

POLICY TO PRACTICE: HIGH STAKES ASSESSMENT AS A CATALYST FOR CLASSROOM CHANGE

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If the use of assessment as a catalyst for systemic reform in mathematics education is to be justified, then research is required which links changed assessment practices with instructional consequences. The focus of this research is the impact on mathematics instruction at Years 7 to 10 arising from the introduction of mandated changes in assessment at Years 11 and 12 as part of the Victorian Certificate of Education (VCE). Based on the Victorian experience, this study provides a systematic investigation of this hypothesised "ripple effect". The overall study consists of three phases: a document analysis; a survey by questionnaire; and a series of selective interviews. Reporting the second phase of this study is the principal focus of this paper.

In the second phase, a questionnaire was given to fifty teachers drawn from participating schools. A key issue addressed in the questionnaire was "How is the Ripple Effect characterized in terms of teachers reported classroom practice in Years 7 to 10?" Data from the questionnaire substantiated the general conjectures and conclusions arising from the document analysis with respect to changed instructional practice replicating, at junior levels, assessment practices and work requirements associated with VCE mathematics. In addition, the questionnaire revealed different patterns of implementation between such groups as experienced teachers and those relatively new to the profession.

INTRODUCTION AND RATIONALE

Application of the "ripple effect" argument is predicated on a belief that curriculum, teaching practice, and forms of assessment in the junior and middle secondary years will replicate practices arising from the implementation of changed assessment at the senior secondary level. However, the question remains as to whether teachers of junior and middle secondary mathematics find in this expanded range of assessment practices and the instructional correlates an opportunity to increase the effectiveness of their teaching, or simply additional

administrative and organizational burdens, which increase their workload in ways that ultimately reduce rather than enhance the quality of their instruction.

In the Victorian Certificate of Education, which forms the focus of this study, students complete a multiple-choice skills test, an extended answer analytic test, a 10-hour "Challenging Problem", and a 20-hour "Investigative Project" (Victorian Curriculum and Assessment Board, 1990). Each of these components is weighted equally in its contribution to the final grade, and all are intended in their totality to model mathematical behaviour in a variety of contexts and forms. Similar innovations in assessment have been introduced in other Australian States and Territories.

The principal thesis encapsulated in the "Ripple Effect" is that the introduction of new assessment practices into existing high stakes assessment creates a climate of change which has immediate and direct consequences for policy and instruction at the level of school and classroom. This change climate functions to stimulate and support the introduction of specific practices. The emergent hypothesis is that unless a term or practice receives the explicit sanction of inclusion in high stakes assessment it is unlikely to influence school policy or classroom practice.

THIS STUDY

The research discussed in this report comprises a study into the instructional effects in Year 7 to 10 mathematics classes of changed assessment practices in the senior secondary years. It is anticipated that the findings and the methodology employed in this study will be applied in similar studies in other Australian states where similar changes in assessment practices have occurred.

Sample

Schools were selected by a process of theoretical sampling to include the following characteristics: rural and metropolitan; government and non-government schools; and social demographic characteristics (including ethnicity and language). The variation in Victorian schools with respect to these characteristics has been encompassed effectively in a sample of eleven schools. Only schools providing instruction for Years 7 through to 12 were included in the sample.

The Three-Stage Design

Stage One

Stage one of the study involved the analysis of documents relating to the mathematics curriculum, teaching practice, as well as to assessment and reporting in mathematics from eleven Victorian high schools revealed extensive adoption of the distinctive features of the

VCE *Mathematics Study Design* (VCAB, 1990), and its multi-component assessment scheme.

The document analysis charted the impact of these changes in nomenclature on the structure and practice of the mathematics curriculum in Years 7 to 10. This first stage of the study strongly confirmed the impact of changed assessment practices in Years 11 and 12 on curriculum policy and practice, and on how mathematics is taught and assessed throughout secondary school. This impact was investigated with respect to the following areas: school policy, curriculum and teaching, assessment, and reporting. This phase of the study was reported at the 1993 MERGA meeting (Clarke, Stephens & Wallbridge, 1993).

Stage Two

In stage two, changed practices which had been inferred from the document analysis, were reassessed through questionnaire. In particular, the second stage documented respondents' perceptions of the changes in administration, curriculum planning, classroom instruction, and assessment in the junior and middle secondary years, which were perceived as being linked to the curriculum and assessment practices of VCE mathematics

In stage two, teachers on the eleven selected school sites completed questionnaires related to their current teaching practices at Years 7 to 10, their involvement in the VCE, and their reports of valued teaching practices and the frequency of use of these. The essential purpose of stage two was to address the question: *To what extent has the documentary evidence of changed classroom practice been sustained and explained by teachers' accounts of their instruction?*

Stage Three

Stage 3 will investigate teachers' articulation of the value systems that distinguished the rationale underlying teachers' introduction of the new practices. It is also intended to associate teacher characteristics and beliefs with actual differences in classroom implementation, where possible.

Methodology

Sample selection

In writing to the eleven schools, the researchers asked each head of department to nominate several teachers of mathematics who would be invited to respond to the questionnaire. In addition to the head of department, other teachers invited to participate in the questionnaire phase were to include those with current or previous teaching experience of VCE mathematics and those with no current or previous teaching experience of VCE mathematics in Years 11 or 12.

This split in the sample was intended to allow the researchers to test the hypothesis that VCE derived practices might be more evident or more clearly affirmed in teaching and

574 assessment of mathematics in Years 7 to 10 among those who had personal experience of implementing related practices in Years 11 or 12 than among those who had no direct experience of teaching VCE mathematics.

Questionnaire analysis

Respondents were required to indicate the degree of importance they attached to each of several specific teaching, assessment and reporting practices. The questionnaire included practices specifically derived from VCE documents (for example, work requirements and investigative projects), but also included other practices of current interest or advocacy within the mathematics education community (for example, student mathematics journals and student self assessment). A four point scale was used: highly important, of some importance, beneficial but not essential, of little importance.

Variation in the degree of importance attached to each of these was analyzed with respect to: current VCE teaching; previous VCE teaching; nature of teaching responsibility; level of teaching experience.

Stage Two Results: The Questionnaire

The questionnaire sample

The total sample comprised fifty teachers, with the number of teachers per site ranging from 2 to 6 with a median of 5. The sample of teachers across all eleven schools included 13 teachers who responded as heads of department, the greater number being due to the fact that in one school Years 7 to 12 was divided into a junior, middle and senior secondary structure with three teachers assuming responsibility for mathematics at each level. There were 37 other respondents who were not heads of department, all of who were teaching in Years 7 to 10. It should be noted that not all heads of department were currently teaching at Years 7 to 10, and for that reason they did not complete a section of the questionnaire dealing with current teaching practice in Years 7 to 10.

The final sample included 15 teachers without previous VCE experience. The sample included comparable proportions teaching each of Years 7, 8, 9, and 10. Within the sample, it was possible to access a wide range of teaching experience (from those comparatively new to teaching to some with over 25 years of teaching experience). The sample included 34 teachers currently teaching VCE mathematics, either at Year 11 or at Year 12 level. Thirty five teachers, currently teaching in Years 7 to 10, across the eleven sites had current or recent experience in teaching VCE mathematics. Fifteen teachers currently teaching mathematics in Years 7 to 10 had no experience of teaching VCE mathematics.

For the purposes of statistical analysis, three categories of teaching experience were created: New (6 years or less), Established (7 to 15 years), and Veteran (over 15 years). In all, there were 6 teachers in the first category, 15 in the second, and 29 in the third.

For those teachers with previous experience of teaching VCE mathematics, the mean number of years of teaching VCE at Year 11 was 2.4 years, and 1.6 years at Year 12. For two teachers, previous experience went back to 1989 when VCE mathematics was first accredited in Year 11, and to 1990 for Year 12.

Problem solving activities and investigations

The proportion of classtime which teachers reported giving to small scale investigations and to problem solving activities at Years 7 to 10 is recorded in Table 1.

Table 1

Percentage of classtime given to small scale investigations in years 7 to 10

Proportion of classtime (%)	Small scale investigations Freq. (percent)	Problem solving activities Freq. (percent)
0 to < 10	7(16)	6(14)
10 to < 20	21(49)	20(45)
20 to < 30	12(28)	15(34)
30 to < 40	3(7)	3(7)

Respondents were asked to indicate the degree of importance they attached to each of the aspects described below. A four point scale was used (*highly important, of some importance, beneficial but not essential, of little importance*) to allow teachers to indicate their purposes in using problem solving activities and investigations with respect to the following aspects. The percentage responses of teachers who indicated that a particular aspect of problem solving or investigation was *highly important* is given alongside each item.

Teaching problem solving skills (69%)

Using problem solving to develop mathematical skills (54%)

Presenting problems spanning a range of content areas in mathematics (45%)

Presenting problems which require a range of problem solving techniques (67%)

Using problems specific to the topic being taught (45%)

Students posing their own problems (22%)

As preparation for these work requirements for the VCE (66%)

The application of mathematics to real world contexts (66%)

The use of different mathematical skills in combination (72%)

Students undertaking an extended mathematical activity (32%)

Students undertaking open-ended mathematical activities (30%)

Students developing investigative skills (74%)

Developing students' report writing skills (55%)

The regular completion of student mathematical journals (18%)

Providing students with substantial written comment on their problem solving attempts (36%)

The list itself reflected different ways in which problem solving and investigations *could* be valued and used by teachers. The majority of items in the list were those which had been clearly endorsed by the manner in which problem solving and investigations had been assessed in VCE mathematics, or which were directly drawn from reference to problem solving and investigations within the VCE Mathematics study, or which could be seen by teachers as a direct preparation for VCE. Two items were intentionally included in the list which, while potentially valuable for the teaching and learning of mathematics, lacked one or more forms of endorsement stated above. These were: Students posing their own problems and the regular completion of student mathematical journals.

Consistently high levels of approval (> 50%) were given by those with VCE experience and by those without VCE experience to those aspects which were strongly endorsed by VCE curriculum advice and assessment practice. The two items which were not derived from VCE practice received the smallest proportion of "highly important", 22% and 18% respectively.

Variation in the degree of importance attached to each of these was analyzed with respect to: current VCE teaching; previous VCE teaching; nature of teaching responsibility; level of teaching experience. In general, no significant difference was found in the evaluations attaching to the above items between those teachers with VCE experience and those with no direct experience of teaching VCE; between those who were heads of department and those who were not; or according to the level of teaching experience using the categories "new", "established" and "veteran" as defined above. There were some exceptions to this general pattern which are now discussed.

While considered "highly important" overall by 66% of respondents, there was a substantially stronger degree of endorsement for *the application of mathematics to real world contexts* by new and established teachers than by veteran teachers.

Significant differences did emerge on several items which were less well supported by the sample as a whole. These are *Presenting problems spanning a range of content areas in mathematics* (45%); and *Using problems specific to the topic being taught* (45%). Significant differences ($p = .0055$) were also found between level of experience and the use of problems spanning a range of content areas. The use of problems spanning a range of content areas was valued inversely with teaching experience. These strategies for integrating problem solving and the content of the mathematics program have not been explicitly advocated in the course documents for VCE Mathematics. This may account for the lower percentage of "highly important" evaluations. Established and veteran teachers were substantially more likely than new teachers to value the use of problems specific to the topic being taught.

There was a significant difference ($p = .039$) in the degree of support for *Providing 57 students with substantial written comment on their problem solving attempts*. This was one of the two items for which a statistically significant difference emerged between those with current VCE experience and those without current VCE experience. In all, 88% of those with current VCE experience considered this practice to be “of some importance” or “highly important” in contrast to only 57% of those without current VCE experience. The practice of providing comments on students' drafts of reports of problem solving projects is well established in Years 11 and 12, especially in Year 12 where for the Investigative project Common Assessment Task (CAT) students are required to submit a first draft of their report to their teacher for comment at least one week before the completion date.

There was a lower percentage of teachers who rated as “highly important” *Students undertaking extended mathematical activities* (32%) and *Students undertaking open ended mathematical activities* (30%) in Years 7 to 10, although these elements are clearly evident within VCE curriculum and assessment practice. Among teachers who considered open-ended mathematical activities to be “highly important”, teachers with current VCE experience gave a significantly ($p = .0426$) stronger degree of endorsement than those without current VCE experience.

Assessment and reporting practices

Respondents were asked to indicate which formal assessment strategies they employed, and whether their use was a consequence of VCE influence (see Table 2). The formal strategies presented were:

A. *Tests or exams* B. *Project reports*
 C. *Student problem solving reports* D. *Student self-assessment*

Table 2
Current VCE teaching and types of formal assessment strategies employed
 (percentages of column totals are given in parentheses)

	Formal strategies							
	A		B		C		D	
	empl.	infl.	empl.	infl	empl.	infl	empl.	infl
non-VCE	100	41.7	92.9	81.8	90.9	75	16.7	20
VCE	100	34.5	93.8	92.6	93.5	85.7	48.4	13.6

empl. = employed by respondent; infl. = reported to be a consequence of VCE influence

Consistently high levels of use and attribution to VCE were reported for *Project reports* and *Student problem solving* regardless of VCE experience. However, teachers with current VCE experience were more likely to employ student self assessment than those without, as Table 3 shows.

Item: Formal strategies - employment of student self-assessment.

Table 3

Current VCE teaching and employment of student self-assessment
(table entries are percents of column totals)

student self-assessment	Current VCE teaching	
	Yes (%)	No (%)
Yes	48	17
No	52	83.

(n=43, Chi square=3.641, DF=1, p=.0564)

The extent to which teachers currently teaching the VCE were more likely to employ student self-assessment, than are non-VCE teachers, is worthy of note. Current VCE teachers were more likely to identify the VCE as an influence on their use of student self-assessment (see Table 4).

Table 4

Current VCE teaching and the influence of the VCE on the use of student self-assessment
(table entries are percents of column totals)

Employment of student self-assessment	Current VCE teaching	
	Yes (%)	No (%)
Yes	41	10
No	59	90

(n=37, Chi square=3.147, DF=1, p=.0761)

This attributed influence is particularly interesting. While student self assessment is not explicitly referred to in VCE documents such as the Mathematics Study Design (VCAB, 1990), the question can be asked whether the use of student self assessment may be derived from the practice of VCE assessment of students' reports? The greater endorsement of student self assessment by current VCE teachers could well be linked to the use of specific criteria to assess students' reports for investigative projects and problem solving activities in Years 11 and 12, and the importance given by VCE teachers to having students know how to apply and interpret these criteria in regard to their own work. However, it is worthy of note that a substantial proportion of veteran teachers, regardless of VCE experience, did not employ student self assessment strategies at Years 7 to 10 (see Table 5).

Table 5

Level of teaching experience and the use of student self-assessment
(table entries are percents of column totals)

student self-assessment	Level of teaching		
	New	Established	Veteran
Yes	57	57	22
No	43	43	77

(n=43, Chi square=5.324, DF=2, p=.0698)

Taken together with the document analysis, the second phase of this study substantiated the hypothesized Ripple Effect in Years 7 to 10 of changed assessment practices at Years 11 and 12. In addition to its confirmatory value, the second phase of the study has provided a more detailed characterization of this Ripple Effect in terms of teachers reported classroom practices in Years 7 to 10.

In particular, specific terminology and practices associated with the VCE were consistently given high levels of endorsement in mathematics instruction at every level of the secondary school. Other practices, such as student self assessment and the use of student journals, while endorsed by the informed community, did not have the explicit sanction of inclusion in high stakes assessment. As a consequence, the uneven occurrence (and widely different interpretations and implementation) of these non-VCE practices in the sample schools is taken as significant confirmation of our research hypothesis. It is a specific finding of this study that teachers are reluctant to embrace new assessment and instructional practices unless these are policy driven, that is, have the endorsement of inclusion in high stakes assessment.

Teaching experience and current involvement in the VCE were both associated with significant variance in the valuing and use of certain teaching practices, particularly with respect to the perceived value of problem solving activities. However, with respect to teachers' actual experience in teaching VCE mathematics, there was a general lack of variance in the reported practices and beliefs among teachers of Years 7 to 10 mathematics. This suggests that the extent of change documented in stage one is less attributable to the actual experience of teaching VCE mathematics than it is to the creation of a climate of change associated with the introduction of the new assessment practices.

References

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