Title	The thinking skills of primary one pupils: An exploratory study
Author(s)	Koay Phong Lee, Berinderjeet Kaur and Yap Sook Fwe
Source	*ERA-AME-AMIC Joint Conference, Singapore, 4-6 September 2000*
Organised by	Educational Research Association of Singapore (ERAS)

THE THINKING SKILLS OF PRIMARY ONE PUPILS: AN EXPLORATORY STUDY

Koay Phong Lee, Berinderjeet Kaur & Yap Sook Fwe
National Institute of Education
Nanyang Technological University
Singapore

Abstract: As part of the International Project on Mathematical Attainment (IPMA), complete cohort of Primary 1 pupils in three schools were given three thinking tasks to do. The tasks required pupils to use skills such as comparing, sequencing and identifying patterns and relationships. These are three out of the eight core thinking skills selected for primary mathematics. In this paper, the presenters will share with the participants the performance of the pupils on these tasks.

Introduction

Sequencing, one of the core skills at clarifying ideas, is frequently experienced and practised by children in primary schools. For instance, children learn to read numbers in a particular order in counting. They also learn the correct sequence of steps in the algorithms so that they can carry out the four operations efficiently. They are aware that their names are arranged alphabetically in the class list and their lessons are arranged in time order so that they know the order in which the lessons are scheduled in each day and in the week. Another specialised form of sequencing is ranking. Pupils are ranked according to their performance in continual assessment and semestral examination. In addition, pupils learn to prioritise which is also a form of ranking. They learn to regard the completion of a homework assignment or a project as a higher priority than watching television or playing computer games.

According to Swartz & Parks (1994), there are different types of sequences. We can arrange things in alphabetical order, time order (operation analysis, causal chains and cycles) or rank them by quantity and / or by quality. We frequently use sequencing in our daily life but we do not always do it skillfully. Swartz & Park attributed our difficulties in sequencing to 'picking a sequence that poorly fits the purpose of ordering, inadequate understanding of the criteria for putting things in a given sequence, inaccurately matching items to a given sequence by misremembering, haste, or failing to attend to details." (p.194). We are not clear about the criteria for forming a given sequence.

One of the core skills for clarifying ideas mentioned in Swartz & Parker (1994) is determining part/whole relationships. Recognizing the parts and how they are connected to contribute to the whole would increase our understanding of the whole. For example, in mathematics, recognizing the fraction $^1/_2$, base of a triangle, height of the triangle and how they are connected to form the area formula of a triangle would increase our understanding of the formula. What would happen to the area (*whole*) if the $^1/_2$ (*part*) is missing?

Swartz & Parker (1994) identify three common defaults in our thinking about the part-whole relationship. They pointed out that "we define parts based only on their appearances…….. We do not think of subdividing parts into other parts…….. We don't connect parts together in relation to the whole they comprise…" (p.170) These difficulties in thinking about parts and wholes are shown by the following responses of Primary 1 pupils in completing number sequences (IPMA).

Fill in the missing number. (Pupil responses are in brackets.)
(a) 31, 37, 43, (49), (55)
(b) (5), 12, 19, 26, (33)
(c) 3, 9, 27, (33)

The child's characteriszation of parts was too hasty and his consideration of the parts was too narrow. He looked at the first two numbers given in the sequence, ignoring the other numbers, determined the relations as add 6 in (a), add 7 in (b) and add 6 in (c), and immediately proceeded to use the relationships to identify the missing numbers. Consequently, he obtained incorrect answer for (c). If the child had considered each subsequent pair of numbers, he would realize his error in (c).

This article examines the performance of Primary 1 pupils in four non-routine problems involving the use the part-whole relationships and sequencing skills. It also reports the teacher's perception of the ability of Primary 1 pupils to solve these problems.

Sample

The subjects of the study were the complete cohort of Primary 1 pupils in three schools participating in the International Project on Mathematical Attainment (IPMA). Table 1 shows the distribution of the pupils by school.

Table 1
Distribution of Pupils by School

School	N (total)
1	194*
2	394
3	435
Total	1023

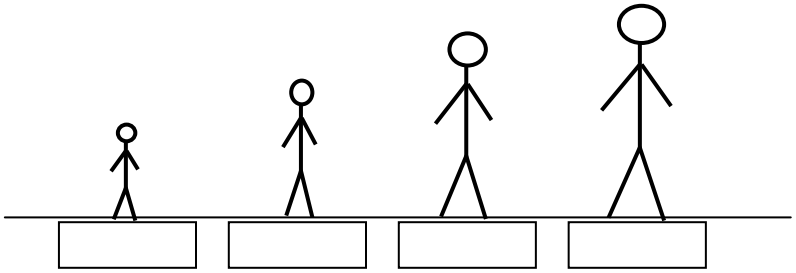
*all girls

Tasks

The three tasks administered are discussed below. The tasks require pupils to think skillfully about the part-whole relationships and either put the items in order of these relationships (Task 1), apply the relationships to complete a sequence (Task 2) and to determine the number of missing items (Task 3) in the whole sequence.

Task 1

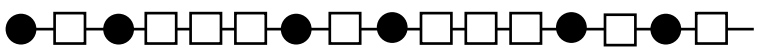
Meng is shorter than Gopal.
Siti is shorter than Mary.
Siti is taller than Gopal.
Use the information to help you label the stick figures.



In this task, pupils are required to attend to *all* the information given including the stick figures, rank the four names in order of height and label the stick figures accordingly. They need to read and comprehend each of the 3 pieces of information, carry out the comparison and place the name of the shorter person on the left.

Task 2

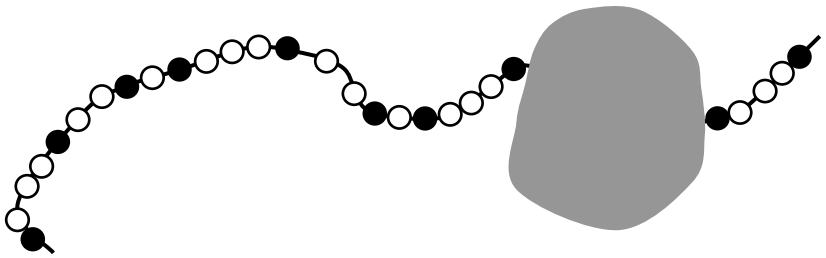
Draw the next three shapes that follow.



In this task, pupils are required to look at the given chain of shapes, subdividing the chain into parts: circle-square, circle-square-square-square, circle-square, circle-square-square-square, circle-square, and so on… in order to see how these parts are connected to each other in the chain. They have to examine the order of appearance of these parts in the chain and apply this order to identify the next three shapes in the sequence.

Task 3

At least how many beads are hidden?



In this task, pupils are to look at the given chain as a whole, subdivide the chain into parts:
1 black circle; 3 white circles; 1 black circle; 2 white circles; 1 black circle; 1 white circle; 1 black circle; 3 white circles; 1 black circle; 2 white circles; 1 black circle; 1

white circle; 1 black circle; 3 white circles; 1 black circle; ----------; 1 black circle; 3 white circles; 1 black circle;

Inability to partition the whole chain into the parts so that the sequence of circles is revealed will lead to incorrect answer.

Task Administration and Scoring

Pupils in this study attempted the four tasks in one sitting. The questions were read one at a time to the pupils. Pupils were given ample time to answer each question before the next question was read to them. For those pupils who had difficulty, the questions were paraphrased to them. At the end of the testing, pupils were given time to look back on their responses. The test papers were scored by the researchers. Frequency count for each set of responses was obtained for each of the four questions.

In addition, a group of 21 inservice primary school teachers who have either taught Primary 1 or who are currently teaching Primary 1 were invited to comment on the tasks. They are asked to gauge the difficulty levels of these tasks for Primary 1 pupils if the tasks are administered at the beginning of term 4.

Results

Task 1

The correct sequence for Task 1 is Meng-Gopal-Siti-Mary. As shown in Table 2, about 57% of the Primary 1 pupils were able to use the given information to rank the four characters according to height while 2.6% of the pupils did not attempt the question.

Table 2
Frequency of Responses for Task 1

Responses	Frequency	Percent
*Meng-Gopal-Siti-Mary	586	57.28
1. Meng-Mary-Gopal-Siti	52	5.08
2. Meng-Siti-Mary-Gopal	34	3.32
3. Meng-Mary-Siti-Gopal	33	3.23
4. Mary-Meng-Gopal-Siti	27	2.64
5. Siti-Mary-Meng-Gopal	26	2.54
6. Meng-Siti-Gopal-Mary	22	2.15
7. Gopal-Siti-Mary-Meng	16	1.56
8. Others	200	19.56
9. Not attempted	27	2.64
Total	1023	

*correct answer

The two common incorrect responses occurred when,

- pupils interpreted correctly the first two given facts, placing Meng to the left of Gopal and Siti to the left of Mary. However, they stopped thinking about the task and proceeded to the next task once the four given names were accounted for. They ignored the last fact given. This fact is essential as it helps to decide where Siti should

be placed with respect to Gopal in the sequence. (Responses 2, 5 and 6 in Table 2). Giving the fact '*Siti is taller than Gopal* ' before '*Siti is shorter than Mary.'* would have help to improve pupils' performance.

- Pupils seemed to be inconsistent in their interpretation of the terms 'taller' and 'shorter'. (Responses 1,3, 4and 7 in Table 2).

Task 2

The correct sequence for the three missing shapes are square-square-circle. As shown in Table 3, about 34% of the pupils were able to draw the three missing shapes in correct sequence. About 10 % of the pupils gave this task a miss. There were about 26% of the pupils who seemed to know the parts that make up the sequence, (i.e., Black circle - white square and Black circle - 3 white squares) but did not draw correctly the shapes required. They either drew two instead of the three shapes required (Response 1 in Table 3) or ignored one of the square already drawn. (Response 2 in Table 3). Apparently, these Primary 1 children considered a sequence that ends with a black circle as 'incomplete' since the black circle indicates the beginning of the next pattern.

Table 3
Frequency of Responses for Task 2

Responses	Frequency	Percent
*square-square-circle	350	34.21
1. square-square	138	13.49
1. square-square-square	125	12.22
2. circle-square-circle	67	6.55
3. circle	52	5.08
4. circle-square-square	50	4.89
5. Others	134	13.10
6. Not attempted	107	10.46
Total	1023	

*correct answer

Task 3

This task is similar to one of the thinking tasks given in the Teacher's Guide 1A for Primary Mathematics (1991). The correct number for this question is 4. As shown in Table 4, less than 8% of the pupils in the study was able to determine correctly the number of beads hidden. Among the four tasks, this task was attempted by the greatest number of pupils (more than 99%) but the percentage of correct answer is the smallest.

Most pupils seemed to be aware of the 'part' that is repeated in the given chain of beads as shown in figure 1 but have difficulties figuring out the missing section of the part.

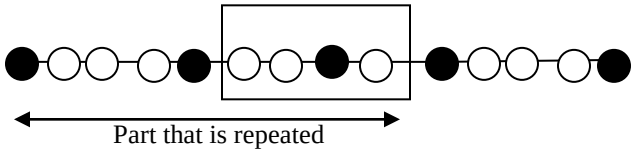


Figure 1

Some of the pupils in the sample might have considered the task as a measurement task. They drew a line joining the two black dots adjacent to the shaded region, draw and count the beads on the line.

Table 4
Frequency of Responses for Task 3

Responses	Frequency	Percent
*4	79	7.72
7	164	16.03
6	156	15.25
5	123	12.02
8	115	11.24
10	83	8.11
9	69	6.74
Others	224	21.90
Not attempted	10	0.98
Total	1023	

*correct answer

Teacher's Perception of Task Difficulty

As shown in Table 6, most teachers expected the problems involving identification of patterns and relationship (Tasks 2 and 3) to be easier than the problems involving comparing and sequencing (Tasks 1 and 4). This is contradictory to the performance of the Primary 1 pupils as shown in Tables 3, 4 and 5.

Table 6
Facility Levels as Gauged by the Teachers

Perceived facility level	Task 1	Task 2	Task 3
75 - 100	3 (14.3%)	15 (71.4%)	5 (23.8%)
50 - 74	7 (33.3%)	4 (19.0%)	8 (38.1%)
25 - 49	2 (9.5%)	0 (0%)	2 (9.5%)
0 - 24	9 (42.9%)	2 (9.5%)	6 (28.6%)

Summary & Conclusions

This study explored the thinking skills of Primary 1 pupils near the end of the school year. Even though thinking skills such as part-whole relationships and sequencing are not taught explicitly in class, about 57%, 34% and 8% of the pupils were able to correctly complete tasks 1, 2 and 3 respectively.

The main findings of the study are:

- Primary 1 pupils seem to find the tasks that required looking for patterns and relationships and completing the patterns relatively more difficult than tasks involving classifying, comparing and sequencing. This is contradictory to the teachers' expectation.

- Primary 1 pupils tend to draw conclusions in haste. They often do not consider all the facts given, and fail to show reflective thinking behaviours.
- Task presentation affect spupils' performance.

The findings have some implications in the teaching and learning of mathematics to promote thinking skills.

- The performance of the Primary 1 pupils on mathematical thinking tasks does not reflect the teachers' expectation. Hence, at the early stage of implementing thinking programme, teachers need to provide opportunities for pupils to perform different thinking tasks, examine their patterns of performance, and find out which tasks are most appropriate with respect to the thinking skills they already have. In addition, teachers must believe that every pupil is capable of quality thinking, that is, thinking more efficiently, critically and creatively irregardless of their academic achievement. They should provide grade-appropriate activities to maintain and strengthen specific thinking skills of all pupils.

- Primary 1 pupils are impulsive. They do not reflect on what they have done. Teachers should try to conduct meta-cognitive discussion, show pupils explicitly how the thinking skill is applied and how a lack of critical thinking can affect performance. In classroom teaching, point out to pupils how and when they make incorrect assumption, ignore given information and jump to conclusion. As pointed out by Fisher (1998), mathematical thinking is encouraged by talking about and talking through the process. Teachers should encourage pupils to talk about how the task is executed, it is alright if the solution is not attained but at least pupils are aware of their errors in thinking.

- Task characteristics such as clarity and difficulty level affect performance. Hence, teachers should scrutinize and select the thinking tasks with care. The task directions should be clear and direct, and the task presentations varied to suit the needs of the pupils without affecting the clarity. In addition, teachers must select tasks that are most likely to promote the desired thinking skills, tasks that allow pupils to actually practise the desired thinking skills.

The main source of data in this exploratory study was a paper-pencil 'test'. Thus, one direction for future work would be to use qualitative methods, including interviews and observation, to probe the thinking skills of Primary 1 children and validate some of the findings suggested in this study. The findings of such studies would be very helpful in assisting our understanding of how children approach mathematical thinking tasks, the development of appropriate thinking curriculum and teaching practices to help our pupils become a good thinker.

References

Carol McGuinness (1999). From Thinking Skills to Thinking Classroom. Research Briefs Department for Education and Employment. Nottingham

Fisher, R.(1998). Teaching Thinking. London:Cassell.

Primary Mathematics 1A Teacher's Guide (1991). Curriculum Development Institute of Singapore, Federal Publication, 2nd ed.
Swartz, R. & Parks, S. (1994). Infusing the Teaching of Critical and Creative Thinking into Content Instruction: A Lesson Design Handbook for the Elementary Grades. California: Critical Thinking Press & Software.