing a conclusion questioning & demonstrating

Learning	It is a learning ability Learning is inheriting existing knowledge since it is inheritance, a certain degree of critical thinking helps students better understand the nature of learning Knowledge comes from practice	learning ability understand the nature of learning practice
Dispositions	The spirit of doubt and criticism Questioning, not blindly obeying authority Thinking independently, and having an academic spirit, not blindly obeying authority With the ability to think critically can an independent personality be formed Can better improve the ability to distinguish between right and wrong	scepticism innovate detect mistakes

Responding to the subsidiary question, a considerable percentage of teachers showed a restricted or inadequate understanding of some of the above-mentioned aspects of critical thinking. The results present the teachers' four ways of perceiving critical thinking. A majority of teachers perceive that critical thinking is a method of thinking, such as creative thinking, and mathematical thinking. Other teachers think critical thinking involves the process of reasoning, such as analysis, drawing inferences and conclusions, which in turn helps students improve their learning ability. The results show that Chinese teachers are more focused on students acquiring knowledge and learning to reason and analyse rather than them reflecting and making a judgment. This finding is in line with the previous finding of Howe (2004). Howe found out that compared with Canadian teachers who related critical thinking more to the cognitive domain, Japanese teachers tended to correlate critical thinking with concrete learning outcomes.

A very interesting finding is that Chinese teachers favour application as a definition of critical thinking, which is not established as a definition of critical thinking within other studies (e.g. Duron et al., 2006; Howe,2004; Riddell, 2007). This implies that the Chinese teacher's definition of critical thinking is a tool to help students in applying their mathematical knowledge into practice. This further verifies Chinese teachers' opinions that critical thinking can be used as a tool in enriching students' knowledge and learning outcomes. To avoid common mistakes, students need to practice until the information is retained.

2. *How do teachers promote critical thinking in their mathematics lessons?*

Different key phrases from research question two were provided by teachers. These responses are grouped into three categories. The first category includes all the strategies that teachers usually apply in mathematics classes, that are not closely related to critical thinking. The second category includes strategies that are related to critical thinking. Teachers in this category are considered to have a good understanding of critical thinking and can apply strategies within teaching to improve students' critical thinking. The third category includes strategizing that is not connected to critical thinking and reflects a lack of knowledge of it.

Table 3. Teachers' strategies in promoting critical thinking skills

Category	Related phrases
General strategies (34%)	Motivate students Individual/ group work Provides a problem/pose a question Application Peer teaching and assessment, Demonstrate problem-solving methods for students. Using different teaching methods or strategies. Providing students enough time to think Discussion Providing students with direct instructions about how to analyse and solve the problem
Strategies related to critical thinking (52%)	Cultivate students' logical thinking abilities Students are asked to express their opinions through discussions Analysis, reasoning in detecting the mistakes Giving the wrong solutions and asking students to detect the error Posing questions, asking students to analyse and make judgments Clarify all points and provide evidence to support the judgment Pointing out mistakes made by teachers or peers and providing evidence Combine known information, make inferences and draw conclusions Multiple solutions, draw inferences from one instance Infuse critical thinking skills in mathematics thinking, through making evaluations and reflecting
critical thinking (14%)	Students improve thinking skills through practices

Table 3 shows that only 52% of teachers' strategies that are applied in mathematics classes are connected to critical thinking. This reflects that nearly half of the teachers do not have adequate knowledge and understanding of critical thinking, they lack strategies that assist students in learning and developing critical thinking skills. The results of this study are in line with other studies (Bissell & Lemons, 2006; Turner, 2006) that demonstrate a lack of explanation and guidelines for teachers to follow while teaching students critical thinking skills. Furthermore, 14% of teachers thought that critical thinking can be developed through lots of practice. This result reveals that Chinese teachers do not have adequate knowledge of how to teach critical thinking. This finding is consistent with other studies (Alwadai, 2014; Gashan, 2015; Howe, 2004; Innabi & Sheikh, 2006) that point out that in a culture in which critical thinking is not the dominant cultural paradigm, teachers require more support in developing their knowledge on it.

Scepticism and independent thinking are the most frequently appearing terms in teachers' responses. Chinese teachers place more importance on scepticism, which counters the stereotypical notions that criticism is always connected with scepticism, challenge, doubt and questioning (Shao, 2013). Chinese teachers hold the disposition that critical thinking is needed only when there is a conflict or when different opinions are opposed, they do not view critical thinking as a habit of the mind. This finding is consistent with the findings of other studies (Alwadai, 2014; Gashan, 2015; Howe, 2004; Innabi & Sheikh, 2006). This view reflects how cultural patterns dominate teachers' beliefs.

Conclusion

The study found that the majority of secondary school mathematics teachers that participated in the survey do not have a comprehensive view of critical thinking. There were about 47% of participants did not respond to the first questionnaire on the definition of critical thinking, demonstrating that critical thinking is not a familiar term for everyone in a secondary Chinese education setting. About half of the Chinese teachers could not identify strategies essential to critical thinking, their responses reveal that they are more focused on students acquiring knowledge. They believe critical thinking is a tool to improve students' learning but not an essential part of it. Critical thinking is more frequently thought to be scepticism, which shows that teachers' perceptions of critical thinking are influenced by their culture.

References

Awadhi, M.A. (2014). Islamic teachers' perceptions of improving critical thinking skills in Saudi Arabian elementary school. *Journal of Education and Learning, 3(4), 37-48.*

Aktas,G.S.,& Ünlü, M.(2013). Critical thinking skills of teacher candidates of elementary mathematics. *Procedia-Social and Behavioral Science,93,831-835.*

Atkinson,D.(1997). *Higher education: a critical business*. Milton Keynes: SRHE and Open University Press.

Bissell, A. N., & Lemons, P. P. (2006). A new method for assessing critical thinking in the classroom. *BioScience,56(1), 66-72.*

Cai, J., & Hwang, S. (2002). Generalized and generative thinking in US and Chinese students' mathematical problem solving and problem posing. *The Journal of Mathematical Behaviour, 21, 401-421.*

Chen, L. (2017). Understanding critical thinking in Chinese sociocultural contexts: a case study in a Chinese college. *Thinking Skills and Creativity, 24,140-151.*

Cheng, M.H.M., & Wan, Z.H. (2017). 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,24, 152-163.*

Clark, R., & Gieve, S. N. (2006). On the discursive construction of 'the Chinese learner'. *Language, Culture and Curriculum,19(1),54-73.*

Coney, C. L. (2015). Critical Thinking in its contexts and in itself. *Educational Philosophy and Theory, 47(5), 515-528.*

Dewey, J. (1938). *Experience and education.* New York: Collier Books.

Duron, R., Limbach, B., Waugh, W. (2006). Critical thinking framework for any discipline. *International Journal of Teaching and Learning in Higher Education, 17(2),160-166.*

Dwyer, C.P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity,12, 67-77.*

Ennis, R. H. (1962). A concept of critical thinking. *Harvard Educational Review, 29, 128-136.*

Ennis, R. H. (1993). Critical Thinking Assessment. *Theory into Practice, 32, 179-186.* doi.org/10.1080/00405849309543594

Ennis, R. H. (1996). Critical thinking dispositions: Their nature and assess ability. *Informal Logic, 18(2), 165–182.*

Facione, P. A. (1984). Toward a theory of critical thinking. *Liberal Education,70, 253-261.*

Facione,P.A.(1990). Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations. *American Philosophical Association.* Retrieved from ERIC Document Reproduction Service.

Facione,P.A.(2013). *Critical thinking: What it is and why it counts.* Milbrae, CA: California Academic Press.

Forawi, S. A. (2016). Standard-based science education and critical thinking. *Thinking Skills and Creativity, 20, 52-62.*

Glaser, E. M., & Watson, M. (1941). *An experiment in the development of critical thinking.* New York: Teachers College of Columbia University, Bureau of Publication.

Gashan, A. K. (2015). Exploring Saudi pre-service teachers' knowledge of critical thinking skills and their teaching perceptions. *International Journal of Education & Literacy Studies, 3(1), 26-33.*

Howe, E.R.(2000). *Secondary school teachers' conceptions of critical thinking in British Columbia and Japan: a comparative study, thesis,* University of British Columbia, Canada.

Howe, E. R. (2004). Canadian and Japanese teachers' conceptions of critical thinking: A comparative study. *Teachers and Teaching, 10(5), 505–525.*

Incikabi, L., Tuna, A., Biber, A.C. (2013). An analysis of mathematics teacher candidates' critical thinking dispositions and their logical thinking skills. *Journal of International Educational Research, 9(3), 257-266.*

Innabi, H., El Sheikh, O.(2006). The change in mathematics teachers' perceptions of critical thinking after 15 years of educational reform in Jordan. *Educational Studies in Mathematics, 64(1), 45-68.*

Kenney, J. (2013). Fostering critical thinking skills: Strategies for use with intermediate gifted readers. *Illinois Reading Council Journal, 41(2), 28-40.*

Ku, K.Y.L., & Ho, I.T. (2010). Dispositional factors predicting Chinese students' critical thinking performance. *Personality and Individual Difference, 48, 54-58.*

Liu, Z. K., He, J., & Li, B.(2015). Critical and creative thinking as learning processes at top-ranking Chinese middle schools: possibilities and required improvements. *High Ability Studies, 26(1), 139-152.*

McBride,R.E., Xiang,P., Wittenburg,D., & Shen,J.H.(2002). An Analysis of Pre-service Teachers' Dispositions Toward Critical Thinking: A cross-cultural Perspective. *Asia-Pacific Journal of Teacher Education, 30(2), 131-140.* doi: 10.1080/13598660220135649

Mei-Yun, L., Swee, L., Jung, M., & Leah, A.(2003). What Hong Kong teachers' and parents think about thinking. *Early Child Development and Care, 173(1), 147-158.*

Onosko, J. J.(1992). Exploring the thinking of thoughtful teachers. *Educational Leadership 49 (7), 40-44.*

Paton,M.(2005). Is critical analysis foreign to Chinese students? In E.Manalo & G.Wong-Toi (Eds.), *Communication skills in university education: The international dimension*(pp.1-11). Auckland: Pearson Education.

Paul, W, R., Elder, L., & Bartell, T.(1997). *California Teacher Preparation for Instruction in Critical Thinking: Research Findings and Policy Recommendations.* Foundation for Critical Thinking.

Riddell, T. (2007). Critical assumptions: thinking critically about critical thinking. *Journal of Nursing Education,46(3),121-126.*

Semmar,Y., & Fakro, A.(2009). Investigating critical thinking skills practices in Qatari elementary schools. *International Journal of Learning,16(1), 13-23.*

Shao,W.(2013). 谈批判性思维培养与主动性知识构建在当代高等教育中的核心地位. A brief review of the core value of nurturing critical thinking and self-directed knowledge construction in current higher education. *University Education, 14, 41-52.*

Siegel, H. (2010). Critical thinking. *International Encyclopedia of Education, 6, 141-145.* Https://doi.org./10.1016/B978-08-044894-7.00582-0

Tian, J., & Low, G. D. (2011). Critical thinking and Chinese university students: a review of the evidence. *Language, Culture and Curriculum, 24(1), 61-67.*

Tiwari, A., Avery, A., & Lai, P. (2003). Critical thinking disposition of Hong Kong Chinese and Australian nursing students. *Journal of advanced Nursing, 44,298–307.*

Turner,Y. (2006). Students from mainland China and critical thinking in postgraduate business and management degree: teasing out tensions of culture, style and substance. *International Journal of Management Education, 5(1),3-11.*

Wolfle, J. A. (1986). Enriching the mathematics program from middle school gifted students. *Roeper Review,9,81-85.*

Wood, D. J., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. Journal of Child Psychiatry and Psychology, 17(2), 89-100.). The role of tutoring in problem solving. *Journal of Child Psychiatry and Psychology, 17(2), 89-100.*

Zhang, L.(2001). Approaches and thinking styles in teaching. *The Journal of Psychology135(5), 547–561.*