Hand-held calculators are rapidly becoming a part of the everyday environment of both adults and children. Hand-held calculators, hereafter called calculators, are inexpensive, readily available and can be used, even by young children, with relative ease. The Report of the Conference on Needed Research and Development on Hand-held Calculators in School Mathematics (National Institute of Education National Science Foundation, 1977) indicates that calculators "...have the potential for replacing the paper and pencil calculations that have been a major component of elementary school arithmetic."

Some teachers, both in Australia and overseas, have introduced the calculator into their primary classrooms. There is an increasing number of research and curriculum development projects being undertaken which are directly related to the use of calculators in the primary school. These trends raise issues that are significant for teachers of mathematics, both primary and secondary.

Before making a decision to introduce calculators into a classroom, a teacher needs to answer some basic questions. Questions such as:

- What effect will calculators have on the learning of, and attitude towards, mathematics for my class?
- What type of calculator can I use?
- How can I use the calculator?
- What resources are available?

The purpose of this article is to provide guidance about these and related questions. While the focus here is the primary school, ideas presented for classroom teaching and for potential curriculum change should be of particular value to secondary mathematics teachers.

Some effects of calculators

Shumway (1976) provides a summary of the major arguments for and against the use of calculators. The most significant of these argument are related to the effect of calculators on children's learning of basic facts and on their attitudes toward mathematics. Recent studies in the United States indicate that, when calculators are used with traditional primary school mathematics topics, children's learning of basic skills and number facts is not inhibited. Furthermore, children's attitudes towards mathematics have not been negatively influenced. One recently completed study, supporting these findings, was supported by the National Science Foundation. It involved fifty classes from grades 2–6 and extended over one school year (Shumway et al., 1981). Gibb (1975) indicates that children enjoy using calculators, moreover, observations by Sullivan (1976) show that calculators can have a motivating effect on children and can lead them to a greater interest in mathematics. Sullivan observed trials of hand-held calculators in two sixth grade classrooms that were conducted over a one year period. In each case, the findings and observations were based on existing programs which were not designed with the use of a calculator in view. It is of course clear, as Bell (1976) warns, that there is a relationship between the way calculators are used and attitude toward mathematics. Calculators, like any other tool, can be used in such a way as to create disinterest and boredom.
Uses of calculators

Calculators can be used in a variety of ways in the classroom. These may be categorised as uses for fun or games; for functional purposes; for pedagogical purposes; and badly. These categories are by no means mutually exclusive. Indeed, the use of a calculator to multiply two numbers may be purely functional for the child who needs the product in order to proceed to the solution of a problem. The same multiplication in another setting may be used to help the child understand the concept of multiplication or a particular algorithm, in other words, the activity is pedagogical. Readers might consider an alternative classification of calculator uses, in terms of concept development, practice, applications and games, to be more useful than the classification used here.

The most popular use of calculators, by both adults and children, is to play games. There are many books of games using the calculator available (Calculator Information Centre Bulletin No. 8, 1977). Many of these games can be used in the classroom, to teach or reinforce both facts and concepts. Judd (1977) has a useful article on instructional games in The Arithmetic Teacher. Imrezeel and Ockenga (1977) have written two books on calculator activities in the classroom.

As a functional tool, the calculator has particular value in problem solving. Teachers are well aware of the difficulty of developing problems that are both meaningful to children and at the same time having a computational level that is congruent with the child’s ability. The calculator removes this computational constraint, thus leaving the way open for the development of meaningful and challenging problem solving activities. A simple example might be to calculate the approximate number of times a child’s heart beats in a year, either given a set number of beats per minute or having the children take their own pulses.

The suggestion is not that children be deprived of the opportunity of doing long calculations by hand, a point of some debate, rather, that where calculation inhibits the basic objective a calculator should be used. The calculator can also be used as a checking device. Observations suggest that many children are checking their homework with a calculator. Used as a checking device a calculator should be used. The calculator can also be used as a checking device. Observations suggest that many children are checking their homework with a calculator. Used as a checking device a calculator provides immediate feedback and can be a useful diagnostic tool for the teacher.

As a pedagogical tool the calculator can be used in many ways, for example, to practise number facts, to teach place values, to introduce multiplication and division through repeated addition and subtraction and to investigate number patterns. A simple test of child’s understanding of place value is with a game called ‘wipe out’. Key in any number, say with four digits, ask the child to use subtraction to wipe out one of the digits leaving the rest as they are. ‘Wipe out’ means replace by zero.

Space does not allow for a wide range of examples. A good starting point for teachers interested in finding out more of the use of calculators is the November 1976 issue of The Arithmetic Teacher which is devoted to mini-calculators.

Classroom concerns

The remaining way to use a calculator is badly. This is not meant as a facetious remark. In my opinion the worst way to use a calculator is to use it for the sake of using it. Calculators should be used as a natural part of the mathematics lesson, not as calculator lessons separate from the other mathematics lessons. Lessons on calculators quickly result in boredom. Lessons on how to use a calculator have been found to be unnecessary. Sullivan (1976), found that children learn to use a calculator with little, if any, formal instruction. Based on informal observations in 20 classrooms, Bell (1976), advises against special books and instructions about how to use calculators. He observed that children learn quickly and are not obstructed by unknown keys.

There are, however, some factors that need to be taken into account when using a calculator in the classroom. Calculators are usually restricted to eight digits. The result of a calculation may be displayed as an approximation, as in the case of say $1 \times 3 \div 3$, or may provide an answer that is too accurate for the problem being solved. Teachers need to discuss these situations as they arise. The inclusion of work on accuracy levels and approximation is clearly needed. Added to this is a need to teach children estimation. It has been observed that children who make an error in keying the calculation into the calculator are unlikely to be aware of the error just by looking at the answer. Children need to be taught to estimate in order to have a rough check on their answer.

Selecting a calculator

Turning now to the calculator itself, the question of note is how to choose a calculator for use in the classroom. Higgins (1978), describes four types of logic used in calculators: algebraic logic, algebraic operating system, reverse Polish notation and arithmetic logic. The basic differences between these logic systems, in terms of calculator use, is the order in which a series of arithmetic calculations is keyed or entered into the calculator.
The type of logic used does not appear to be of much consequence to children. A simple survey of the logic most common in calculators owned by children in your school is one way of deciding which system to use. It will be more convenient, but not necessary, if all the children in your class have a calculator using the same logic. Even if calculators have the same logic they may have a variety of function keys, many of which will not be used in the primary school. It would appear that the extra keys are of no consequence to children and cause no problems (Bell, 1976).

Teachers interested in more details about selecting a calculator will find many books and articles available. In general, however, these are not directed toward selection for teaching purposes, they are mainly concerned with describing calculator properties. There is no research evidence to suggest that one form of logic is of more pedagogical value than another. A useful article by Caravella (1976) on selecting a calculator can be found in The Arithmetic Teacher.

Looking ahead

One fear many people have is that children will become calculator dependent. The way the calculator is used will have some influence in preventing this. It is clear that in society today more people and businesses rely on the calculator. What it will be like in ten years time we can only guess. It may well be that much of our present curriculum will be redundant. It is important to note that you cannot use a calculator to solve a problem unless you first understand the operations necessary to solve the problem.

At this stage, little is known about the ways a calculator will effect long term learning. It is certain that a complete review of the primary school curriculum content will be needed.

In conclusion, there is no evidence available to suggest that the use of calculators will have a harmful effect if they are used sensibly. Indeed we have at our disposal a tool that will be used by the whole of society not just by those in schools.

The potential impact of calculators on society can be more fully appreciated when one notes recent developments in programmable devices. Prices of micro-processors, the key component of these devices, continue to fall. The price of programmable devices, both programmable hand calculators and home or office mini-computers is fast resulting in a situation where the only factor preventing their use by a large segment of the population is lack of knowledge of how to use them. Recent developments of programs, pre-packaged on cassette tapes, will reduce the skill and knowledge level required to use these devices to a minimum. Indeed, they are already being introduced into some upper primary school grades.

References


