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Instrument Development of Teaching Practice on Higher-Order Thinking Skills for 21st-Century Learning

Huda Afiqah Hashim[1], Rahimah Embong[1], Rapi'ah Jusoh[1], Uzairu Muhammad Gwadabe[2], Zamri Chik[3] & Wan Marfazila Wan Mahmud[1]

[1] Faculty of Islamic Contemporary Studies, Universiti Sultan Zainal Abidin, Terengganu, Malaysia, [2]Faculty of Business and Management, Universiti Sultan Zainal Abidin, Terengganu, Malaysia, [3]Terengganu Strategic & Integrity Institute (TSIS)
Corresponding Author's Email: rahimahembong@unisza.edu.my

Abstract
The 21st-century learning paradigm emphasises the need for students to develop thinking skills, particularly higher-order thinking skills (HOTS). In this regard, teachers play a crucial role in facilitating the application of HOTS in the classroom. Thus, this paper aims to develop a measuring instrument to assess teachers' practice of HOTS in secondary schools. The questionnaire consists of 30 items and three dimensions: facilitating HOTS, Socratic questioning, and applying the i-THINK map. Three experts validated the instrument for face and content validity. Data was collected in Terengganu from a total of 126 respondents and analysed using the Statistical Package for Social Sciences (SPSS) version 25. The analyses included exploratory factor analysis (EFA), Bartlett's sphericity test, Kaiser-Meyer-Olkin (KMO) sampling adequacy test, and Cronbach's alpha reliability test. The findings revealed a three-dimensional model with 28 items. In addition, Bartlett's sphericity tests for all dimensions were significant ($P<0.05$), the sampling adequacy revealed a favourable result ($KMO>0.6$), and the values of Cronbach's alpha exceeded the threshold value of 0.7. Overall, the results indicate that the instrument has high validity and reliability in measuring HOTS teaching practice. Furthermore, this study highlights the importance of teachers' roles as facilitators, effective questioning techniques, and thinking aids in holistic teaching.
Keywords: Higher-Order Thinking Skills, Learning and Facilitation, Socratic Questioning, I-Think Map, Exploratory Factor Analysis

Introduction

The 21st-century learning paradigm focuses on two main aspects: student-centred learning and 21st-century skills to produce a trained, productive, and capable generation as national leaders. Besides, this education aims to facilitate lifelong learning more practically. Moreover, through 21st-century classroom activities, students are exposed to real-world problem situations. Therefore, one of the most critical aspects of 21st-century learning is the implementation of various strategies and activities, such as communication, cooperation, and higher-order thinking skills (Poh et al., 2020).

Higher Order Thinking Skills (HOTS) are one of the pillars of the educational transformation envisioned in the Malaysia Education Blueprint (PPPM) 2013–2025. HOTS is a way of thinking that incorporates understanding, application, synthesis, analysis, reasoning, and evaluation while performing activities requiring complex skills, such as problem-solving, decision-making, and innovation (MOE, 2013). In this regard, teachers play a crucial role because they must master the improved curriculum and develop new and old ideas through a variety of activities in order for HOTS to be implemented in the classroom (Muzirah & Atiqah, 2021).

According to Slavin (1994), the effective teaching practice of teachers is affected by four factors: the quality of teaching, the appropriate level of teaching, the length of teaching, and incentives. Meanwhile, Shahril (2005) explains that effective teaching practice consists of the following eight criteria: diversity of teaching methods, provision of teaching aids, mastery of the lesson plan, knowledge of students' ability to receive lessons, moral support through motivation to students, the ability to control student behaviour, the ability to gather students in groups, and the frequent administration of assessments or tests. Despite this, most of the teaching instruments used in previous research focused more on teachers' readiness, attitude, and skills without considering the teaching techniques and teaching aids that comprise pedagogy. Therefore, this study was conducted to investigate and establish the validity and reliability of the measurement items for a more holistic construct of HOTS teaching practice, including facilitating HOTS, using Socratic questioning techniques, and applying the i-THINK map.

This study determined the validity and reliability of measurement items for the HOTS teaching practice construct among secondary school teachers. This study has three main goals: first, to determine if the measurement items for HOTS teaching practice are suitable and comprehensible; second, to ensure high validity and reliability of the measurement items that represent HOTS teaching practice; and third, to conduct a pilot study to test the instrument's validity and reliability. In conclusion, the validity and reliability of measurement items are crucial because they influence the effectiveness of HOTS teaching practice.

Literature Review

This section explains the three main dimensions of hots teaching practice: facilitating hots, socratic questioning, and the application of the i-think map. These three dimensions are analysed based on the opinions of scholars in the field of education and discussions of related past studies.

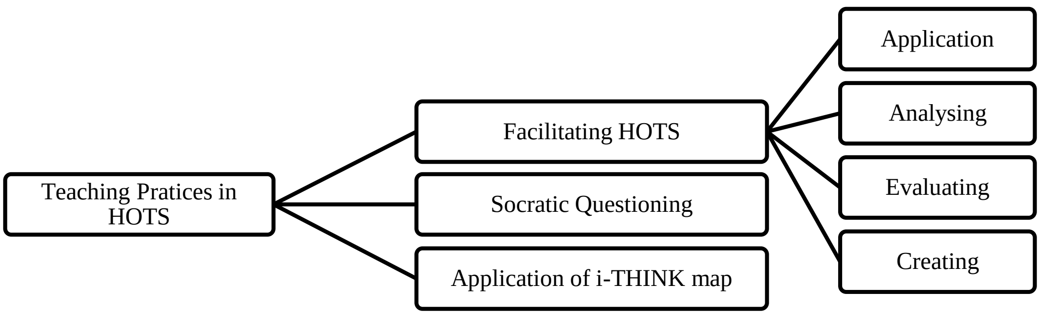

Figure 1. The three main dimensions of HOTS teaching practice

Figure 1 depicts the three primary dimensions of HOTS teaching practice: facilitating HOTS, Socratic questioning, and applying the i-THINK map. The facilitation of HOTS consists of four levels of thinking: application, analysis, evaluating and creating.

Facilitating HOTS

Today's educational transformation requires teachers to implement instruction based on the Malaysian Education Quality Standard or SKPM. Learning and facilitation in HOTS are characterised by student-centred instruction characterised by active engagement through challenging assignments and questions (MOE, 2014). For effective implementation of teaching HOTS, teachers must refer to the Learning Standards (SP) outlined in the Standard Document for Curriculum and Assessment (DSKP), which describes what students should know and be able to do. In order to cultivate HOTS among students, teachers must create a classroom environment that encourages students to think by employing the appropriate thinking tools and questioning strategies (MOE, 2014). In addition, teachers must be proficient in learning and facilitation, understand student development, teach psychology, and possess counselling skills to meet the challenges of teaching HOTS (Shamilati et al., 2017).

A study on teachers conducted by Zaid et al (2018) found that implementing HOTS is at a high level because teachers are bound by the responsibility to teach HOTS techniques as outlined by the ministry. This finding is consistent with the findings of Ashraf et al (2020), who found that teachers demonstrated a high level of interpretation in terms of readiness, knowledge, understanding, and skills in implementing HOTS. Furthermore, Zulkifly et al (2021) discovered a high rate of HOTS implementation among teachers in Machang primary schools. However, according to Aziana and Fadzilah (2018), most Malay teachers must prepare to integrate HOTS into their teaching methods. This is due to a need for more understanding of how to implement HOTS in learning and teaching, a lack of exposure to HOTS techniques, and the burden of other tasks that prevent them from effectively incorporating HOTS into their teaching. In addition, not all teachers are exposed to comprehensive CBT teaching practices, as some are less effective at implementing HOTS in the classroom.

Socratic Questioning

The Socratic method is implemented based on Socrates' dialogue-based concepts. This two-way communication process between the teacher and the students (Knezic et al., 2010) requires reading, research, thinking, and reasoning, ultimately leading to solutions to the questions given (Swain, 2007). This strategy promotes student participation in expressing thoughts and supporting a presented argument by making them more active and responsive. This strategy is appropriate for secondary school students and higher since students are better equipped and able to argue against the topic being discussed (Pihlgren, 2009) while the teacher guides students to ask, discuss, and answer the questions that have been posed (Zare & Othman, 2013).

Previous studies showed that teachers who employ this instruction could inspire students to think more critically, particularly before answering questions or expressing their thoughts. Teachers must generate various questions that require students to engage in critical thought to answer them (Fauzan & Hafizhah, 2020). This explains that the teaching strategy employed by teachers is crucial to the achievement of student learning objectives. According to a study by Fauzan and Hafizhah (2020), teachers have a high level of Socratic method knowledge and skill. According to another study, the frequency with which teachers ask questions based on students' ability levels can positively impact student achievement. As a result, the students are seen to be more flexible, relevant, and able to adapt to the current modernity (Zamri & Razah, 2011). This demonstrates that appropriate questioning techniques stimulate students' creative and critical thinking.

Application of i-THINK Maps

The i-THINK programme, introduced in 2012, aims to improve and cultivate thinking skills among students to produce creative, critical, and innovative human capital and compete. In addition, students are expected to be able to reason, concentrate, be confident, be active, and enjoy learning, as well as to develop a close relationship with their teacher, which can improve their learning performance. As part of an effort to implement HOTS among students, the i-THINK map has been introduced as a thinking tool in learning and facilitation (MOE, 2012). The i-THINK map is presented in eight readily understandable and usable visual mind map formats. There are eight types of i-THINK maps: the circle map, the treemap, the bubble map, the double bubble map, the flow map, the multi-flow map, the brace map, and the bridge map. Each thinking map has distinct characteristics and a distinct thought process that can be adapted based on the topic of discussion (MOE, 2012). A bubble map, for instance, aids students in attributing information, a flow map guides students in explaining a process step-by-step, and a bracket map illustrates the relationship between the parts and the whole. In other words, the i-THINK maps highlight eight forms of visual language for every thought process.

Among the researchers who studied the effectiveness of the i-THINK map are Chew and Siti Syahirah (2021), who found that students' knowledge, attitude, and readiness towards the i-THINK map in KOMSAS learning were at a high level. Furthermore, Ashikin et al (2021) also found that the learning of Islamic Education among students increased with the use of the i-THINK map, and this is in line with the research results of Zarina and Ruzanna (2021), who reported that teachers well received the use of the i-THINK map because it brought about emotional changes that were positive in the students and at the same time contributed to active involvement in activities during learning and facilitation.

Methodology

This study involves two phases, namely the instrument's validity and the implementation of a pilot study, to ensure that the questions are sensitive to the language and culture of the respondents (Sekaran & Bougie, 2010). This study uses face, content, and construct validity (Alanazi, 2014). For the face validity and content validity of the instrument, the questionnaire was reviewed and examined by three experts (Zikmund et al., 2013), consisting of two field experts and one methodological expert, namely Prof. Adjunct Dr Rosnani Hashim (KBAT and pedagogy), Ms Raimah (KBAT and i-THINK map) and Dr Zamri Chik (SEM methodology). At this stage, the researcher obtains expert feedback to confirm the questionnaire's validity and ensure it measures what it is supposed to measure. Evaluation by experts in the field is critical to identify vague and awkward items in the questionnaire by assessing the wording and clarity of the items and confirming that the items are sufficient to measure the construct (Presser et al., 2004). The researcher then modified the instrument based on expert comments and feedback and improved it into a renewed questionnaire version. The instrument showed acceptable reliability and good validity for collecting primary data.

After the instrument underwent three validations and improvements, the questionnaire was tested for validity and reliability through a pilot study. According to Riedl et al (2006), the pilot study aims to improve materials, systems, and parameters for the actual study and cover gaps in the study method. Researchers collected data randomly from two national secondary schools in the State of Terengganu and obtained a total of 126 respondents from teachers. Data were analysed using Exploratory Factor Analysis (EFA) to explore and evaluate items and their dimensions in measuring specific constructs. Factor analysis was used to establish construct validity. This technique validates the concept of components defined as practical. It shows the most appropriate element for each component (Sekaran, 2009). The researcher used Bartlett's test to test variance stability for all samples.

In contrast, the Kaiser-Meyer-Olkin (KMO) test was used to determine the adequacy of the sample size for analysis (Kaiser, 1974). Then, the construct validity and appropriateness of the instrument in the context of KBAT teaching practice are determined. Finally, the study needs to calculate Cronbach's Alpha, which shows the items' reliability, to see this construct's internal consistency (Keith, 2018). Internal consistency indicates the strength of items united in measuring a particular construct. For elements to achieve internal reliability, Cronbach Alpha should be greater than 0.7 (Rahlin et al., 2019).

Discussion and Findings

The discussion of the analysis results begins with a descriptive analysis, followed by the KMO value and Bartlett's test, the Total Variance Explained (TVE), component extraction, and finally, the reliability test to examine the internal consistency of the measurement items. The dimensions of the measurement items for this questionnaire may change compared to other studies due to differences in the respondent's background factors, the location of the study, and the type of school.

Exploratory Factor Analysis (EFA) Procedure

This study uses an interval scale between 1 (strongly disagree) and 10 (strongly agree) with the given element statement to measure this construct with its 28 elements in the instrument. The measurement of each element in HOTS teaching practice is shown in descriptive statistics. Table 1 presents the mean score and standard deviation for each element. Based on EFA analysis, three key dimensions were extracted from HOTS teaching practice: facilitating HOTS, Socratic questioning, and applying the i-THINK map. This analysis treats the dimension of facilitating HOTS separately, yielding four sub-components: application, analysis, evaluation, and creation. The remaining two dimensions, Socratic questioning and the application of the i-THINK map, were analysed simultaneously.

Table 1 shows the descriptive analysis of the measurement items for facilitating HOTS. The item "I encourage students to apply their existing knowledge to complete an activity" has the highest mean value of 8.48 (SP = 1.244) for the sub-component of the application. In contrast, the item "I encourage students to make connections between learning topics and their existing knowledge" has the highest mean value of 8.68 (SP = 1.171) for the sub-component of analysis. For the sub-component of evaluating, the item "I guide students to make decisions based on strong arguments" yields the highest mean score of 8.46 (SP = 1.231). In contrast, the item "I encourage students to generate new ideas" yields the highest mean score of 8.48 (SP = 1.218) for the sub-component of creating. Overall, the mean value for all items is moderately high, ranging between 7.90 and 8.68, while the standard deviation ranges between 1.129 and 1.530.

Table 1
Descriptive analysis for measurement items for facilitating HOTS

Items	Statements	Mean	Standard Deviation
FP1	I encourage students to apply their existing knowledge to carry out an activity.	8.48	1.244
FP2	I encourage students to apply the i-THINK map in learning.	7.90	1.531
FP3	I guide students to manipulate information based on the topic of discussion.	8.39	1.206
FP4	I guide students to illustrate ideas in the form of diagrams.	8.21	1.412
FN1	I encourage students to make comparisons about a topic of discussion.	8.52	1.129
FN2	I guide students to identify the function or role of each part of a discussion topic.	8.54	1.218
FN3	I encourage students to analyse findings about a topic of discussion.	8.38	1.301
FN4	I encourage students to make connections between learning topics and existing knowledge.	8.68	1.171
FE1	I encourage students to debate an issue critically.	8.21	1.304
FE2	I guide students to make decisions based on solid arguments.	8.46	1.231
FE3	I guide students to make a comprehensive summary based on a topic of discussion.	8.35	1.273
FE4	I encourage students to defend their opinion on a matter.	8.20	1.333
FC1	I encourage students to generate new ideas.	8.48	1.218
FC2	I encourage students to create their own model of a topic.	8.12	1.451
FC3	I guide the students to produce a group project.	8.33	1.350
FC4	I encourage students to make predictions about a discussion topic.	8.19	1.288

Table 2 shows the descriptive analysis of the measurement items for the dimension of Socratic questioning and the application of the i-THINK map. As for the dimension of Socratic questioning, the item "I ask questions that require an explanation from students" gives the highest mean value of 8.40 (SP = 1.233). In contrast, the item "I ask students to use a flowchart when explaining a topic step by step" gives the highest mean value of 7.84 (SP = 1.685) for the i-THINK map application dimension. Overall, the average score for all items is moderately high, with a range of 7.44 to 8.40 and a standard deviation ranging from 1.233 to 1.987.

Table 2
Descriptive analysis of measurement items for Socratic questioning and the application i-THINK map

Items	Statements	Mean	Standard Deviation
SQ1	I ask questions that require clarification from students.	8.40	1.233
SQ2	I ask students' assumptions or predictions about a discussion topic.	8.28	1.250
SQ3	I ask the students to present evidence against the statements given.	8.25	1.384
SQ4	I ask the students' perspective about a topic of discussion or a current issue.	8.29	1.413
SQ5	I ask students about the consequences of an event.	8.39	1.239
SQ6	I clarify the question raised by the students.	8.17	1.386
iTM1	I ask the students to use circle maps when defining an idea.	7.67	1.738
iTM2	I ask the students to use bubble maps when explaining the characteristics of something.	7.66	1.785
iTM3	I ask students to use double-bubble maps when comparing two or more topics.	7.77	1.785
iTM4	I ask students to use a tree map when classifying information.	7.61	1.784
iTM5	I ask students to use a brace map when explaining the parts of something.	7.51	1.987
iTM6	I ask students to use a flow map when explaining a topic step by step.	7.84	1.685
iTM7	I ask students to use a multi-flow map when explaining cause and effect for a topic.	7.73	1.786
iTM8	I ask the students to use the bridge map when making parables/analogies.	7.44	1.966

KMO and Bartlett's Test

Table 3 shows the KMO and Bartlett's test values for the dimension of facilitating hots. Bartlett's test of sphericity gives a highly significant value (sig. 000). Also, the sampling adequacy determined by Kaiser-Meyer-Olkin (KMO = 0.957) is excellent and exceeds the minimum value of 0.6. (Hoque et al., 2018). These two results indicate sufficient data exists to continue the EFA data reduction procedure (Hoque et al., 2018; Yahaya et al., 2018).

Table 3
KMO Value and Bartlett's Test for Facilitating Hots

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.957
Bartlett's Test of Sphericity	*Approx. Chi-Square*	2273.981
	Df	120
	Sig.	.000

Table 4 shows the values of KMO and Bartlett's test for Socratic questioning and the application of the i-think map. The value provided by Bartlett's test of sphericity is highly significant (sig. 000). Also, the sampling adequacy determined by Kaiser-Meyer-Olkin (KMO = 0.947) is excellent and exceeds the minimum value of 0.6. These two results indicate that the data is sufficient for the data reduction procedure in EFA (Hoque et al., 2018; Yahaya et al., 2018).

Table 4
Kmo values and bartlett's test for socratic questioning and application of i-think map

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.947
Bartlett's Test of Sphericity	*Approx. Chi-Square*	2236.103
	Df	91
	Sig.	.000

Total Variance Explained - TVE
Table 5 shows how the four components of facilitating hots were extracted through the EFA procedure based on the eigenvalues. The eigenvalues range between 2.486 and 4.984. The total variance explained for component 1 is 31.150%, component 2 is 20.453%, component 3 is 17.093%, and component 4 is 15.539%. The total variance accumulated for this construct is 84.234%, exceeding the minimum value of 60% (Yahaya et al., 2018).

Table 5
Values of total variance explained (TVE) for facilitating hots

Total Variance Explained (TVE)			
	Rotation Sums of Squared Loadings		
Component	*Total*	*% of variance*	*Cumulative %*
1	4.984	31.150	31.150
2	3.272	20.453	51.602
3	2.735	17.093	68.695
4	2.486	15.539	84.234
Extraction Method: Principal Component Analysis.			

Table 6 shows the two components of hots teaching practises that were extracted through the efa procedure based on eigen values. The eigenvalues range between 5.286 and 6.462. The total variance explained for component 1 is 46.158% and that for component 2 is 37.755%. The total variance explained accumulated for this construct is 83.912%, exceeding the minimum value of 60% (Yahaya et al., 2018)

Table 6.
Total variance explained value (TVE) of socratic questioning and application of i-think map

Total Variance Explained (TVE)			
	Rotation Sums of Squared Loadings		
Component	*Total*	*% of variance*	*Cumulative %*
1	6.462	46.158	46.158
2	5.286	37.755	83.912

Extraction Method: Principal Component Analysis.

Table 7 shows the number of components for the dimension of facilitating hots. The results of the extraction reveal four components with their corresponding elements. For any element to be retained, its factor loading must be greater than 0.60 (Yahaya et al., 2018). There were two items that were removed because they did not exceed a value of 0.6.

Table 7
Number of components for facilitating hots

Rotated Component Matrix[a]				
	Component			
	1	**2**	**3**	**4**
TLP1			0.742	
TLP2			0.872	
TLP3			0.669	
TLP4	Item removed			
TLN1		0.696		
TLN2		0.672		
TLN3	Item removed			
TLN4		0.804		
TLE1	0.734			
TLE2	0.745			
TLE3	0.806			
TLE4	0.692			
TLC1				0.654
TLC2				0.641
TLC3				0.623
TLC4				0.687

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 7 iterations.

Table 8 shows the number of components for socratic questioning and the application of the i-think map. The extraction results provide two components and their respective elements. For any element to be retained, its factor loading must be greater than 0.60 (Yahaya et al., (2018).

Table 8
Number of components for socratic questioning and application of i-think map applications

Rotated Component Matrix[a]		
	Component	
	1	**2**
SQ1		0.821
SQ2		0.847
SQ3		0.806
SQ4		0.890
SQ5		0.874
SQ6		0.866
iTM1	0.831	
iTM2	0.909	
iTM3	0.829	
iTM4	0.890	
iTM5	0.896	
iTM6	0.780	
iTM7	0.813	
iTM8	0.844	

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 3 iterations.

Internal Reliability
Table 9 shows the internal consistency cronbach alpha value for the component of facilitating hots. The results indicate that the cronbach alpha value for all four components exceeds 0.7, while the cronbach alpha value for all fourteen items was 0.967, exceeding the threshold value of 0.7 (Yahaya et al., 2018).

Table 9
Cronbach alpha values for internal consistency for facilitating hots

Component	**Name of sub-components**	**No. of components**	**Cronbach's alpha**
1	Application dimension of HOTS	3	0.809
2	Analysis dimension of HOTS	3	0.935
3	Synthesising dimension of HOTS	4	0.936
4	Creating dimension of HOTS	4	0.938
		14	**0.967**

Table 10 shows the internal consistency cronbach alpha values for the socratic questioning component and the application of the i-think map. The analysis reveals that both components have cronbach alpha values greater than 0.70. In addition, the cronbach alpha value for all fourteen items was 0.966, exceeding the minimum threshold of 0.7 (Yahaya et al., 2018).

Table 10
Cronbach alpha values for internal consistency for socratic questioning and application of the i-think map

Component	Name of sub-components	No. of components	Cronbach's alpha
1	Application of i-THINK map	8	0.972
2	Socratic questioning	6	0.960
		14	**0.966**

Based on the discussion of the cronbach alpha value, the reliability analysis results for the hots teaching practice construct yielded a value that exceeded 0.7. In conclusion, the extracted components and associated measurement items are reliable and suitable for measuring the construct of hots teaching practice. Furthermore, they can be applied to similar studies in the future.

Conclusion and Implications of the Study

The EFA results form a configuration that extracts three dimensions of hots teaching practice, which can be measured with 28 measurement items developed in this study, with a high cronbach's alpha value, a KMO (> 0.6), and a factor loading that exceeds the threshold of 0.6. These results indicate that these elements apply to this study. Furthermore, the current study's rigorous scale development and validation confirm that the validated instrument is consistent and stable across samples and can be used in future studies to measure the dimensions of hots teaching practice.

Additionally, the scope of this study is restricted to the procedures followed, and the findings obtained. First, the educational institutions investigated in this research are primarily those that fall under the purview of malaysia's ministry of education as policymakers. Second, the scope of this investigation is limited to hots teaching practices, which are discussed concerning pedagogy in the classroom; it needs to examine assessment and evaluation in depth. This study provides implications from holistic teaching aspects such as teachers' roles as facilitators in the classroom, effective questioning techniques, and appropriate thinking aids.

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