The Revised VCE Mathematics 2000: The "Ripple Effect" for Junior Secondary Mathematics

Christine Brew
La Trobe University
<c.brew@latrobe.edu.au>

Steve Tobias
La Trobe University
<s.tobias@bendigo.latrobe.edu.au>

David Leigh-Lancaster
Victorian Curriculum and Assessment Authority
<leigh-lancaster.david.d@edumail.vic.gov.au>

Research shows that significant changes at the senior levels of schooling have implications for teaching and learning approaches in the prior years of schooling. In 2000 a new structure was implemented for school based assessment in the Victorian Certificate of Education. This paper draws on data from a survey of senior mathematics teachers focusing on their responses to the impact these changes are making on the teaching and learning in junior level mathematics. Data on reported frequency of investigations, problem solving, modelling and group work is presented. While the majority of teachers reported that no changes have, or will occur, there is evidence to indicate that a trickle down effect is in motion, the implications of which are discussed. Together this data will provide a base-line for future comparative studies.

Following the 1997 review of the Victorian Certificate of Education (VCE) the school-based, but centrally set and externally reviewed Common Assessment Task (CAT) was discontinued in the revised VCE 2000. This action was taken in response to real and perceived problems associated with excessive student and teacher workloads and authentication of student work. Recently, Brew, Milne, Tobias, and Leigh-Lancaster (2000) provided evidence that these issues have been partly addressed by the new structure within many schools, but considerable variation of experience was apparent across schools. The new school-based assessment structure is more flexible in the sense that it provides teachers with an opportunity to select or devise their own assessment tasks from specified task types. the requirement for the tasks to be smaller in scope than the previous CATs, and for them to be undertaken mainly in class (see Board of Studies, 1999a), may have overlaid a level of inflexibility to the structure.

Research supports the view that changes to assessment structures impacts directly on curriculum reform. Clarke and Stephens (1996) described "the ripple effect" of the original VCE mathematics curriculum into junior levels after its full introduction in 1992. In a similar study, Barnes, Clarke, and Stephens (2000) provided further evidence of a greater emphasis on alternative teaching and learning strategies in Victoria compared with New South Wales (NSW) during the mid 1990s. In Victoria from 1990 – 1999, problem solving, modelling and investigations were a required part of the senior secondary mathematics curriculum through work requirements and the extended school based assessment tasks. According to Barnes et al. (2000), "these assessments exercise a significant leverage on teaching and forms of assessment especially when the assessment tasks are set by the examining body with extensive guidance for teachers in applying criterion-based assessment" (p. 645). While the NSW curriculum documents do emphasise comparable approaches, Barnes et al. (2000) suggest that NSW teachers receive contradictory messages about innovative reform due to the externally set years 10 and 12 examinations. They state

that in the NSW context "there is a clear implication in the various curriculum documents that assessment solely by means of examination is perfectly acceptable" (p. 632) where the underlying belief is that only through external examinations can students' work be truly authenticated.

In Victoria the implementation of the new school coursework structure using application tasks, analysis tasks and tests, has been supported by the publication of considerable resources by the former Board of Studies and the Victorian Curriculum and Assessment Authority (VCAA) to encourage teachers to continue to include a variety of contexts for application tasks and different types of analysis tasks in the new school-based assessment (Board of Studies, 1999b, 1999c, 2000a, 2000b, 2000c; Victorian Curriculum and Assessment Authority, in press). Within this current structure teachers are able to draw on ideas and approaches from previous extended investigative and problem solving CATs.

Brew et al. (2000) provided evidence that in the first year of implementation of the revised VCE, investigations, problem-solving and modelling approaches continued to be an important component of the school based assessment in many Victorian schools. In part, this arises from the nature of the outcomes for the revised VCE Mathematics courses that require students to:

> apply mathematical processes in non-routine contexts, to analyse and discuss these applications of mathematics and to select and appropriately use technology to develop mathematical ideas, produce results and carry out analysis in situations requiring problem solving, modeling or investigative techniques or approaches (Board of Studies, 1999a, pp.130-1).

Achievement of this set of outcomes for a unit is required for satisfactory completion. It also arises from the nature and purpose of the application and analysis tasks specified for the VCE coursework assessment. Brew et al. (2000) noted, however, that in the case of the most advanced mathematics study, Specialist Mathematics, there is some tendency for teachers to prefer types of analysis tasks that are perceived to be more likely to prepare students for examinations.

This paper explores the beliefs of senior mathematics teachers on the potential for flow-on effects from the revise VCE cousework assessment structure, with particular attention to a possible change in emphasis on open-ended inquiry based approaches to teaching mathematics in earlier years.

Methodology

Survey items were developed from consultation with the Victorian Curriculum and Assessment Authority (formerly the Board of Studies, Victoria), university mathematics and education faculty academics, and experienced mathematics teachers. The survey consisted of 85 questions, although only 35 questions were to be answered by all teachers. The remaining questions were divided into sections seeking teachers' perceptions across year levels and mathematics courses taught in 2000. A standard five-point Likert scale was adopted for most questions ranging from "strongly agree" to "strongly disagree." In some cases a "yes/no" response was requested.

The Sample

In July 2000, surveys were mailed to a stratified random sample of secondary schools within the three school sectors and nine school regions and to all VCE adult providers. In total, 328 VCE mathematics teachers responded from 128 schools or colleges. Sixty percent of respondents also taught Years 9 or 10 mathematics and 40% Years 7 or 8. For further details on the sample, see Brew et al. (2000).

Survey Questions

Teachers of Years 7 and 8, Years 9 and 10, and Year 11 (typically VCE units 1and 2) were each asked separately to respond to a series of questions that explored the flow-on effect of the recent changes to the VCE. The first question explored whether they believed the changes would impact on how they would assess and teach their junior classes. The second question asked teachers to indicate whether they believed the amount of time they allocated to specific tasks such as problem solving, investigative tasks and mathematical modelling had decreased as a consequence of the changes to the VCE. The third question sought the frequency of implementation of these more open-ended inquiry approaches to the learning of mathematics at the junior levels. Teachers responded to a straightforward *yes*/*no* statement.

Results

The Impact on Assessment and Teaching Practice

The impact of the revised VCE both on assessment and teaching practice was reported to be highest at the Year 11 level and decreased consistently through to the earlier year levels. The largest impact was reported to be in assessment practice (Figure 1). Nearly four in every five Year 11 (or Units 1 and 2) VCE teachers believed they had altered, or were going to alter the way they assessed their students. The majority of Years 7-10 teachers reported that no shift would occur in either their assessment or teaching practice as a consequence of the changes to the VCE.

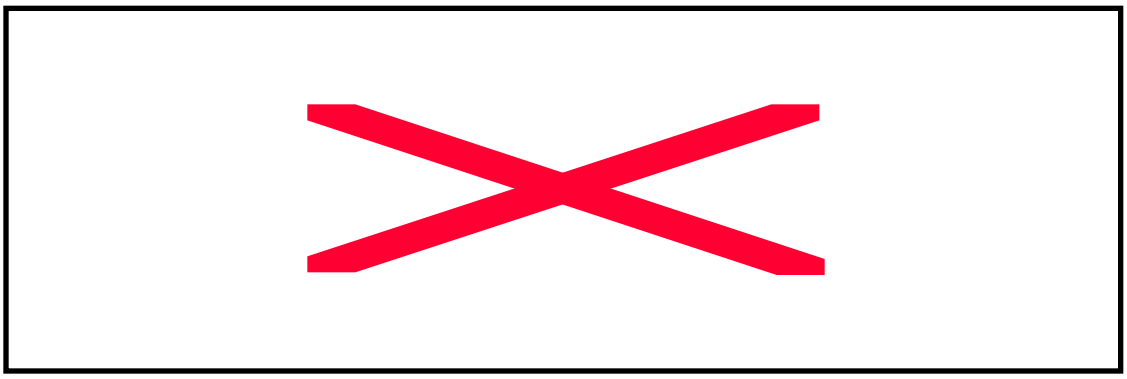

Figure 1. Teachers' views on the impact of the VCE changes to teaching and assessment in the pre-VCE year levels

A school sector difference emerged for the question on teaching practice. Only a very small percentage of teachers from the Independent school sector compared to those teaching in the State and Catholic sectors, reported that the revised VCE would impact upon their teaching practice at the Year 9 and 10 levels (Independent: 4%, State 32%: Catholic 30%). A similar pattern, though not as dramatic, was evident at the Year 7 and 8 levels. This school sector difference may be related to previous concerns about the inability of the original VCE to cater for student diversity (Rowley, Brew, Leder, Ryan, & South, 1996) and this issue is taken up in the discussion. A higher percentage of female teachers compared to male teachers reported that the revised VCE would influence how they would assess their junior levels. At Years 9 and 10, 62% of female teachers answered *yes* compared to 40% for male teachers. At Years 7 and 8, the corresponding figures were 39% and 23% respectively.

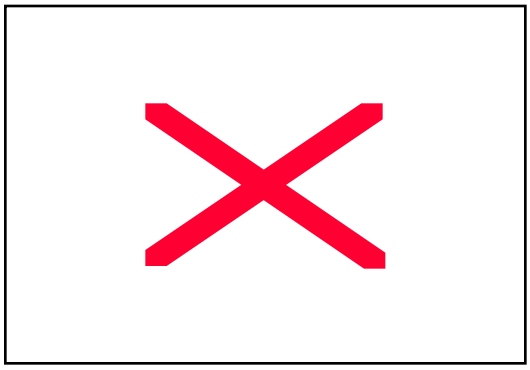

Figure 2. Time engaged in investigations has decreased due to changes in the VCE.

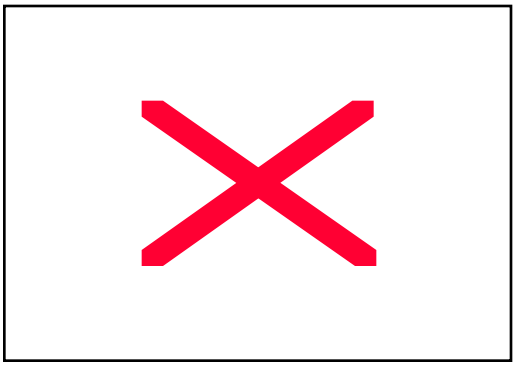

Figure 3. Time engaged in mathematical modelling has decreased due to changes in the VCE.

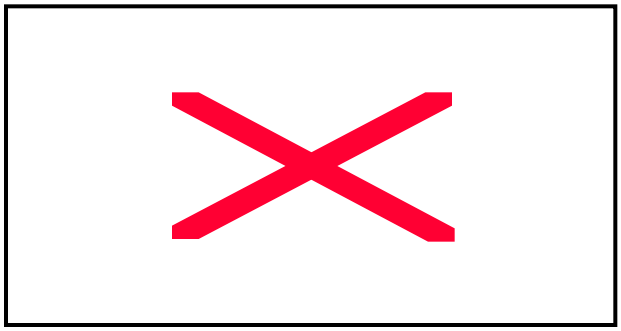

Figure 4. Time engaged in problem solving has decreased due to changes in the VCE.

Change in "Time Allocation" for Open-Ended Inquiry Strategies

VCE teachers are experiencing and responding to the changes differently with respect to *time allocation* to specific teaching and learning strategies in the junior classrooms (Figures 2-4). Approximately 20% of teachers were unsure as to whether there has been any reduction in time allocated to problem solving, investigation, and modelling strategies. The remaining 80% of teachers were divided in their experiences, though their responses

were generally consistent across the year levels. Investigations were the main type of activity where a reduction in allocated time was reported (around 40% of teachers), followed by a reported 30% reduction in mathematical modelling and 25% for problem solving activities.

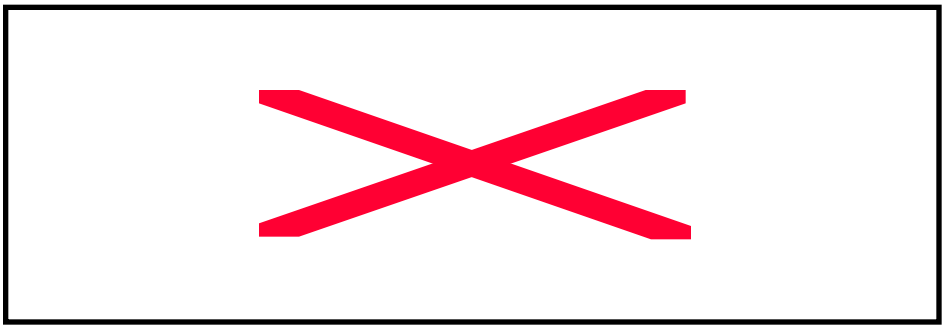

Figure 5. Frequency of mathematical investigations.

Current Frequency of Open-Ended Inquiry Strategies

The large majority of teachers report implementing an investigation activity once a term in their junior classes (Figure 5) and this may reflect the influence of the previous CAT assessment structure that encouraged larger project-based investigations. It is reasonable to anticipate that this pattern may change over the next few years as the impact of the revised VCE school assessment, with its reduction in the scope of tasks, filters its way down to the junior levels. Those teachers who are currently electing to implement investigation activities more frequently are likely to be using shorter activities now. Only a negligible percentage of teachers said they never use such activities in their classroom.

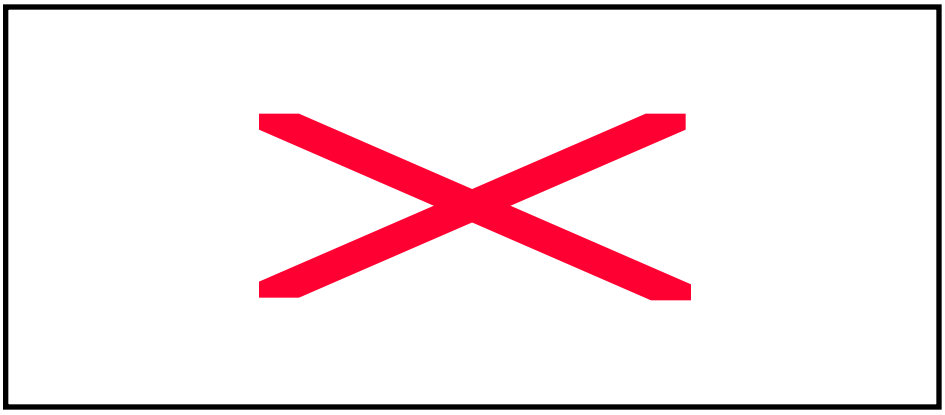

Figure 6. Frequency of problem solving activities.

Mathematical problem solving was used more frequently than investigations and has apparently been integrated into the curriculum on a regular basis by about 30% of teachers (Figure 6). Again only a negligible percentage of teachers said they never use problem solving activities in their junior classrooms. The extent to which mathematical modelling

was adopted suggests that teachers are less clear on what is involved in this type of activity as it has never been used in up to 15% of junior classrooms (Figure 7).

We also asked VCE teachers to report on the frequency of group work activities in their pre-VCE classrooms. Group activities are consistent with the original focus of the VCE on developing students' communication skills in mathematical knowledge. Current research supports the view that by allowing students to communicate their mathematical ideas and concepts through collaboration, discourse and reflection they develop a more comprehensive understanding of mathematics (Burton, 1999) and hence a greater appreciation of the exploratory aspects of mathematical activity.

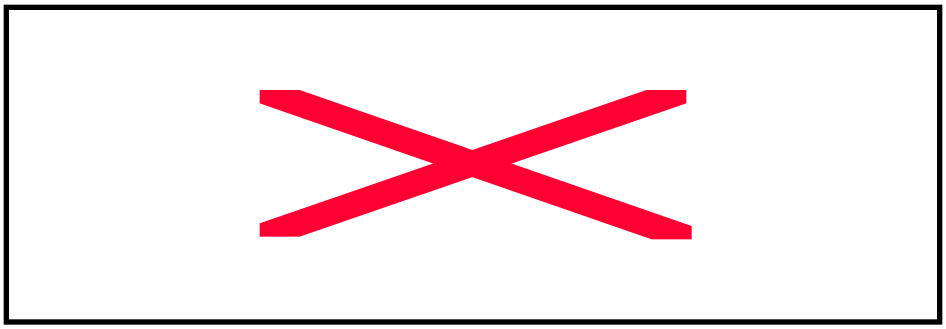

Figure 7. Frequency of mathematical modelling activities.

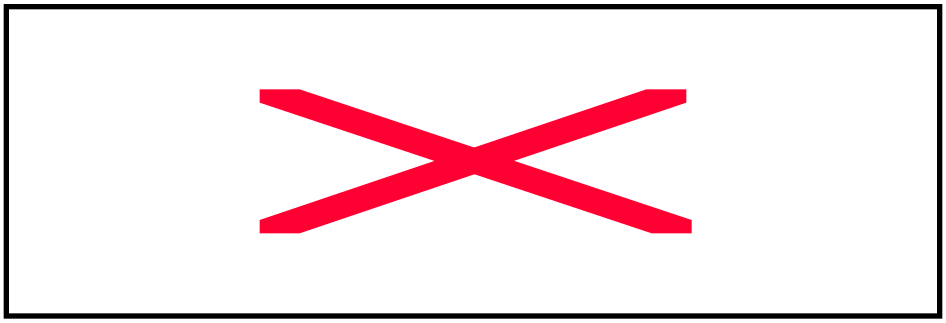

Figure 8. Frequency of group work activities.

Close to 40% of VCE teachers indicated they have never used group work at Year 11 (Figure 8). Around 30-40% of teachers use group work once a term, and around 20% of teachers instigate group work on a regular basis. Female teachers reported a higher frequency of use of group work in their Years 7-10 classrooms compared to male teachers. On average group work was adopted at the years 7 and 8 levels on a monthly basis by female teachers while male teachers averaged between once a term and once a month. At the Year 9 and 10 levels, female teachers use group work less often than at Years 7 and 8 but still more frequently than male teachers. There is an interesting parallel with this data and that reported by Brew et al. (2000) where it was reported that female teachers had been less concerned about the issue of authentication of students' work prior to the changes to the VCE (29%) compared to 49% of male teachers.

Discussion

This paper follows up a recent publication on the initial impact of implementation of the revised VCE. In that paper evidence was presented on the extent to which concerns with excessive student and teacher workloads along with the authentication of student work have been addressed by the revised VCE structure (Brew et al., 2000). In this paper we have focused on the "ripple effect" of the new structure on junior mathematics with a focus on the more open ended inquiry strategies. A considerable number (20-40%) of VCE mathematics teachers did report they would make changes in their assessment practices, and to a lesser extent in their teaching practice, as a consequence of the revised VCE in their junior mathematics classrooms. The greatest impact was reported to be a decrease in time allocation to investigations. This reduction may have gender implications as the former extended CAT did afford girls generally with a greater opportunity to excel in mathematics while boys consistently outperformed girls generally on examinations (Leder, Brew, & Rowley, 1998; Rowley, Brew, & Leder, 1997). The use of the VCE examinations to statistically standardise the school-based assessment may inadvertently introduce a gender bias in favour of boys and a statistical investigation is suggested to explore this issue.

The implications of the results presented here depends on what teachers understand by mathematical 'investigation', 'problem solving' and 'modelling'. To a certain extent these had a de facto definition in the previous VCE through the extended CATs which were variously called 'Investigative projects', 'Challenging problems' and 'Problem solving tasks'. Significant elements of what many would identify as 'mathematical modelling' could be found in each of these types of tasks. Of the three open-ended approaches to teaching and learning mathematics, problem solving appears to be the one most integrated into junior classes either weekly or fortnightly by at least 30% of teachers and used at least once a term by most. This result seems to indicate at one level a broad acceptance of problem solving as an integral component of the junior curriculum. Given that senior mathematics teachers have had ten years of experience with a mandated reform package that encouraged the use of problem-solving tasks, an average frequency of use just once a term by most teachers suggests that pre-service mathematics teacher education may not have been fully reflecting the reform efforts of the 1990s.

The use of mathematical modelling is not reported to be used at the same level as problem solving in the junior classes. An important aspect of mathematical modelling is to describe and explain events in the 'real world' or in 'theoretical structures' through mathematical abstraction. As up to 15% of teachers have never used mathematical modelling in their junior classes, resourcing, similar to that offered at the VCE level to improve the integration of broad-based approaches, may also need to be considered for the junior level.

Many teachers, though not the majority, suggested that the changes will influence the pedagogical approaches and assessment procedures they adopt in their junior classes, and this was far more evident in state and catholic schools compared to those teachers in the Independent sector. One explanation for this outcome may relate to the findings of a study undertaken in 1996 where senior mathematics teachers, from these two sectors particularly, voiced a concern about the inability of the VCE to cater for those students who wished to pursue mathematics in years 11 & 12 but were not keen to undertake a highly academic

mathematics stream. The teachers suggested that the previous structure (pre 1990) had offered them greater scope to cater for such students (Rowley, Brew, Leder, Ryan, & South, 1996). Catering for student diversity and providing greater breadth in the curriculum will be an important future research focus when exploring the influence of the revised VCE.

The context in which this study needs to be considered is that VCE teachers were perhaps more focused on the implementation of the revised VCE during 2000 to seriously consider the flow-on effect for their junior classes. As the effects of the revised VCE mathematics studies impact more strongly on curriculum decisions and structures at the junior secondary level over the next few years this study will provide useful base-line data for future research.

Acknowledgments

This study was financially supported by a La Trobe University inter-campus research incentive scheme grant. We would like to acknowledge the support of the Victorian Curriculum and Assessment Authority (formerly the Board of Studies) for collaborating in this research project. This is an independent research project and hence it is important to state that the opinions put forward in this paper do not necessarily reflect the views of the Victorian Curriculum and Assessment Authority. We would also like to thank the assistance of Lex Milne and Julianne Lynch for some of the analyses.

References

Barnes, M., Clarke, D., & Stephens, M. (2000). Assessment: The engine of systemic curricular reform? *Journal of Curriculum Studies, 32*, 623-650.

Board of Studies (1999a). *VCE Study design Mathematics*. Melbourne: Author.

Board of Studies (1999b). *Mathematics Assessment Guide Revised VCE 2000*. Melbourne: Author.

Board of Studies (1999c). *VCE mathematics application tasks. Dec. 1999 VCE Bulletin*. Melbourne: Author.

Board of Studies (2000a). *Mathematics Assessment Guide VCE 2001*. Melbourne: Author.

Board of Studies (2000b). *Revised VCE Studies 2000 Implementation Resource Kit*. Melbourne: Author.

Board of Studies (2000c). *VCE mathematics application tasks. Dec. 2000 VCE Bulletin*. Melbourne: Author.

Brew, C., Milne, L., Tobias, S., & Leigh-Lancaster, D. (2000, December). *From CATs to coursework: Teacher feedback on the VCE mathematics 2000*. Paper presented at the annual conference of the Australian Association for Educational Research, Sydney. Available: http://www.aare.edu.au/index.htm

Burton, L. (1999). The practices of mathematicians: What do they tell us about coming to know? *Educational Studies in Mathematics, 37*: 121-143.

Clarke, D., & Stephens, M. (1996). The ripple effect: the instructional impact of the systemic introduction of performance assessment in mathematics. In M. Birenbaum & F. Dochy (Eds.), *Alternatives in assessment of achievements, learning processes and prior knowledge* (pp. 63-92). Dordrecht, The Netherlands: Kluwer.

Leder, G., Brew, C., & Rowley, G. (1998). Gender differences in mathematics achievement: Here today and gone tomorrow? In G. Kaiser, W. Luna, & I. Huntley (Eds.), *International comparisons in mathematics education: The state of the art*. Falmer Press.

Rowley, G., Brew, C., & Leder, G. (1997, November-December). *The impact of self-selection on patterns of gender differences in mathematics achievement.* Paper presented at the annual conference of the Australian Association for Research in Education, Brisbane.

Rowley, G., Brew, C., Leder, G., Ryan, J., & South, A. (1996, November). *Innovation in senior secondary mathematics curriculum: The voice of the teacher.* Paper presented at the joint annual conference of the Educational Research Association (Singapore) and the Australian Association for Research in Education,. Singapore.

Victorian Curriculum and Assessment Authority. (in press). *VCE mathematics coursework assessment advice – Analysis tasks and tests.* Melbourne: Author.