

# TEACHERS' ATTITUDES TOWARDS THE STUDENT USE OF CALCULATORS IN K-6 MATHEMATICS CLASSES

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This report examined the findings of a study into primary teachers' present attitudes toward the student use of calculators in primary (Kindergarten-Year 6) mathematics classes. Data were collected from a questionnaire administered during 1990 to a sample of 147 teachers undertaking their fourth year of study for a Bachelor of Education (Primary) at three university campuses in New South Wales, Australia.

The results of the study showed 32% of primary teachers had their students using calculators, though 85% supported the student use of calculators in primary mathematics classes. Teachers indicated that calculators were not being used because either none were available, there was no school policy on their use and/or they were not considered relevant for the class being taught. Those teachers who supported the primary student use of calculators believed that calculators are a technological tool for use in mathematics, that they increase childrens' confidence, they take the focus off computation in doing problems and that children use them outside the classroom. It was found that of these teachers, 55% supported the introduction of calculators before the end of Year 2. A total of 4% did not support their use at all in primary mathematics classes.

This study concluded that there was not overall support from primary teachers for the introduction of the calculator into Kindergarten as recommended in the *National Statement on the use of Calculators for Mathematics in Australian Schools* (1987).

## A LITERATURE OVERVIEW

There has been little in the last 25 years related to mathematics education that has caused more debate and concern amongst educators and the community than the introduction of the calculator into primary mathematics classrooms. Over the last 20 years calculators have become readily available to the community and their use in schools has been shown to be increasing (Moursund, 1981; ICME, 1984; FASTS, 1988;). During this time its great promise to many has been "that it enables a student to concentrate on the problem at hand, without it being obscured with what, to some students, seems to be an impenetrable barrier of calculation" (Willis, 1979, p. 3). Yet there has continued to be a controversy within the community concerning the use of calculators in the mathematics classroom.

During the 1970's and 1980's there had been a gradual international move towards the recommended student use of calculators from Kindergarten. The 1970's had seen research focus on the effect of the calculator on students' computational skills. This research and the ensuing discussion led to the publication of the NCTM's *Agenda for Action* (1980) including Recommendation 3 on the use of calculators in the mathematics class :

That mathematics programs take full advantage of the power of calculators and computers at all grade levels. (NCTM, 1980, p.8)

There then followed the release of the Cockcroft Report (1982), in England, which further discussed the place of calculators in the mathematics classroom. With the publication of Hembree and Dessart's meta-analysis in 1986 the NCTM (1987) reaffirmed its policy on the student use of calculators. This build up over 10 years resulted in a definite statement being issued within the *Curriculum and Evaluation Standards for School Mathematics* (1989) which recommended calculators be made available to all students in all grades. This has set the focus for the student use of calculators in the USA for the 1990's.

In Australia, over this time Blane and Willis (1986) had recommended that a National Statement on the use of calculators in classrooms be developed. This national policy statement was released (CDC and AAMT, 1987) with all state educational authorities supporting the view that calculators be available to students from Kindergarten. In 1991 there was the release of a *National Statement of Principles on Mathematics in Australian Schools* which supported the use of calculators from K -12.

Of most importance 1990 saw the report of work carried out in the United Kingdom on the *Calculator - Aware Number* curriculum. The work of the PRIME project and specifically the CAN curriculum work (1989), which focussed on the early primary years, found that when calculators were used the children's knowledge of number was beyond that expected from them at that age.

The children certainly show greater competence in mathematics at an earlier age than would normally be assumed. This is particularly true for large and small numbers, negative numbers, the ability to recognise patterns and awareness of their significance, and the understanding of place value. The growth in the children's development of concepts such as fractions, decimals, square roots, has also become more evident during this second year of CAN development. (PRIME, 1989, p.12)

There have been clear directions given by research (Hembree and Dessart, 1986), reports (NCTM, 1980; Cockcroft, 1982), national statements (CDC and AAMT, 1987) and state education systems (NSW Department of School Education, 1989) as to the place of calculators in mathematics classes.

Their role in the classroom was perceived to be varied. The literature suggested that calculators could be used for games (Koop, 1977), in problem solving (Lambert, 1985), for computation work (Reys, 1989), number exploration (Wilson, 1986), estimating and checking (Discipline Review Report, 1989) and in developing mathematical language (Del Campo, 1986). There was also the acceptance that they were part of our everyday world (Koop, 1979) and a part of the technological change that is taking place in our society.

There was consistent research evidence that the use of calculators did not reduce computational skill. Indeed they may even have a positive effect on the performance of students (Bell et al, 1983; Hembree and Dessart, 1986; Willis and Kissane, 1989). In fact research findings indicated that the introduction of calculators into the mathematics class has a positive effect on children's motivation and enthusiasm in doing mathematics (Foster, 1979; ICME, 1984; Comstock and Demana, 1987; Suydam, 1987, 1989, p.12)

Presently there exists an increasing curriculum policy direction for the student use of calculators by all students in all classes, while at the same time there continues to be a community controversy and an apparent divergence of opinion amongst teachers (Bitter,

1980; Shult, 1981; Cooper and English, 1985; Del Campo, 1986; Perry, 1989; McIntosh, 1990) over their use.

## **METHODOLOGY**

The major issues that emerged from the literature review were related to:

- the ways in which calculators are used;
- the grade from which calculators should be used;
- the continuing community controversy over the use of calculators;
- the support teachers required for the effective introduction of the calculator into primary mathematics classes.

These and other issues formed the basis of the research questions used within a questionnaire administered to an available sample of 147 teachers during May/August 1990. The final format comprised 20 questions categorised into two sections. Section 1 identified the respondent's demographic information while Section 2 was directed at issues involving the student use of calculators in primary mathematics classes.

The sample of teachers chosen were those undertaking a course of study towards their fourth year qualification, Bachelor of Education (Primary), at three Sydney based university campuses. It was assumed that this sample would contain currently practising primary teachers and that their attitudes would be representative of teachers as a whole. A limitation of the study was that all teachers in the sample share the characteristic of undertaking their fourth year of study and thus the findings cannot be generalised to the population of all the primary teachers in New South Wales. It could also be assumed that this sample population may differ from the remaining teachers in the state in that they may have a heightened awareness of curriculum policies and advanced knowledge of calculator usage through the course work that they were completing.

## **ANALYSIS OF DATA**

The collected data were analysed for response rates for each variable from each campus and then the overall response rate for each variable from all completed questionnaires. There were two procedures used in the analysis of the data:

1. A frequency count of responses for each variable from each campus was calculated.
2. A cumulative frequency count of responses to each variable from all collected data was calculated.

Chi square was used to test for significant differences across the variables of age, gender, years of teaching experience and class presently taught. This resulted in identifying Kindergarten teachers as having a significant difference of opinion as to the relevance of the calculator as compared to other teachers.

## GENERAL DISCUSSION

In comparing the results of this study to that of Blane and Willis (1986) there was evidence of a growth in support over the last five to six years for the student use of calculators in primary mathematics classes. There was evidence of a growth in teacher support for the earlier introduction of calculators when compared to the report given at ICME 5 which indicated that "a study in 1983 in New South Wales, Australia, 40% of grade 5 students used calculators in the classroom" (Mohyla, 1984, p.69). It was also different to the findings of the UNESCO/CDC (1986) study which found that "the modal age at which it was considered most appropriate to use calculators in mathematics classes was '14', that is in Year 9 in schooling in Australia" (Blane and Willis, 1986, p.12).

Teachers strongly supported ( 85%) the introduction of calculators into the primary years though only 32% responded that they were currently using calculators. They acknowledged that calculators were mathematical tools available to and used by children outside the classroom and that there were a number of

uses for them in mathematics classes. Teachers ( 13%) who did not support the student use of calculators expressed concern that they reduced the need for children to learn their basic facts and that children would not learn pencil and paper computational skills.

## YEAR FOR INTRODUCTION

However, there was an obvious divergence of opinion amongst teachers concerning the Year of primary school that calculators should be introduced. The teacher responses ranged from Kindergarten to not at all, though the vast majority of teachers believed that they should be introduced by the end of Year 5. This did not support the national calculator policy (AAMT/CDC, 1987) that recommended their introduction from Kindergarten. Perhaps the majority of teachers did not support the student use of calculators from Kindergarten because they were unsure of their use in the early primary years. This may add support to the need for further investigation of the student use and relevance of calculators from Kindergarten.

The divergence of opinions amongst teachers reinforced the need for clearer directions from educational authorities on the student use of calculators in primary schools, the need for further research into the appropriate use of calculators in the early years and the need for the ongoing professional development of teachers to disseminate research findings and to generate discussion regarding this issue.

## REASONS FOR LACK OF USE

The vast majority of teachers supported the student use of calculators in primary mathematics classes but they were currently only being used in a minority of mathematics classes (32%). This should be a concern for two reasons. Firstly, the NSW K-6 Mathematics Syllabus (1989) recommended the student use of calculators from Kindergarten and it is apparent that this was not occurring. Secondly, the teachers who participated in this study were completing their fourth year of study towards a Bachelor of Education

(Primary) and it could be assumed that these teachers would be aware of current curriculum policies and yet only a third had their students using calculators.

The reasons given for not using calculators were varied but centred on calculators not being available, no school policy on their use and not being seen as relevant for the class being taught. These reasons need comment.

1. That there were no calculators available seems to be an oversight in supporting the N.S.W. K-6 Mathematics Syllabus which recommended their use. It also raised the question of why calculators were not available. It may be that the school personnel responsible for making decisions about resources may:

- not be aware of the syllabus' recommendation;
- not support that recommendation;
- not know how to implement the use of calculators in the mathematics classroom;
- be concerned about parent reaction to the use of calculators.

Perhaps schools believed that it was the responsibility of the educational authorities to supply schools with an adequate number of calculators for teachers to introduce them into their mathematics classes as recommended in the N.S.W. K-6 Mathematics Syllabus (1989). The lack of calculators was identified by teachers as a major reason why students were not using them in primary mathematics classes.

2. Schools need to develop policies that support and reflect the relevant syllabus documents. It appeared that a number of schools have not yet developed a calculator policy and this was identified by teachers as a reason why students were not using calculators.

The student use of calculators has generated such community discussion over time that schools need to discuss the issue and develop a school policy on their use.

3. Many teachers did not see calculators as being relevant for their class. There were 26 teachers who indicated this and when identified 12 of these teachers were Kindergarten teachers. In the total study there were 16 teachers who said that they were currently teaching Kindergarten. Of these, 12 said that calculators were not relevant for their students. This needs further investigation for if this was the case amongst all Kindergarten teachers it would be difficult for educational authorities to implement a state and national policy on calculators that recommended their introduction from Kindergarten. It may also be that since many schools have not developed a policy on the student use of calculators, teachers have not discussed their place in Kindergarten, leading teachers to believe that they were not relevant for the first year of schooling. There needs to be further study undertaken to investigate the use of calculators in Kindergarten in order to gauge their relevance for this grade. It may well be that the introduction of calculators into Kindergarten is not supported by teachers or the community.

These three issues must be addressed by educational authorities, researchers and schools if teachers are to use calculators effectively and efficiently in their mathematics classes.

The sample for this study comprised primary teachers who were completing their Bachelor of Education (Primary) which limited the generalisation of findings to all primary teachers. A broader study needs to be carried out to investigate the support amongst teachers of varying backgrounds towards the student use of calculators. Such teachers could be those in executive positions within the school, teachers in various classes and teachers with varying years of experience.

The majority of teachers involved in this study were in their first five years of teaching. Perhaps the lack of student use of calculators could be due to the teachers just beginning their careers and they may be more concerned with surviving the day to day rigours of teaching. Perhaps they will begin to have students use calculators more as they gain experience and confidence in their teaching.

It could also be argued that these teachers were among the most recent graduates from teacher training courses and that the mathematics units within these tertiary courses should have prepared them to use calculators in their mathematics lessons. These courses need to be evaluated in the light of recent research and syllabus documents concerning the issue of calculator use to better prepare initial teachers for the role of calculators in the primary mathematics curriculum.

## **SCHOOL POLICY STATEMENTS**

Teachers indicated that a number of schools did not have policies on calculator use mainly because they were not aware of official policy, were waiting for directions or it was not seen as a priority. Concern should be expressed that schools were "unaware of official policy" or "waiting for directions for their use in schools" for they have been given an official syllabus and directions in the form of the NSW K-6 Mathematics Syllabus (1989). These directions may not have been effectively communicated to teachers through the syllabus and clearer statements may need to be made.

In NSW the K-6 Mathematics Syllabus (1989) and nationally the calculator policy (AAMT/CDC, 1987) have recommended the use of calculators from Kindergarten. One could have assumed that school policies would reflect these statements. This was not always the case. School calculator policies varied regarding the years in which students were allowed to use them. Some had them available from Kindergarten others from Year 4. A clear policy statement should be developed by schools on how and when calculators can be used by students. Such a policy needs to be made available to teachers, students and parents so that a positive direction regarding their use is given to all within the school community.

The issue of the student use of calculators has been a community concern for twenty years. With the increasing student access to calculators and the directions given to its place in the mathematics syllabus the development of a school calculator policy should be seen as a priority and discussion of the issue needs to be entered into by school communities.

## SCHOOL-BASED PROFESSIONAL DEVELOPMENT COURSES

Teachers emphasised the importance of school based professional development courses and their willingness to attend if they were organised during school time. Schools need to respond to this stated need and organise such courses through their staff development plan. To assist teachers and schools in their discussion of this issue educational authorities could disseminate research findings to schools. Schools and teachers need a research base for these discussions. Hembree and Dessart's (1986) meta-analysis considered only 16 studies relating to grades Kindergarten to Year 3 (Saxon, 1987). The work carried out and reported through the CAN study (1989) focussed on the early primary years. The findings from this study need to be disseminated to teachers and schools.

Professional groups either nationally such as the Australian Association of Mathematics Teachers (AAMT) or state based such as the Mathematical Association of New South Wales (MANSW) could investigate ways in which they could assist schools with structured workshop material and dissemination of research findings.

## PERCEIVED PARENT VIEWS

It was apparent that teachers were aware of the parent concern over the student use of calculators as many teachers believed that parents would not support the student use of calculators. Such a view was found in Blane and Willis' study (1986) which reported that at the upper primary level "parents were perceived to be strongly against" (p.8) the use of calculators. There was also evidence that teachers were uncertain at the present time of how parents viewed the student use of calculators in the primary years. Such a degree of uncertainty is another area in need of investigation perhaps focussed on 'Parent views on the student use of calculators in primary mathematics classes'.

Calculators are here to stay and there was strong support from teachers in this study for their use by students in the primary years. Though presently, a minority of teachers had their students using calculators. The reasons teachers gave for not having their students using calculators need to be addressed by educational authorities if they are to be introduced effectively into the primary mathematics curriculum.

## CONCLUSIONS

This study investigated teacher attitudes towards the student use of calculators in primary mathematics classes. The findings from this study have been generalised to the following conclusions.

1. Calculators were not in general use in the primary grades.
2. There was not the same support for calculators being used in computational work as there was for it as a tool for problem solving and to reinforce estimation skills.
3. Teachers were not using calculators primarily because there were none available and/or there was no school policy on their use.

4. There were a number of teachers who did not see calculators as being relevant for their class.
5. There was strong support amongst teachers for the use of calculators in primary mathematics classes.
6. Teachers did not see that the use of calculators would reduce individual differences.
7. Teachers were concerned that calculators reduced the need for children to learn the basic facts and that they would not learn pencil and paper computational skills.
8. There were many schools that did not have a stated calculator policy.
9. There was a difference in stated school policies as to the student use of calculators. Some stated all students Kindergarten to Year 6 should have access while others stated only students from Year 4.
10. Educational authorities had not effectively communicated to schools their policies on the student use of calculators in primary mathematics classes.
11. There was not general support among teachers that calculators should be used from Kindergarten.
12. The main influence on teachers in forming their attitudes was their own opinion from teaching students.
13. School based professional development courses on the use of calculators in their primary mathematics classes had not been offered to teachers.
14. The vast majority of teachers were willing to attend school based professional development courses. Of these teachers, most would attend courses only within school time.
15. Most teachers were either unsure of parents' attitudes towards the student use of calculators or felt that parents would not support their use.

## **RECOMMENDATIONS**

Based on the findings that have emerged from this study and the conclusions that have been drawn, the following recommendations are made.

### **A. Recommendations for Curriculum Change**

1. Educational authorities must communicate more effectively syllabus directions for student use of calculators in primary mathematics classes. There should be a statement issued to schools by the relevant educational authorities clarifying the role of calculators in primary mathematics classes.



2. Educational authorities need to take on the responsibility or liaise with professional bodies to update schools and teachers with emerging research findings. This could be done in the form of a research findings bulletin published twice a year outlining the possible implications for the primary mathematics syllabus. This could be a joint publication from relevant educational authorities and professional bodies such as the NSW Board of Studies, the Mathematical Association of New South Wales and the Mathematics Education Research Group of Australasia.
3. Calculators should be made available for student use in primary mathematics classes. Schools could be supplied with calculators, schools could purchase calculators or students could purchase calculators as part of their school requirements.
4. Schools need to develop a policy on the student use of calculators. This policy needs to be developed through discussion between teachers and parents.

#### **B. Recommendations for Professional Development Courses**

Teachers could be offered structured school based professional development courses on the use of calculators in primary mathematics classes. These courses would need to be offered within school time for all teachers to attend. Such courses would be part of a school's staff development plan.

These could be structured courses involving discussion sessions, source material and classroom research tasks for teachers and students. The teacher/student observations from the research tasks could form part of each discussion session. Outcomes from such a course could be disseminated to other schools within a region across the state or nationally.

#### **C. Recommendations for Future Research**

1. A research study be set up across Australia or within a state to investigate the student use of calculators in primary mathematics classes, initially, over a six to twelve month period. This study to comprise a range of schools and classes from Kindergarten to Year 6. The study to focus on calculators being available to all students as part of the mathematics class with the teacher/student use of calculators being recorded and the findings reported.

The research needs to be school based with calculators being available to students at all times. The study would be directed at gauging the usefulness and relevance of calculators to various grades. Student access to the calculators would be complemented with specific calculator lessons as the students or teachers identify a need. Teachers and students would be asked to record their work with the calculators, the results of which will be discussed amongst other teachers in school based workshops with research material or commentaries on the issue being available to supplement the teachers' classroom experiences.

2. The findings of such a study to be incorporated into the development of state and national syllabus statements leading to a calculator integrated mathematics curriculum (K-12).

3. This study suggested that there was uncertainty among teachers as to parent attitudes towards calculator use. In order to gauge community reaction a study be set up to investigate community attitude towards the student use of calculators in primary mathematics classes. Such a study would be school based and be set up with discussion workshop sessions being given for parents. These sessions could include semi-structured interviews being given before and after the workshops to gauge parent attitudes towards the use of calculators and to gauge any change to parent attitudes that may come about as a result of their participation in the workshops.

## REFERENCES

- Australian Association of Mathematics Teachers / Curriculum Development Centre. (1987). *A national statement on the use of calculators for mathematics in Australian schools*. Canberra: Curriculum Development Centre.
- Australian Education Council. (1991). *A statement of principles for mathematics in Australian schools*. Canberra: Australian Education Council.
- Bell, A., Costello, J., & Kuchemann, D. (1983). *Research on learning and teaching, Part A*. Berkshire: NFER-Nelson.
- Bitter, G. (1980). Calculator teacher attitudes improved through inservice education, *School Science and Mathematics*, 80 (4), pp. 323-326.
- Blane, D. & Willis, V. (1986). *Report on the UNESCO pilot project on the applications of calculators to mathematics teaching in Australia*. Clayton Victoria: Monash University.
- Cooper, T., & English, L. (1985). Calculators do more than just compute: using the calculator to teach an understanding of concepts and processes. In Peter Sullivan (Ed.), *Mathematical Association of Victoria Twenty-Second Annual Conference*. (pp.31-36). Melbourne: Mathematical Association of Victoria.
- Committee of Inquiry into the Teaching of Mathematics in Schools. (1982). *Mathematics counts*. London: Her Majesty's Stationery Office.
- Comstock, M., & Demana, F. (1987). The calculator is a problem-solving concept developer, *Arithmetic Teacher*, 34 (6), pp. 48-51.
- Del Campo, G. (1986). Calculators: Vehicles for developing mathematical language in infant classes. In Nerida Ellerton (Ed.), *Mathematics who needs what ?* (pp. 240-242). Melbourne: The Mathematical Association of Victoria.
- Department of Employment, Education and Training. (1989). *Discipline review into teacher education in mathematics and science*. (Vols. 1-3). Canberra: Department of Employment, Education and Training.
- Federation of Australian Scientific and Technological Societies. (1988). *Report to AAMT council*. Unpublished.

- Foster, B. (1979). Calculators and primary mathematics. *The Australian Mathematics Teacher*, 35 (4), pp. 13-14.
- Hembree, R., & Dessart, D.J. (1986). Effects of hand-held calculators in precollege mathematics education: a meta-analysis. *Mathematics Education*, 17 (2), pp. 83-99.
- Koop, A.J. (1979). Calculators in schools: some curriculum considerations. *Australian Mathematics Teacher*, 35 (4), pp. 6-7.
- Lambert, P. (1985). *Teaching with calculators K-6*. Darlinghurst, New South Wales: Primary Association for Mathematics.
- McIntosh, A. (1990). Becoming numerate: developing number sense. In S. Willis (Ed.), *Being numerate: What counts?* (pp. 24-43). Hawthorn Victoria: The Australian Council for Educational Research.
- Mohyla, J. (Ed). (1984). *ICME 5 Congress: the role of technology theme group 3*, Adelaide: South Australia College of Advanced Education.
- Moursund, D. (1981). *Calculators in the classroom: with applications for elementary and middle school teachers*. New York: John Wiley & Sons.
- National Council of Teachers of Mathematics. (1980). *An agenda for action: Recommendations for school mathematics in the 1980's*. Reston Virginia: NCTM.
- National Council of Teachers of Mathematics. (1987). Calculators: Focus issue. *Arithmetic Teacher*, 34, (6).
- National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics*. Reston Virginia: NCTM.
- NSW Department of School Education. (1989). *K-6 mathematics syllabus*. Sydney: Department of School Education.
- Perry, R. (1989). Issues in early childhood mathematics teacher education. In *Discipline Review of Teacher Education in Mathematics and Science (Vol. 3)* (pp. 138-172). Canberra: Department of Employment, Education and Training.
- Primary Initiatives in Mathematics Education (PrIME) Project. (1989). *The second year of CAN*. Homerton College Cambridge: National Curriculum Council.
- Reys, B. J. (1989). The Calculator as a tool for instruction and learning, In P. Trafton (Ed.). *New directions for elementary school mathematics*. (pp.168-173). Reston Virginia: NCTM.
- Saxon, J. (1987). Say no to calculators in elementary schools. *Arithmetic Teacher*. 34 (6), p. 21.
- Shult, D. (1981). Calculator use in schools. In D. Moursund, *Calculators in the classroom; with applications for elementary and middle school teachers*. (pp. 181-183). New York: John Wiley & Sons.

- Suydam, M. (1987). What are calculators good for? *Arithmetic Teacher*. 34 (6), 22.
- Willis, G. (1979). Editorial. *Australian Mathematics Teacher*, 35 (4), p. 3.
- Willis, S. (1990). *Being numerate: What counts?*. Hawthorn Victoria: Australian Council for Educational Research.
- Willis, S., & Kissane, B. (1989). Computing technology and teacher education in mathematics. In *Discipline review of teacher education in mathematics and science (Vol. 3)* (pp. 57-92). Canberra: Department of Employment, Education and Training.
- Wilson, P. (1989). Critical variables for teacher involvement in curricular change. In J. Malone (Ed.). *The mathematics curriculum: Towards the year 2000*. (pp 331-336). Perth: Curtin University of Technology.