Q-MATRIX AS A METHOD IN PROMOTING STUDENT-GENERATED QUESTIONS TO DEVELOP CRITICAL THINKING SKILLS

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ABSTRACT

Malaysian students mostly lack critical thinking skills which are essential for them to be effective in the real world. The goal of this study was to explore the application of q-matrix as a technique which can be used by students to generate their own questions that involve lower order and higher order thinking questions. 17 secondary school students were required to apply this technique in ESL reading tasks. They were trained and guided on how to use the tool in order to generate questions that include higher order thinking questions. They were then required to answer these questions. Their self-generated questions and answers were assessed using Structure of Observed Learning Outcomes (SOLO) Rubric. The findings revealed that Q-matrix is a feasible technique in enhancing students' higher order thinking skills especially in generating critically challenging questions.

Keywords: Q-Matrix, Structure of Observed Learning Outcomes (SOLO),

1.0 INTRODUCTION

Hudson (2007) highlighted that critical reading skills are essential part of critical reading because critical reading precedes critical thinking as students need to have the abilities to analyze, synthesize, and evaluate what they read. Wallace (2003) proposed that teachers should encourage students to generate their own questions when they read a particular text. As students engage more in the reading process, they should raise further questions in order to challenge and enhance their thinking skills. It implies that asking questions are an effective way of being a critical reader. Thus, the objective of this study was to identify whether Q-Matrix chart can be utilized effectively by students to design student-generated higher order questions as an effort of improving their critical thinking skills.

2.0 RESEARCH QUESTIONS

1. To what extent that the students are able to generate higher order thinking questions using Q-matrix as measured by SOLO levels?

2. What type of learning verbs that students would likely choose to measure in their self-generated questions?

3. To what extent students are able to answer the higher order thinking questions generated by Q-Matrix according to SOLO levels classification?

3.0 CRITICAL READING IN MALAYSIA

Norizul and Abdul Rashid (2001) asserted that Malaysian secondary school reading programme stipulates that students should be able to read with critical awareness when they graduate from their secondary school education. However, Hazlina et al. (2012) discovered that more than sixty one percent of Malaysian students in schools are considered as incompetent readers due to poor strategies. Leng Choo, Eng and Norlida (2011) stated that Malaysian students are mostly struggling ESL readers as the Malaysian University English Test (MUET) revealed that most students obtain lower scores in reading comprehension which implies that they fail to master critical reading that they should have acquired in school. As a result, most students who enter higher learning institutions cannot handle the demand for critical thinking required in academic reading such as critiquing and evaluating academic texts (Noorizah, 2003). Malaysian students lack appropriate reading strategies in English language because most of them cannot analyze, evaluate, predict, reflect or perform any other higher order thinking skills. Their strategies are limited to lower-order thinking skills only (Subbiah & Singh, 2004; Ghanaguru, Liang & Kit, 2003;Nuraihan & Zamnah, 2004; Zuhana & Wong, 2014; Manson & Zaimuariffudin, 2014; Noorbayah, Roose, Farah & Juhaida; 2014; Noorizah, 2003). Teachers also lack pedagogical content knowledge in facilitating students' development of higher order thinking skills (Abdul

Halim, Mariam Mohamed, Abdul Ghani & Azizan, 2007; Hazlina, Nik Suriyani & Airil, 2012; Rajendran; 2002).

3.1 Q-MATRIX AS A QUESTIONING TECHNIQUE

Hattie and Brown (2004) argued that questioning is essential in promoting students' higher order thinking skills as most questions that teachers ask are lower-order thinking questions. However, if richer, divergent and higher order thinking questions are posed to the students, their learning will be enhanced. The Q-Matrix (Q for question) was designed and developed by Chuck Wiederhold in 1991. It is constructed from the six questions starters of what, where, when, which, who, why, how which can be combined with six verbs: is, did, can, would, will and might. It contains 36 different combinations of question starters. This matrix can be used by teachers and by students to create questions (Wiederhold, 1993).

Surface Understanding ⟷ Deep Understanding

Surface Understanding ↕ Deep Understanding

	Event	**Situation**	**Choice**	**Person**	**Reason**	**Means**
Present	What is?	Where/ When is?	Which is?	Who is?	Why is?	How is?
Past	What did?	Where/When did?	Which did?	Who did?	Why did?	How did?
Possibility	What can?	Where/When can?	Which can?	Who can?	Why can?	How can?
Probability	What would?	Where/When would?	Which would?	Who would?	Why would?	How would?
Prediction	What will?	Where/When will?	Which will?	Who will?	Why will?	How will?
Imagination	What might?	Where/When might?	Which might?	Who might?	Why might?	How might?

Figure 1: Q- Matrix
Source: Wiederhold, C. (1993). *Cooperating Learning and Critical Thinking: The Question Matrix. California.* Resource for Teachers.

The 36 question starters can be used for any topic that move from recall questions at the very basic level to higher level that involves analytical, creative and critical thinking. The questions become more complex-open ended as it proceeds through the matrix. This chart can guide teaching and learning as teachers are able to design questions at the level the student is able to fulfil and also to construct increasingly more complex questions that can challenge them to think more critically. The matrix also enables teachers to deliver differentiated instructions which can cater to students' mixed abilities more efficiently as they can pose different questions for different students according to their needs, levels and learning styles (Wiederhold, 1993).

Structure Observed Learning Outcome (SOLO) taxonomy is a taxonomy that can be effectively used to construct questions based different levels of thinking in which each thinking level encompasses certain learning verbs that can demonstrate what skills that the question requires and what skills that the students are able to exhibit in their answers. In addition, the taxonomy can be used to differentiate lower order thinking and higher order thinking (Biggs & Collis, 1982; Brabrand & Dahl; 2009; Potter & Kustra, 2012). As proposed by Wallace (2003) and Hattie and Brown (2004), it is essential for students to be able to generate their own questions and SOLO taxonomy can be utilized to serve as the foundation for the technique of generating questions, evaluating their level of complexity and assessing the answers given to these questions. Table 1 illustrates the five SOLO levels and the characteristics of each of the thinking levels. The table also includes the learning verbs as the operational aspects of each of the level. Questions can be designed on these levels and the answers can also be assessed and classified according to these levels. Pre-structural, unistructural and multistructural levels are considered as surface understanding and relational and extended abstract levels are deep understanding.

Table 1: SOLO Taxonomy

Level	Characteristics	Learning Verbs
Pre-structural	Incompetent, nothing known about the area	None
Uni-structural	One relevant aspect is known	paraphrase, define, identify, count, name, recite, follow simple instructions, calculate, reproduce, arrange, recognize, find, note, seek, sketch, and pick
Multi-structural	Several relevant independent aspects are known	combine, classify, structure, describe, enumerate, list, do algorithm, apply method, account for, execute, formulate, solve, conduct, prove, complete, illustrate, express, and characterize
Relational	Aspects of knowledge are integrated into a structure	analyze, compare, contrast, integrate, relate, explain causes, apply theory (to its domain), argue, implement, plan, summarize, construct, design, interpret (some senses), structure, conclude, substantiate, exemplify, derive, formulate questions and adapt
Extended Abstract	Knowledge is generalised into a new domain	theorize, generalize, hypothesize, predict, judge, transfer theory (to new domain), assess, evaluate, interpret (some senses), critically reflect, predict, criticize, imagine and reason.

Source: Potter, M.K & Kustra, E. (2012). *A Primer on Learning Outcomes and the SOLO Taxonomy.Course Design for Constructive Alignment.* Centre for Teaching and Learning, University of Windsor.

According to Hook and Mills (2011; 2012), Q-Matrix can be used as a questioning framework for SOLO questioning techniques in which the increasing complexity of the questions is consistent with the ascending cognitive complexity of SOLO levels that can be illustrated as a shift from surface understanding to deep understanding (figure 1). These four questions which were related to the short story "Goldilocks and the Three Bears" were constructed based on Q-Matrix and Solo Taxonomy:

Table 2: Constructing Questions with Q-Matrix and SOLO Taxonomy

Questions	**Starter**	**SOLO levels**	**Learning Verb**
What did Goldilocks discover in the story?	What did	Unistructural	Identify
How can you tell that the house belonged to a family?	How can	Multistructural	Prove
Why would the bears leave their houses unlocked without anyone inside?	Why would	Relational	Explain causes
Why might authors of fairytales make animals act like humans in most stories?	Why might	Extended abstract	Critically reflect

Therefore, the purpose of this study was to examine students' application of Q-Matrix in generating their own questions in reading activities. Despite the purpose of the chart as a technique of generating questions, there research on the application of Q-matrix is scant. Their questions can be assessed and classified using SOLO taxonomy in order to identify whether it is a higher order thinking question or lower order thinking question. Similarly, the answers to these questions can also be analyzed using SOLO levels.

4.0 RESEARCH METHODOLOGY

There were 17 students who were randomly selected for the study. They were 17 years old from a secondary school in a rural area of Sabah, Malaysia. They came from various parts of the interior region of the state. Their English proficiency was intermediate and most of them obtained grade "D" and "E' in English subject and the rest of the subjects in their previous assessment of Form 3 Assessment, also known as PT 3 in Malaysia. There were eleven male students and six female students. The entire task procedure is illustrated in Figure 2.

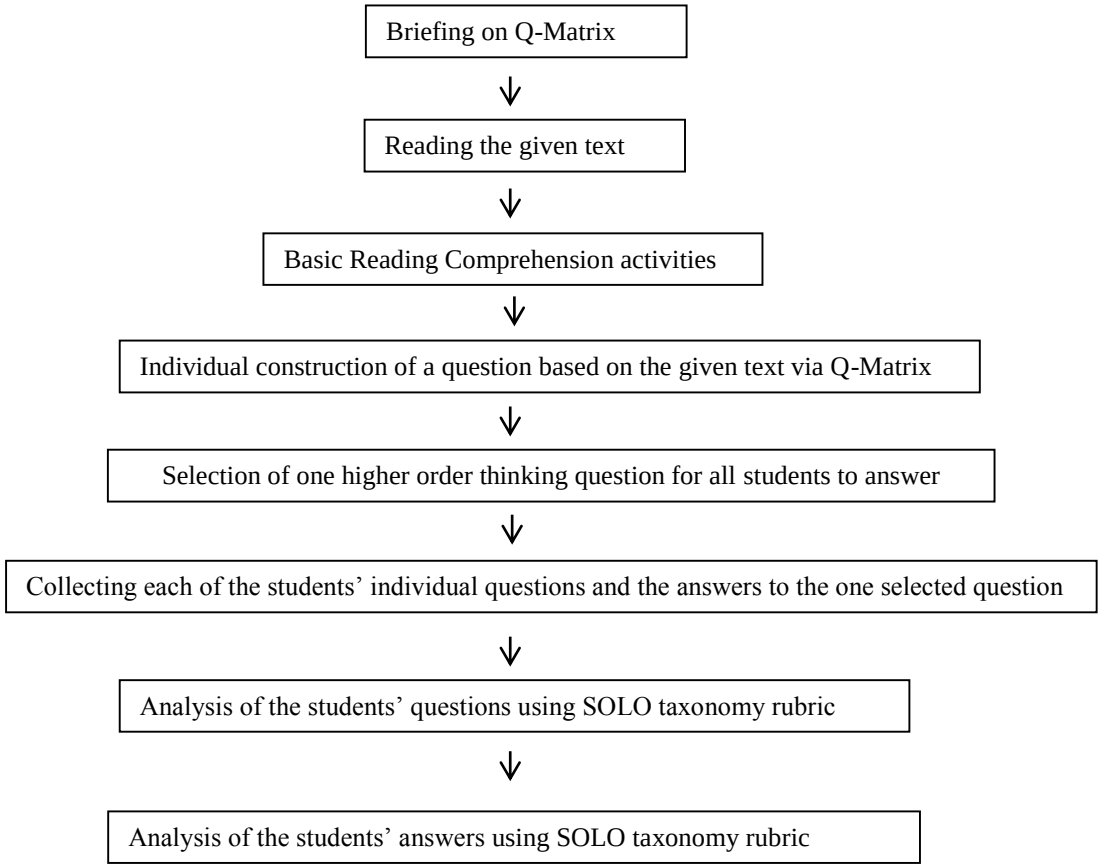

Figure 2: The Flow Chart of the Implementation Procedure

There were three reading tasks which required the students to generate questions from Q-Matrix. The reading texts consisted of three literary texts from a collection of short stories and poems entitled "Think-Tales" (Sirhajwan, 2016). The instrument used to assess the questions and responses was Structure of Observed Learning Outcomes (SOLO) rubric that was taken from Bradbrand and Dahl (2009) and Hook and Mills (2012). The instruments were validated by a panel of experts of three experienced ESL teachers from Australia, United Kingdom and United States. Prior to the study, the students were briefed on how to apply q-matrix. The students were instructed to read the given texts and this was followed by some comprehension questions in order to ensure that they understood the texts. Each of them was then required to construct one higher order thinking question based on the q-matrix. The most plausible and challenging question was selected for the whole class to answer. The study took place in three days in which one session of 60 minutes was allocated for every reading task.

In the first task, the students were given a short story entitled "Bonnie the Shepherdess". They were given five minutes to peruse the story before a set of questions was discussed among the students and the teacher in order to help them to understand the text for about 10 minutes. They were then required to construct questions using Q-matrix based on the short story within 20 minutes. Once every student managed to create their questions individually, the teacher chose the one question for every student to answer in 25 minutes. This process was repeated in the second and third reading task, the students were given a poem entitled "Freaks of Night" in the

second reading session and a short story "Scarecrow" was given to them in the final task. The teachers collected their written responses at the end of every task in order to be assessed, scored and classified. The students' written responses consisted of the questions they constructed from the Q-matrix and their answers to the open-ended selected questions. SOLO rubric was used to assess the students' individual question and their responses to the one selected question from every session of the reading tasks. The questions were classified according to the five SOLO levels based on the designated criteria. The learning verbs that the questions intended to measure were identified based on the sets of learning verbs in each SOLO level. The students' responses to the selected questions were also classified according to SOLO level. Table 3 shows the allocation of scores for each SOLO level. The students' raw scores in their construction of questions, selection of learning verbs and responses to open-ended questions were converted to percentage.

Table 3: Allocation of Scores for SOLO levels

SOLO Level	Point	Thinking Levels
Pre-structural	1	Lower-order
Unistructural	2	
Multistructural	3	
Relational	4	Higher-order
Extended Abstract	5	

Source: Brabrand & Dahl, 2009

5.0 FINDINGS AND DISCUSSION

Table 4 indicates the classification of the questions generated by students in each of the reading task into the five SOLO levels. Most of the questions that the students generated were classified as extended abstract level and some of the questions were classified as relational in each session. In fact, there was a steady increase in the percentage of extended abstract questions produced by the students over the span of three sessions of reading tasks: reading task 1 (70%), reading task 2 (82%) and reading task 3 (94%). Overall, the average percentage of extended abstract questions generated by the students from the three reading tasks was 82%. There was zero percentage of questions classified as pre-structural and multistructural produced by the students and there were only 12 percent of unistructural questions generated in the first reading task. A gradual decline in the percentage of relational questions was evident throughout the three reading tasks.

They produced more complex questions as they used the tool repeatedly from the first reading task to the third one. The decline in the percentage of questions classified as relational was because the students learnt to produce questions which were more challenging. They learnt to construct questions of the extended abstract level. The fact that the students did not produce any question that fell under the first three levels (with the exception of 12 % unistructural questions in the first reading tasks) suggested that students knew that the levels were considered as lower order thinking skills. This shows that Q-Matrix can improve students' ability to generate higher order thinking questions since extended abstract is the final level of SOLO taxonomy which represents deep understanding and higher order thinking.

Table 4: Classification of Student-Generated Questions according to SOLO levels in Percentages

SOLO Levels	Reading Task 1	Reading Task 2	Reading Task 3	Average percentage
Pre-structural	0	0	0	0
Unistructural	12%	0	0	4%
Multistructural	0	0	0	0
Relational	18%	18%	6%	14%
Extended Abstract	70%	82%	94%	82%

Table 5 denotes the percentage of learning verbs used in student-generated questions. It shows that predicting was the most frequently used learning verb. Predicting is classified as one of the learning verbs of extended abstract level (Brabrand & Dahl, 2009). The students' preference in using the verb was consistent with the percentage of questions classified as extended abstract level they generated and the demand for them to construct higher order thinking questions. This could also be attributed to the nature of q-matrix in which the last two levels of the matrix are prediction and imagination which are highly associated with predicting. Students

also exhibited a slight tendency to use reasoning as a learning verb in designing their questions and this could be due to the two middle levels of the chart, possibility and probability, which require reasoning skills (Wiederhold, 1993). Out of the six learning verbs identified from the three reading tasks, four of them were considered as higher level thinking: predicting (76%), reasoning (14%), explaining (4%) and imagining (2%). The overall percentage for higher order thinking learning verbs that the students used in constructing questions in the three reading tasks was 94%.

Table 5: Classification of Student-Generated Questions according to SOLO Learning Verbs in Percentages

Learning Verbs	Reading Task 1	Reading Task 2	Reading Task 3	Average percentage
Predict	70%	70%	88%	76%
Reason	6%	24%	12%	14%
Explain	12%	0	0	4%
Imagine	0	6%	0	2%
Paraphrase	6%	0	0	2%
Identify	6%	0	0	2%

Below are the samples of the students' self- generated questions. Most of the questions could be considered as predicting, imagining, and reasoning. The questions starters that students usually selected were from the prediction and imagination level of Q-matrix which could be identified from the frequent use of the word "might" which was used to ask about events, reasons or means. This shows that the students were capable of designing plausible higher order thinking questions.

How can the sheep escape from the barn? **(S1)**

How might Bonnie find the sheep without the bottle? **(S9)**

*What will happen to Bonnie if she (was) being tricked by the genie ho was actually an evil genie that (had) been seal(sealed) in the bottle by a powerful sorcerer?***(S11)**

*What might happen if Bonnie didn't granted (fulfill) her promise to water sprite and the leprechaun?***(S12)**

What might happen if the genie did not helping (help to cure) Bonnie's father('s) illnesses? **(S5)**

What will happen if Halloween is banned? **(S16)**

What might happen if humans live in the vampire century? **(S2)**

What would you do if you become a ghost for a day? **(S7)**

How might the ghost scare the human if they are not scar? **(S14)**

Table 6 indicates the classification of students' answers to the selected higher order thinking question in each reading task into the five SOLO levels. It implies that the students' responses classified as relational level were low in the first two reading tasks with only 29 percent of relational responses but their responses increased significantly in the last task with 41 percent of relational responses. Relational level is classified as deep understanding and higher order thinking level (Biggs, 1999; Hook & Mills, 2012). However, the students' responses were mostly multistructural and none was able to demonstrate extended abstract levels.

Table 6: Classification of Students' Responses to Questions according to SOLO levels in Percentages

SOLO Levels	Reading Task 1	Reading Task 2	Reading Task 3	Total
Pre-structural	6%	0	12%	6%
Unistructural	18%	53%	6%	26%
Multistructural	47%	18%	41%	35%
Relational	29%	29%	41%	33%
Extended Abstract	0	0	0	0

The three questions selected by the teacher to be answered by every subject were questions that were considered to be challenging and answerable. The first two questions from the first and second reading tasks were questions that fell under the category of predicting based something closely related to the story. The third question encouraged students to go beyond the given context as it requires the students to overgeneralize and reason on something that was beyond the short story. As the first two questions were strictly designed from Q-matrix, the third one was more original and critical. This denotes an improvement in students' ability to think critically and generalize the given context to include a wider context which what Biggs (1982) and Hattie and Brown (2004) deemed as extended abstract level.

Question in Reading Task 1: What might have happened if Bonnie didn't give the necklace and the gold bar to the water sprite and the leprechaun?

Question in Reading Task 2: What might happen if monsters really exist?

Question in Reading Task 3: Why do people usually mistreat people who are different?

6.0 CONCLUSION

It can be deduced that q-matrix is a practical and viable tool in training the students to generate their own higher order thinking questions. Integrating the chart into the students' learning helps to boost students' understanding of higher order thinking skills that they might learn to distinguish from lower-order thinking skills. The chart has been designed in a way that guarantees the construction of higher order questions with the incorporation of six levels including possibility, probability, prediction and imagination which are classified as higher order thinking constructs. It familiarizes students with the technique of asking questions to the extent that they were slowly able to generate questions beyond the given sets in the Q-matrix. Ability to formulate questions is also considered as a higher order thinking skill (Hattie & Brown, 2004; Potter & Kustra, 2012). Hence, it is imperative for students to learn how to ask higher order thinking questions. However, this is inadequate as the chart does not really prepare students to develop and demonstrate higher order thinking in answering questions although it might slightly facilitate their cognitive process to link different ideas. Therefore, teachers still need to identify ways to stimulate critical thinking skills so students can fully apply higher order thinking skills in their learning. Q-matrix chart is a good start for students to understand and distinguish higher order thinking and be more pro-active in their learning by designing their own questions.

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