An Exploratory Factor Analysis of Holistic Thinking Behaviour of the Teachers in Teaching Higher-Order Thinking Skills

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Abstract

Higher-order thinking skills (HOTS) are critical skills that a student needs to master, especially in the era of 21st Century Learning. Teacher plays a vital role in inculcating and instilling the values of HOTS in the classroom. Such as more than HOTS, knowledge is required to implement HOTS teaching because the teacher's thinking is the main factor in successfully fulfilling the education agenda in Malaysia. Therefore, this paper aims to develop an instrument of holistic thinking behaviour among teachers in secondary schools. The study used a quantitative research design to know the facts and figures of the construct's reliability and validity. A questionnaire was developed with 24 measurement items comprising six main components: metacognition, creative thinking, flexible thinking, interdependent thinking, efficacy in thinking and precision language of thinking. This instrument has gone through the process of face validity and content validity by three academic experts. A pilot study was conducted involving 108 respondents in the state of Terengganu. Data were analysed using the Statistical Package for Social Sciences (SPSS) version 25 via exploratory factor analysis (EFA), Bartlett's sphericity test, Kaiser-Meyer-Olkin (KMO) sampling adequacy test and Cronbach's Alpha reliability test. The study's findings have shown that the model produces five components with 23 items. Bartlett's test of sphericity for all components gave a significant value ($P<0.05$), significant sampling adequacy ($KMO>0.6$) and a Cronbach's Alpha value that exceeded the threshold value of 0.7. Overall, the results of the EFA analysis show that the instrument has high validity and reliability for measuring the construct of holistic thinking behaviour construct. This study gives implications from the aspect of holistic thinking among teachers, which includes five main elements that act as catalysts in teaching and instil higher-order thinking skills among students in the classroom.

Keywords: Higher order thinking skills; Holistic thinking, Exploratory factor analysis; Measurement instruments

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Introduction

The focus of the study is on the holistic thinking behaviour of the teachers and teaching higher-order thinking skills (HOTS). Twenty-first Century Learning emphasises four essential components for the student: creative, critical, collaboration and communication. Among these

four elements, the element of critical thinking is crucial to be cultivated and infused among students because it can help the students to face the challenges in the future successfully. Thus, realising the importance of this element, the Malaysian Ministry of Education (MOE), through the Malaysian Education Blueprint (PPPM) 2013-2025, has outlined six elements that a student must achieve to be competitive at national as well as global levels. Among them is the need for a student to master thinking skills, which include higher-order thinking skills (HOTS) (MOE, 2013).

HOTS includes critical and creative thinking accompanied by other skills such as interpretation, explanation, analysis, inferences, evaluation, self-reflection, meta-cognition, synthesis, and creation (King, Rohani & Goodson, 1997; Facione, 2006). Meanwhile, the Ministry of Education defines HOTS based on the revised Bloom's Taxonomy (Anderson & Krathwohl, 2001) by setting four high-level thinking skills: application, analysis, evaluation and creating. The Ministry of Education is very serious about succeeding in the mastery of the thinking skills agenda through the execution of HOTS, which is not only in the curriculum but also includes the application of HOTS in pedagogy, assessment and co-curriculum. The teachers are also given the training to ensure that their knowledge and understanding of HOTS is in line with the current of national education and share with excellent teachers about the best teaching practices that can ensure successful implementation in schools.

Accordingly, teachers as educators in the education sector in schools play a vital role to implement vision as outlined in the PPPM 2013-2025 in the schools. The teachers have to prepare themselves with the proper knowledge about HOTS and master the skills in order to teach thinking skills and achieves the learning objectives (Wan Mazwati & Shamilati, 2018). In addition, the teachers themselves have to be role models for students as thinkers which manifested through positive and excellent behaviour (Rahimah et al., 2022). This can be seen through the teacher's attitude, who carefully listens to any questions or suggestions, asks challenging questions, asks students to provide arguments or justifications, asks questions about new problems or implements creative learning activities.

In addition, most of the previous studies focused on knowledge, perception, attitude, implementation and assessment of teachers in teaching HOTS (Pillay et al., 2018; Chun & Abdullah, 2019; Nani et al., 2022) because these studies consider the success factors HOTS achievement among students is greatly influenced by the knowledge and teaching practice of teachers in HOTS (Abdullah et al., 2017). However, there is another catalyst that influences students' mastery of HOTS which is the quality of the teacher himself. An excellent teacher should be a role model for students, especially regarding the tendency and disposition to think critically. Many studies show a positive relationship between thinking disposition and their effects on the mastery of thinking skills (McGrath, 2003; Wan Sulaiman, Abdul Rahman & Dzulkifli, 2008; Poondej & Lerdpornkulrat, 2015).

Therefore, this study was conducted to explore and determine the validity and reliability of measurement items for the construct of holistic thinking behaviour among secondary school teachers. There are three specific objectives in this study which are developing an appropriate and understandable instrument for holistic thinking behaviour, determining high validity and reliability of the measurement items representing the construct of holistic thinking behaviour and lastly, conducting a pilot study to measure the validity and reliability of the instrument.

Framework of Holistic Thinking Behaviour

Based on the literature review, there are three selected theories which discuss thinking disposition, namely "habits of mind" by Costa (2008), "language of thinking" by Costa and Marzano (2001) and "human passion" by Costa and Garmston (2001). In the debate about human passion, Costa and Garmston (2001) explain that the enthusiasm to think is needed to motivate a person to practice thinking skills. Meanwhile, Costa and Marzano (2001) claim that the repetition of a specific and particular thinking language can influence how an individual thinks and acts. Furthermore, this situation is closely associated with the habits of mind presented by Costa (2008) because the repetition of something will form a habit. Consequently, teachers need a passion for thinking to use the language of thinking, which ultimately forms thinking habits.

Based on the content analysis of the three theories mentioned, holistic thinking behaviour results from the entwined elements within the three theories that show the same meaning from different words. For example, the analysis of the three theories of human passion, habits of mind and language of thinking concerning consciousness show similarities with the theme of metacognition, which is thinking about thinking. Therefore, all the indicators with the same meaning from these three theories were collected until five different themes were developed.

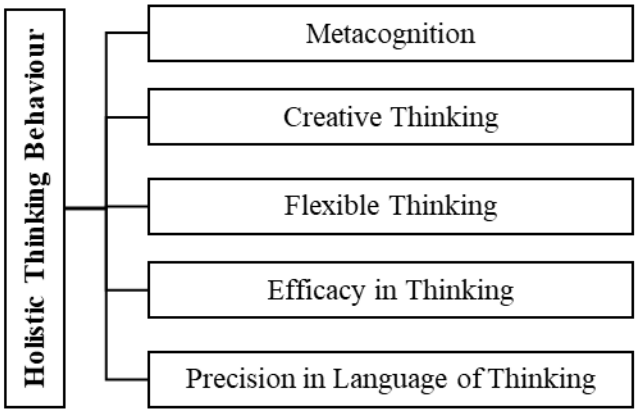

Figure 1: Five components of holistic thinking behaviour

Figure 1 shows the five main components of holistic thinking behaviour: metacognition, creative thinking, flexible thinking, efficacy in thinking and precision in the language of thinking. These five components are analysed based on the views of scholars in the field of education and discussions based on past studies related to each component.

Metacognition

Metacognition is thinking about one's thinking process. This element is found in all three theories, which are habits of mind (Costa, 2008), human passion (Costa & Garmston, 2001), and language of thinking (Costa & Marzano, 2001), which refer to the terms metacognition and

managing impulsiveness, the passion of awareness and developing metacognition. Metacognition reflects one's thinking process and enables thinking to be implemented into observable action. Metacognition significantly influences an individual's actions because this element can distinguish between right and wrong ways of thinking, being aware of thinking obstacles, goals, values, actions and the environment.

Metacognition is a vital skill in developing HOTS among students. Teachers can develop metacognitive skills by asking students to reflect and naming the thinking processes they have used at the end of each teaching and learning session. Students need to be aware of the thinking skills they have used during teaching and learning sessions. Furthermore, teachers should be role models who reflect on themselves by sharing the thought process they have just done with their students. Self-reflection also allows a teacher to assess the degree of progress, strength or weakness and then take action to improve the quality of teaching and achievement among students.

Creative Thinking

The argument about creative thinking can be found in habits of mind (Costa, 2008) and human passion (Costa & Garmston, 2001), which are the passion for craftsmanship as well as creating, imagining, and innovating. In this regard, Lutnaes (2018) mentions in a model developed by researchers at the Real World Learning Center (CRL) that craftsmanship is one of the five core tendencies of creativity. According to Torrence (1979), a creative thinking framework includes four elements: fluency, flexibility, elaboration, and originality. He further explained that creative thinkers are prolific in generating ideas or presenting alternative solutions to a problem, able to generate ideas that highlight the diversity of thought that can generate the diversity of possibilities, improve ideas with more details and generate new and innovative ideas.

Teachers have a great responsibility and role in nurturing creativity among students (Aminuddin et al, 2019). Teachers who think creatively can see things from various perspectives, using different approaches or strategies and often have new ideas or suggestions. Besides, creative teachers can readily appreciate the aesthetic value of a creation (Costa, 2008), prioritising the artistic quality of a product and encouraging students to innovate. Furthermore, creative teachers will discuss teaching methods and thinking tools among colleagues and willingly accept criticism to improve their teaching strategies. They also take the initiative to participate in educational workshops to find new materials, strengthen their expertise, as well as to make creativity a part of their lesson plans and teaching materials.

Flexible Thinking

Both habits of mind (Costa, 2008) and human passion (Costa & Garmston, 2001) discuss flexible thinking. Flexibility is the ability of one person to adapt and change according to the environment. People with flexible thinking can change their position and beliefs when they receive additional information and solid evidence. Besides, they attempt to understand people and find explanations from various perspectives, which makes them readily accepted in a diverse society.

Flexible thinking is crucial for a teacher because of the diversity of the students in the classroom who come from various aspects like different personalities, thinking styles, lifestyles, academic achievements, and individual abilities. Teachers with flexible thinking will be able to handle the diverse personalities of the students because they also have a high value of empathy (Costa, 2008). Therefore, teachers can empathise with the students' feelings, predict their thoughts, and avoid misunderstandings in communication. Furthermore, a congenial teacher will create a conducive environment for the students to communicate and express any problems with Learning.

Efficacy in Thinking

Efficacy in teaching thinking is discussed in both habits of mind (Costa, 2008) and human passion (Costa & Garmston, 2001), which includes elements of continuous learning and passion for efficacy. A person with high efficacy will strive to improve and equip themselves with new knowledge and skills so they can easily overcome challenges when facing troubles and have a reservoir of strategies in problem-solving. Teachers who are influential in teaching thinking will be motivated to contribute more efforts in their tasks, strive to achieve high goals, be persistent and persevere in the face of difficulties or failure (Costa, 2008; Costa & Garmston, 2001).

Teachers with high efficacy in thinking have the confidence to apply HOTS in various situations and can effectively teach thinking skills. In addition, they are confident in their ability to constantly improve their teaching skills so that students can depend on them. Furthermore, they will always look for opportunities to find solutions when facing difficulties in dealing with the diversity of students who have different backgrounds, knowledge, and levels of thinking skills in order to be able to achieve the learning outcomes of the subjects.

Precision in Language of Thinking

Precision in the language of thinking is defined by using appropriate and accurate words and concepts to express thinking processes and actions. This element was discussed in all three theories (Costa, 2008; Costa & Garmston, 2001; Costa & Marzano, 2001). For example, a person who practices the language of thinking will avoid using vague terms or hastily making generalisations about something. On the other hand, these individuals will also use appropriate language, precise terms and correct analogies (Costa, 2008) when communicating so that the information can be quickly understood. According to Costa & Marzano (2001), using correct linguistic expressions such as and, but, after or because will give an apparent cognitive effect through understanding the relationship between the ideas in a sentence.

In order to cultivate higher-order thinking skills among students, teachers should use specific cognitive terms so that students will learn the accurate language of thinking. Teachers practising precision in the language of thinking consistently in the classroom will help students develop a thinking process for each term used (Shamilati et al., 2015), appreciate the words, and finally apply them in their daily lives (Costa & Marzano, 2001). This is consistent with Beyer (1985), who stated that repeatedly applying the accurate language of thinking could

develop thinking habits of the mind because there is a strong relationship between language and thinking. On the other hand, students who are not used to being exposed to the language of thinking will use vague and inaccurate language when explaining something or a phenomenon, consequently causing the process of inculcating higher-order thinking skills among students cannot be implemented effectively in the classroom.

Methodology

The study used a quantitative research design with a positivistic approach. This study involved two phases: the instrument's validity and the pilot study's implementation. At the initial stage, the instrument was built from three primary sources, namely "habits of mind" by Costa (2008), "language of thinking" by Costa and Marzano (2001) and "human passion" by Costa and Garmston (2001). This instrument had 24 items, using an interval scale between 1 (strongly disagree) and 10 (strongly agree). This instrument was constructed through face, content, and construct validity to ensure the items were sensitive to the language and background of the respondents (Sekaran & Bougie, 2010), especially among secondary school teachers. For face validity and content validity, three experts were appointed to review and evaluate the instrument's content. At this stage, the feedback received from the experts confirmed the validity of the questionnaire and ensured that this instrument measures what it should be measured (Sekaran & Bougie, 2016). This is a critical stage in identifying any blurry and awkward items in the instrument based on assessing wording and item clarity and confirming sufficient numbers of items to measure the construct (Sekaran & Bougie, 2016).

Next, an improved instrument based on the expert comments was ready to be applied to the pilot study. A pilot study was conducted on 108 teachers randomly selected from two secondary schools in Terengganu. The pilot study is critical because it can improve the quality of the items, parameters and systems for the actual study and minimise shortcomings that may occur in the study's methodology (Riedl, Kainz & Elmes, 2006). First, data were analysed using Exploratory Factor Analysis (EFA) to confirm the existence of the elements in the construct by presenting practical and suitable items for each component (Sekaran, 2009). Next, Bartlett's test was applied to test the stability of variance across the samples, whereas the KMO test was used to determine the adequacy of the sample size for analysis purposes (Kaiser, 1974). Finally, the instrument's reliability was analysed based on Cronbach's Alpha to test the internal consistency of the construct (Cronbach, 1951). The internal consistency shows the strength of the accumulated items in measuring particular components and is shown based on Cronbach's Alpha value greater than 0.7 (Rahlin et al., 2019).

Analysis and Discussion

The discussion of findings begins with descriptive analysis, KMO value and Bartlett's test, the total variance explained, component extraction and the reliability test for internal consistency of each measurement item. 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 schools.

Exploratory Factor Analysis (EFA)

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 24 items in the instrument. The measurement of each element in holistic thinking behaviour is shown in descriptive statistics, represented by the mean score and standard deviation for each item. Based on EFA analysis, five key dimensions were extracted from holistic thinking behaviour: metacognition, creative thinking, flexible thinking, efficacy in thinking and precision in the language of thinking.

Table 1 shows the descriptive analysis for the measurement items of the construct of holistic thinking behaviour. Item MT1 gives the highest mean value of 8.48 (SD=1.279) for the metacognition component, while item CT3 gives the highest mean value for the creative thinking component of 8.44 (SD=1.279). For the components of flexible thinking and efficacy in thinking, items FT1 and ET have the highest mean values of 8.76 (SD=1.279) and 8.28 (SD=1.345), respectively. Finally, for the component of precision in the language of thinking, item PT4 gives the highest mean value of 8.40 (SD=1.253).

Table 1: Descriptive analysis for the construct of holistic thinking behaviour

Component	Code	Mean	Standard Deviation
Metacognition	MT1	8.48	1.279
	MT2	8.45	1.241
	MT3	8.40	1.360
	MT4	8.44	1.416
Creative Thinking	CT1	7.93	1.451
	CT2	7.95	1.637
	CT3	8.44	1.248
	CT4	8.20	1.352
Flexible Thinking	FT1	8.69	1.219
	FT2	8.36	1.377
	FT3	8.43	1.262
	FT4	8.44	1.233
	FT5	8.57	1.334
	FT6	8.49	1.234
	FT7	8.52	1.227
	FT8	8.76	1.222
Efficacy in Thinking	ET1	8.18	1.413
	ET2	8.28	1.345
	ET3	8.24	1.373
	ET4	8.25	1.319
Precision in Language of Thinking	PT1	8.21	1.283
	PT2	8.28	1.214
	PT3	8.35	1.299
	PT4	8.40	1.253

As a result, the mean values for all items of the construct of holistic thinking behaviour are at a moderately high level, which ranges between 7.93 to 8.76. At the same time, the standard deviation gives a value ranging from 1.214 to 1.637.

KMO and Bartlett's Test

Table 2 shows the values of KMO and Bartlett's Test for the construct of holistic thinking behaviour. Bartletts Test of Sphericity gives a highly significant value (sig. 000). The sampling adequacy by Kaiser-Meyer-Olkin (KMO=0.952) is excellent, exceeding the required value of 0.6 (Hoque et al., 2018). This result shows that the data is sufficient to continue the data reduction procedure in EFA (Hoque et al., 2018; Yahaya et al., 2018).

Table 2: KMO and Bartlett's Test for holistic thinking behaviour

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.952
Bartlett's Test of Sphericity	Approx. Chi-Square	3514.696
	Df	276
	Sig.	.000

Total Variance Explained (TVE)

Table 3 shows how the five components of holistic thinking behaviour were extracted through the EFA procedure based on the Eigenvalues. The eigenvalues range between 2.934 and 6.298. The total variance explained for component 1 is 26.241%, component 2 is 17.544%, component 3 is 17.363%, component 4 is 12.648%, and component 5 is 12.225%. The total variance accumulated for this construct is 86.021%, exceeding the minimum value of 60% (Yahaya et al., 2018).

Table 3: Total Variance Explained for holistic thinking behaviour

Total Variance Explained			
	Rotation Sums of Squared Loadings		
Component	Total	% Variance	Cumulative %
1	6.298	26.241	26.241
2	4.211	17.544	43.785
3	4.167	17.363	61.148
4	3.036	12.648	73.796
5	2.934	12.225	86.021

Extraction Method: Principal Component Analysis.

Table 4 shows the number of components for the construct of holistic thinking behaviour. The extraction results give five components and their corresponding elements. To

retain any item, the factor loading for each element should be greater than 0.5 (Yahaya et al., 2018). There was one item excluded, giving a value below 0.5. The five components of holistic thinking behaviour are metacognition, creative thinking, flexible thinking, efficacy in thinking and precision in the language of thinking. Furthermore, it was found that interdependent thinking resulted from the same component as flexible thinking.

Table 4: Number of components for holistic thinking behaviour

Rotated Component Matrix					
Items	Component				
	1	2	3	4	5
MT1		0.749			
MT2		0.786			
MT3		0.699			
MT4		0.636			
CT1				0.761	
CT2				0.637	
CT3				0.599	
CT4				0.550	
FT1	0.734				
FT2	0.680				
FT3	0.679				
FT4	0.640				
FT5	0.656				
FT6	0.693				
FT7	0.734				
FT8	0.770				
ET1			0.695		
ET2			0.686		
ET3			0.688		
ET4			0.619		
PT1					0.594
PT2					0.744
PT3			Item was removed		
PT4					0.562

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization [a]
a. Rotation converged in 8 iterations.

Internal Consistency of Cronbach's Alpha

Table 5 shows Cronbach's alpha values on testing internal consistency for the construct of holistic thinking behaviour. The analysis results show that all five components have a Cronbach alpha value exceeding 0.7. While the Cronbach alpha value for all fourteen items gives a value of 0.985, exceeding the threshold value of 0.7 (Rahlin et al., 2019).

Table 5: Internal consistency of Cronbach Alpha for holistic thinking behaviour

Component	Name of components	No. of components	Cronbach's Alpha
1	Metacognition	4	0.953
2	Creative Thinking	4	0.912
3	Flexible Thinking	8	0.965
4	Efficacy in Thinking	4	0.967
5	Precision in Language of Thinking	3	0.921
		23	0.983

Based on the discussion above, the reliability analysis results for the construct of holistic thinking behaviour gave values that exceeded 0.7. In conclusion, the components extracted according to the measurement items involved are reliable and suitable for measuring the construct of holistic thinking behaviour. They can then be applied in future studies that are similar to it.

Conclusion

The EFA results form a configuration that extracts five components of holistic thinking behaviour, which can be measured with 23 measurement items constructed in this study, with high Cronbach's Alpha value (>0.7), significant value for Bartlet's Test, KMO (> 0.6), and factor loading which exceeds the threshold of 0.5. These results revealed that these elements could be used in this study. Furthermore, rigorous scale development and validation of this study confirm that the validated instrument is consistent and stable across samples and can be used in future studies to measure components of teachers' holistic thinking behaviour.

Additionally, this study is limited to the methods and results obtained. First, the scope of this study is limited to educational institutions in schools supervised by the Malaysian Ministry of Education as policymakers. Second, this study only focuses on the teacher's thinking, which is metacognition, creative thinking, flexible thinking, efficacy in thinking and precision in the language of thinking. Finally, this study involved respondents among teachers without involving the achievement of students' mastery in HOTS. This study gives implications in terms of holistic thinking, which includes five elements: metacognition, creative thinking, flexible thinking, efficacy in thinking and precision in the language of thinking.

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Refereces

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