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Classroom Activities to Improve Primary School Children's Performance in Mathematics

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It is understandable that primary school children's performance at the Primary School Leaving Examination (PSLE) is the top priority of Singapore mathematics teachers. But is it possible to improve pupil performance without sacrificing understanding in mathematics or without too much dependence on the usual worksheets? This paper sets out to explore these issues and suggests some activities that might improve primary school children's performance in mathematics.

Why poor performance?

Among the many factors affecting poor performance, I discuss the following three: a) lack of interest, b) lack of understanding and skills, and c) too much teacher and worksheet dependence.

a) Lack of interest

Too often, teachers tend to demonstrate or explain algorithms and set worksheet exercises prematurely, without considering student interest. For example, the need for multiplication and division, or situations where multiplication and division occur in everyday life are seldom discussed before numerical examples are given and exercises set. Even where such discussion takes place, they are cursory or uninteresting and artificial.

To overcome this lack of interest, I suggest teachers try relating mathematics to student experience, everyday life, puzzles, and ensure frequent success in solving mathematics problems. Only then should the symbols be written, together with the connection between multiplication and addition. For example, Menon (1995b) says,

> *Because student experience and context are so important for student understanding and successful solution of problems, one could begin by a meaningful word problem situated in the student's experiential context (e.g."If there are 17 girls in this class of 32, how many are boys?") and ask for students' solutions, followed by a discussion of the*

> *various solutions, even before teaching the algorithm. This contrasts with the usual practice of starting of, say, with the symbols 32 - 17 (without putting the symbols in the context of student experience), and explaining the subtraction algorithm involving renaming, followed by repetitive, mechanical practice, using other two-digit numbers. (p.3)*

Similarly, rather than asking students to compute, say, 2 + 2 + 2 + 2 + 2, they could be asked to find out how many wheels five bicycles have, discuss how they worked out the answer, and continue for 8, 10, 12 bicycles, etc.

It cannot be emphasised enough that exercises should be posed in context, using various topics, and not merely being limited to exercises which only use numbers. In other words, word problems should *precede* numerical "sums" and different everyday contexts such as shopping (money, e.g. if $2 were spent every day for 5 days, how much was spent for the 5 days?), measurement (e.g. height, weight), and counting (e.g. number of legs of chairs in a house) should be used. The newspaper is another resource that can be used as an invaluable aid to relate mathematics to everyday life, as it has many situations that can be exploited for their mathematical value (e.g. advertisements, sales, graphs). Students could also be asked to prepare their own problems, based on their own experiences (see, for example, Menon, 1995a; Menon, in press).

Puzzles are another way of motivating children. For example, children could be asked to arrange the digits 1 to 9 in a three by three matrix to obtain the sum of 15 in a "magic square" (where the row, column and diagonal numbers add up to 15). Number puzzles based on a crossword format could also be an alternative to the typical list of numerical "sums" children are usually exposed to. Even asking children to fill up the missing digits in the following "subtraction sum" could prove motivating: • • – • • = 18.

Whatever the method used, children have to be provided with tasks that will result in a reasonable amount of success, at least in the initial stages, before going on to more challenging ones. Such initial successful experiences will certainly affect children's continued interest in mathematics, especially if they have had repeated unsuccessful experiences in their mathematics classes.

b) Lack of understanding

Student understanding can be enhanced through ownership, involvement, associations, and language/communication. For example, encouraging students to generate their own questions (Menon, 1995a) and to work out their own solutions, *before* the teacher explains, engenders a sense of ownership and gets students involved. Also, since associations with prior knowledge facilitate understanding, teachers must consciously relate operations such as addition and subtraction, as well as multiplication and division. For example, 5 + 3 = 8 should be discussed together with 8 - 3 = 5 and 8 - 5 = 3, as well as with words to go along with the symbols. Such an approach that encourages the seeking of relationships will also help enhance computational skills. For example, by linking percent to common fractions, students can see immediately that 50% is equivalent to 1/2, and so be able to compute 50% of $40 as half of $40, thereby giving the answer $20 rapidly and mentally, without inefficient and unnecessary written computation.

An approach that uses language development and communicative activities will also help enhance understanding and skills in mathematics. For instance, because language development activities emphasize listening, speaking, reading, and writing, new mathematical terminology has to be introduced and developed just as in a language lesson, through listening, speaking, reading, and writing (Capps & Pickreign, 1993; Greenes, Schulman, & Spungin, 1992; and Menon, 1995b). For example, when the word "factor" is first introduced, it would be beneficial for the children to first listen to the teacher saying the word, repeating it after the teacher, reading the written word on the board and writing the word by themselves, correctly spelling and pronouncing it at the same time.

Also, everyday language or children's own terminology may be used before the actual mathematics terminology is employed (Van de Walle, 1994). In the case of "factor," for example, children could be told that 2 "can divide" 6, or is a "divisor" of 6, before saying that 2 is a "factor" of 6. Then exercises on the use of terminology could be set, very much as are done for exercises in language (e.g. 2 is a (factor, multiple) of 6). Similar exercises could be set to familiarise students with words such as sum, difference, factors, quotient etc. Worksheets could be prepared that have to do with filling in the blanks or with a list of phrases suggesting a particular operation. Students sometimes have great difficulty in using mathematical terms interchangeably in word problem contexts and an example of an activity that might be beneficial for such students is given on the following page.

Activity

Each group of students is given a set of cards (13 cards per set) with these words/numbers on them:

is	24	3
more than	less than	the sum of
is a multiple of	the product of	divided by
is a factor of	are factors of	is divisible by
the difference between		

Rearrange the cards and make as many different sentences as you can.
For example, "24 is a multiple of 3" is one possibility.

Figure 1

Sometimes students cannot easily distinguish similar-sounding words. Such difficulties are compounded when a mathematical term sounds like, but is different in meaning from, an everyday word. In such cases, it would be useful to compare the spelling and pronunciation of these words. For example, two, to, and too; sum and some.

Students have also to be exposed to arithmetic operations where the same operation is indicated by different words. For example, subtraction could be indicated by words such as the following: spend, lose, give away, need. Otherwise, they might be limited to looking for key words and assuming that such key words are associated only with certain operations. For instance, "more" might only be associated with addition if students are limited to word problems of the following kind: John has 5 apples and Daisy has 3 more apples than John. How many apples does Daisy have? However, if problems of the following type, "John has 5 apples and this is 3 more than what Daisy has. How many apples does Daisy have?" are also included, then students might begin to realise that the operation is dependent on the context of the problem, not just a key word.

Many teachers are aware that students sometimes have great difficulty in understanding word problems. One way to help students understand these word problems is to give guiding questions to help solve them. For example, consider the following word problem for the Singapore Primary 3 level:

There are 1407 green beads.
There are 795 fewer green beads than brown beads.
How many brown beads are there?

Rather than expecting the children to solve this after reading and re-reading it, the following guiding questions might help:

How many types of coloured beads are we talking about here? Are there more green beads or more brown beads? How do you know? If you draw one rectangle to show the number of green beads and another to show the number of brown beads, which rectangle would be longer/shorter? Why? Will the answer be more than or less than 1407 beads? How do you know?

Note that the above are only some of the questions that might be posed by the teacher, and they are certainly not exhaustive or unique. The teacher will be the best person to decide on the type and number of questions to give, as he/she will know the students' ability, interest etc.

c) Lack of skills

Very often students who have difficulty in mathematics have had difficulties in mastering the basic facts in arithmetic, and also in doing mental arithmetic. The following are suggestions to remedy this state of affairs.

(1) Use thinking strategies

These are strategies most children learn by themselves, but some children need to be told explicitly how to use them. For example, to add 2 and 9, children should be encouraged to (i) identify the larger of the two given numbers, and then (ii) "count on" from the larger number. In this instance, after identifying 9 as the larger number, they add 2 to it by counting 2 more as "ten, eleven" to get the sum 11. For further ideas on the use of thinking strategies, refer to Rathmell's chapter, "Using thinking strategies to teach the basic facts," in the 1978 NCTM Yearbook.

(2) Use patterns

Encouraging the search for patterns not only makes mathematics more interesting, but also helps children remember better. For example, patterns for the 5, 9, 10 and 11 times tables make it easier for the recall of associated basic multiplication facts. Knowing, say, the pattern of the 9 times table up to 9 x 9, the product of 9 and 7 can be easily recalled as "7 - 1 = 6" (for the tens digit) and "6 + ? = 9, therefore ? = 3" for the ones digit, giving 63 as the product.

(3) Use benchmarks and mental arithmetic

Knowing that adding 10 to a number only changes the tens digit (e.g. 26 + 10 = 36) can be used as a benchmark for the addition of 9. For example, 26 + 9 can be obtained by "26 + 10 = 36, less 1, equals 35." Similarly, adding 11, or even subtracting 9 or 11 from a given number, can be done mentally, as can the number 100 be used for adding or subtracting 99. For further ideas on the effective use of mental arithmetic, refer to, for example, Menon (1995c). Benchmarks can also be used for fractions (e.g. the number 1 and 1/2 could be used as benchmarks to justify that 5/6 is nearer to 1 than to 1/2, as 5/6 is nearer to 6/6, not to 3/6, which is 1/2).

(4) Use drill

Though premature drill is to be avoided, drill is necessary for fast recall, once concepts have been developed. Daily, interesting drills of short duration (about 5 minutes), are recommended (Davis, 1978). One effective drill for basic facts is called "Beat the Teacher" (see Figure 2, on the following page).

Beat the Teacher!								
<u>5 seconds</u>	S	T	<u>3 seconds</u>	S	T	<u>2 seconds</u>	S	T
1.			1.			1.		
2.			2.			2.		
3.			3.			3.		
4.			4.			4.		
5.			5.			5.		
6.			6.			6.		
7.			7.			7.		
8.			8.			8.		
9.			9.			9.		
10.			10.			10.		
Total								

Figure 2

To play "Beat the Teacher," each student is first given a sheet of paper as shown in Figure 2. The teacher calls out, say, 3 + 1, and students write down the answer, 4, on the dotted line next to the (question) number 1. After about 5 seconds, the teacher announces the answer. Since almost every child would have had the answer 4 before the teacher gave the answer, the students have effectively "beaten" the teacher! The students then draw a "happy face" below the letter "S" (for student), to indicate the student has won. The teacher then gives a second question, such as 1 + 5, and by the time the teacher gives the answer 6 (after about 5 seconds), the students would have written the correct answer and so can draw another "happy face" below the "S." This continues until 10 questions have been answered.

The teacher must ensure that the questions chosen are easy enough for every child to "beat" the teacher, so that possibly the scores range from 8 to 10 for the student and 0 to 2 for the teacher. These scores are obtained by totalling the number of "happy faces" under each column of S and T (for teacher). Then the teacher can pretend to be unhappy about losing to everyone in the class, and state that perhaps they were given too much time (5 seconds) for each question, and so only 3 seconds would be given for the next round of 10 questions (see 2nd column, headed by "3 seconds"). Once again, the teacher must ensure that students win, but perhaps with a slight improvement in the teacher's score. Finally, the teacher can pretend to be really unhappy about losing to the students, and state that, for the final round, only 2 seconds would be given per question, and the teacher would then definitely win! Of course, the teacher will try once again to lose in the third round, but possibly will beat a few of the students.

Now, the whole activity would take no more than 5 to 6 minutes (including the teacher's act of being unhappy, etc.). Note, however, that the students have been indirectly progressing to a 2-second response per question. This 2-second response time would leave very little time to compute or resort to inefficient strategies, and would necessitate a more or less "automatised" response, which can be taken as appropriate evidence of mastery of the basic fact in question. For more examples of ways to help children master the basic facts, see Van de Walle, 1994, Chapter 8, pp.133-153.

(5) Use the part-part-whole (PPW) idea

The PPW idea is a very powerful one and should be used by students as soon as possible. For example, addition should be thought of as putting the parts together to get a whole and subtraction as finding one of the parts, given the whole and the part(s). That is, when students learn that $5 + 3 = 8$, they should be aware that 5 and 3 are the parts, and 8 is the whole. And if $5 + ? = 8$, then what is required is finding the part, "?," as the whole, 8, and the other part, 5, are given. They should also realise that the part is numerically smaller than the whole, and will then be more careful about, say, writing 13 for "?," the unknown part.

Such PPW ideas are also useful in other topics, for example, in finding the area of the uncarpeted part of a carpeted rectangular room.

(6) Renaming

Renaming is another useful concept which cuts across a number of topics. For example, in addition and subtraction such as in 28 + 46 and 46 - 28, the ones have to be renamed as tens and the tens as ones. If students are given practice in exercises such as 432 = 2 hundreds, ... tens and 12 ones (rather than the usual 4 hundreds, ... tens and 2 ones), then facility in moving from hundreds to tens etc., will be improved, especially if they can explain that many different ways of grouping numbers can give rise to different ways of writing or representing the numbers, but that the numerical value remains unchanged. Place value concepts, are, after all, intricately linked to ideas of renaming. Such renaming comes in useful also in other topics, and helps link different topic areas such as percents, common fractions and decimal fractions. Even equivalent fractions, mixed numbers and improper fractions can also be thought of as different names for the same number (e.g. $\frac{8}{6} = \frac{4}{3} = 1$ and $\frac{1}{3}$). Similarly, conversion between units of measure can be thought of as renaming.

Too much dependence on teachers and worksheets

It is not uncommon for students to ask teachers to check whether their answers are correct. To overcome too much dependence on teachers, teachers should encourage self-checking, estimation and justification. For a start, teachers should emphasise that before handing in an exercise, students should have made some attempt at checking the reasonableness of their answers. Further suggestions on how to wean students away from too much reliance on the teacher are listed below:

1. Daily mental arithmetic sessions that include exercises on estimation, followed by discussions on ways of getting and justifying the estimates.
2. Opportunities for peer evaluation and self evaluation (either in oral or written form, for example, with the use of checklists).

3. Using student-generated questions for revision of certain specific topics.
4. Using a certain percentage of student-generated items as part of a mathematics test.

Next are listed some suggestions on how to overcome too much dependence on worksheets:

1. Encourage students to talk, explain and justify (e.g. Is $\frac{98}{99}$ larger than or smaller than $\frac{97}{98}$? Why?)
2. Set exercises that only require identification/classification of familiar sums in the worksheet, WITHOUT the requirement of working them out first (e.g. Which are the two-step word problems?)
3. Set problems which have more than one solution (e.g. If 36 cm is the perimeter of a rectangle, what are the dimensions of the rectangle?)

Conclusion

In this paper I have attempted to address the concerns of teachers who want to improve student performance in mathematics, without sacrificing student understanding. I first discussed some reasons for the poor performance in mathematics, and then gave some suggestions on how student performance might be improved. I hope these suggestions will prove useful.

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