

A Survey of Graphics Calculator Use in Victorian Secondary Schools

Alla Routitsky and Patrick Tobin

Swinburne University of Technology, Australia

In 1997, Victoria became the first state to permit the use of graphics calculators in final external examinations. The action was seen as radical for both social and educational reasons. Concerns were raised about the propriety of using the calculators and whether their use would add to existing educational disparities. With the support of the Board of Studies, a survey of secondary schools was undertaken to gauge the response to this decision and inform further action on graphics calculator use in mathematics courses.

Introduction

Although graphics calculators have been available for about a decade, their penetration in the secondary school system has been slow - largely because of a ban on their use in the external examinations which applied universally in Australia until 1997, and which still mainly persists. A decision was taken by the Victorian Board of Studies (1995) to lift this ban from 1997 in all external examinations but a policy was adopted that the examination questions would be required to be 'calculator-neutral'. This no-advantage clause was promulgated to minimise any social inequities which might flow from the decision. In Western Australia, the decision to allow the use of graphics calculators in external examinations from 1998 was made without the use of this 'no-advantage' rule. It can be argued that this rule artificially constrains the form of the paper (Tobin, 1997) and that the desired improvements in mathematical performance are cut back. In fact Western Australia also sanctioned the use of calculators with a small degree of algebraic/calculus capability by accepting the HP-38G as an endorsed calculator model. This has not yet been permitted in Victoria.

The VCE Graphics Calculator Project was funded by the calculator companies and the Board of Studies and preceded the implementation of the Board's policy. This project was conducted in two phases - a phase for teacher familiarisation with the various graphics calculator models, run by Swinburne University of Technology and a phase for preparing sample materials using the calculators, run by the University of Melbourne (Jones, 1997; Tynan and Dowsey, 1997). Many of the educational issues of graphics calculator use in mathematics courses or examinations have been canvassed before (see Penglase and Arnold, 1996, for a review of the graphics calculator literature and Tobin, 1997, for a discussion of the impact using a graphics calculator would have made on VCE mathematics papers prior to 1997) .

One of the authors (Tobin) was interested in graphics calculator penetration of the schools as a consequence of the decision and in related questions of teacher attitudes

towards the Board policy and their use of the calculators in the mathematics courses. There has been little previous research undertaken on teacher attitudes although Chamblee (1995) reported that the only significant variable in quantifying teacher support for use of graphics calculators in a college algebra course was the degree of familiarity of the user. With the support of the Board of Studies, a survey was conducted in two parts - the first to determine from mathematics coordinators the level of ownership or access of calculators by students in their school and the second to determine teacher attitudes and use of the calculators in various subjects or topics.

The survey was initially sent in September 1997 with a follow up to non-responding schools in March 1998. The information to be discussed in this paper arose from the initial response to the survey.

The Survey Questionnaire

The survey was sent to approximately 485 educational providers on the basis of whether they taught the basic mathematics subject, Mathematical Methods Units 1&2. This was devised as a suitable screening procedure to ensure the survey was not limited to schools - some TAFE colleges teach VCE mathematics - but would not stray to specialised VCE providers such as language or music schools.

There were initially 165 responses from school coordinators and data from these is discussed here. The brief coordinator questionnaire included information on school size (indirectly) calculator models, booklisting policies, class sets, student access and estimations of student calculator ownership. The focus of this questionnaire was school penetration of the graphics calculators.

The more detailed teacher surveys were initially completed by over 900 teachers and some data from these is discussed here. The focus of the teacher survey was on attitudes to the Board's calculator policy and attitudes to the graphics calculators themselves. This teacher survey enables us to assess any variations in responses between school regions, types or sectors as information on these was gathered also. There are seven educational regions classified by the Ministry: Eastern Metropolitan (EM), Western Metropolitan (WM), Barwon South Western (BSW), Central Highland (CH), Gippsland (G), Goulburn-North Eastern (GNE) and Loddon-Campaspe-Mallee (LCM).

The four sectors are Government Secondary, Catholic, Independent and TAFE. The bulk of respondents in the first group were schools - only two TAFE colleges out of a possible ten providers gave any feedback. The three types of educational providers classified were boys schools, girls schools and co-educational schools.

The main target was teachers of mathematics subjects in the Victorian Certificate of Education (VCE). This spans years 11 and 12 and includes the five mathematics subjects, Mathematical Methods (MM) 1&2, General Mathematics (GM) Units 1&2, Mathematical Methods Units 3&4, Further Mathematics (FM) Units 3&4 and Specialist

Mathematics (SM) Units 3&4. It is only the unit 3&4 subjects which have external examinations affected by the new policy - these are 90 minute papers involving multiple choice, short answer and analysis questions which are called Common Assessment Tasks or CATs. Graphics Calculators and other forms of computer assistance have been encouraged in the past in the remaining external assessment, a project or problem solving task called CAT 1. The surveys also obtained information on ownership, access and use of calculators in years 7 to 10 but the figures for this are low, especially in junior levels and will not be discussed here.

Results

Coordinator Survey

Calculator Models: The Texas Instruments models dominate the market with 83% of market share. This result was expected from anecdotal evidence and appears to contrast with the situation obtaining in other states such as Western Australia. The CASIO models cover about 15% and there are a few schools using Sharp or other calculators.

Access Policies: The information on booklisting by schools (i.e. adding a calculator to the school booklist) shows that independent non-catholic schools are much more likely to prescribe calculators than government schools. Catholic schools are also more likely to booklist calculators than their government counterparts - though to a lesser degree. This is shown in Table 1.

Conversely government and catholic schools show slightly higher rates of possessing at least one class set although this is prevalent across all sectors as seen in Table 1.

Table 1

Educational Providers: Percentage booklisting or having at least one class set

Provider	Sample Size	% Booklisting	% Class Sets
TAFE	2	100	50.0
Catholic	35	54.3	88.6
Government Secondary	85	47.7	86.4
Independent Non-catholic	40	85.0	75.0

Student Ownership: There was a wide variety of student ownership reported between school types and across year levels. Grouping the data into '95% or more' ownership and '5% or less' ownership as two extreme cases, the results for Unit 1&2 subjects (usually done in year 11) are shown in Table 2.

Table 2
Calculator ownership for subjects in Units 1&2.

Subject	Ownership ($\leq 5\%$)	Ownership ($> 95\%$)
Mathematical Methods 1&2	27%	19%
General Mathematics 1&2	40%	10%

As many students do both subjects, we may infer that students only doing General Mathematics are not yet buying the calculators much.

In Unit 3&4 subjects (usually done in year 12) the pattern shifts between FM 3&4 with its low student ownership of calculators and MM 3&4 and SM 3&4 which have higher rates. The data are shown in Table 3.

Table 3
Calculator ownership for subjects in Units 3&4.

Subject	Ownership ($\leq 5\%$)	Ownership ($> 95\%$)
Further Mathematics 3&4	40%	16%
Mathematical Methods 3&4	15%	33%
Specialist Mathematics 3&4	21%	41%

Of course the students doing Specialist Mathematics would all be included in the Mathematical Methods 3&4 figure inflating that result. Students doing MM 3&4 alone or with FM could be expected to have lower rates of calculator ownership. The anomalous higher figure for low calculator ownership in SM 3&4 over MM 3&4 may be a consequence of some schools rejecting use of the calculators for more able students because of university resistance to their use later on. Some anecdotal evidence supports this.

Overall, the penetration of calculator usage has been quite high for the first year of VCE use. The schools reported figures around 80% for school ownership of class sets has doubtless helped with equity issues. It could be that private ownership will not increase at a great rate if the examination embargo on 'no advantage' remains. This depends on how the teachers and students perceive the success of this policy in the 1997 papers. If the embargo is removed - perhaps progressively with Specialist Mathematics and Mathematical Methods first, there is a good base for student ownership evident in booklisting figures and a prospectively large second hand market emerging.

Teacher Survey

Board Calculator policy: In general most of teachers agree or strongly agree with the Board of Studies decision to allow graphics calculators on the VCE examinations in 1997. For each of the unit 3 & 4 subjects the pattern of response is broadly similar (see Table 4).

Table 4

Teachers support for the VBOS decision to allow graphics calculators to be used in the VCE exams 1997

	MM3&4 (%)	SM3&4 (%)	FM3&4 (%)
Strongly agree	32.3	36.5	31.5
Agree	36.3	33.2	32.8
Not sure	15.2	15.2	19.4
Disagree	9.0	7.9	9.5
Strongly Disagree	7.1	7.2	6.9

Among Further Mathematics teachers, support for the Board policy differs significantly between different types of schools ($p = .01$) as shown in Table 5.

Table 5

Teacher Support for calculator use in FM by school type (Agree or Strongly Agree)

	FM3&4 (%)
Boys Schools	60.4
Girls Schools	72.0
Coeducational Schools	63.2

This significant difference also occurs between different school sectors ($p = .01$) as shown in Table 6.

Table 6

Teacher Support for calculator use in FM for school sector (Agree or Strongly Agree)

	FM3&4 (%)
Government	61.1
Catholic	66.4
Independent non catholic	71.3

There is no significant difference between type of school or school sector in teachers' support of Board of studies decision to allow Graphics Calculators on the VCE examinations of Mathematical Methods and Specialist Mathematics. There is also no significant difference between different regions in teachers support of Board of Studies decision to allow graphics calculators in all three Mathematics subjects.

Social Equity: Despite the strong support for the VBOS policy, 73.5% of all respondents agree or strongly agree that allowing the use of graphics calculators in Year 12 examinations has added to problems of equity among students. These figures fluctuate insignificantly between types of schools, but they do vary significantly between different sectors ($p = .000$) and regions ($p = .009$).

Table 7 shows that teachers from Catholic schools are less likely to agree or strongly agree (67.8%) than their colleagues from Independent non-catholic schools (77.4%) or those from the Government schools (73.8%) that that allowing the use of graphics calculators in Year 12 examinations has added to problems of equity among students.

Table 7

Teachers attitudes to the problem of equity for each sector

	Government (%)	Catholic (%)	Independent (%)
Strongly agree	40.3	29.7	30.4
Agree	33.5	38.3	47.0
Not sure	13.4	13.7	14.3
Disagree	8.6	15.8	6.9
Strongly Disagree	4.3	2.7	1.4

Examining regional variation, Table 8 shows that teachers from Gippsland (62.1%) or Barwon South Eastern (62.8%) are less likely to agree or strongly agree than their colleagues from other regions (compare to 77.2% for Eastern Metropolitan, 75.5% for Western Metropolitan, for example).

Table 8

Teachers attitudes to the problem of equity for each location.

	(%)						
	EM	WM	BSW	CH	G	GNE	LCM
Strongly agree	38.3	37.4	29.5	38.8	29.7	51.9	22.8
Agree	38.8	38.1	33.3	30.6	32.4	25.3	52.6
Not sure	12.3	9.0	21.0	18.4	18.9	15.2	10.5
Disagree	8.7	9.0	11.4	10.2	13.5	7.6	10.5
Strongly Disagree	1.8	6.5	4.8	2.0	5.4	0.0	3.5

Future Directions: The teachers expectations of future directions show that most anticipate that the present 'no-advantage' rule will need to be replaced with a policy whereby questions can be set which exploit the power of graphics calculators more fully. Teachers were asked when they expect almost all their students to have access to graphics calculators in VCE Mathematical Methods 1&2, VCE General Mathematics, VCE Mathematical Methods 3&4, VCE Specialist Mathematics, and VCE Further Mathematics. The choice of answers was: 1997, 1998, 1999, Later, and Never. In all subjects most of respondents expected almost all students to have access to graphics calculators in 1997 or 1998, although this figures varies from subject to subject, between different types of schools within the subjects, and between different school sectors within the subjects. The overall results are given in Table 9. This issue is important for the Board in framing the next phase of graphics calculator use which removes the no-advantage rule.

Table 9

Teacher expectations on first year when almost all students will have access to graphics calculators in Year 12.

	MM3&4 (%)	SM3&4 (%)	FM3&4 (%)
1997	54.3	57.3	41.4
1998	19.7	18.7	18.3
1999	13.6	13.3	16.6
Later	9.4	7.1	15.9
Never	3.1	3.6	7.8

For all subjects, teachers' expectations that almost all students will have access to graphics calculators in 1997 or 1998 were significantly lower for teachers from Government schools than for teachers from Independent non catholic schools. Therefore, if we consider over representation of Independent non catholic schools in the survey and under representation of Government schools, we must conclude that overall expectations that almost all students will have access to graphics calculators in 1997 or 1998 are higher in the survey than it must have been in reality. The additional survey data currently being analysed has ensured a more equitable response from the government sector.

Gender Differences: For all subjects, teachers' expectations that almost all students will have access to graphics calculators in 1997 or 1998 are significantly higher for teachers from Girls' schools than for teachers from Boys' and Co-educational schools. In fact the survey of teachers reveals greater interest in the graphics calculators by Girls schools as indicated by Table 10. In this Table we list the percentages of respondents of each type for which 90% or more of students have their own graphics calculator.

Table 10

Calculator Ownership in Year 12 mathematics by Type.

	MM3&4 (%)	SM3&4 (%)	FM3&4 (%)
Boys Schools	33	42	7
Girls Schools	87	87	43
Co-educational Schools	38	43	16

Summary

The results of this survey suggest strong teacher support for the Board's policy to introduce graphics calculators despite a prevailing view that there is inevitably some social disadvantage at least in the transition period. The survey sample size is substantial for both coordinators and teachers and in all school types (except TAFE), sectors and educational regions but the results still need to be treated with some caution as the sample is to a degree self-selecting and there was a higher response from independent schools than they represent in the educational system. The graphics calculator penetration has

been substantial in VCE year levels – particularly in Mathematical Methods 3&4 and Specialist Mathematics 3&4. Predictably, as yet there has been less use of the calculator in middle or junior school levels. The survey is currently in the second phase of analysis but some interesting results are already apparent. Although the strong uptake by independent schools could be anticipated, the striking variation between how girls schools and the other types have responded in adopting graphics calculators is surprising. There has been some evidence in the past that the use of graphics calculators may favour girls (see, for example, Ruthven, 1990; Boers and Jones, 1994). This issue will need further research.

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