Using Calculators in Primary Mathematics

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Abstract

Evidence from research has proven calculators to be quite effective tools for problem solving, reinforcement of computational skills, pattern recognition, and number sense. Yet, many teachers continue to believe that they can bring more harm than good in the learning of mathematics, therefore their use for instruction should never be encouraged. This paper presents various possibilities on how the calculators can be incorporated in the teaching and learning of mathematics. Sample calculator activities are included to provide concrete examples of how calculators can aid in developing and reinforcing concepts in mathematics. Several concerns raised by teachers as regards the use of calculators and what research says about these are discussed.

Introduction

The world has rapidly moved in the direction of technology that has rendered obsolete many of the techniques and methods of teaching and learning previously used in the classroom. Calculators for instance, have eliminated the need for great skill in paper-and-pencil arithmetic computation and algebraic manipulations. As such, students now have more opportunities to work enough problems to discover, observe patterns and are able to focus on useful, practical applications for the theories and concepts they learn in class.

Since it was invented, the calculator has evolved from a machine that could only perform simple four-function operations into one that can now also execute highly-technical algebraic symbolic manipulations instantly and accurately (Pomerantz, 1997). The latest versions of calculators provide students access to mathematical concepts and experiences that are not possible with the usual paper-and-pencil methods. Since they make possible exploration, experimentation, and enhancement of learning mathematical concepts, the National Council of Teachers of Mathematics (NCTM) and various educational organizations recommend that calculators be used for instruction at all grade levels including kindergarten. Nevertheless, there are still many who are skeptical on its use since it may impair students' mathematical ability and result in increased mathematical illiteracy. Results of extensive research on the use of calculators in the classroom however, show that calculators are valuable educational tools that empower students to reach higher mathematical understanding (Pomerantz, 1997).

Mathematics has always been identified with memorizing formulas, tedious drills, and performing long and monotonous computations. This has turned off many students, including those who are mathematically inclined. Calculator technology now allows students who would ordinarily be bored by cumbersome computations to experience true mathematics, gain mathematical insight and reasoning skills and cultivate a high sense of mathematical understanding.

Concerns on the Use of Calculators and What Research Says about These

Many teachers are more than apprehensive at the mere thought of implementing the use of calculators at all grade levels. One valid concern they have is developing pupils' paper-and-pencil as well as mental computation ability. Teachers fear that the use of calculators may prevent pupils from learning the basic mathematics that they need later in life. They worry that the only mathematical skill that children will acquire upon completion of their mathematics education is button-pushing. Parents and teachers alike are concerned that pupils will become so dependent upon the use of calculators to the point of not being able to do simple calculations in their daily lives without the aid of a calculator. Research, however, has suggested that the introduction of calculators as early as pre-school does not harm computational ability. Studies have shown that appropriate use of calculators enhances young children's ability to learn basic facts (Suydam, 1987) and that those who use calculators frequently exhibit more advanced concept development and problem solving skills than those who do not use calculators (NCTM, 1997; Hembree & Dessart, 1992). When calculators are incorporated into the learning process, achievement in problem solving increases, and more solution methods and strategies are utilized. Moreover, "the calculator makes exploration of hypotheses feasible, and is useful in developing counting, computation, estimation and other mathematical skills" (Suydam, 1987).

Another concern is related to pupils' motivation to do mathematics. Teachers think that since calculators do all the work, pupils will be less stimulated and challenged. The study conducted by Campbell & Stewart (1993) has shown that appropriate use of calculators results in greater persistence in problem solving. This could be explained by the fact that since calculator use allow more time for them to explore, pupils can work enough problems to discover and observe patterns which are not seen when computation are done by tedious paper and pencil methods. Hembree and Dessart (1986) found that students who use calculators exhibit greater self-confidence and that calculator use generates more enthusiasm about mathematics.

Many teachers believe that mathematics is and should be hard work, work which normally are associated with manual computations and manipulations. Calculators eliminate much of that work, making them appear nothing but a "crutch" for students who are too "lazy" to perform the assigned mathematical tasks. The truth is, calculators are simply tools to help students solve problems; they do not do the work for students. It is still up to the student to read the problem, understand what is asked, determine the solution, and decide whether the answer makes sense. The use of calculators simply allows teachers and students to spend more time on the non-computational parts of the problem-solving process (Campbell & Stewart, 1993).

Using Calculators in the Daily Primary Mathematics Lessons

To make calculators an integral part of mathematics instruction, appropriate changes will need to be made to the curricula. Less time will need to be spent on tedious paper-and-pencil computations and manipulations, which means more time will be available for concept development, problem-solving, mental arithmetic, and estimation. This may require the earlier introduction of certain new skills and topics such as geometry and data analysis and connecting science and mathematics.

The existing body of literature reveals that calculators are excellent for exploring number patterns; promoting important mathematical ideas of prediction, estimation and approximation; helping children understand the number and number system; and introducing decimal notation and negative numbers. They are also great help in teaching topics on percents, fractions, perimeters and areas.

NCTM (1991) recommends that every teacher at every level promote the use of calculators to enhance mathematics instruction by:

- modeling the use of calculators in a variety of situations;
- using calculators in computation, problem solving, concept development, pattern recognition, data analysis, and graphing;
- incorporating the use of calculators in testing mathematical skills and concepts;
- keeping current with the state-of-the-art technology appropriate for the grade levels being taught; and
- exploring and developing new ways to use calculators to support instruction and assessment

The NCTM Curriculum and Evaluation Standards (1989) also recommend that all students use calculators to:

- explore and experiment with mathematical ideas such as patterns, numerical and algebraic properties, and functions;
- develop and reinforce skills such as estimation, computation, graphing, and analyzing data;
- focus on developing problem-solving processes rather than the computations associated with the problems;
- perform tedious computations that often develop when working with real data in problem situations; and
- gain access to mathematical ideas and experiences that go beyond those levels limited by traditional paper-and-pencil computation.

Regardless of how calculators are used in the classroom, children need to be taught the technical skills required for them to use calculators constructively and efficiently. For example, teachers may teach children the order in which to use the keys; how to enter numbers such as sums of money, measurements or fractions; how to interpret the display; how to use the memory and many other features which are important.

Sample Calculator Activities for School Children

The following activities offer a unique way of learning about numbers and number system, properties of numbers and fractions and decimals. They encourage children to see patterns that numbers make thus, helping them to think mathematically. They aim to provide teachers concrete examples on how calculators can help in developing and reinforcing concepts in mathematics. These activities were adapted from journals on teaching and learning mathematics such as Maths Solutions and BECTA. These were tried out with pupils by participants who attended the regular courses conducted at SEAMEO RECSAM.

Factors!

There are two main purposes of this activity: finding patterns and rules concerning factors and discovering properties of numbers up to 100 including primes. This activity can be done either in pairs or whole class discussion.

Resources:
Set of class calculators
Overhead projector
Overhead calculator (if available)
Paper and pencil

Procedure

Ask children to put 36 into the memory of their calculator and find which numbers divide exactly into it. Tell children to record each successful attempt.

How many numbers divide exactly into 36?
Tell children that these numbers comprise the factors of 36

Try with other numbers up to 100.

Can you find numbers with only 2 factors?

Can you find other numbers with an odd number of factors?

Can you find a pattern or a rule? Explain

Closest to 1000!

This activity was written by Len Sparrow and Paul Swan and published on Maths Solution (2002). The activity aims to provide opportunities for children to develop skills in estimation and to enable them to practice and better understand multiplication. In this activity children will be able to realise that estimation achieves a close approximation to a required answer. They will find that multiplying by a number and then by another number achieves the same result as multiplying by the product of these two numbers e.g. multiplying by 5 and then by 8 achieves the same result as when multiplying by 40, the product of 5 & 8.

Resources:
One calculator for each group
Paper and pencil

Procedure:
Each group chooses a starting number between 10 and 30.
They multiply this number by a number between 1 and 10. Answer must then be multiplied by another number between 1 and 10.

Direct children to construct a chart similar to the one below to record their results for each attempt. Do an example or two to model for children how to record. Encourage them to use information on their charts in subsequent attempts to reach the target number.

Starting No.	Multiply by (1 -10)	Multiply by (1 – 10)	Answer	Comment
23	5	9	1035	Too large
23	5	8	920	Too small

After the children have had time to explore the activity, they can do one or more of the following investigations:

- For which starting numbers can you get a final result of exactly 1000?
- For which starting numbers can you get a final result of exactly 1000 in more than one way?
- For which of the numbers is it impossible to get a final result exactly 1000?

Note: the following question may be asked for a follow-up class discussion

- What strategies did you use to get closes to 1000?
- How did you decide when you had gotten as close as possible to 1000?
- What do you know about the numbers for which it is possible to get a final result of 1000? (List these numbers on the board and look for their common characteristics)
- What do you know about the numbers for which it's not possible to get a final result of 1000? (List these numbers on the board and look for their common characteristics)

Broken Keys

This is an activity which will reinforce children's understanding of the number system. They will use this understanding to solve a problem. Teachers can model this activity with the whole class during the main part of the lesson. The discussion should enable children to understand the effect of and relationship between the four operations and the principles of the arithmetic laws.

Resources:
Set of class calculators
Overhead calculator (if available)
OHP
Activity sheets/cards

Procedure:

Your calculator has a busted 6 button. Can you show 66 on it?
Find lots of ways of doing it.

Which is the most interesting way you have found?
Can you find a way that uses the **x** button?
Can you find a way that uses the ÷ button?

For more advanced children the following may be given:

Write 53 x 7 on the board. Tell children that your calculator has a busted **3** button.

Ask children to suggest ways to calculate the answer.

Write suggestions on the board and discuss.

Ask children to try each of them. Let them explain if any of the suggestion gives an incorrect answer.

Make sure children realise there is more than one way of calculating the answer.
Repeat for the following: 26 x 13; 43 x 11

Note: During the activity observe whether children show evidence of understanding the distributive law, for example, by expressing 53 x 7 as 7 x (52 + 1) or 7 x (60 – 7), etc.
Do children suggest a range of alternative calculations?

In the Balance

This activity can be used to start a lesson on converting fractions to decimals using division. Children will be able to recongnise the equivalence between the decimal and fraction forms of ½, ¼, ¾, and also tenths, hundredths and thousandths. The children can work in small groups to create fractions and match these to the decimal equivalents.

Resources:

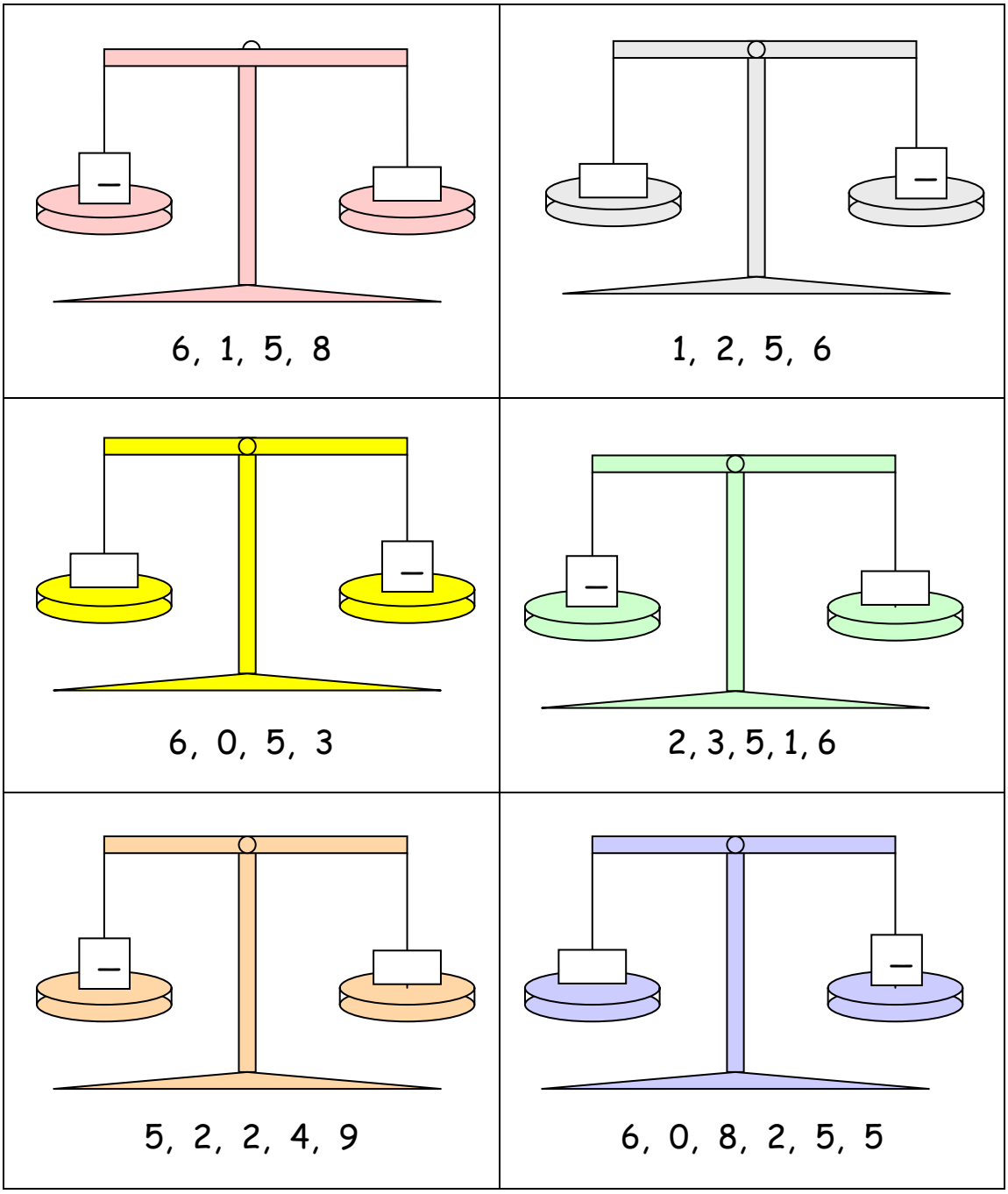
A set for calculators for the class
Activity sheets
Paper and pencil

Procedure:

Children work together to solve the tasks specified in the activity sheet (refer to balance sheet).

Balance Sheet

The numbers have fallen off the balances. Can you put them back so that the numbers on each side balance each other?



Source: BECTA (2002) Promoting Effective Practice

Note: This activity can also be used to develop concepts on percentages, ratio and proportion

Conclusion

The benefits of calculator use in the classroom are extensive. Calculators enable children to focus more on the 'whys" of mathematics rather than on the "hows". Mathematical investigations which were not possible in the past are now explored more easily by children enabling them to make more complex and insightful discoveries. However, calculators will never replace the human mind when it comes to reading and understanding a problem situation, choosing a solution and interpreting the answer. Calculators do not "understand" mathematics. Calculators do not understand mathematics but they do considerably facilitate the understanding of mathematics. It is then incumbent upon teachers to make decision on when and how to use calculators in their classrooms. As suggested by the various literatures, calculators, in conjunction with mental, paper-and-pencil, and estimation when appropriate, comprise the tools to help children work through the computations and manipulations necessary for solving problems.

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