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Evaluating the Best-Practice Criteria of Higher-Order Thinking Skills for Design and Technology Courses

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Abstract*: A more systematic and better Higher-Order Thinking Skills (HOTS) approach would allow teachers to offer their best effort in order to produce students with higher-order thinking skills. Successful nurturing of HOTS requires the student's initiative to change from normal thinking to a critical way of thinking. Educational transformation aimed at cultivating HOTS is in line with contemporary situations because teachers also encounter students who are far different today compared to a decade or so before. The implementation of HOTS among teachers should be intensive and continuous via various methods to ensure the teacher's capability to teach and learn is always improving. Failure to implement a good HOTS would weaken the objective of the Malaysia Education Development Plan 2013-2025 (PPPM 2013-2025) aimed at producing students who are highly productive and skilled in using information technology and communication. Hence, this paper intended to comprehensively identify the criteria for best-practice for HOTS in the Design and Technology course as well as evaluate the criteria by using the Delphi Method. This method comprised three interview sessions with a panel of 15 experts whose function was to determine the criteria obtained from literature sources. These criteria were then used as components to develop an instrument to measure teachers' experience when carrying out HOTS during the teaching and learning sessions.

***Keywords* : Delphi Technique, Design and Technology, Higher Order Thinking Skills, Teaching and Learning**

I. INTRODUCTION

According to Nurzalina [1], among the main problems afflicting the education sector in Malaysia is the low quantity and quality of higher-order thinking skills (HOTS) being implemented. HOTS is a crucial factor that enhances the capability and ability of students [2]. According to the problem stated earlier, the preparedness of a teacher to understand the best-practices as the main pillar in assimilating HOTS during the teaching and learning process is an effort towards the improvement required in the education sector today. The development of the education sector today has gone through several development phases that demands the use of more effective best-practices in order to face the demands and burden of a more challenging workload, especially when teaching thinking skills to students [3]. Moreover, effective best-practices could be a guide when enhancing the performance and quality of teaching and learning. This enhanced teaching and learning could produce a more positive outcome as stated by [4] and [5], whereby quality teaching is produced when the intended information is received, is attractive as well as easily remembered and practiced by students.

II. HOTS BEST PRACTICE IN DESIGN & TECHNOLOGY COURSE

In efforts to achieve an effective implementation of HOTS, teachers who teach Design and Technology course need new ideas, specifically related to concepts, philosophy, theories, implementation strategy, innovation in teaching and learning as well as implementing these innovations effectively and attractively in the class room [6]. In contrast with the teacher-centered traditional method, HOTS emphasizes on collaborations between teachers and students [7]. This practice trains students to analyze, synthesize and reflect on their learning for their own benefit. This benefit is important because it helps students to build self-confidence as well as increase the current capability and ability, either inside or outside the classroom, until they are at the tertiary level.

Each Design and Technology teacher needs to create a good practice by focusing on HOTS in every teaching and learning session [8], which would then lead to the active participation of students in practical and demonstrative activities that would enable these good practices to turn learning sessions into experiences. According to [9], best-practices is a technique or method, which through experiences and research, had been conclusively proven to produce what is needed. The commitment to use best-practices in any field is a commitment to use all the knowledge and technology in a person to ensure success is achieved [10]

Ministry of Education (KPM), assimilating HOTS practices into the education system using a systematic and comprehensive approach comprises seven HOTS elements consisting of three main elements (curriculum, assessment and pedagogy) as well as four supporting elements (co-curricular, community and private sector support, resources and constructability) [11]. All these elements were meant to enculturate higher-order thinking skills among teachers and students.

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A. Curriculum

The Best-Practices of HOTS in the curriculum generally depicts the elements in HOTS that are explicitly written in the curriculum documents. Besides that, it also explains the meaning of HOTS in the curriculum, the important aspects of HOTS and identifies the verbs categorized according to the order of thinking.

B. Assessment

The Best-Practices of HOTS in assessment explains how teachers can measure the capability of HOTS. There are three forms of assessment, namely school, center and examination assessments.

C. Pedagogy

There are three forms of assessment, namely school, center and examination assessments. The Best-Practices of HOTS in pedagogy stresses on the planning and implementation of HOTS during the teaching and learning process. This includes planning of the teaching and learning according to pedagogy, teaching and learning's strategy and implementation of teaching and learning strategies.

D. Co-curricular

The Best-Practices of HOTS in co-curricular touches on the implementation of the HOTS elements in the co-curricular by using the 5-step problem solving approach. Incorporating the HOTS elements in co-curricular activities is achieved when students obtain a meaningful experience through a pre-determined problem-solving process.

E. Community and Private Sector Support

The Best-Practices of HOTS in the community and private sector support component explains the mechanism provided by KPM that enables the community and private sector to play their roles in supporting the implementation of HOTS in schools.

F. Resources

The Best-Practices of HOTS in resources shows the resource materials that could be used to enhance the HOTS in teaching and learning. Besides that, it could be a guide for teachers when using available materials, access other related resources or build resources in efforts to enable the assimilation of HOTS in the teaching and learning.

G. Constructability

The Best-Practices of HOTS in constructability suggests the approach that could be taken by administrators and teachers to increase self-capability when enculturating HOTS in schools.

The success in achieving an effective HOTS depends on a comprehensive and coherent planning that involves the measurement of all seven best-practices mentioned above [11].

III. OBJECTIVE

The main objective of this study was to develop a measurement instrument for the best-practice of Higher-Order Thinking Skills for the Design and Technology course. Overall, this study involved three main phases, namely the analysis, design and evaluation phases. For a start, this paper discussed the findings of the first phase, which was to identify the critical criteria and attributes for measuring the best-practice of HOTS for the Design and Technology course based on expert consensus.

IV. METHODOLOGY

In order to answer the objectives of this study, the expert consensus approach or better known as the Delphi technique was used. The Delphi technique was chosen to provide an understanding about the main data, which involved the perception and presumptions of the panel of experts related to important criteria and attributes based on the Linear Numerical Scale (Table II), which could be used to develop an instrument for measuring the best-practice of HOTS in Design and Technology course based on the consensus of the panel. The Delphi technique in this study comprised three rounds of structured interviews with 15 subjects who were experienced experts and practitioners in the Design and Technology field as well as held positions for at least 10 years as leaders in the educational field. The min value was used to identify the important criteria and attributes because the min could be easily used to cordon information about the respondent's collective consideration. Table 1 below shows the background of the subjects in the interview.

Table- I: List of subjects (experts) for the interview.

Designation	Institution	N
Assoc. Prof	Public University	2
Senior lecturer	Public University	3
Lecturer	Teacher Education Institute	4
Outstanding RBT Teacher	Primary School	3
RBT Chief Coach	Primary School	3
	Total	15

V. FINDINGS AND DISCUSSION

Figure 1 shows the results of the Delphi process for all the interview sessions together with the final item list of attributes agreed upon by the panel of experts. Generally, each attribute that had a 'very important' (min > 4.2) level of importance for two rounds was chosen as a best-practice attribute in this study.

In the first round of the Delphi process, 7 main criteria comprising 79 attributes were tested. From that figure, 77 attributes were maintained while 2 attributes were discarded. Modifications on these attributes were carried out before the second round by taking into consideration the suggestions and comments of the panel of experts including the restructuring of sentences as well as combining the attributes that carried the same meaning. After the modifications, there were 73 best-practice attributes that were maintained under the 7 main criteria.

In the second round of the Delphi process, 43 attributes were discarded because the min values were lower than 4.2 (min < 4.2) for a second time, whereas 19 attributes were unanimously chosen after posting a min value of 4.2 or more (min ≥ 4.2) for a second time.

Meanwhile, there were 11 attributes that were maintained for the third round of the Delphi process because they had one min value less than 4.2 (min < 4.2) and one min value of more than 4.2 (min > 4.2). The 11 attributes were tested in the third round of the Delphi process and all the attributes achieved the second level of consensus and were selected as the best-practice attributes for this study. At the end of the Delphi process, 30 attributes were selected according to the second level consensus under the 7 criteria.

Table III shows the detailed attributes of each criteria and Table IV shows the breakdown of the attributes according to the main criteria that were identified as the best-practice for HOTS in the Design and Technology course.

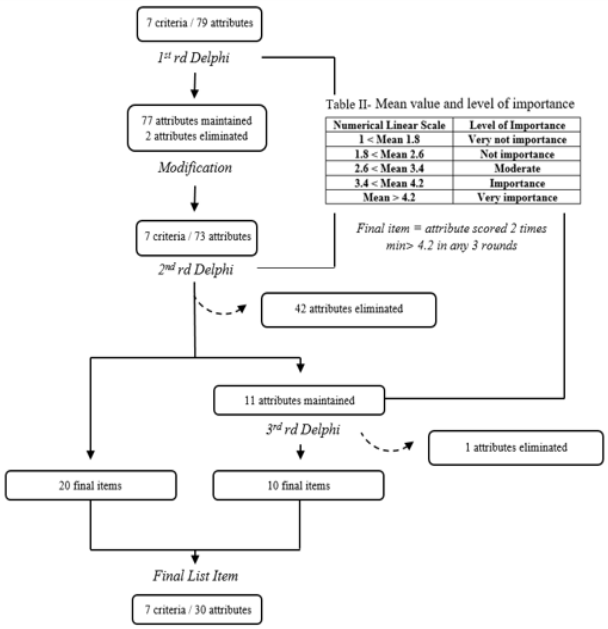

Fig. 1.Delphi process decision and final attribute selection

Fig. 2.

Table- III: Final criteria and Attributes

Criteria	Attribute
Curriculum	Understand in detail and identify the HOTS elements in curriculum documents so that the T&L can be implemented effectively and eventually enculturated.
	To consider and make decisions using knowledge, skills and values.
	To produce ideas, products or methods that are creative and innovative.
	To apply it in the form of T&L activities that challenge the mind and stimulates learning in students.
Assessment	Plan and implement actions that increase the effectiveness of T&L and the level of command of HOTS in students.
	Assess the level of command of HOTS among students by using a new context, real-life situations as well as various questions and stimuli.
	To extensively use the stimuli to generate inference skills and specific reasoning.
	To diversify the *function* in order to assess various order of thinking in the cognitive domain.
	To have a new perspective in assessment to foresee a successful education program that not only focuses on examinations that create students with higher-order thinking skills capable of solving problems, making decisions as well as being innovative and creative.
	To continuously assess through training, tests, oral tests, Q&A, quiz, worksheets, project assignments and observations.
Pedagogy	To use thinking tools or questioning technics in efforts to enculturate critical and creative thinking among students.
	Plan and implement HOTS through various T&L strategies that are effective and suitable with the objectives of T&L.
	To adduce high-level questions to enable students to think and use knowledge that is accepted by current knowledge to build new knowledge.
	Prepare a concrete learning schedule that involves *'hands on'* and *'minds on'* activities.
	Make references and further readings related to the elements of HOTS in the pedagogy.
Co-curricular	Provide opportunities to students via assignments and projects in order to explore, try and create innovations.
	To be a responsive facilitator who provides training and guidance to students and drive them towards a deeper understanding.
	To build confidence in students, encourage discussions that help assess problems, contribute suggestions, clarify ideas, examine and criticise ideas, arrange information and solve problems.
	To create students with creativity, imagination, values and able to make logical decisions.
	Instil leadership skills through co-curricular activities.
Community & Private Support	To allocate programs that involve HOTS skills to the community and the private sector.
	To provide experts that give advice and training.
	To sponsor training for teachers involved in RBT subjects aimed at increasing their level of skills.
Resources	Use materials from various sources and do not be solely dependent on structured materials.
	Develop resource materials commensurate with the level and capability of the student.
	Use materials that are related to real-life problems.
	Create and widen the network amongst themselves through various web applications, portals and social media.
Constructability	Increase the productivity and competency of teachers by implementing HOTS.
	Enhance the professionalism and personality of teachers for the purpose of career development
	Enhance the teacher's level of professionalism based on the school's need.

Table- IV: Summary of the breakdown of the criteria and best-practice attributes in HOTS

Criteria	Num. of attribute
Curriculum	4
Assessment	6
Pedagogy	5
Co-curricular	5
Community and Private sector support	3
Resources	4
Constructability	3
Total	30

VI. CONCLUSIONS

It could be concluded that all the expert panel members agreed to use the 7 criteria items and 30 attribute items as items contained in the best-practice of HOTS in the Design and Technology course. Overall, all the expert panel members agreed to use the 7 criteria items and the last 30 attribute items in the best-practice of HOTS in the Design and Technology course. There were three rounds of the Delphi technique for validating the criteria and attributes. Based on the data analysis that used the matrix method of research review, the suitable main criteria in the best-practice of HOTS were 'curriculum', 'assessment', 'pedagogy', 'co-curricular', 'community and private sector support', 'resources' and 'constructability'.

It could be concluded that all the criteria and attributes were identified and could be used to develop an instrument for measuring the best-practice of Higher-Order Thinking Skills for Design and Technology (RBT) subjects.

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