ENLIVENING PROBLEMS WITH HEURISTICS THROUGH LEARNING ACTIVITIES AND PROBLEM SOLVING (LAPS)

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Abstract

Problem solving receives much emphasis in the mathematics curriculum. The use of heuristics as an approach to problem solving is equally significant. From the time Polya (1946) introduced heuristics to the present, there has been a significant change in the way teaching mathematics has been delivered. LAPS, which stands for Learning Activities and Problem Solving is an intervention strategy using heuristics approach designed to elicit active participation from students during a mathematical problems solving activity. This paper discusses the impact of LAPS to students' performance on mathematical problem solving of primary school students. Eighteen standard 4M primary pupils of a boys' school in Penang, Malaysia participated in the study. Based on the individual mean score of pupils during the pretest, the overall mean of the students on creative problem solving was 15.17 (of a possible 25) which is quite low. When LAPS was introduced as a strategy to solve problems, the pupils improved their problem solving performances. This study shows that LAPS station is an effective approach in learning problem solving. The students found the activities fun and engaging. The enthusiastic responses from the pupils imply that given proper motivation, clear instructions and challenging activities, the pupils appreciate mathematics positively and constructively.

Keywords: creative problem solving, heuristics, LAPS, problems, problem solving

Introduction

Problem solving can be defined as the process to formulate answers or new approaches to answers involving more than the simple application of previously learned rules to arrive at an answer; the situation is arrived at when automatic or the usual references are different from the same situation. Problem solving is taught often by using singly or both problem solving strategies and heuristics. The amount of metacognitive skills apparent and within the learner is related to the degree of success in problem solving. Thus the teaching of thinking and metacognitive skills is intrinsically important at all times in education.

Moreover, emphasis has been given to learning by using and by doing, especially in problem solving (Weber-Russel & Le Blanc, 2004). Learning by doing in pursuit of real-world goals has received much attention from education researchers. Learning by doing is promoted and realized by the Institute for the Learning of Science (Schank & Cleary, 1995; Schank, Fano, Bill, & Jonas, 1993; 1994) as a way of becoming good at some real-world task. Addressing the different approaches for successful understanding of mathematics concepts and their wide applications, it is accepted by far and large, that a choice of learning approaches is particularly important for the education of the young children who, according to Case (1985) and others, do not have the same developmental readiness to form connections as do children who are older.

For mathematics education at the elementary level, contemporary literature revealed that researchers have found out from observations and conclusions of previous studies that most students at all levels just cannot do arithmetic (or other) word problems. Thus research has focused on aspects of problem presentation, context, semantics, wording (Burton, 1988;

Cummins, 1991a, 1991b; Daws-Dorsey, Ross & Morrison, 1991; De Conte, Verschaffel, & De Win, 1995; Riby & Green, 1988; Staub & Reusser, 1995).

Education in Malaysia has not been static; in fact the educational process in Malaysia is to enable all those who attend school to develop their potential as individuals holistically so they can achieve intellectual, spiritual, emotional and physical balance to be in harmony with their belief to a Creator (Curriculum Development Centre, 1989). The new philosophy of education was defined further to what has currently been expressed as the National Education Philosophy as found to be the cornerstone of education practice in Malaysia. Very definitely to allow those attending primary or secondary schools in Malaysia, every effort should be made to provide the school ethos to allow for pupils and students to every opportunity to experience their problem solving skills and to involve themselves in thinking skills. A systematic planning should be engineered, culminating in the successful achievement of the national objectives in education, especially in investigatory activities so that their needs are attended to, before, during and after an investigation-based activity has been executed (Roslena, 1999). It is a teacher’s task to realize that pupils learn best when the learning environments give an impetus for investigation and active engagement through the use of higher order thinking skills.

Mathematical problem solving has been a central and focusing issue in much of the literature of The National Council of Teachers of Mathematics (NCTM) during the past two decades. Studies done with problem solving have placed a major focus on the role of heuristics and its impact on the performance of students in problem solving.

Heuristics are rules of thumb that often help in solving a certain set of problems. Heuristics can be used to solve non-routine or ill-structured problems. These techniques are general guidelines that are useful in solving a wide range of problems. Different heuristics serve different purposes such as helping the child to understand the problem; simplify the task; identify possible causes; identify possible solutions; think or reason.

The introduction of heuristics to students via Learning Activities and Problem Solving (LAPS) stations engages learners in real-life problem solving and promotes cooperative learning. According to Brady (1991), small groups, frequently used in discovery activities, are one of the best means of enhancing students’ heuristic usage, control behavior and world views.

Most studies conducted on problem solving deal with strategies and approaches on how to go about solving the problem. These studies focus more on how the solvers arrive at the correct solutions. In school, there is emphasis on how pupils understand the problem, follow a logical method, figure out the answer, eliminate unwanted information and focus on the correct answer. However, pupils must be taught on how to explore ideas, generate various possibilities, and consider right answers rather than just one. This is crucial in developing success in life, yet it is almost always ignored. Pupils need to be made aware that a solution to a problem may be arrived at by using different strategies. In the study, creative problem solving deals with the generation of diverse ideas and processes culled from experiences.

The Study

The study sought to find out how Learning Activities and Problem Solving (LAPS) stations improve creative problem solving abilities of the pupils. Specifically, it aimed to use creative problem solving activities to improve problem solving skills of pupils in primary school.

The data were taken from a project work carried out by eight participants who attended the course PM-4264 Higher Order Thinking and Creative Problem Solving in Student-Centred Primary Mathematics Classrooms which was supervised by this author from 20 February to 17 March 2006 in SEAMEO RECSAM, Penang, Malaysia. The participants selected the topics, activities and heuristics used to help students solve problems. They also accommodated the constraints of language and time.

The study was conducted in a primary school for boys in Penang. The school is presently among the top schools in Penang. Eighteen pupils from Standard 4M were selected as sample for the study. The pupils come from the best class and are of mixed abilities. These pupils learned Mathematics in English since Standard 1. Initial dialogue conducted by the participants with the teachers and students revealed that the pupils have no prior knowledge on heuristics, specifically act it out, work backwards and make a systematic list. Moreover, the pupils have no exposure to creative problem solving and learning stations. They also have no prior knowledge in finding the volume of regular and irregular objects. However, the pupils are familiar with fractions and volume of liquids.

Based on the individual mean score of students from the pre-test on creative problem solving, the overall mean of the students was 15.17 (of a possible 25) which is quite low. Thus, the researcher planned and introduced Learning Activities and Problem Solving (LAPS) stations as an intervention teaching strategy using the heuristics approach.

Instruments

There were three instruments used to gather data essential for the study.

1. Creative Problem Solving Test
   There were two items given in the pretest and posttest. The first item, aimed at delving into the pupils' divergent thinking, asked the pupils to draw as many figures as possible in the geoboards (grid) provided as shown in Figure 2 and the second item, aimed at their convergent thinking, asked the pupils to determine the number of objects in the container as shown in Figure 3.

2. Lesson Plans and LAPS Stations
   These plans were used to implement the lessons during teaching. The LAPS activity and survey sheets were both used during this phase. Observations were conducted among the pupils while the activities were going on.

   There were four learning stations and each station was based on different heuristics. These heuristics were:
   LAPS 1: Act It Out
   LAPS 2: Work Backwards
   LAPS 3: Exploring Volume
   LAPS 4: Fun with Fractions

3. LAPS Stations Survey Sheets
   The LAPS survey sheets generated the perceptions of the pupils towards the activities in each of the 4 LAPS stations.

Results and Analysis

The scores from the creative problem solving test were analyzed using simple descriptive statistics such as mean and standard deviation. The responses from the survey sheets were tabulated and analyzed. Mean scores were computed to analyze perceptions of the pupils about the LAPS activities.

Creative Problem Solving

The results of the pretest and posttest administered to the pupils during the conduct of the study reveal that the post-test mean score (X= 19.11, SD = 4.36) is substantially higher than the pre-test mean score (X= 15.17, SD = 5.41). Figure 1 below shows a graphical representation of these scores.

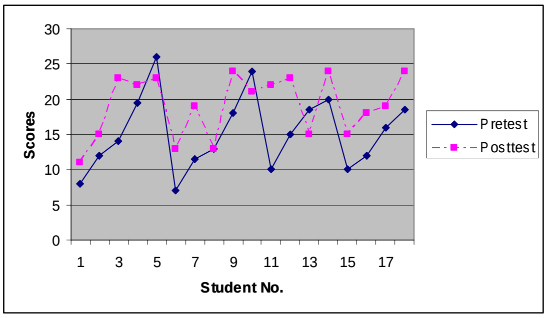


Figure 1. Pupils' scores on creative problem solving test before and after LAPS station activities.

Pretest and Posttest Results

Observations on the posttest results show that the pupils gave more and varied answers to the same problem as compared to that of the pretest results. Examples of pupils' answers on the pretest and posttest in the two items are shown below.

Pretest Posttest

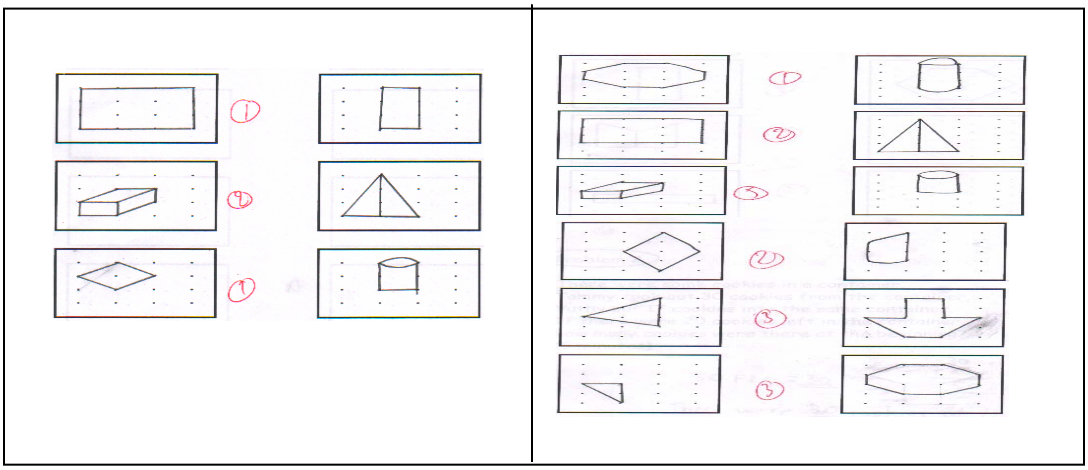


Figure 2. Examples of pupil's answers in problem 1 in both the pretest and posttest.

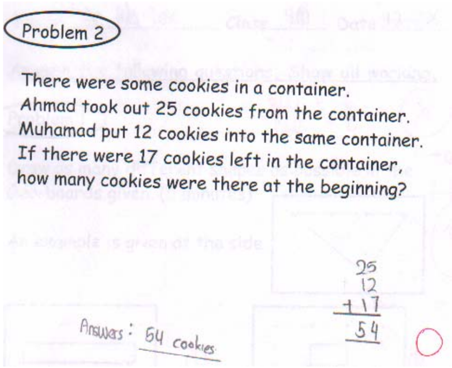
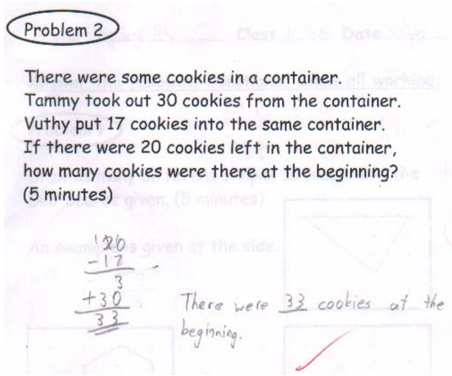
Pretest	Posttest
	

Figure 3. Examples of pupil’s answers in problem 2 in both the pretest and posttest.

Pupils’ Perceptions towards LAPS Activities

Most of the pupils found the activities in the LAPS Stations interesting (48.65%), fantastic (43.09%), boring (5.56%) and very boring (2.78%). The most interesting LAPS Station is Station 3: Exploring Volume. This is followed by LAPS Station 1: Act it out and then LAPS Stations 2 and 3: Work backwards and Fun with Fraction.

Discussion

At the beginning of the sessions, pupils were briefed on what to do in each of the LAPS stations. They were given proper instructions as to how each of them would go about in the activity and the length of time they had to spend in each station.

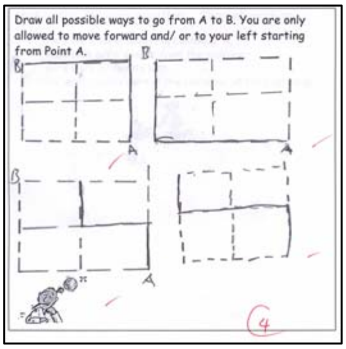


Figure 4. A question in LAPS station 1.

In the first LAPS station, a grid pattern was prepared on the floor. Specific points were identified in the pattern and pupils were asked to find all possible ways from point A to point B by acting it out. Pupils attempted several ways to do this and immediately verified if some of these ways were feasible, the shortest, or the best possible way. To check understanding of the mathematical concept being taken into consideration, the pupils worked on a question related to the activity in the worksheet. An example of pupil’s answer is shown in Figure 4.

In the second station, a container and some pieces of candy were placed on a table. The pupils were given questions that would lead them to arrive at the correct answer by working through the problems backward. Responses from two pupils are shown in Figure 5.

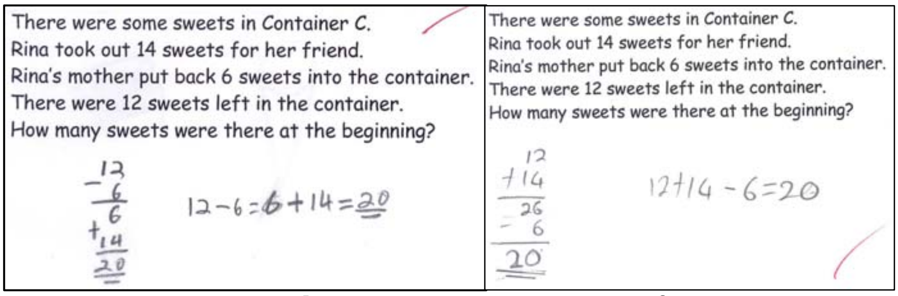


Figure 5. Pupils' responses on a question for LAPS 2.

In the third LAPS station, the pupils were given a piece of paper and sand. The pupils were asked to make a container that could hold the most volume of sand. The pupils were not given any constraints on the design of the container. The only limitation known is the size of the paper. Each one of them tried various designs and estimated the amount of sand the container could hold. An example of a pupil's work is shown in Figure 6.

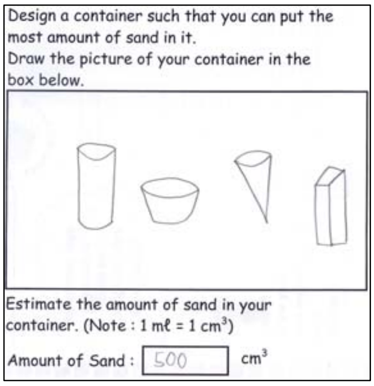


Figure 6. A pupil's work in LAPS 3.

In the fourth LAPS station, the pupils were expected to find as many ways to divide the rectangle into eight equal parts. The pupils were given a piece of bread and were asked to cut it into equal portions. A pupil's response is shown in Figure 7.

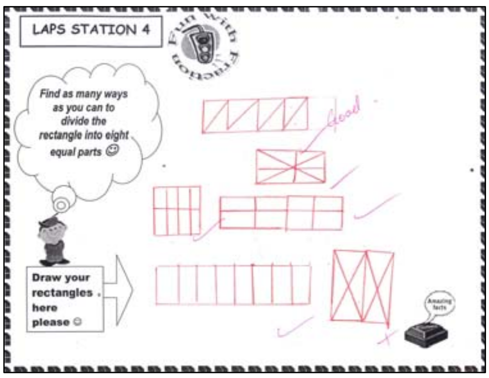


Figure 7. A pupils' work in LAPS station 4.

Based on observation during activities, the pupils found the activities engaging. Even after the time duration, some pupils went back to the LAPS station which they felt they have not done satisfactorily. Some claimed that they could still provide better solutions to the problems. Left to work independently, the pupils were able to arrive at solutions which they would have not thought had it only been done on paper.

The enthusiastic response from the pupils implies that given proper motivation, clear instructions and challenging activities, the pupils are apt to respond positively. The activities elicit positive response from the pupils and generate encouragement to the teachers to provide better activities.

The study has been undertaken under several constraints. First, there were only two sessions conducted with the pupils for actual lesson teaching. Second, there were only 18 male pupils as participants. Third, the activities in each of the LAPS stations were not focused on a single topic but considered problem solving as a unifying concept.

Since the results of the study cannot be generalized, the study may be replicated with more samples of pupils coming from various levels. The study can also be done with different heuristics. It can be done with both boys and girls as subjects of the study.

Conclusion and Recommendations

Each of the activities in the LAPS stations tried to develop a mathematical concept through the different heuristics which the pupils should learn after carrying out the activities. The understanding of these concepts is manifested in the way the pupils responded to the problems given in the worksheet. As pupils responded creatively to each question and with varied alternate answers, it could be claimed that the activities engaged with in each session were significant in enhancing pupils' creativity to solve problems.

The problem solving abilities of the 18 pupils improved after the use of the LAPS stations had been employed by the teachers; moreover, the pupils had responded to the activities positively.

The results of the study are revealing. The pupils had definitely improved after receiving inputs from the teachers. This study shows that LAPS station is an effective approach to learn problem solving.

Acknowledgement

The author wants to acknowledge Dr. Michael Liau Tet Loke, consultant, and the participants of the course PM-4264 in SEAMEO RECSAM from which the data and findings of this study were taken.

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