



How to cite this article:

Ismail, S. N., Muhammad, S., Omar, M. N., Shanmugam, S. K. S., & Rajoo, M. (2022). The practice of critical thinking skills in teaching mathematics: Teachers' perception and readiness. *Malaysian Journal of Learning and Instruction, 19*(1), 1-30. <https://doi.org/10.32890/mjli2022.19.1>

THE PRACTICE OF CRITICAL THINKING SKILLS IN TEACHING MATHEMATICS: TEACHERS' PERCEPTION AND READINESS

**¹Siti Noor Ismail, ²Shamsuddin Muhammad, ³Mohd Norakmar
Omar**

& ⁴S. Kanageswari Suppiah Shanmugam

**^{1,3&4}School of Education, Universiti Utara Malaysia, Kedah,
Malaysia**

**²Teacher Education Institute, Kota Baharu Campus, Kelantan,
Malaysia**

¹Corresponding author: siti.noor@uum.edu.my

Received: 15/10/2020 Revised: 25/5/2021 Accepted: 14/6/2021 Published: 31/1/2022

ABSTRACT

Purpose - This study was conducted to identify the relationship and influence of mathematics teachers' perception and readiness on the practice of critical thinking skills (CTS) in implementing pedagogical processes in secondary schools.

Methodology - Participants of the study consisted of 226 mathematics teachers who taught in three different secondary school categories, namely high performing schools (HPS), moderate performing schools (MPS) and low performing schools (LPS) throughout the state of Kelantan, Malaysia. The instrument used was adapted from Thurman (2009) to test the teachers' perception of CTS, while the teachers' readiness to apply CTS was adapted from Nagappan (2001) and Yusof

and Ibrahim (2012). Besides, measurement of the teachers' practice of CTS was adapted from Aldegether (2009), Barak and Shakhman (2008), and Shim and Walczak (2012).

Findings - Teachers' perception, readiness, and CTS practice in mathematics teaching were high in HPS but low in LPS. There was a strong positive relationship between teachers' perception of CTS practice and teachers' readiness to implement CTS practice in mathematics teaching. In addition, a total of 65 percent variance was contributed by both variables, namely teachers' perception and teachers' readiness for CTS practice in mathematics teaching, and this contribution was very high.

Significance - The findings of the study also proved that the practice of CTS has improved the pedagogical quality of teachers, especially in meeting the needs of 21st century learning in the classroom. The emphasis on higher order thinking skills (HOTS) is a continuation of the excellence of teaching strategies through a variety of planned learning resources.

Keywords: Teacher perception, teacher readiness, critical thinking skills, mathematics, HOTS.

INTRODUCTION

Critical thinking is an approach that is increasingly applied in the education system as a guide and also as an indicator to build a highly skilled and quality workforce in the future. Thus, each teaching and learning process nowadays are more focused on the methods of how teachers and students develop their ability and capability in CTS to solve problems (Cansoy et al., 2018). The development of CTS not only builds capacity in HOTS, but it also enhances the identity of the teacher as an educator who has great attitude and authority, informing more effective teaching (Janssen et al., 2019). Therefore, the practice of CTS is now becoming more widespread and creative in modifying existing education curricula for the implementation of higher-purpose learning (Erdem & Adiguzel, 2019).

The ability and confidence of teachers to apply CTS in shaping meaningful teaching is a requirement that should be routine for each learning process. CTS is essential in the problem-solving process, in addition to building other cognitive skills such as problem identification skills, making comparisons, classifying, finding cause

and effect, hypothesis testing and also in the decision-making process (Maryuningsih et al., 2019). The practice of CTS in this teaching has been clearly stated in the Malaysian Education Blueprint 2013–2025 (PPPM 2013–2015) by the Ministry of Education Malaysia (MOE) through its emphasis on the aspects of human capital development that is critical, creative, innovative and highly skilled. The impact on this development plan is to develop people who can be competitive in the social, cultural and economic growth of the country (MOE, 2013).

Several studies have recognized that the practice of CTS has a huge significance in promoting problem-solving methods among students (Dehghayedi & Bagheri, 2018; Kozikoglu, 2019; Widana et al., 2018). Most of the problem-solving methods can be explained by students more efficiently, especially involving HOTS in mathematics. For example, Widana et al. (2018) found that HOTS elements have been highly emphasized in developing students' mental ability to think more critically and creatively to solve problems involving mathematical calculations. Besides, CTS is also effectively applied when students use problem-based learning in mathematics associated with daily life. What is most interesting is that CTS is used to solve complex mathematical problems by building and integrating 4D models as learning aids in specifically difficult topics (Putri et al., 2020).

Although previous studies have been of significant importance in developing the potential of students in CTS, there are still obstacles in realizing the concept of learning. Students still need to apply the fundamental aspects related to CTS because not everyone can acquire these skills naturally (Mahanal et al., 2019; Rini et al., 2020). This situation was also raised by Snyder and Snyder (2008) who found four factors which proved to be significant barriers to the proliferation of CTS namely (1) insufficient training, (2) lack of resources and information, (3) bad feelings and prejudices, and (4) time constraints. Therefore, the effectiveness of teachers' teaching methods using CTS may be hindered when these four factors are still plaguing the students.

The implementation of CTS requires a high level of readiness among educators to ensure that CTS practice becomes a reality in the existing curriculum. The readiness of teachers to implement CTS is an effort that must be nurtured to advance the vision and mission of education to a higher level (Changwong et al., 2018; Ennis, 2016). A study by As'ari et al. (2017) found that the level of CTS readiness among mathematics teachers was still low as the majority of them were categorized as non-critical thinkers. Besides, a CTS perception study by Kusaeri and Aditomo (2019) also concluded that only 60

percent of mathematics teachers tried to incorporate CTS elements in their teaching process. However, the rest preferred to use traditional approaches. These findings indicate that the application of CTS in mathematics has not been fully implemented by educators.

On the other hand, teachers' perception and readiness are aspects that need to be given attention in providing teachers the competencies to plan, manage and diversify practical-based teaching activities (Ismail et al., 2019). At present, the teaching of mathematics in the existing curriculum still does not indicate a clear direction towards the construction of critical, creative and innovative skills among teachers and students (Firdaus et al., 2015; Widana et al., 2018). There are also a handful of mathematics teachers who try to apply some aspects of CTS in the teaching process. However, such situations occur unconsciously or beyond the knowledge of teachers as a result of various activities and the indirect application of HOTS values (Tanujaya et al., 2017).

Based on this problem, it is appropriate to conduct a study to identify the cause(s) of weaknesses in the implementation of CTS in the teaching process, especially in the subject of mathematics in Malaysia. The focus of the study conducted was on the practice of applying CTS in mathematics implemented by teachers in the classroom. First, the study attempted to identify the level and relationship between teachers' perception and readiness to apply CTS practice that have been implemented over the years. Besides, this study also determined the influence of teachers' perception and readiness on CTS practice in the teaching of Mathematics.

THEORETICAL BACKGROUND

Theory and Concept of Critical Thinking Skills

Critical thinking is one of the elements in HOTS that explains in more depth about creative thinking methods, problem-solving processes, and critical situations in making good decisions (Behar-Horenstein & Niu, 2011). In comparison, Duran and Dokme (2016) argue that CTS is a continuation of out-of-the-box thought processes that involve questioning methods and ways to get answers focused on inquiry-based learning. Previously, the Curriculum Development Division, MOE has listed HOTS elements presented in the i-Think program namely critical thinking, logical thinking, reflective thinking, creative thinking and meta-cognitive thinking (MOE, 2012). Furthermore,

Acharya (2017) agrees that the insight factor is another element that should exist in shaping CTS processes more practically.

However, some basic concepts need to be built in an individual to use CTS successfully in teaching and learning. Among the concepts include the ability to interpret, analyse, make inferences, evaluate, explain and self-regulate (Facione, 2006, 2015). These concepts are similar to the views of Paul and Elder (2005). They agree that critical thinking is a method employed by an individual in attempting to improve his thinking abilities to the highest level, creating unique ideas and thoughts with a range of skills, competencies and intellectual standards that he already has. Meanwhile, there are several elements that make up CTS in education today, namely problem definition, systematic observation, brainstorming, beginning of problem solution, setting short-term goals, argumentation based on qualitative indicators, feedback and self-assessment (Plotnikova & Strukov, 2019).

Besides, CTS can be created through a variety of cognitive and intellectual skills that an individual possesses. These skills are identifying problems, arbitrating an idea, avoiding any biased factors, formulating strategies to support a cause, making thoughtful decisions and meeting needs (Birgili, 2015). CTS is also associated with various levels of skills according to the ability and wisdom of a person to reason, decide and solve problems (Mahanal et al., 2019). Meanwhile, Vaughter (2016) has also elaborated that the concept of critical thinking is more widespread where every high-quality critical thinking result should be translated into real action.

In mathematics, the application of CTS is usually more inclined to the skills of analyzing arguments, making inferential analysis either through inductive or deductive reasoning methods, performing assessments, and making accurate decisions from existing problems (Ismail et al., 2019; Munawaroh et al., 2018). Therefore, students who can think critically will have a high level of scientific thinking and can perform work very systematically. Usually these students can also solve learning problems and daily tasks more perfectly (Su et al., 2015).

Figure 1

Critical Thinking Model (Modified from Zechmeister and Johnson, 1992)

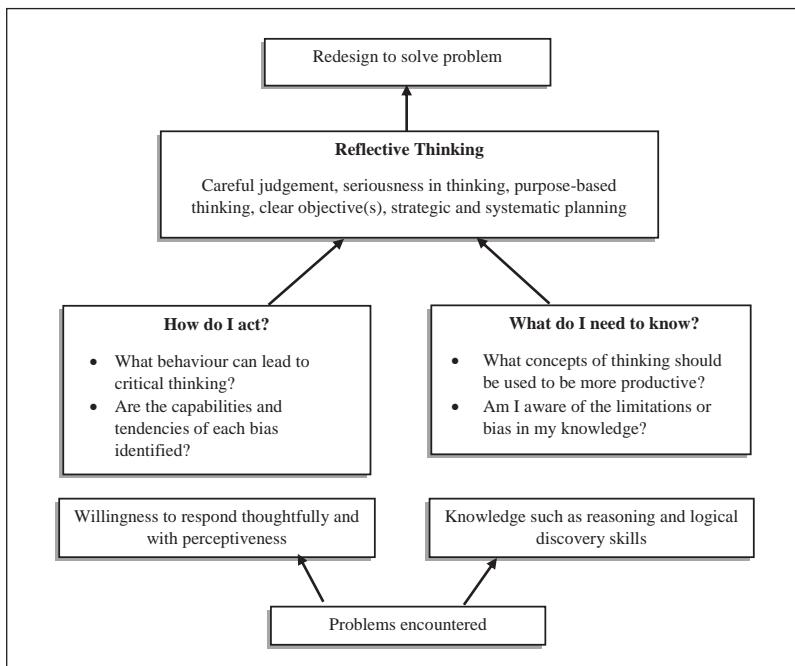


Figure 1 shows the model of critical thinking put forward by Zechmeister and Johnson (1992), which explains how a problem can be easily solved through CTS. According to them, CTS should be linked to three main factors, as follows:

- (a) Tendency to accept and consider thought and perception in managing problems.
- (b) Knowledge of methods to carry out logical reasoning and inquiry.
- (c) Skills in using method(s) to solve problems encountered.

Critical Thinking Model in Malaysia

The education system in Malaysia is indeed focused on the development of students based on four elements namely physical, emotional, spiritual and intellectual. This matter has been touched

on in one of the objectives of the secondary school curriculum development in Malaysia where students are expected to develop and enhance their intellectual capacity, possess rational behaviour, are creative and critical in their thinking when making decisions (Curriculum Development Centre, 1989). In 1993, the MOE found that the education system in Malaysia was able to combine four models of critical thinking. These models were used to implement each programme under the management of the MOE which was based on the concept of thinking skills in a more creative, critical and systematic manner (Curriculum Development Centre, 1993).

In 2011, the Primary School Standard Curriculum (PSSC) was introduced to further strengthen the conceptual capacity of teaching and learning in primary schools. The PSSC policy also embedded elements such as CTS in shaping subject content, pedagogical methods, interpretation, time management and organization (Yusof & Ibrahim, 2012). Subsequently, the Secondary School Standard Curriculum (SSSC) was introduced in 2017, by prioritizing 4C skills, namely communication, critical thinking, creativity, and collaboration (Kaviza, 2020). The main focus of SSSC was to shape the future of students in terms of knowledge, skills and values. This case has also been enshrined in the National Education Philosophy, which aims to produce educators and students with a high level of creativity, critical thinking and innovativeness to drive the country to greater glory.

Previously, there were four models of thinking skills practised by teachers in the teaching and learning process. The following are the four models:

(a) Swartz and Parks Model

This model was introduced by Robert Swartz and Sandra Parks, who went through a planned preparation process through the National Centre for Teaching Thinking. In Malaysia, this model is more popularly known as the ‘Boston Model’ by taking the name of the location of this model which was in Boston City. According to Swartz and Parks (1994), three elements must be mastered by a critical thinker namely understanding, retention, and clarifying ideas.

(b) KWHL Model

This model combines four key elements with ‘K’ for knowledge, ‘W’ for What, ‘H’ for How, and ‘L’ for Learnt (Nagappan, 2001). ‘Knowledge’ refers to what source of knowledge an individual has, while ‘what’ describes the

objectives that an individual must achieve after going through a phase of critical thinking. Meanwhile, ‘How’ is interpreted as a method that should be implemented to achieve the goal through critical thinking, and ‘Learned’ is the result obtained through the process after implementing the phases of thinking creatively and critically.

(c) CoRT 1 and CoRT 4 Model

CoRT 1 refers to ‘widening the perception’, while CoRT 4 refers to ‘creative and lateral thinking’. Both models were introduced by Edward de Bono, who placed more emphasis on the training and coaching aspects to improve critical thinking. An individual has critical thinking when he/she can form initial perception, be able to shape existing problems, analyze and have high creativity in decision-making (DeBono, 1985).

(d) PILTS and PADI Model

PILTS model means Program Instruction in the Learning of Thinking Skills, while PADI refers to Intellectual Power Upgrades and Enhancements. This model was introduced in 1992 which emphasized on the method of thinking conceptually, thinking through analytical method, absorbing creative and critical thinking, and also solving a problem(s) in a more organized way (Ismail et al., 2019).

The theoretical framework introduced in the Swartz and Parks Model, is on the ability and tendency of teachers to think critically. Based on Swartz and Parks (1994), these two factors will affect the ability of teachers to master the CTS method and the content of a subject. In contrast, the KWHL Model considers that every piece of information obtained is due to critical and creative thinking. In some aspects, not all information can be easily obtained through the power of thought alone, and it has to go through certain phases in forming the ability to think (Kozikoglu, 2019). Thus, a systematic phase is indispensable in facing the challenges of learning in the 21st century.

The CoRT1 and CoRT4 models are highly compatible with lateral and creative thinking, in forming an initial perception of a problem. The advantage of this model is that it can encourage teachers to think ahead in determining what action(s) should be taken before, during and after teaching and learning activities take place (Al-Faoury &

Khwaileh, 2014). Nevertheless, the PILTS and PADI Model are more compatible with mathematics because they are created based on the learning environment in Malaysia. CTS among mathematics teachers in Malaysia and those abroad varies in terms of culture, moral values and ethics (Ismail et al., 2019).

There are also CTS models such as Marzano's New Taxonomy model that focuses on improving the thinking styles of teachers and students. According to Marzano (2001), critical thinking is based on four elements: (i) self-system, (ii) metacognitive system, (iii) a cognitive system, and (iv) knowledge domain. Studies in Malaysia have found that this model has triggered new ideologies in developing high levels of critical thinking among teachers and students (DeWitt et al., 2016; Rahman & Manaf, 2017). A crucial fundamental point in this critical thinking is the teacher's ability to make decisions in line with planned activities. In addition, this model is also highly synonymous with the accuracy of goal-based decisions and authentic sources resulting from the robustness of critical thinking generated.

There is no denying that CTS models have a uniformity in which educators must enhance creativity and innovation in making the teaching and learning a desirable process. Based on Sulaiman et al. (2017), CTS is very useful in the teaching process because it motivates students to apply its benefits in daily life. CTS can also balance the concept of learning in the classroom with the challenges that students will face in the future (Choy et al., 2017). Thus, teachers are advised to adopt the corresponding CTS models to evoke their ability in shaping more outstanding students in line with the concept of 21st-century learning.

Teacher's Readiness in CTS

The teaching and learning process in schools, begins with careful planning and preparation carried out by teachers. Without proper planning, classroom management will become chaotic and can affect the teaching and learning process (Omar et al., 2019). According to Danielson (2007), the planning and readiness of a teacher in organizing effective teaching strategies can be defined as 'behind-the-scenes business' in designing the learning environment in the classroom. The effectiveness of teaching requires a high sacrifice to change the learning environment to suit the diversity of students' backgrounds and also their level of acceptance. Therefore, the readiness and planning of teachers in applying pedagogical content, teaching methods, determining learning outcomes, use of diverse

teaching resources and student interpretation are among the elements that should be emphasized (Tatto et al., 2012).

Further, the readiness of teachers in practising CTS in teaching and learning is a behaviour that needs to be observed from time to time. If teachers fail to apply these CTS elements, the development of innovation in teaching will not become a reality. According to Nisbet and Collins (1978), there are several barriers and obstacles in implementing teaching innovation including conflicting and adverse reactions, inadequate planning, imperfect teacher preparation, lack of commitment from teachers and the school community, and also lack of resources. Other barriers include lack of in-depth knowledge, experience, and ability that make teachers less prepared to undergo each planned change (Vaughter, 2016).

Every teacher should have a repertoire of skills, including extensive knowledge in the core areas of teaching, additional skills, a genuine interest in educating students and a positive attitude to implement change. These aspects will boost teachers' ability to implement CTS in teaching and learning in the classroom. However, the willingness of teachers to shape the effectiveness of teaching also has high significance together with the commitment of various other parties to generate a vision and mission towards educational excellence (Yusof & Ibrahim, 2012). The effectiveness of mathematics teaching also depends entirely on the willingness of teachers to make the learning environment more meaningful. In other words, the elements of CTS become the booster for mathematics teachers to implement teaching based on the content that has been embedded in the curriculum in order to develop critical and creative thinking abilities of students (Aini et al., 2019; Firdaus et al., 2015).

Thus, this study will focus on four main elements in teacher readiness to apply CTS practice in the classroom such as knowledge, pedagogical skills, attitude and interest in the teaching process. According to Hollins (2011), teacher readiness and sound planning in pedagogy can lead to a higher quality teaching process. At the same time, CTS practice can also be applied in a more direct way when teachers plan and prepare lessons that are focused on practical activities (Kusaeri & Aditomo, 2019). Hands-on activities can help enhance students' critical and constructive thinking processes to generate HOTS elements in mathematics learning.

Research Questions

Based on the description, the study emphasized in answering the following research questions:

1. What is the level of teachers' perception of CTS, teachers' readiness to apply CTS and teachers' practice of CTS in high performing schools (HPS), moderate performing schools (MPS) and low performing schools (LPS)?
2. Is there a significant relationship between teachers' perception of CTS, teachers' readiness to apply CTS and teachers' practice of CTS in teaching mathematics?
3. Is there an influence on teachers' perception of CTS and teachers' readiness to apply CTS that affects teachers' practice of CTS in teaching mathematics?

METHODOLOGY

Research Design

This study was conducted based on a cross-sectional survey method involving a quantitative approach. A questionnaire was used to collect data from selected participants consisting of secondary school mathematics teachers in the state of Kelantan, Malaysia. The focus of the study was to obtain information related to the relationship and influence of teachers' perception of CTS and teachers' readiness for CTS, which may have an impact on changes in teachers' practice of CTS. Based on the objective, the implementation of quantitative research was the best method because this method is suitable for researchers to collect research data based on phenomena that occurred at a particular time (Creswell, 2014).

Population and Sampling

The population of this study consisted of mathematics teachers serving in the state of Kelantan, Malaysia. The selection of this population was based on the recommendation of Tabachnick and Fidell (2007) who suggested that the entire population should reflect the characteristics of the desired respondents. Therefore, the sampling technique used to select participants was proportional stratified random sampling according to the school category, which was classified into three, namely HPS, MPS, LPS. According to Creswell (2014), the use of proportional stratified random sampling can be implemented if the

number of mathematics teachers in each category, that is, the school category in the context of this study varies. Using the sample size determination table of Krejcie and Morgan (1970), the division of the total number of participants is shown in Table 1.

Table 1

Number of Samples by School Category

School Category	Number of schools	Total number of teachers	Sample selected
High Performing School (HPS)	5	60	25
Moderate Performing School (MPS)	15	225	106
Low Performing School (LPS)	17	230	95
Total	37	515	226

Based on Table 1, each sample was randomly selected, referring to each stratum by looking at the percentage of mathematics teachers in the study population. In HPS, 25 samples were selected from a total of 60 mathematics teachers, with a rate of 11.1 percent. Meanwhile, 106 mathematics teachers were selected from a total of 226 teachers in MPS (46.9%) and the remaining 95 samples were selected from 230 mathematics teachers in LPS with a rate of 42.0 percent.

Instrumentation

There were four sections in the questionnaire. Part A consisted of the demographics of the participants such as gender, teaching experience, attendance of HOTS courses and type of school. Part B contained items related to teachers' perception of CTS adapted from Thurman (2009). Section C contained items to measure teachers' readiness for CTS whereby the items were modified from a questionnaire conducted by Nagappan (2001) and also, Yusof and Ibrahim (2012). Meanwhile, Part D contained items which measured the practice of CTS in the teaching of mathematics, adapted from Barak and Shakhman (2008), Aldegether (2009) and also Shim and Walczak (2012). Before the study's implementation, the instrument's validity was made by three experts in related fields. For instruments in English, the translated version in the Malay language was checked for compatibility with

the original instrument. All instruments were consolidated, and a pilot study was conducted to obtain the following instrument reliability values as shown in Table 2.

Table 2

The Reliability Value of Each Variable

Code	Section	Item	Alpha Value
Section B			
PE	Teachers' Perception of CTS	6	0.86
Section C (Teachers' Readiness for CTS)			
KN	Knowledge	9	0.96
SK	Skills	8	0.94
AT	Attitude	8	0.92
IN	Interest	7	0.90
Section D (Teachers' Practice of CTS)			
TE	Creating a thinking environment	6	0.91
MC	Meta-cognitive conversation map	6	0.90
QU	Questioning	5	0.84
TH	Thinking habits	3	0.85
SL	Self-learning	4	0.82

Based on Table 2, it was found that all parts of the instrument had achieved a high level of reliability. This was evidenced by the Cronbach's Alpha value (α) which ranged between 0.82 and 0.96. According to Pallant (2011) a reliability value above 0.70 was good and indicated that an instrument could measure what was to be evaluated in a study. Thus, the high value of reliability indicated that the study was equipped with a highly consistent measuring tool in achieving its objectives (Hair et al., 2014).

Data Analysis

After the questionnaire was returned, the data was analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0 and Structural Equation Modeling-Analysis of Moment Structures (SEM-

AMOS). SPSS software was used to answer the first research question, which was to determine the level of study variables through the use of descriptive data such as mean values and standard deviations. Meanwhile, SEM-AMOS was used to answer the second and third research questions, which were to determine the relationship and influence between the study variables involved. The study model could be formed through SEM-AMOS, and the findings could help improve the quality of the study through the value of fitness indexes for each study variable (Awang et al., 2018; Hair et al., 2014).

RESULTS

Participants' Profile

The total number of participants in this study was 226 secondary school mathematics teachers in the state of Kelantan, Malaysia. Of these, 81 teachers (35.8%) were male, and the remaining 145 teachers (64.2%) were female. There were 13 teachers (5.7%) who had served for five years or less, 31 teachers (13.7%) had between six and 10 years of teaching experience, and 65 teachers (28.8%) had between 11 and 15 years of teaching experience. The largest group came from 117 mathematics teachers who had taught for more than 15 years (51.8%).

Furthermore, the analysis showed that a total of 181 teachers (80.1%) had participated in training related to HOTS/CCTS via workshops and/or courses. In comparison, the remaining 45 teachers (19.9%) did not receive any training via related courses/workshops. Findings through descriptive analysis showed the breakdown of participants based on the type of schools where they served. From the report, there was a total of 25 mathematics teachers (11.1%) teaching at HPS, another 106 teachers (46.9%) teaching at MPS, and the remaining 95 teachers (42.0%) serving at LPS throughout the state of Kelantan. A summary of the descriptive analysis of these participants categorized according to demographics is shown in Table 3 as follows.

Table 3

Demographic Distribution of Study Participants

Demographics	Category	Number of Participants	Percentage (%)
Gender	Male	81	35.8
	Female	145	64.2
Teaching experience	1–5 years	13	5.7
	6–10 years	31	13.7
	11–15 years	65	28.8
	More than 15 years	117	51.8
Attendance of HOTS/CCTS courses	Yes	181	80.1
	No	45	19.9
Type of school	High performing school (HPS)	25	11.1
	Moderate performing school (MPS)	106	46.9
	Low performing school (LPS)	95	42.0

Levels of Each Variable

For the first research question, the mean value was used to measure and compare the level of each study variable based on three school categories namely HPS, MPS and LPS. Previously, Nunnally (1994) suggested that the interpretation of mean values at high levels be between 4.01 and 5.00, moderate levels between 2.01 and 4.00 and low levels between 1.00 and 2.00. For the first variable, it was found that teachers' perception of CTS for mathematics in HPS was higher than the perception of CTS of the teachers in MPS and LPS. Teachers' perception of CTS in HPS recorded a high mean value (mean = 4.24, SP = 0.45), however only moderate levels were recorded for teachers' perception of CTS in MPS (mean = 3.89, SP = 0.68) and LPS (mean = 3.63, SP = 0.52).

The results also showed that teachers' readiness to apply CTS in mathematics was at a high level for two types of schools namely HPS (mean = 4.32, SP = 4.07) and MPS (mean = 4.07, SP = 0.32) compared to LPS which recorded a moderate level (mean = 3.82, SP = 0.32). The results of the study also showed the level of practice of

CTS among mathematics teachers in Kelantan, Malaysia. The mean score for teachers' practice of CTS was high among mathematics teachers in HPS (mean = 4.39, SP = 0.43) and in MPS (mean = 4.20, SP = 0.37), but teachers' practice of CTS in LPS was at a moderate level (mean = 3.79, SP = 0.44). In general, all three study variables showed a high level in HPS. However, the findings were the opposite for mathematics teachers in LPS, where all the three study variables showed moderate level findings. The summary of the mean score for each study variable is shown in Table 4 as follows.

Table 4

Mean Score of Each Variable Based on School Category

Variable	Category of School	Mean	SD	Result
Teachers' perception of CTS	HPS	4.24	0.45	High
	MPS	3.89	0.68	Moderate
	LPS	3.63	0.52	Moderate
Teachers' readiness for CTS	HPS	4.32	0.33	High
	MPS	4.07	0.32	High
	LPS	3.83	0.32	Moderate
Teachers' practice of CTS	HPS	4.39	0.43	High
	MPS	4.20	0.37	High
	LPS	3.79	0.44	Moderate

Relationship between teachers' perception, teachers' readiness and teachers' practice of CTS in teaching mathematics

The following Figure 2 shows the confirmatory factor analysis (CFA) for pooled models of all study variables. This CFA model reached the level of fitness indexes as suggested by Awang et al. (2018) where the value of RMSEA = 0.049 (RMSEA < 0.08), CFI = 0.906 (CFI > 0.90), TLI = 0.902 (TLI > 0.90) and Chi Sq / df = 1.548 (Chi Sq / df < 5.0). According to Arbuckle (2016), these fitness indexes need to be adhered so that the model formed can be used to analyze the objectives of other studies. Therefore, the correlation values between the study variables can be identified more easily, clearly and accurately through the CFA model once the level of fitness indexes has been reached.

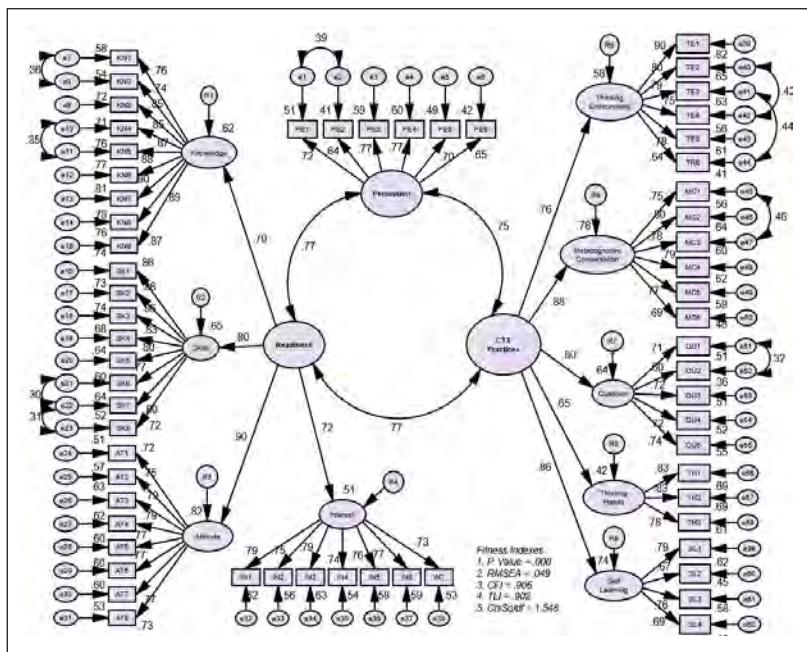
Figure 2*CFA for Pooled Mode*

Table 5 shows the correlation values between the study variables released as a result of the CFA for the pooled model shown in Figure 2. Based on the analysis, teachers' perception of CTS indicated a high positive and significant correlation to teachers' practice of CTS ($r = .75$, $p < .01$). At the same time, teachers' readiness for CTS also showed a high and significant positive correlation with teachers' practice of CTS ($r = .77$, $p < .01$). This correlation strength value was with reference to Dancey and Reidy (2011), where the high correlation was between 0.70 and 0.99. These findings clearly showed that mathematics teachers in Kelantan had high perception and readiness in applying CTS in their practice.

Table 5

Correlation Between Study Variables

Variable	Variable	Correlation	Output
CTS Practice	↔ Perception	.75**	High positive correlation
CTS Practice	↔ Readiness	.77**	High positive correlation

**p<0.01

The Influence of Teachers' Perception and Teachers' Readiness that Affects Teachers' Practice of CTS in Teaching Mathematics

The following Figure 3 shows the output of standardized path coefficients based on the beta expectation value to measure the influence of the teachers' perception and readiness on their practice in CTS. Based on this diagram, it was found that the expected value of beta on the influence of teachers' perception on CTS practice was 0.38, while the expected value of beta on the influence of teachers' readiness for CTS practice was 0.47. Meanwhile, the coefficient that determined the value of R^2 was 0.65. This value meant that 65 percent of the variance of CTS practice was present from the influence of teachers' perception and teachers' readiness variables. In comparison, the remaining 35% was the error variance present from other factors not mentioned in this study. This study model was considered a good model because the value of $R^2 = 0.65$ was high; in addition, the factor load value for each item exceeded the value of 0.60. A factor load value above 0.60 indicated that the item used in the model was highly consistent and measured every construct in the study (Awang et al., 2018; Shiau et al., 2019).

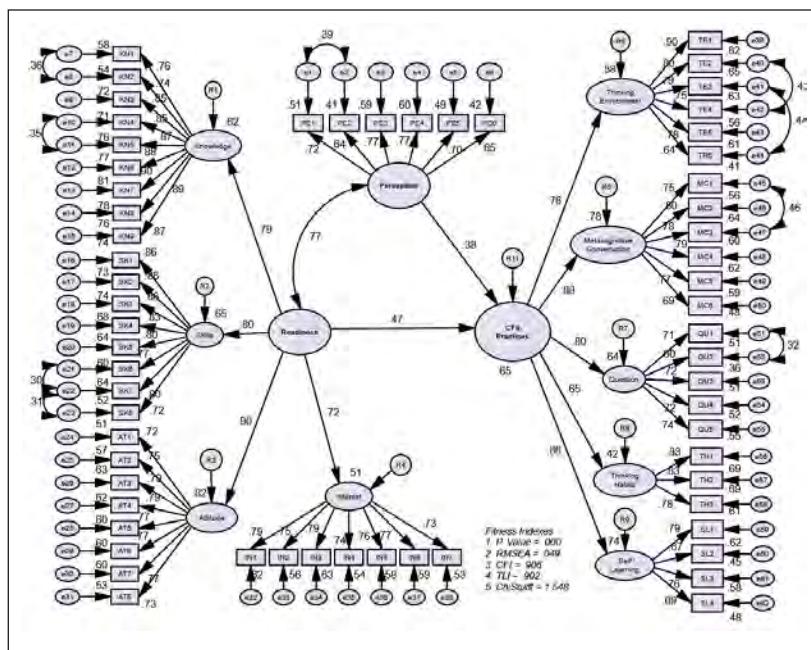
Figure 3*Output Standardized Path Coefficients Between Variables in The Model*

Figure 4 shows the value of the regression path coefficient between the variables in this study. From the analysis, it was found that the path coefficient value for teachers' perception of CTS practice was 0.54. At the same time, the same regression value of 0.54 was also obtained on teachers' readiness for CTS practice. Therefore, these findings proved that teachers' perception and teachers' readiness had a significant impact on CTS practice among mathematics teachers in Kelantan.

Figure 4

Regression Path Coefficients between the Variables in the Model

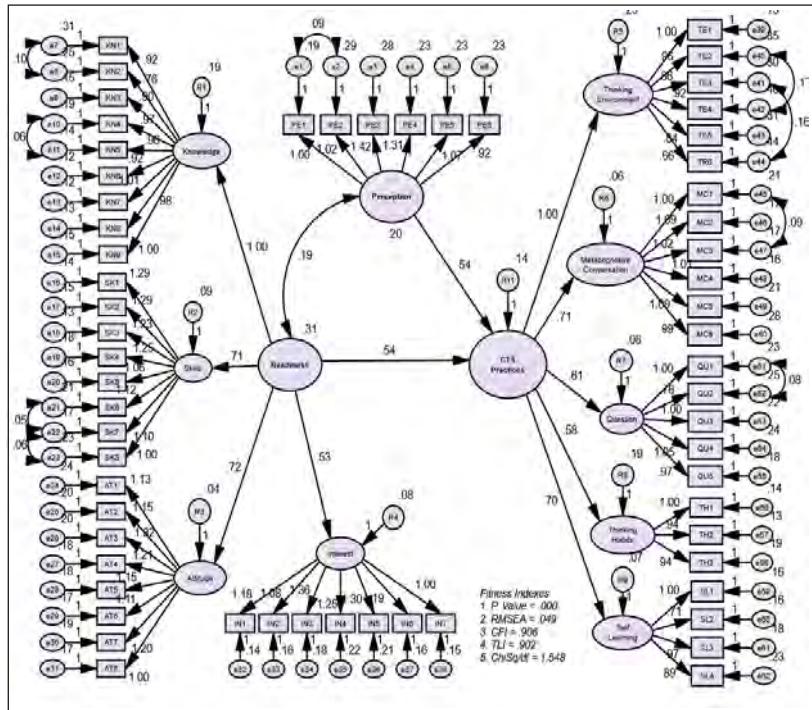


Table 6 shows the effect of the influence of teachers' perception and teachers' readiness for CTS practice in more detail. The beta value of 0.544 indicated that when teachers' perception increased by 1 unit, then the CTS practice variable also increased by 0.544 units. Besides, the beta value of 0.538 indicated that when teachers' readiness increased by 1 unit, then the CTS practice variable also increased by 0.538 units. Thus, the regression equation coefficients that can be formulated are as follows:

$$\text{CTS Practice} = 0.544 \text{ (Teachers' Perception)} + 0.538 \text{ (Teachers' Readiness)}$$

$$\text{CTS Practice} = 0.544 \cdot \text{Teachers' Perception} + 0.538 \cdot \text{Teachers' Readiness}$$

Table 6

Regression Path Coefficient among Study Variables

Variable	Variable	Beta Value	SE	CR	p-value	Output
CTS Practice	β Perception	0.544	0.151	3.610	0.00	Significant
CTS Practice	β Readiness	0.538	0.123	4.387	0.00	Significant

Note. SE = standard error, CR = critical ratio

DISCUSSION

HOTS is a field of knowledge that is highly demanded in the current education system. However, the level of practice is not yet satisfactory. Based on the findings, it was found that only mathematics teachers in HPS recorded high levels for all three study variables. These findings also showed that the level of practice among mathematics teachers in LPS was of a moderate level for all three variables, while findings were mixed for MPS for each variable, which was between medium and high levels. Thus, previous theory which claimed that the application of CTS practice contributed to the academic improvement of students is accurate. Studies by Aini et al. (2019), Kusaeri and Aditomo (2019), Su et al. (2015) and Widana et al. (2018) also agreed that mathematics teachers who apply the practice of CTS in teaching can further strengthen their pedagogical processes in the classroom.

Differences in the level of perception, readiness and application of CTS practice in mathematics in schools also depend on the level of students' ability to accept the teaching process. Thus, the practice of CTS is more suitable to be applied in HPS because teachers can maximize the HOTS elements in the learning due to high student acceptance (Ganapathy & Kaur, 2014). However, it is quite challenging to implement CTS practice in MPS and LPS due to low student acceptance as well as their academic achievement, especially in mathematics, which is relatively unsatisfactory. According to Facione (2015), the practice of CTS should be made a culture in the learning environment so that the existence of HOTS elements can

be integrated more effectively. Teachers should take the initiative to implement teaching strategies, including creating strategic teamwork so that students can accept the practice of CTS more effectively (Plotnikova & Strukov, 2019).

Meanwhile, the findings of the study have implications based on existing theories discussed further by Swartz and Parks (1994), Aldegether (2009), Paul and Elder (2005), and also Zechmeister and Johnson (1992). These studies mentioned how CTS practice can be implemented in the education system, especially in schools. Based on the findings, it was found that teacher perception and teacher readiness had a highly significant and positive relationship with the practice of applying CTS. This situation proves that mathematics teachers have excellent perception and readiness for the practice of CTS, and they are ready to implement CTS either in HPS, MPS and LPS. These findings also give the impression that teachers with CTS can reconstruct their thinking to solve any problem in mathematics, as proposed in the model by Zechmeister and Johnson (1992).

This result indicates that mathematics teachers can apply the elements of CTS and HOTS teaching methods such as inquiry-based learning, problem-solving skills and project-based learning which suit the knowledge and skills possessed by teachers as well as aligned with student acceptance (Duran & Dokme, 2016; Kozikoglu, 2019; Rini et al., 2020). Hollins (2011) suggest that the planning and readiness of teachers in implementing lessons are essential elements in describing teachers' personality, seriousness and practice in designing high-quality teaching.

Through the SEM-AMOS model, there was a significant effect between the two independent variables, namely teachers' perception and teachers' readiness for the application of CTS practice. This situation concurred with the findings by Erdem dan Adiguzel (2019), whereby the application of CTS practice was based on the perception of teachers in the school environment that they served. Besides, demographic factors such as gender and teaching experience, the level of education of teachers also play a significant role in improving teacher perception of CTS practice in teaching. Even so, teachers' perception of CTS practice can also depend on internal factors and skills such as self-motivation, expectations in acceptance, simple language use, teaching methods and communication skills with students (Dehghayedi & Bagheri, 2018; Warsah et al., 2021).

Indeed, teacher readiness to implement CTS in mathematics is highly demanded in the teaching process. Teacher readiness is not only based on pedagogical skills and knowledge, but it is also influenced by the attitude and interest of teachers in placing CTS as a vital aspect in the classroom (Nagappan, 2001; Yusof & Ibrahim, 2012). Based on the SEM-AMOS analysis, it turned out that the four elements of teacher readiness affected the application of CTS practice in the teaching of mathematics. Birgili (2015) has also touched on the importance of teachers' pedagogical skills and knowledge in implementing CTS practice so that it can produce students who can solve problems involving everyday situations, more critically and creatively. Thus, the practice of CTS demands a positive attitude and deep interest among educators. Failure to practice CTS in teaching usually occurs when teachers themselves do not care about the importance of critical thinking (As'ari et al., 2017).

CONCLUSION

Perfect teaching is teaching that incorporates elements that can enhance creativity and critical thinking among students. To achieve this goal, teachers must have a positive perception of the implementation of CTS and have a high readiness in practising CTS in teaching. When both elements of teacher perception and readiness have been developed, the application of CTS practice can be implemented in teaching, especially in mathematics. To improve the quality of teaching mathematics, teachers should be thoroughly prepared before the teaching and learning process until the end of the process based on the elements of CTS. Thus, factors such as skills, knowledge, attitude and deep interest among teachers become a priority in ensuring the practice of CTS implementation can occur successfully in teaching (Yusof & Ibrahim, 2012).

As mathematics is one of the core and essential subjects of the Malaysian curriculum, the approach emphasized should help teachers and students in that the application of CTS practice does not interfere with existing curriculum requirements. One of the best steps is to apply the elements of HOTS in every teaching process to produce students who are highly creative and able to think critically (Munawaroh et al., 2018). Therefore, teachers need first to have a high level of perception and readiness in the application of CTS. Mathematics teachers should be aware that the practice of CTS is not an easy thing, as it requires huge sacrifices to produce a positive outlook. When teachers have awareness, then it is easier for teachers to make careful preparation,

including empowering their skills and knowledge to practice CTS in every lesson (Hollins, 2011). Through a variety of teaching strategies, the use of teaching aids that are appropriate and aligned with the level of student acceptance, the interest and attitude of teachers to implement CTS will be more prominent to produce high student creativity (Su et al., 2015).

Based on the findings of the study, a good implication for teachers is that the application of CTS practice requires continuous training. Mathematics teachers are also advised to follow professional development programmes in the field of pedagogy, or soft skills in cultivating a variety of teaching strategies and to have high self-esteem to form high-quality CTS practices (Ennis, 2016; Erdogan, 2020). Based on the latest developments, the education system is moving towards the implementation of 21st-century learning. Therefore, the application of CTS practice should have continuity towards that goal with the implementation of the vision and mission of a national education focused on the development of culture and human beings with critical thinking (Ab Kadir, 2017). The common practice of CTS among teachers will be a catalyst for students to gradually accept the concept of CTS in their learning and to eventually produce high-quality academic achievement.

ACKNOWLEDGMENT

This research received no specific grant from any funding agency in the public, commercial or non-profit sectors. There was no potential conflict of interest as reported by the authors.

REFERENCES

- Ab Kadir, M. A. (2017). What teacher knowledge matters in effectively developing critical thinkers in the 21st century curriculum? *Thinking Skills and Creativity*, 23, 79–90. <https://doi.org/10.1016/j.tsc.2016.10.011>
- Acharya, K. P. (2017). Exploring critical thinking for secondary level students in chemistry: From insight to practice. *Journal of Advanced College of Engineering and Management*, 3, 31–39. <https://doi.org/10.3126/jacem.v3i0.18812>

- Aini, N. R., Syafril, S., Netriwati, N., Pahrudin, A., Rahayu, T., & Puspasari, V. (2019). Problem-based learning for critical thinking skills in mathematics. *Journal of Physics: Conference Series*, 1155(1), 1–7. <https://doi.org/10.1088/1742-6596/1155/1/012026>
- Al-degether, R. (2009). *Teacher educators' opinions and knowledge about critical thinking and the methods they use to encourage critical thinking skills in five female teacher colleges in Saudi Arabia* (Doctoral dissertation). University of Kansas, USA.
- Al-Faoury, O. H., & Khwaileh, F. (2014). The effect of teaching CoRT program no. (4) entitled 'creativity' on the gifted learners' writings in Ein El-Basha Center for gifted student. *Theory and Practice in Language Studies*, 4(11), 2249–2257.
- Arbuckle, J. L. (2016). *IBM SPSS AMOS 24 User's Guide*. Amos Development Corporation.
- As'ari, A. R., Mahmudi, A., & Nuerlaelah, E. (2017). Our prospective mathematics teachers are not critical thinkers yet. *Journal on Mathematics Education*, 8(2), 145–156. <https://doi.org/10.22342/jme.8.2.3961.145-156>
- Awang, Z., Hui, L. S., & Zainuddin, N. F. S. (2018). *Pendekatan Mudah SEM: Structural Equation Modelling*. MPWS Rich Resources Sdn Bhd.
- Barak, M., & Shakhman, L. (2008). Reform-based science teaching: Teachers' instructional practices and conceptions. *EURASIA Journal of Mathematics, Science and Technology Education*, 4(1), 11–20. <https://doi.org/10.12973/ejmste/75301>
- Behar-Horenstein, L. S., & Niu, L. (2011). Teaching critical thinking skills in higher education: A review of the literature. *Journal of College Teaching & Learning*, 8(2), 25–42. <https://doi.org/10.19030/tlc.v8i2.3554>
- Birgili, B. (2015). Creative and critical thinking skills in problem-based learning environments. *Journal of Gifted Education and Creativity*, 2(2), 71–80. <https://doi.org/10.18200/JGEDC.2015214253>
- Cansoy, R., Parlar, H., & Polatcan, M. (2018). Teacher candidates' critical thinking tendencies research in Turkey: A content analysis. *Universal Journal of Educational Research*, 6(9), 1974–1980. <https://doi.org/10.13189/ujer.2018.060916>
- Changwong, K., Sukkamart, A., & Sisan, B. (2018). Critical thinking skill development: Analysis of a new learning management model for Thai high schools. *Journal of International Studies*, 11(2), 37–48. <https://doi.org/10.14254/2071-8330.2018/11-2/3>

- Choy, S. C., Yim, J. S. C., & Tan, P. L. (2017). Reflective thinking among preservice teachers: A Malaysian perspective. *Issues in Educational Research*, 27(2), 234–251.
- Creswell, J. W. (2014). *Research design : Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications, Inc.
- Curriculum Development Centre. (1989). *Rancangan kurikulum baru sekolah menengah*. Kementerian Pendidikan Malaysia.
- Curriculum Development Centre. (1993). *Kemahiran berfikir: Konsep, model dan strategi pengajaran-pembelajaran*. Kementerian Pendidikan Malaysia.
- Dancey, C. P., & Reidy, J. (2011). *Statistics without maths for psychology* (5th ed.). Prentice Hall.
- Danielson, C. (2007). *Enhancing professional practice: A framework for teaching*. Association for Supervision and Curriculum Development.
- DeBono, E. (1985). *DeBono's thinking course*. Facts on File Publications.
- Dehghayedi, M., & Bagheri, M. S. (2018). EFL teachers' learning and teaching beliefs: Does critical thinking make a difference? *International Journal of Instruction*, 11(4), 223–240. <https://doi.org/10.12973/iji.2018.11415a>
- DeWitt, D., Alias, N., & Siraj, S. (2016, July 31-August 3). Problem solving strategies of Malaysian secondary school teachers. *Educational Technology World Conference*, Bali, Indonesia.
- Duran, M., & Dokme, I. (2016). The effect of the inquiry-based learning approach on student's critical thinking skills. *EURASIA Journal of Mathematics, Science and Technology Education*, 12(12), 2887–2908. <https://doi.org/10.12973/eurasia.2016.02311a>
- Ennis, R. H. (2016). Critical thinking across the curriculum: A vision. *Topoi*, 37(1), 165–184. <https://doi.org/10.1007/s11245-016-9401-4>
- Erdem, A. R., & Adiguzel, D. C. (2019). The opinions of primary school teachers on their creative thinking skills. *Eurasian Journal of Educational Research*, 19(80), 1–14. <https://doi.org/10.14689/ejer.2019.80.2>
- Erdogan, F. (2020). The relationship between prospective middle school mathematics teachers' critical thinking skills and reflective thinking skills. *Participatory Educational Research*, 7(1), 220–241. <https://doi.org/10.17275/per.20.13.7.1>
- Facione, P. A. (2006). *Critical thinking: What it is and why it counts*. California Academic Press.

- Facione, P. A. (2015). Critical thinking: What it is and why it counts. In *Insight assessment* (pp. 1–28). Hermosa Beach, CA: Measured Reasons LLC. Retrieved from <https://www.insightassessment.com/CT-Resources/Teaching-For-and-About-Critical-Thinking/Critical-Thinking-What-It-Is-and-Why-It-Counts/Critical-Thinking-What-It-Is-and-Why-It-Counts-PDF>
- Firdaus, Kailani, I., Bakar, M. N., & Bakry. (2015). Developing critical thinking skills of students in mathematics learning. *Journal of Education and Learning*, 9(3), 226–236.
- Ganapathy, M., & Kaur, S. (2014). ESL students' perceptions of the use of higher order thinking skills in English Language writing. *Advances in Language and Literary Studies*, 5(5), 80–87. <https://doi.org/10.7575/aiac.all.v.5n.5p.80>
- Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Pearson Education Limited.
- Hollins, E. R. (2011). Teacher Preparation For Quality Teaching. *Journal of Teacher Education*, 62(4), 395–407. <https://doi.org/10.1177/0022487111409415>
- Ismail, S. N., Muhammad, S., Kanesan, A. G., & Ali, R. M. (2019). The influence of teachers' perception and readiness towards the implementation of critical thinking skills (CTS) practice in Mathematics. *International Journal of Instruction*, 12(2), 337–352. <https://doi.org/10.29333/iji.2019.12222a>
- Janssen, E. M., Mainhard, T., Buisman, R. S. M., Verkoeijen, P. P. J. L., Heijltjes, A. E. G., van Peppen, L. M., & van Gog, T. (2019). Training higher education teachers' critical thinking and attitudes towards teaching it. *Contemporary Educational Psychology*, 58(March), 310–322. <https://doi.org/10.1016/j.cedpsych.2019.03.007>
- Kaviza, M. (2020). Hubungan antara amalan kemahiran 4C dan pencapaian Sejarah. *Malaysian Journal of Social Sciences and Humanities*, 5(12), 405–412. <https://doi.org/10.47405/mjssh.v5i12.652>
- Ministry of Education Malaysia. (2012). *Program i-Think: Membudayakan kemahiran berfikir*.
- Ministry of Education Malaysia. (2013). *Malaysia Education Blueprint 2013–2015*. <https://www.moe.gov.my/en/dasarmenu/pelan-pembangunan-pendidikan-2013-2025>
- Kozikoglu, I. (2019). Investigating critical thinking in prospective teachers: Metacognitive skills, problem solving skills and academic self-efficacy. *Journal of Social Studies Education Research*, 10(2), 111–130.

- Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 38(1), 607–610. <https://doi.org/10.1177/001316447003000308>
- Kusaeri, K., & Aditomo, A. (2019). Pedagogical beliefs about critical thinking among Indonesian Mathematics pre-service teachers. *International Journal of Instruction*, 12(1), 573–590. <https://doi.org/10.29333/iji.2019.12137a>
- Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction*, 12(2), 417–434. <https://doi.org/10.29333/iji.2019.12227a>
- Maryuningsih, Y., Hidayat, T., Riandi, R., & Rustaman, N. Y. (2019). Critical thinking skills of prospective biology teacher on the chromosomal basic of inheritance learning through online discussion forums. *Journal of Physics: Conference Series*, 1157(2), 1–6. <https://doi.org/10.1088/1742-6596/1157/2/022090>
- Marzano, R. J. (2001). *Designing a new taxonomy of educational objectives. Experts in assessment*. Sage Publications.
- Munawaroh, H., Sudiyanto, & Riyadi. (2018). Teachers' perceptions of innovative learning model toward critical thinking ability. *International Journal of Educational Methodology*, 4(3), 153–160. <https://doi.org/10.12973/ijem.4.3.153>
- Nagappan, R. (2001). The teaching of higher-order thinking skills in Malaysia. *Journal of Southeast Asian Education*, 2(1), 1–21.
- Nisbet, R. I., & Collins, J. (1978). Barriers and Resistance to Innovation. *Australian Journal of Teacher Education*, 3(1), 1–29. <https://doi.org/10.14221/ajte.1978v3n1.1>
- Nunnally, J. C. (1994). *Psychometric theory* (3rd ed.). Tata McGraw-hill education.
- Omar, M. N., Ismail, S. N., & Kasim, A. L. (2019). Hubungan kepimpinan teknologi pengetua dan efikasi kendiri guru. *Jurnal Kepimpinan Pendidikan*, 6(4), 1–21.
- Pallant, J. (2011). *SPSS survival manual* (4th ed.). Allen & Unwin.
- Paul, R., & Elder, L. (2005). *The miniature guide to critical thinking: Concepts and tools*. The Foundation for Critical Thinking.
- Plotnikova, N. F., & Strukov, E. N. (2019). Integration of teamwork and critical thinking skills in the process of teaching students. *Cypriot Journal of Educational Sciences*, 14(1), 1–10. <https://doi.org/10.18844/cjes.v14i1.4031>
- Putri, A., Roza, Y., & Maimunah. (2020). Development of learning tools with the discovery learning model to improve

- the critical thinking ability of Mathematics. *Journal of Educational Sciences*, 4(1), 83–92. <https://doi.org/10.31258/jes.4.1.p.83-92>
- Rahman, S. A., & Manaf, N. F. A. (2017). A critical analysis of Bloom's Taxonomy in teaching creative and critical thinking skills in Malaysia toward English literature. *English Language Teaching*, 10(9), 245–256. <http://doi.org/10.5539/elt.v10n9p245>
- Rini, D. S., Adisyahputra, & Sigit, D. V. (2020). Boosting student critical thinking ability through project based learning, motivation and visual, auditory, kinesthetic learning style: A study on Ecosystem topic. *Universal Journal of Educational Research*, 8(4A), 37–44. <https://doi.org/10.13189/ujer.2020.081806>
- Shiau, W.-L., Sarstedt, M., & Hair, J. F. (2019). Internet research using partial least squares structural equation modeling (PLS-SEM). *Internet Research*, 29(3), 398–406. <https://doi.org/10.1108/IntR-10-2018-0447>
- Shim, W.-J., & Walczak, K. (2012). The impact of faculty teaching practices on the development of students' critical thinking skills. *International Journal of Teaching and Learning in Higher Education*, 24(1), 16–30. Retrieved from <http://www.isetl.org/ijtlhe/>
- Snyder, L. G., & Snyder, M. J. (2008). Teaching critical thinking and problem solving skills. *Delta Pi Epsilon Journal*, 50(2), 90–99.
- Su, A. H. F. H., Ricci, F. A., & Mnatsakanian, M. (2015). Mathematical teaching strategies: Pathways to critical thinking and metacognition. *International Journal of Research in Education and Science*, 2(1), 190–200. <https://doi.org/10.21890/ijres.57796>
- Sulaiman, T., Muniyan, V., Madhvani, D., Hasan, R., & Rahim, S. S. A. (2017). Implementation of higher order thinking skills in teaching of science: A case study in Malaysia. *International Research Journal of Education and Sciences*, 1(1), 1–3.
- Swartz, R., & Parks, S. (1994). *Infusing the teaching of critical and creative thinking into content instruction: A lesson design handbook for the elementary grades*. Critical Thinking Press.
- Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Pearson Education Inc.
- Tanujaya, B., Mumu, J., & Margono, G. (2017). The relationship between higher order thinking skills and academic performance of student in Mathematics instruction. *International Education Studies*, 10(11), 78. <https://doi.org/10.5539/ies.v10n11p78>

- Tatto, M. T., Peck, R., Schwille, J., Bankov, K., Senk, S. L., Rodriguez, M., & Rowley, G. (2012). *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries: Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M)*. Amsterdam, Netherlands: International Association for the Evaluation of Educational Achievement.
- Thurman, B. A. (2009). *Teaching of critical thinking skills in the English content area in South Dakota public high schools and colleges* (Doctoral dissertation). University of South Dakota, USA.
- Vaughter, P. (2016). *Climate change education: From critical thinking to critical action*. United Nations University.
- Warsah, I., Morganna, R., Uyun, M., Hamengkubuwono, H., & Afandi, M. (2021). The impact of collaborative learning on learners' critical thinking skills. *International Journal of Instruction*, 14(2), 443–460. <https://doi.org/10.29333/iji.2021.14225a>
- Widana, I. W., Parwata, I. M. Y., Parmithi, N. N., Jayantika, I. G. A. T., Sukendra, K., & Sumandya, I. W. (2018). Higher order thinking skills assessment towards critical thinking on Mathematics lesson. *International Journal of Social Sciences and Humanities*, 2(1), 24–32. <https://doi.org/10.29332/ijssh.v2n1.74>
- Yusof, S. M., & Ibrahim, N. (2012). Kesediaan guru Matematik tahun satu dalam pelaksanaan Kurikulum Standard Sekolah Rendah (KSSR) di daerah Kluang. *Journal of Science and Mathematics Education*, 6(1), 26–38.
- Zechmeister, E. B., & Johnson, J. E. (1992). *Critical thinking: A functional approach*. Thomson Brooks/Cole Publishing Co.