

Problem Solving Strategies of Malaysian Secondary School Teachers

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Abstract

Higher order thinking skills are needed for problem-solving which is the highest level of cognitive knowledge. However, studies seem to indicate that Malaysian students lack problem solving and higher order thinking skills. Teachers do not seem to inculcate higher order thinking skills for problem solving. The purpose of this study is to investigate the problem solving strategies teachers use during instruction. A total of 131 science secondary school teachers in a selected state in Malaysia were surveyed to determine the strategies used. The results indicate that teachers prefer teaching facts, and asking students to listen to the teachers' explanation. The dominant problem solving strategy teachers use is making analogies to similar problems. Further research is required to develop instructional models with strategies for problem solving in the Malaysian context. This will enable teachers to use the model to develop higher order thinking among students.

Keyword: problem solving, problem solving strategies, instructional models, analogy, higher order thinking

INTRODUCTION

Problem solving is not an easy task as it requires higher order thinking skills. In Bloom's taxonomy, problem solving is categorised at the highest level of cognitive knowledge (Dick, Carey & Carey, 2014). Problem solving is an important skill as it enables students to

critically evaluate arguments, and to develop and support their own arguments (Bassham, Irwin, Nardone, & Wallace, 2012).

The Malaysian Education Blueprint from preschool to post-secondary, and for higher education have noted that Malaysian students need to develop thinking skills in order to be prepared for their future jobs (Ministry of Education (MOE), 2013; 2015). Potential employers require staff who are creative and innovative and are able to solve problems at the workplace. Hence, it is the aspiration of the government of Malaysia to develop graduates for the job market who are able to think critically, are innovative and able to solve real world problems, as well as are holistic and well-balanced (MOE, 2015).

However, employers seem to indicate that Malaysian graduates lack the problem solving skills required for the workplace (MOE, 2015). Employers are less concerned with the highly specialized career skills which can be learnt on the job, but emphasise that graduates should have generic skills like problem solving (Bassham et al., 2012). Instead, studies seem to indicate Malaysian students lack problem solving and higher order thinking skills and are not able to apply knowledge and to think critically in new situations (MOE, 2012b).

Critical and creative thinking skills have been incorporated into the Malaysian school syllabus since 1994. Teachers have been trained in strategies for teaching critical and creative thinking in pre-service courses since then (Nagappan, 2001). The infusion approach or the 'Boston Model' was adopted to teach trainee teachers thinking skills (Nagappan, 2001; Kuldass, Hashim, & Ismail, 2015). The 'Boston Model' has four components: introduction to content and process, thinking about thinking, active thinking and thinking application. This model allows the teaching of the same thinking skills in different subjects at all grade levels (Swartz & Parks, 1994). Specific to the needs of the Malaysian situation, an additional

component, consolidation and enrichment activities was added to the model (Kuldas et al., 2015).

However, Malaysia's poor performance in international assessments such as Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) in recent years has led the Malaysian government to introduce initiatives to assist students who do not have higher order thinking and problem solving skills (MOE, 2013). One of the bodies set up to inculcate the practice of creative innovation is *Agensi Inovasi Malaysia* (AIM). Through the i-THINK programme, thinking maps were used to develop thinking skills in primary and schools (AIM, 2014). This technique seems to improve students' mastery of the content and stimulate students' higher order thinking (Suhaili, 2014; Mazmin, 2013; Yusop & Mahamod, 2016).

However, studies from the implementation of thinking skills in the curriculum indicated that teachers had problems in inculcating higher order thinking for teaching problem solving. Teachers seem to focus on surface level understanding of the subject matter and not on higher order thinking or problem solving (MOE, 2012). In addition, teachers were confused on the definition of thinking skills and could not distinguish between the different levels of thinking (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, & Suhor, 1988; Nagappan, 2002). Further, teachers found it difficult to include thinking strategies in their current teaching style (Jones, 2008). The teachers also believed that they required more courses on how to teach problem solving (Marzano et al., 1988; Nagappan, 2002).

Studies seem to indicate that teachers may not be able to apply their knowledge of thinking skills in their classroom practices (Nagappan, 1998, 2001). In a specific study in Malaysia, a quarter of teachers (26%) did not allocate any time for teaching higher order

thinking, while 77% of teachers allocated less than 10% of their class time in teaching higher order thinking. Nagappan (2001) believed that teachers are not completely ready to apply their knowledge on thinking skills in practice. This had lead other researchers to conclude that in order to have a better understanding of critical thinking and problem solving strategies, teachers, both novice and experienced, needed to be trained in the instructional strategies to enable them to face the challenges of teaching critical thinking and problem solving (Nagappan, 2010; Suhaili, 2014).

Before a training module can be developed, it would be important to determine what strategies are currently used by teachers for teaching problem solving and developing higher order thinking. Hence, the purpose of this study is to investigate the instructional strategies used by a Malaysian teachers. The objective is to determine to what extend do teachers make use of the following modes during instruction: analogizing, modeling, reasoning causally, and arguing.

Problem Solving Strategies

There are several strategies for promoting critical thinking skills. Questioning can be used by teachers to engage students with the lesson, as well as to stimulate critical thinking (Blosser, 1991). In addition to questioning, debates involves argumentation and reasoning, and can develop problem solving skills (Zare & Othman, 2015). Feedback given to monitor students' progress during problem solving also assists students in developing problem solving skills (Osman & Kassim, 2015; Toledo & Dubas, 2016).

Technology can be used to support problem solving. Firstly, search engines enables information to be obtained speedily. However, in order to use this information, processes such as planning, searching the web, and evaluating online sources will be required (DeWitt, Alias, Siraj,

& Hutagalung, 2014; Jonassen, & Colaric, 2001). These processes involve the thinking skills required for problem solving.

Searching and finding information alone is insufficient for learning. However, when there is a purpose, information searching becomes meaningful and can be used for problem solving. The information searching process involves the process of selecting and evaluating information and activating the thought processes for reflective thinking and decision making (DeWitt et al., 2014).

Software applications can assist in modeling the system to understand the problem and in order to make decisions for problem solving. Technology enhanced representations of the systems from simple SmartArt diagrams to more complex models in SPSS and AMOS can be designed to model the problem (Dick, Carey & Carey, 2014). Simulation software can be used to assist the process of building models for visualizing and modelling (Soloway, Krajcik, & Finkel, 1995). Complex problems with multiple solutions requires the student to evaluate the choices. Hence, decision making with rational analysis is required. Technologies can be used to model decision situations, make simulations to test predictions and represent different perspectives to evaluate the the solution.

Hence, problem solving using *Mindtools* which enable internet searches, completing projects, experimentation, virtual field trips and collaborative writing on wikis and collaborative discourse online have been shown to encourage problem solving skills (Dick, Carey & Carey, 2014).

Instruction for Problem Solving

Meaningful problem solving involves several modes of thinking, called the principles of learning, which are analogizing, modelling, reasoning causally, and arguing (Jonassen, 2013).

Analogizing is the process of transferring information from a particular situation to another situation. When learning is transferred, new ideas are developed. This is because ideas are compared and new schemas need to be built (Jonassen, 2013; Mayer, 1983). Experience and prior knowledge enables the learner to retrieve previously encountered problems and to use analogical reasoning to address the new problem this form of thinking for learning (Dick Carey & Carey, 2014; Luchins, 1942). Experience and observation of more cases builds the learner prior knowledge and enables him to employ case-based reasoning process.

Modeling is the process involving the building of mental models that can be tested. Models show relations between the elements in a system, and can be represented using databases, images, hypermedia and other tools (Dick, Carey & Carey, 2014). Mental models of learners' understanding can be represented formally using these tools. As these models are tested, manipulated and changed, there will be deeper understanding. Processes such as making predictions, inferences and experimentation can occur during modeling and testing.

Causal reasoning enables learners to make predictions, draw implications, make inferences, and articulate explanations. The concepts will be derived based on semantics. A set of conditions are given and predictions of the possible effects can be made. The hypothesis made can then be tested. Examples of tools that support causal reasoning are diagrams, question prompts to focus the learner simulations and modelling tools.

Argumentation is the means by which we rationally solve problems using theories to support claims with evidence. When required, alternative theories with counterarguments, and rebuttals are used to support the claims. Argumentation encourages productive thinking for conceptual change (Mayer, 1983).

Hence the principles of learning might be used to encourage processes used for effective problem solving as these principles incorporate the strategies of problem solving. In this study, the strategies which teachers use will be determined based on the principles of learning.

METHOD

In this study, the sample was 131 secondary school teachers from three districts in a state in the central zone of Malaysia. The districts selected had a majority of rural schools. Only government-funded schools, which included a large proportion of national schools which uses the national language Bahasa Melayu as the medium of instruction, and follows the standard curriculum, were included in the study. However, efforts were taken to ensure that the different types of schools in the district, example, technical and vocational schools, religious schools, and vernacular schools, where possible, were included in the sampling. A total of 150 questionnaires were distributed through the District Education Office but only 130 were returned, a response rate of 88.0%. The selection of the schools for distribution may not necessarily be representative for the country as the central zone may be unique in the student and teacher population. For practical reasons, the questionnaire may have been distributed to schools nearest or most convenient to the District Education Office and this may also limit the generalizability of the study.

The instrument used is the Learning Skills Questionnaire, which was developed based on literature on the strategies for teaching problem solving. The questionnaire comprises items related to the teaching methods and strategies for problem solving. The modes of thinking for meaningful problem solving in the domains of analogizing, modeling, reasoning causally, and arguing were employed (Jonassen, 2013). Respondents' rated the frequency of employing the strategy based on a 5-point Likert scale. On the scale, 1 indicates never using the strategy; 2 almost never, which is less than 20% of the time or once in two to three months; 3 as sometimes, which is about 40% of the time or once in two to three months; 4 as frequently, which is about 60% of the time or once in two weeks; and 5 as always, or more than 80% of the time or almost every lesson.

The data was analysed using descriptive statistics using percentages, means and standard deviation. Data was collected from teachers who volunteered to answer these questionnaires. This again may be a limitation on the generalization of the findings as only the more extrovert or skilled teacher might have volunteered.

RESULTS AND DISCUSSIONS

The majority of the teachers (75.8%) who took part in the study were teaching at the upper secondary level while 22.0% (29) at the lower secondary level. Most of the teachers were experienced teachers with 41.7% (55) who had 11 to 20 years of experience and 31.1% (41) with 6 to 10 years' experience. A large proportion (58.3%) considered themselves to be skilled in information communications technology (ICT), followed by the averagely skilled group (31.1%). Surprisingly, when asked the frequency of ICT use for teaching, only 47.0% (62) teachers used

ICT about once a week, and about 24.2% (32) used ICT once in two or three weeks (see Table 1).

Table 1. Frequency of use of ICT use

Frequency of use	Frequency	Percentage
One a week	62	47.0
Once in 2 weeks	32	24.4
Once a month	19	14.6
Once in 6 months	7	5.5
Almost never	11	8.5
	131	100.0

The results seem to indicate that teachers prefer teaching facts, and asking students to listen to the teachers' explanation (see Table 2). Teachers from the sample seemed to prefer having students listen to the teachers explanation (Mean = 4.2576, S.D. = .75787), followed by reading notes and books to learn facts (Mean = 3.8864, S.D. = .87935). ICT tools were used less often as listening to an explanation on video or audio was lower than listening to the teacher (Mean = 3.4545, S.D. = .81366), or using ICT tools to construct a model (Mean = 2.8712, S.D. = .98388).

Table 2. Frequency of use of direct instruction strategies

Items	Mean	Std. Deviation
Read notes and books to learn the facts	3.8864	.87935
Listen to the teachers explanation to learn concepts	4.2576	.75787
Listen to the explanation on video/ audio/ other media to learn concepts	3.4545	.81366
ICT tools or software to construct a model	2.8712	.98388

Note:

- 1: Never
- 2: Less than 20% of the teaching time
- 3: Sometimes: 40% of the teaching time
4. Frequently: 60% of the teaching time
5. Always: More than 80% of the teaching time

The teachers' preference for teaching facts may be because they are less familiar with teaching for higher order thinking or using problem solving strategies. The lack of time, confidence, skill and knowledge might have contributed to this (Nagappan, 2001). In addition,

the use of technology did not seem to be seen as important for instruction. Although teachers perceived themselves to be skilled in ICT (58.3%), but a large number do not use ICT often enough as 24.2% still used ICT only once in two or three weeks.

The dominant problem solving strategy used is making analogies to similar problems (Mean = 3.8333, S. D. = .66220), followed by arguing (Mean = 3.6894, S. D. = .47347), and reasoning causally (Mean = 3.5833, S. D. = .68709).

Table 3. Strategies for problem solving

Domain	Minimum	Maximum	Mean	Std. Deviation
Analogizing	1.67	5.00	3.8333	.66220
Modeling	1.80	5.00	3.3348	.59232
Reasoning causally	1.40	5.00	3.5833	.68709
Arguing	2.43	5.00	3.6894	.47347

Note:

- 1: Never
- 2: Less than 20% of the teaching time
- 3: Sometimes: 40% of the teaching time
4. Frequently: 60% of the teaching time
5. Always: More than 80% of the teaching time

The findings indicate that Malaysian teachers were better at solving problems by making analogies with other similar problems which were encountered by students in previous questions or situations. In this way ideas were compared for forming new schemas and learning (Jonassen, 2013; Mayer, 1983). However, the disadvantage of this method is that the learner had to have built sufficient prior experience. Without sufficient experience, the levels of thinking would be lower and learning might not be taking place (Dick Carey & Carey, 2014; Luchins, 1942).

Argumentation was done less frequently than analogizing. Students would probably need to justify arguments, to elaborate the steps taken and the alternative methods and solutions (Jonassen, 2013). Providing evidence and supporting claims is an important process to

encourage productive thinking (Mayer, 1983). Causal reasoning is also supported by making logical arguments and inferences to elaborate theories and important for instruction (Jonassen, 2013).

However, teachers seemed less inclined to use modeling. Modeling is essential to defining and representing relationships for testing concepts and understanding. The manipulation of these models will be important for the thinking processes to develop. However, the lack of preference for experimenting and testing, perhaps due to the lack of time, may have contributed to modeling being a less popular strategy (Nagappan, 2001).

CONCLUSIONS

The Malaysian government has invested in developing human capital by encouraging the development of innovative and higher order thinking through programmes such as i-Think for schools. However, teachers do not seem to be implementing instructional strategies which can promote higher order thinking often enough, but instead seem to focus on teaching factual and conceptual knowledge. The training programmes for both pre-service and in-service teachers need to be edlook at to determine how teachers can be trained to use the strategies for thinking with their students.

Hence, instructional models for teaching problem solving and higher order thinking skills, which are easy to apply in the Malaysian context is required for teachers to acquire the skills and knowledge, and to practice with the students. This is required for developing higher order thinking among students. One consideration to encourage teachers in teaching thinking skills may be to reduce the curriculum content and the emphasis on teaching for passing the examination. This may allow students and teacher to explore content and spend time on

modeling so that there can make hypothesis, and conduct experiments to test their hypothesis. This may be useful for developing a thinking nation who are able to solve problems in their studies and at the workplace.

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