# Calculators as an Agent for Change in the Teaching of Primary Mathematics:

# The Victoria College Calculator Project*

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The Victoria College Calculator project is a long-term investigation into the effects of the introduction of calculators on the learning and teaching of primary mathematics. It is based on the premise that calculators have the potential to significantly change mathematics curriculum and teaching, but that there is little evidence that such changes are commonly occuring. The project commenced in 1990 with nine preparatory and grade 1 classes at two schools and is designed to continue through to grade 4 in 1993. Victoria College has funded the first two years of the project, with 13 preparatory to grade 2 classes participating in the project in 1991. All children in the project are "given" their own calculator to use and teachers are provided with systematic professional support, although they are not provided with curriculum materials or classroom activities. The investigation focusses on the extent and purpose of calculator use; changes in teachers' expectations of children's mathematical performance and consequent changes in the curriculum; and changes in teachers' beliefs and teaching practice. Funding has also been obtained from the ARC for a joint project with Melbourne University to investigate the learning outcomes for children at a total of six schools where similar use is being made of calculators. This paper gives an overview of the Victoria College project and outlines findings from its first two years. Results of a large scale

survey indicate that support for calculator use, especially in the junior primary grades, is frequently not matched by practice. Project teachers, however, are demonstrating a wide range of uses for calculators with young children, changing their expectations of mathematical performance and beginning to make tentative changes in the ways in which they approach their mathematics teaching as a whole.

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## Introduction

Over the past decade, calculators have been recognised as having the potential to profoundly change the curriculum and the nature of mathematics teaching (Corbitt, 1985, p.14; Cockcroft, 1982, p.109). There has been widespread agreement amongst mathematics educators that calculators should be integrated into the core mathematics curriculum (National Council of Teachers of Mathematics, 1980, p.9; Cockcroft, 1982, p.109; Curriculum Development Centre and The Australian Association of Mathematics Teachers, 1987). Nevertheless, previous studies have not found such changes taking place in Australia (Curriculum Development Centre, 1986, p.18) or in the USA (Hembree & Dessart, 1986, p.83).

In Britain, the Calculator-Aware Number project (CAN), which was directed by Hilary Shuard from 1986 to 1989, began to explore what a curriculum might look like if it takes seriously the implications of calculator technology. Children in CAN schools used calculators freely from ages 6 or 7 onwards, along with the normal concrete aids of any infant program. Schools made a commitment not to teach refined versions of written algorithms, but to emphasise instead the "real-life" skills of mental computation, estimation and sensible calculator use. The CAN project found that children developed a wide range of strategies for carrying out calculations and, in general, reached a high level of numeracy for their age (Duffin, 1989; Shuard, Walsh, Goodwin & Worcester, 1991).

The question of the role of formal paper-and-pencil algorithms and the balance of emphasis placed on mental, paper-and-pencil and calculator computations is of critical importance in mathematics teaching at this time. Of the three available methods of computation, mental and calculator computations are the ones typically used in everyday life. However, paper-and-pencil methods still receive the

most emphasis in schools (Department of Employment, Education and Training, 1989, p.69). The emergence of calculators and computers serves to highlight the lack of congruence between school mathematics and real mathematics (Willis & Kissane, 1989, p.58).

Recently, powerful attempts have been made to change this situation in Australia and overseas. For example, the recently published national statement on mathematics for Australian schools (Australian Education Council, 1990) endorses the 1987 national policy on calculator use and adds that:

> (It) should be taken for granted that a calculator is available whenever it can be used, from years 1-12 … (Furthermore, while) paper-and-pencil techniques (will) continue to be in daily use … people with good number skills … usually do not use the standard algorithms taught in classrooms. Rather, they use a variety of informal but reliable written methods which are appropriate to the person … to the numbers involved … and to the context …. The development of flexible computational skills can be inhibited by emphasising the practice of standard paper-and-pencil methods to the exclusion of other methods …. Access to (calculators) allows children to develop mathematical concepts more thoroughly …. Consequently, less emphasis should be given to standard paper-and-pencil algorithms and, to the extent that they continue to be taught, they should be taught at later stages in schooling.
>
> ( Australian Education Council, 1990, p.109)

Nor is Australia alone in attempting to change this emphasis. A recent conference Challenging Children to Think When They Compute: Developing Number Sense, Mental Computation and Computational Estimation (QUT, Brisbane, 9-11 August 1991) saw speakers from Australia, England, Japan and the USA providing instances of trends in the direction of increased emphasis on developing number sense through mental computation and the recognition of the role of the calculator. Statements by influential national bodies include comments such as :

> Calculators must be accepted at the K-4 level as valuable tools for learning mathematics. Calculators enable children to

explore number ideas and patterns (and) to have valuable concept-development experiences … The thoughtful use of calculators can increase the quality of the curriculum as well as the quality of children's learning.

(National Council of Teachers of Mathematics, 1989, p.19).

Nevertheless, widespread change in the use of technology has not come about because it is no trivial matter to bring about such change: teachers need to rethink mathematics, mathematics teaching and mathematics learning, as well as develop new and substantially different skills for teaching and assessment (Willis & Kissane, 1989, p.74).

Unlike the CAN project, which was a classroom based curriculum development project, the Victoria College Calculator Project is a research project concerned with teacher change. The project is based on a model of teacher change which assumes that the major motivation for teachers to change is the desire for improvement in student learning outcomes and that changes in teachers' classroom practice need to precede changes in teachers' beliefs and attitudes (Guskey, 1986, p.7-10).

The purpose of the Victoria College project is to determine teachers' attitudes to the use of calculators in primary school and to investigate the extent to which the ready availability of calculators, coupled with a systematic program of professional support, results in changes in the learning and teaching of primary mathematics.

The project is designed as a long-term investigation which seeks to:

- document the extent to which teachers incorporate calculators into their teaching and the ways in which calculators are used

- ascertain whether teachers' expectations of children's mathematical performance change as a result of the introduction of calculators and what long-term effect this has

on the curriculum

- explore changes in teachers' beliefs and practice in regard to the learning and teaching of mathematics.

The Victoria College Calculator Project commenced in 1990 with nine prep and grade 1 classes at two schools. In 1991, this has been extended to 13 classes from prep to grade 2. It is anticipated that the project will continue to move up through the schools to eventually include grade 4 in 1993. Children in the Victoria College project are introduced to calculators on entry to school (i.e. at age 4 or 5), with all children involved having access to "their own" Texas Instruments TI-108 calculator in class. Unlike the CAN project, schools have not been specifically asked to refrain from teaching standard written algorithms. Victoria College has funded the project in 1990 and 1991 through its Special Research Fund.

Schools are visited on a regular basis (usually weekly) by members of the project team, in order to support teachers and observe the project in action. Teachers meet regularly in their schools and once a term at inter-school network meetings. A newsletter also appears each term.

The Victoria College project has worked in close collaboration with the Melbourne University Calculator - Aware Program for the Teaching of Number. ARC funding has been obtained for a joint Victoria College and Melbourne University project, commencing in 1992, to investigate the learning outcomes for children at the six schools involved in the two projects (Welsh, 1991).

## Calculator Use in the Wider School Community

In 1990, the Victoria College project conducted a survey of all primary classroom teachers and all year 7 and 8 mathematics teachers at 100 metropolitan schools to determine attitudes towards calculator use and the extent and purpose of current calculator use

in the wider school community, and to compare these with the attitudes and practices reported from a similar survey ten years earlier (Ferres, 1981). Full details of the findings from the 700 responses will be reported elsewhere (Ferres, Groves & Stacey, in preparation), however, a brief summary of some of the results are included here to set the project in a broader context.

Results from the 1990 survey indicate a remarkable shift in attitudes over the past ten years in favour of the early introduction of calculators. In the 1990 survey, 75% of teachers supported calculator use in prep to grade 3, compared to a mere 7% in 1980. These attitudes, however, did not necessarily translate into practice, as 58% of junior primary teachers admitted to rarely or never using calculators in their classrooms. Reys et al (1990) have found equally striking results in the USA - in 1990, over 90% of primary teachers surveyed agreed that students should use calculators in school (although not necessarily at their own year level), while less than 20% replied that students actually used them in their classrooms, this latter figure representing a slight decrease in actual use since a similar survey was carried out in 1979 (p.13).

It might be hypothesised that the main reason for such a low rate of calculator use is their lack of availability. However, at a time when most primary classrooms boast a computer costing about ten times the price of a class set of calculators, any lack of availability of calculators in junior primary schools must reflect the priority attached to their use, rather than mere cost. Hence lack of availability cannot be seen as the cause for the mismatch between attitudes and practice. This view is supported by teachers' responses to a question relating to their confidence in using a calculator effectively in the classroom. While twice as many teachers claimed confidence in operating a calculator in the 1990 Victoria College survey as in the corresponding 1980 survey (84% compared to 42%), this did not necessarily mean that they felt confident in using them in a classroom. In fact, there had been little change over the ten year period with 71% of the 1990 teachers still feeling a need for more inservice in order to use calculators effectively as an aid to learning, compared to 79% in 1980. This is not surprising, as 73% of the 1990 teachers claimed to have had no pre-service or inservice training in the area. It therefore seems likely that one of the main causes for the lack of use of calculators in the junior primary grades is a lack of confidence and knowledge of how to use them effectively in the classroom.

The introduction of calculators to young children requires a realisation of the fact that their use is not restricted to "number crunching" and an awareness of how other uses might be incorporated in their mathematics programs. Teachers in the 1990 survey were questioned about their attitude towards a number of potential uses of the calculator in their teaching and, later, using slightly different wording, about their actual practice. It is significant that while there was a high level of support across all year levels for what might be termed "more creative" uses of calculators, this was not matched by teaching practice. The gap was particularly evident in the junior primary years. For example, over 80% at all year levels supported the use of calculators to allow for more challenging problems solving situations and also to develop new concepts and skills. Yet in both instances, 60% of junior primary teachers rarely or never used calculators for this purpose. Even for more mundane uses of the calculator, a similar mismatch was apparent. While 72% of all primary teachers supporting calculator use to check computations, 50% of junior primary teachers admitted to rarely or never using them in this way. The same issue also produced a surprising mismatch of attitudes and practice for junior secondary teachers, but this time in the opposite direction, with 92% claiming to frequently or occasionally use calculators to check computations, despite the fact that only 79% supported such a use!

In the 1990 survey, 61% of teachers believed that children should understand the meaning of the four operations before using calculators (compared to 91% ten years earlier), with junior secondary teachers being much more strongly in favour of delaying the introduction of calculators than primary teachers (85% compared to 49% for junior primary). Approximately 80% of teachers across all levels believe that calculators should serve as a tool of the existing curriculum rather than cause an adaptation of the curriculum. This is in stark contrast to the trends which are already beginning to emerge in the two project schools, where teachers foresee radical changes in the mathematics curriculum as a result of the use of calculators (Beeby & Cheeseman, 1991, p. 4).

## The Role of Calculators in the Classroom

Calculators are frequently regarded purely as "number crunching" devices, which makes it especially difficult for infant teachers to envisage how they might be used in their classrooms. Data on the extent and purpose of calculator use in the project

classrooms is obatined through regular classroom observation (approximately fortnightly) and through teacher self-reporting by means of the completion of weekly evaluation sheets. Data collected so far indicates a wide variety of ways in which calculators can be used with young children. Four major ways of using the calculator are described below:

## The calculator as a recording device

The calculator provides young children, who often find writing numerals a time-consuming and onerous task, with the opportunity to easily record (often very large) numbers and change them at will. Calculators have been used as a recording device in many situations: to record children's 'phone numbers in memory; to keep a record of the number of turns taken in a game; to record a child's "secret number" when playing "guess my number". Small groups of children have entered numbers into their calculators' displays and then sorted themselves into ascending order (with grade 1 and 2 children often including negative, as well as very large, numbers in this activity). Entire grades have entered numbers between 1 and 99 into their calculators' displays, found their "family" (i.e. other children in the same group of ten), ordered themselves firstly within their families and then, by lining up in families around the room, across the whole grade. In a recently observed grade 1/2 class, children were asked to enter the "largest number you can read". One child refused to use his calculator. Instead he wrote 99 000 000 000 on paper, as it wouldn't fit on his calculator, and clearly explained why the number was 99 billion.

## The calculator as a counting device

One of the most effective uses of the calculator with young children is as a counting device. The built-in constant function on the calculator allows counting by any chosen number, from any desired starting point. By watching the display, children can match the numerals to the words for small numbers; see what number comes before or after any given number; learn about place value; and make discoveries such as how to count by odd numbers on their calculator, or how to count backwards. By making vertical number lists to record their counting, children can recognise final digit and other patterns when counting. Many children count into thousands and tens of thousands, while others count backwards and learn about "underground numbers" - i.e. negative numbers.

## The calculator as a "number cruncher"

The presence of the calculator allows children to work with larger numbers and solve more realistic problems. Grade 1/2 children worked in groups to tally the number of small, medium and large trees in the school ground, using several different methods. The calculator allowed the total (several hundred) to be found. Prep children found the number of legs on a drawing showing 7 spiders, working with much larger numbers than would be possible without the calculator. Even when the calculator is used to "calculate", it is not always a straightforward matter. For example, prep children sorted the teddy bears they had brought to school according to colour and counted how many teddy bears there were altogether - some counted aloud by ones, some by twos, others used the constant function on their calculators, while a few used the calculator to do 7 + 4 + 3 + 4 = 18 . When they went back to their tables to record what they had done, some children drew bears, others wrote number sentences, while many struggled to accurately record what they had done. One child immediately wrote the number sentence shown above and then proceeded to find as many ways as he could to get 18 on his calculator as the sum of other numbers - e.g. 9 + 1 + 8 and, even more remarkably, 6 + 6 + 6. Although the calculator was performing the actual additions for him, he had to work out beforehand how he could get 18 on the display!

## The calculator as a machine to investigate

The calculator is also being used as an object of discovery in its own right. Children at all levels are keen to discover the functions of the various keys and to establish for themselves that the + key, for example, has the effect of determining "how many altogether". Individual children who discover how to use certain functions, such as the memory, quickly pass on the information to others who are interested - usually by no means the whole class. Children are fascinated to find out how to switch off their solar-powered calculators - many prep children try to see what happens to the display when they put the calculator under their windcheaters. A grade 2/3 turned an accidental discovery that the calculator switches itself off after a time into a maths / science experiment to find out how long this takes. This involved children in devising methods for accurate timing, discussions about how many trials would be needed for a sufficient degree of accuracy, as well as finding ways to calculate a rough average of the different trials.

The extent to which some teachers are incorporating calculators into their everyday mathematics programs is indicated by the following comments from a grade 1/2 teacher nearing the end of two years of involvement in the project:

I tried very hard to get a transfer this year and … I was thinking about going to a school that didn't have calculators and what I'd do about it … I just think you are bogged down and limited without them. Not that they are the "be-all and end-all" and they're not the only thing you ever do. They're just another tool that's there for you to use and for the kids … Most schools which have calculators stick them in the senior school … not many schools would have them in the lower grades … I'd feel restricted (without calculators) - it would be like having no Unifix or like having no bead frames or like having no materials. It's really difficult to function without the things that you need. If I didn't have access to them when required I'd feel restricted.

(Grade 1/2 teacher, November, 1991)

Further details regarding the actual uses of calculators in the classroom can be found in Groves, Ferres, Bergfeld & Salter (1990); Groves, Cheeseman, Clarke & Hawkes (to appear).

As the project continues, the data collected on calculator use will also be classified according to three further characteristics: the nature of the task (describing the degree of "open-endedness" of the task, ranging from free exploration to directed activity); the purpose for using the calculator (e.g. teaching or reinforcing a concept, immediate reinforcement of answers, real problem solving, open-ended investigation); and the type of use (e.g. at the teacher's direction, on the child's initiative, not used, unrelated to the teacher's intentions).

## Teachers' Expectations of Children

The purpose of introducing the calculators is not to make children dependent on calculators, but rather to enhance that elusive quality of "number sense" referred to earlier in this paper, by

providing children with a rich mathematical environment to explore. As a result, young children are dealing with much larger numbers than would normally be expected, as well as, in many cases, negative numbers and, to a lesser extent, decimals.

Some teachers report that the presence of the calculator enables children and teachers to talk about numbers in a way which would otherwise be impossible. A prep teacher summed it up this way:

I mean how else would I have half an hour a week when you can play with numbers? What other material could I have used or what other tool to get the same result? There probably would be something, but I hadn't thought of doing it.

(Prep teacher, November, 1990)

Changes in teachers' expectations of children's mathematical performance and consequent changes in the mathematics curriculum provide one of the major foci for the project. Data on teachers' expectations and changes in the actual or desired curriculum is being obtained through a variety of sources, including school mathematics curriculum statements; samples of children's work collected throughout the project; an extensive written questionnaire containing specific attainment targets, with teachers asked to indicate their expectations of children at the beginning and end of each year; and teachers' reflections on changes in their expectations as reported in interviews, at meetings and on weekly evaluation sheets.

While it is too early to draw conclusions from the questionnaire data, teachers have been reporting changes in their expectations since early in the project. For example, one of the schools involved had only just completed a review of the mathematics policy at the commencement of the project. Within a term, some teachers were already claiming that the presence of the calculator made it impossible to adhere to their policy and that they already foresaw changes being required, especially as the children moved up through the school.

We have our guidelines about what we are going to teach at each year level, but I think that it means that in a couple of years time we will have to re-assess our expectations.

(Grade 1 teacher, November, 1990)

At the other school, where there is less adherence to a formal policy statement, the deputy principal now foresees changes at the next review of the mathematics policy, but he feels the real impact of the project will not be felt until the project children have moved up to at least the middle primary grades.

Recently, a prep / grade 1 teacher at the end of her first year of involvement in the project, when asked about unexpected mathematical concepts or skills developed by the children, summed it up this way:

This is one of the things I … felt some reserve about in the early part of the year, because I was absolutely convinced that children only learn mathematical concepts through the handling of concrete materials. But I do think I am beginning to be convinced that younger children such as mine - 5 and 6 year olds - do have the capacity to absorb abstract concepts if they have a firm grounding in the concrete. Yes, I do think the calculator is extending the children's mathematical ability. If they've got that firm grounding in counting and concepts related to number, then the things that they do on the calculator make sense. … (Before) I was sceptical shall we say. I didn't think that large numbers would mean much to the children. They can be counting on their calculator, long strings of numbers - for instance counting from zero by 5's - and they can get right up into the hundreds and anticipate the next number. That really is mathematical knowledge! … Once upon a time in grade 1 we didn't extend beyond 50 at the most when we were counting. The understanding was thought to be limited for children of that age and, once they ran out of fingers and toes, that was as much as we expected them to do. But they really do have an understanding now, and they can translate what they are finding out on their calculator into concrete materials, rather than working from the concrete to the calculator. They can work backwards too. if you make large numbers in the hundreds, they can quickly make a model of that number with Unifix using bars of ten. They can do it

really quickly and I think that's true understanding.

(Prep / grade 1 teacher, November, 1991)

An an exciting research question which needs to be addressed is the extent to which the calculator is causing changes in children's development of number concepts or merely revealing a state of affairs which has always existed. Some teachers clearly attribute the perceived changes to the presence of the calculator, while others, like the teacher quoted above believes that:

The capabilities must have always been there … we just haven't exposed them to enough. The caluclator … tells me that the children are capable of much more than we expected from them … It's obvious! We're not creating miracles. The miracles were there all the time.

(Prep / grade 1 teacher, November, 1991)

## Teachers' Beliefs and Practice

Many teachers began the project enthusiastically, but feeling that they needed "activities" in order to make effective use of the calculators. Although the project team promised (and has attempted to deliver) professional support through the classroom visits, school and network meetings, and the newsletter, we have tried to make it clear from the outset that this is a joint project. Together, we are all trying to find out how calculators will be used and what effect their presence will have on the children and the teachers. It took some time for teachers to at least accept the fact that we really do not intend to provide "ready made activities" - not because we are withholding information, but because we believe that it is impossible to do so in an appropriate way - especially in an area such as calculator use in the infant school where very little information is available at all.

We provided teachers with reports about the CAN project and teachers began the process of sharing information and supporting

one another. One of the schools, after a term, requested fortnightly lunch-time meetings to follow up on the morning school visits. This has proved to be most successful, despite the frequent complaints about lack of time before the event. At the other school, activities are shared during the regular fortnightly infant school meetings. This is also reported to provide valuable support for the teachers, although the project team have no direct experience of these meetings, which have commenced relatively recently. Teachers have also visited one another's schools and classrooms in the same school - the latter being a suprisingly major step for some teachers. Teachers value the opportunities for professional contact.

(Involvement in the project) has provided an opportunity to discuss what you are doing in your classroom, to offer suggestions to other people and to ask for suggestions.

(Grade 1 teacher, December, 1990)

Part of the data referred to in the earlier section on the role of the calculator relates to classroom practice. However, the major source of data is teacher self-reporting through the weekly evaluation sheets, meetings and interviews. While data relating to this aspect has not yet been systematically analysed, a few comments can be made at this stage.

The calculator has certainly been a disruptive influence for most teachers, whether for better or worse. After the initial excitement wore off (about a term into the project) teachers became anxious for a variety of reasons. Some anxieties related to not knowing what to do with the calculators, especially when members of the project team came to observe. Others related to teachers' uncertainty about the effect of the calculator on the mathematical content, as exemplified by the following comment from a teacher later in the year:

Children have got to things that they were not intended to meet - e.g. multiplication. We're not sure whether to go ahead and tidy it up now to clear up any misunderstandings with the average kids. The better ones are all right. Struggling ones we'll leave. It's something we said we wouldn't do in the school policy.

(Prep / grade 1 teacher, November, 1990)

Other concerns have focussed on classroom organisation and issues relating to planning. One teacher discovered early in the project that the calculator activities which appeared to be most successful were those which were the least structured. Her prep class began recording on "number rolls" (i.e. long vertical strips of paper) strings of numbers obtained by using the constant function on the calculator as a counting device. Having initially intended this to be a relatively brief activity, she was amazed when children continued to return to it for at least a term. Children were able to choose their own level of difficulty and retain control of the learning process. She was interested to find a similar response from her grade 3 class this year when she introduced the activity to them! Some teachers, however, have mixed feelings in response to the changes:

You feel you've been doing the wrong thing for years … as if you haven't given the children the opportunity … It's a bit like opening Pandora's Box … I think I had to be more flexible … if I planned to do certain things, they'd just go out the window. I don't mind - it possibly suits my style of teaching.

(Grade 1 teacher, November, 1990)

The fact that calculators introduce children to concepts which are not normally part of the infant school curriculum also causes concern for some teachers - especially when children appear to be using the calculators in ways which they do not seem to understand. In response to teacher's concerns, the project team carried out interviews with a random sample of children from each class, using questions devised in consultation with the teachers. While the results were by no means conclusive, they seemed to allay some of the teachers' fears. For further details of the interviews, see Beeby & Cheeseman (1991, p.4).

For many of the teachers now in their second year of the project, the calculator has become part of their normal mathematics program. Nevertheless, these teachers recognise the changes brought about by the calculator and welcome the way in which the

mathematics curriculum has expanded.

I'm a lot happier to go where the children want … it's a lot less teacher directed… The calculators have enabled us to do that … You don't have to structure things so that you know the answer will be within their reach… If the children want to find out stuff, I say "go for it"… because I'm not so worried about them finding out things they won't understand anymore… I used to think what's the point of kids talking about thousands… because they're not going to know what they are talking about … After having done this for quite a while now I think they do understand what they're talking about to a certain extent - enough anyway to use it for their own needs. And they will get to understand it as they get older. But why impose artificial boundaries … and say "you're not allowed to know any numbers beyond 1000"? It's so stupid and that's what we used to do … I think I'm being a lot more open-ended with their activities… I'm putting more on them to do more finding out. I'm just sort of starting them off. In some ways we are still structure driven when we play games … but the activities I try and do with them are the ones they can take themselves where they want to go … You never know what's going to happen.

(Grade 1/2 teacher, November, 1991)

The same teacher goes on to describe an activity where a child started with a "mystery number" (in this case - 89), manipulated the number according to directions from other children, told the children the end result, after which the others had to try and "guess the mystery number". As part of the process, a number was divided by 55. When the process was reversed, the end result was - 88.999999. This resulted in much discussion about decimals, approximations, rounding off, etc. The teacher, in keeping with her previous comments, was not unduly concerned that not all of the children could follow all of the discussion:

Some of them switch off because they don't understand. The kids who are ready to listen, they listen. I could feel their eyes on me - John's eyes, Marshall's eyes, and the others … and the "ooh" when they saw it. Even when you do everyday things that you do every week, you never know what's going to happen next. And you would never ever come across doing stuff like that unless you had a calculator to use.

(Grade 1/2 teacher, November, 1991)

## Conclusion

Project teachers have incorporated calculators into their mathematics programs in many imaginative ways. The activities they use are quite different from the "one-off" calculator activities found in many commercial publications. Instead, the calculator is being used within the "normal" range of classroom activites, as well as providing a mathematically rich environment of its own for children to explore. Teachers, although still anxious to find more calculator "activities", are finding that often a simple "everyday" activity has a rich potential in terms of mathematical outcomes. The same activities can be used over and over again, with surprisingly different results. Often the teachers are being lead by the children to continue to re-use and expand the same activity over a long period of time. A large repertorire of activities is being built up and shared among participants, but the question of the best way of sharing this knowledge with others outside the project (and even new teachers within the project) remains.

The presence of the calculator allows children to display a knowledge of mathematics which often surprises their teachers - but many children, especially early in their prep year, are still struggling with number recognition and are very uncertain about all aspects of the calculator. The wide range of skills and understandings present in any classroom appears to be highlighted by the presence of the calculator.

Calculators are being used together with the normal concrete materials and other teaching aids in the classroom - their use is certainly not intended to replace these. Nor are calculators being used to replace mental computation - in fact their presence often has the effect of motivating and supporting it. Above all, teachers are finding that calculators provide a powerful means of initiating discussion about numbers in their classrooms.

Teachers, especially those in their second year of the project, are becoming aware of quite substantial changes in their beliefs

about the learning and teaching of mathematics.

In light of the current emphasis on the development of number sense and the use of appropriate means of computation, we anticipate that this project will make a significant contribution in the long term, by providing a practical demonstration of how teachers can incorporate calculators into their teaching and by investigating the effect this will have on the curriculum and on teaching practice.

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