SMC&PA Submission 121
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Submission by
[redacted]
to the Parliamentary Inquiry into
Assessment Methods for Senior Maths, Chemistry and Physics in Queensland.

Personal Background & Experience

I am over 50 years of age and currently work as a senior science teacher in North Queensland. Prior to becoming a teacher I worked as a scientist with my areas of expertise being biochemistry & physiology. I have been employed as a scientist both in private enterprise and by Government bodies including the CSIRO and from time to time continue to do contract research for the Federal Government and various state agencies. I completed my teaching degree in Queensland and have taught in both public schools and in the private system for 17 years in this state. My principle teaching areas are Senior Chemistry and Biology though at times I have taught Physics and Maths A. I currently hold a middle management position responsible for school curriculum and data analysis including evaluation of QCS Test performance, program & assessment writing and staff curriculum professional development. One of my focuses is the teaching of higher order thinking skills - I have assisted about a dozen schools in the creation of assessment instruments in this regard and provided advice on QCS performance data. I have also assisted schools in other states into the creation of science assessment tasks and assisted in evaluating school performance data.

I have read the proceedings of the enquiry and all of the submissions posted on the enquiry website as of early May. I have met Prof. Ridd at one public meeting. I believe that my background of having previously worked as a scientist, currently as a classroom teacher and having a comprehensive knowledge of the assessment data processing used by the QSA and that in other jurisdictions provides me with a strong foundation to present a perspective on the current system of science assessment in Queensland. I will present my opinions but wherever possible will support it with evidence in the form of data, examples and observations. I will also attempt to provide specific solutions to some of issues facing science assessment in Queensland.

I wish to tender the following submission to the Education & Innovation Committee of the Queensland Parliament undertaking the Inquiry into Assessment Methods for Senior Maths, Chemistry and Physics in Queensland.

Yours Faithfully,

[redacted]

May 16, 2013

Executive Summary

The ability of assessment processes to support valid and reliable judgments of student outcomes.

- The research evidence cited by the QSA suggesting that current assessment practices are reliable dates back to an examination of student work in 1992 (Masters & McBride, 1994) when the assessment conducted in maths and science was principally exams and NOT assignments (EEIs & ERTs);
- In 1992 Maths and Chemistry exams had a focus on mathematical and analytical problem solving with correct/incorrect answers. In both subjects the assessment showed much greater reliability than English and Modern History which focussed on written genres in their assessment;
- External exams used in other states in maths and science show very high statistical reliability;
- Starting with the Radford report in 1972, through to the ROSBA Review in the 1978 and the research of Masters and McBride in 1994 there have been recommendations that external 'reference' exams be used to improve the reliability and consistency of results in at least some key subjects in Queensland (as is the case in NSW and Victoria). Despite this recommendation being repeatedly made by previous inquiries & research initiated by successive Queensland governments it has been ignored;
- It has been explicitly stated that the current Queensland assessment system developed not as a result of solid education research but as a belief that such an approach would be superior to the alternatives (Matters, 2006);
- The 15 point scale used in Queensland introduces a gross source of error in the assessment process. The research cited by the QSA on teacher judgement accuracy (Masters & McBride, 1994) indicates that teachers can make more accurate judgements than this;
- The use of ticks on a grid representing a 15 point scale results in the allocation of overall grades through teacher 'impressions';
- A 50 point scale (or 50 marks) as used in the other states doesn't guarantee greater accuracy but provides the potential, something that cannot occur in Queensland at the present time;
- The use of broad descriptors in maths and science to assign grades rather than marks aligned to standards has been publicly stated to have been driven by adherence to a philosophy rather than education research on reliability or validity (Matters, 2006), however, the QSA reports student performance on the QCS Test with letter grades defined using complex mathematical rules contradicting its own philosophy;
- In other states external exam results are recorded as marks which are matched to the criteria standards identifying the points at which student work becomes representative of the different levels (grades) in the standards. It is just as much a standards-based approach as that used in Queensland with the advantage that a common reference exam in each subject ensures that the same standard is being applied across the state;
- The research cited by the QSA on teacher judgements clearly indicates that in the past science teachers successfully allocated marks in their assessment reflecting criteria standards to a high level of reliability (Masters & McBride, 1994). The QSA uses such an approach with the QCS Test;
- Statistical evidence from the QCS Test indicates that subject grades determined by schools <u>are not</u> accurate indicators of subject-specific maths/science skills;
- In Victoria and NSW external exam results are statistically matched to school-based assessment and if serious discrepancies are identified the exam results are used exclusively. No statistical approach is used in Queensland to detect anomalous subject results in schools;
- The panel review process for school submissions is not anonymous with the names of students, their teachers and the school being present on the assessment instruments – raising serious questions about its independence and credibility;
- District Panel Chairs adjudicate on disputed panel decisions without any hard evidence – the submissions containing all of the student work have been returned to the school by that time. Negotiations with the District Panel Chair during disputes is nothing more than a bartering process when the key evidence is unavailable to them;
- The inquiry should seriously consider the potential exposure of teachers, the QSA and the State Government to litigation as a result of inconsistent judgements delivered by District Review Panels;
- The QSA and its predecessor the QBSSSS indicated their clear intention to reduce the amount of mathematical problem solving in the current science syllabuses towards a greater literary focus. QCS Test evidence clearly suggests that this disadvantages students with a high ability in maths. Devoting more time in maths and science to literary skills and genres has come at the expense of maths-science skills;

- To satisfy panels when both reports and journals are included a typical science EEI in Queensland exceeds well over 6,000 words and those of 'A' grade students sometimes approach or exceed 10,000 words, much larger than similar forms of assessment interstate. The size of the projects, the number of them, open ended-ness, lack of resources and sometimes time constraints are a source of greater stress for Queensland students compared to those interstate;
- Most reviews initiated by the Queensland Parliament over nearly four decades of our assessment system have reported inconsistent judgements by panels, unethical assessment practices and great stress being placed on teachers and their students;
- Despite the alleged 'advantages' of the maths and science syllabi in Queensland other states have not followed our lead. A NSW inquiry expressed significant concerns about aspects of consistency and reliability of the maths syllabi in this state. The initial drafts of the senior Australian Curriculum mandated an EEI in almost every term of study. They were explicitly removed from the most recent version at the instigation of the other states in the Commonwealth;
- Is the Queensland community satisfied by senior science students developing very good generic skills through 'inquiry' based education or should students develop a broad base of skills and knowledge in the science disciplines?

Ensuring assessment processes are supported by teachers

- The QSA did not consult widely with experienced science teachers in the writing of the new syllabuses and consistently ignored their genuine concerns. The development of the new syllabuses was driven by philosophical objectives (Matters, 2006) which were then imposed upon teachers;
- The panels established to monitor the implementation of the new syllabuses and school assessment did not always reflect a broad range of views and expertise on senior assessment;
- The QSA rushed the implementation of the new syllabuses, poorly resourced them and the lack of resources was compounded by the alienation of experienced science teachers who could have made major contributions in this area;
- Two key statements issued by the QIEU about the views of their members are strongly contradicted by their own survey results: most science teachers showed dissatisfaction with the core processes of the QSA and in general maths and science teachers show much higher dissatisfaction levels than English teachers;
- The attitudes of the teachers unions are driven by a desire to reduce the accountability of teachers, philosophical opposition to exams and ties within the education 'establishment'. Their views are at odds with a significant number of maths-science teachers;
- The system has become polarised between teachers who believe in the teaching of generic skills under the constructivist philosophy and those who value subject-specific knowledge and skills. A significant number of highly experienced science teachers and panellists have withdrawn their services in response to the new syllabuses and what they see to be as unsuitable assessment practices. The loss has exacerbated the science teacher shortage in Queensland.

Student participation levels

- The percentages of students enrolled in Biology, Chemistry and Physics are lower than in NSW and Victoria;
- In some cases EEIs have become so onerous that students have a negative view of them;
- EEIs have a tendency to focus on one specific area and can actually lower student interest when the topic does not interest them. This has been recognised by Victorian educators who changed their syllabuses so as to allow smaller more diverse practical activities (SEIs);
- Enrolments in the senior sciences in schools having programs where EEIs and ERTs are the basis of the teaching and assessment may be stable or even increasing. In schools attempting to provide a broader base of science knowledge and skills enrolments can decline due to the stress placed upon students by having to complete large assignments and learn a lot more additional material;
- In general students don't have a positive view about ERTs except as a means for increasing grades;

- Many Biology students absolutely despise evaluating sources, meanings, issues, etc. Some students state that they won't enrol in Biology as they don't want to do the 'stupid SOSE assignments'. In some schools mainstream science and medicine students are turning away from Biology;
- The time devoted to ERTs in science is robbing Queensland students of the opportunity to undertake practical activities at the cutting edge of science such DNA technology.

Recommendations

It is my recommendation that the State Government of Queensland takes the necessary action to ensure that the following reforms are introduced into maths and science education and assessment in this state.

It is proposed that in the short term (to be implemented for the 2014 school year) that the following action takes place:

1. Immediately allow a minimum of a 50 point scale or marks (equivalent to VHA10 to LA1) in allocating grades in all senior assessment in maths and the sciences as is generally done in NSW and Victoria;
2. Immediately modify the Panel Review System to introduce anonymity in the review of school submissions;
3. Ensure that District Panel Chairs have access to school submissions until student placements have been agreed to;
4. Allow schools at their discretion to remove science ERTs from their assessment processes and use portfolios of a series of short experiments (SEIs) to replace large EEIs;
5. Take necessary action to reform the QSA. Those responsible for overseeing the creation of the current maths and science syllabi should have no further input into curriculum development. Other sections of the QSA, such as those involved in data processing & analysis which are highly regarded interstate, should be retained;
6. Create an interim board consisting of discipline-experienced science and maths teachers, representatives from the science and maths faculties of universities, and industry and community representatives to oversee reform of maths and science education in Queensland to align it with the standards and procedures used in NSW and Victoria;
7. Trial external reference exams at the end of Year 12 in 2014 in Maths A, B and C and in Chemistry, Physics and Biology based on those used in recent years in NSW and Victoria. They should be focussed solely on maths-science skills and genres, not those of the humanities and employ questions that have definitive answers and not 'open ended' responses. The exams should be designed with a significant input from those people that develop them in the other states, combined with the expertise of the QCS Test writers, employing previously used interstate questions. They should not be used to alter student grades or OPs in 2014 but used purely to:
   (a) compare the responses of Queensland students to their interstate counterparts to make comparison of their relative ability;
   (b) identify knowledge and skill weaknesses in Queensland students;
   (c) compare the performance of the students on the external reference exams to the grades awarded by schools and panels to assess the consistency and reliability of assessment practices;
   (d) familiarise teachers of the likely standards and structure of potential future reference exams.
8. Clarify if and when the Australian Curriculum for senior maths and the sciences will be introduced – this may alter if there is a change in the Federal Government;
9. Take action to ensure that the senior Australian Curriculum focuses on discipline-specific knowledge and skills in maths and science and reduce the focus on social issues and literacy genres.

It is proposed that in the medium term (to be implemented ideally from 2015) that the following action takes place:

1. Prepare new senior maths and science syllabuses for use in Queensland either aligned to the Australian Curriculum or if that is delayed stand-alone syllabuses for Queensland. They should be comparable to those used interstate with a high proportion of material mandated to be taught with some electives;

2. The new syllabuses should employ detailed, descriptive standards similar to or identical with those used in Victoria;
3. Implement the new curriculum in science and maths using external reference exams to improve the consistence and reliability of student subject grades;
4. The marks in the external exams should be 'pegged' by an external group of examiners to determine grades aligned to the standards as is done in NSW;
5. The results from the external exams should comprise 40-50% of the final grade in the subjects. More importantly they MUST be used to scale school maths and science results and detect anomalous school groups as is done in NSW and Victoria. Where serious discrepancies are found between school and exam results the latter should be adopted as the final grade for students;
6. Reform the District Panel Review Process to align it with that in Victoria – the panels act as advisors that ensure assessment processes in schools reflect the state standards but lack the power to alter individual student grades. This places the responsibility for valid assessment onto the school but also provides them with the freedom to create a broader range of teaching and assessment activities. Review of school programs and assessment instruments should be conducted every three years for individual schools;
7. External reference exams may not be applicable to subjects other than maths and science which are more subjective (e.g., English, the Arts). Unless they are requested by other subject disciplines it is recommended that District Review Panels continue to verify student subject placements in the arts and humanities and the QCS test be used to scale individual school subject groups as is currently done;
8. The QCS Test be retained and used to scale the performance of schools across the state as is done in Victoria with their GAT Test and tertiary entrance scores reported as ATARS bringing Queensland into line with the rest of Australia;
9. That the junior science and maths programs in Queensland be reformed in terms of assessment so as to support the proposed changes in the senior programs;
10. That the Queensland Government offer financial incentives to graduates from maths and science faculties at universities to enter the teaching profession via a Diploma of Education. The incentive should be in the form of scholarships subsidising the completion of their education qualification and partial subsidy of their HECS debt for each year they teach. Similarly incentives should be offered to people in the workforce with science and maths degrees to enter the teaching profession. These initiatives are recommended in order to help offset the loss of teacher expertise in maths and science in Queensland in recent years and to make the state more competitive in recruiting high quality teacher candidates.

Introduction

Background of the Queensland System

In order to address the terms of reference for the inquiry some historical background needs to be provided. I have read most of the reviews, seminal and supporting documents covering the evolution of the current Queensland system. In 1972 as a result of the Radford Report Queensland moved away from senior assessment and tertiary entrance based on final external exams to the use of school-based assessment. Since that time **there have been quite a number of reviews of the system** (e.g., Campbell in 1976, Fairbairn in 1976, the Ahern Report (1980), Scott in 1978 (ROSBA report), Viviani in 1990, Wiltshire in 1994, etc.). **The reviews have usually been initiated due to public or teacher concerns about the assessment system**. In particular these reviews usually report that teachers from time to time have expressed concerns about the panel system of moderation, specifically inconsistent or erratic decisions of panels and panellists negatively impacting on teaching practices, the development of good assessment instruments and creating unnecessary work when instruments have had to be reviewed.

In 1990 the Goss Government initiated a review which resulted in the Viviani Report recommending many significant changes resulting in the introduction of the current incarnation of the system in 1992. In 1995 new Senior Science Syllabuses were introduced and while concerns were still expressed by teachers about the consistency and fairness of the system, in particular panel deliberations, the new programs enjoyed broad teacher support. Beginning with Biology in 2004, followed by Chemistry and Physics in 2007 new science syllabuses were introduced. From their inception they have been the subject of strident criticism by some teachers, academics and parents and the result has been the current parliamentary enquiry.

In order to address the terms of reference and make comparisons with other systems a fair bit of background needs to be provided on the Queensland system. The inquiry has been presented with a description on how assessment is undertaken in Queensland: (http://www.parliament.qld.gov.au/documents/committees/EIC/2013/QldAssessment/bp-20Mar2013.pdf). It is rather incomplete as it fails to explain the fundamental rationale behind the system or how the grades obtained are turned into university entrance scores which in Queensland are called OP's (overall positions). The complex processes involved are provided by the QSA in one of their publications (https://www.qsa.qld.edu.au/downloads/senior/te_op_fp_procedures.pdf).

Summarising the key elements of the Queensland System:

1. The foundation of the system are 49 Common Curriculum Elements (CCEs), a set of generic skills which all students should have good skills at by the end of Year 10;
2. The CCEs are paced into five groups (baskets) reflecting similar cognitive processes;
3. Not all the CCEs are taught by each subject. The senior subjects carry the responsibility of developing the skills of students only in the CCEs of allocated to them (**Appendix 1)**. The CCEs are embedded in the teaching and assessment of each subject;
4. Subject assessment is 100% school-based with classroom teachers designing school work programs and assessment tasks governed by state-wide syllabuses developed by the QSA;
5. Teachers award students letter grades using a 15 point scale from A+ to E- on each piece of assessment;
6. Grades are determined using teacher judgement referenced against a set of criteria (standards);
7. Late in Year 12 the students are ranked (rank order) in each subject and placed on a 50 point scale being Levels of Achievement from VHA10 to VLA1;
8. Nine samples of student folios encompassing the full range of student abilities are forwarded to a local District Review Panel (two teachers) for peer review. They have the power to change the placement of students;
9. Once assessment & placements are finalised students are awarded by their teachers SAIs in each subject from a top score of 400 to a bottom score of 200. Student grades are not used to determine the SAIs but large differences in ability are reflected in large gaps in the scores between students. The gaps are determined by 'teacher judgement';
10. The QSA measures the gaps between students in all subjects in a school. For each school this is combined to produce a Within School Measure (WSM) for every student in all of their subjects which is an indicator of relative ability compared to their peers;

11. The WSM for each student is matched to their QCS Test score. For each subject the group's average and spread on the QCS Test is calculated to create Scaling Parameters indicating a mean and spread of ability for the group;
12. In each subject student's SAIs are have their mean and spread adjusted using the scaling parameters;
13. Students in 'small subjects' (<10 students) do not have their results scaled by the QCS Test results of their school. A measure of average QCS Test performance (the small subject score) based on the average QCS Test performances of all students undertaking the subject at the same level of achievement is automatically applied;
14. The scaled SAIs from their best five subjects are combined to produce an average for each student who are then ranked in the school to create an unscaled OAI (Overall Achievement Indicator);
15. The rank order in the school is then rescaled using the whole school average and spread on the QCS Test compared to the rest of the state;
16. The final OAI for each student is them compared to designated cut-offs on a 25 band scale to allocate an Overall Position in the state (OP) from 1 to 25;
17. The QSA provides data to each school on the subject scaling parameters and the performance of each subject on the QCS Test as a whole and in each of the five CCE baskets.

It may be useful to compare the Queensland system with that of other nearby jurisdictions. The Australian Capital Territory uses an almost identical system to that of Queensland, i.e., 100% school-based assessment, peer review by panels, and scaling of subject results with a general ability test (the ACT Scaling Test).

In Victoria about 40% of the science assessment is school-based. Like Queensland, assessment is criterion-based but marks are awarded typically amounting to 50, i.e., teachers use a 50 point scale. School programs undergo regular external audits which are advisory. There is no equivalent of a Queensland panel that can directly change student grades. The remainder of the assessment comes from an external exam with serves two purposes. Firstly, it contributes 60% of the overall grade. Secondly, it is used to scale the school's performance in the subject, i.e., if the students perform better on average than the students in the rest of the state in the subject their final results go up and the opposite is true. This then determines the final grades awarded to students out of 50 with 30 being the average for the state. If there is a significant difference between the school's results in a subject and those obtained in the exam the latter becomes the final mark. To determine university entrance scores student performances in all subjects across the state are compared to see which subjects contain the most capable students (similar to the WSM in Queensland but the measure is for all students in the state doing the subject compared to everybody in every subject in the state) and this combined with results from the General Achievement Test (GAT) to scale subjects (this is very similar to the QCS Test). After scaling student results are reported as an ATAR (Australian Tertiary Admissions Rank) which reports the percentile each student is in relative to all other students, i.e., an ATAR of 95 places a student in the top 5%, an ATAR of 99 in the top 1%.

In New South Wales school-based assessment contributes 50% of student results in science. Criterion-based assessment is also used and marks are also awarded – recently increased from 50 to 100 marks – compared to a set of criteria standards. In the external exams a 100 marks scale is aligned to criteria standards in performance bands by an expert panel in each subject area. Like Victoria results in subjects are reported out of 50 with an average of 30. Schools design their own programs and assessment instruments the usual protocol being that they have their own internal review process and liaise with other schools. The balance of the results come from an external exam which is used to scale student results in a similar manner to that used in Victoria. A more complicated process is used than in Victoria to determine an overall tertiary entrance score utilising scaling of subjects through the results obtained in English. This is also reported as an ATAR.

There has been some discussion on the comparability of OPs with ATARs. Both are determined in a similar fashion relying on a numerical measurement of where each student is placed relative to their peers in the state. ATARs provide a clear indication of relative position, i.e., 99 = above 99% of all other students. The QSA provides ATARs to tertiary institutions on request and could easily assign ATARs to all Queensland students.

The ability of assessment processes to support valid and reliable judgments of student outcomes.

From the perspective of the community at large this term of reference is the one at the forefront of the current debate. The inquiry is not investigating the fairness of the OP system used in Queensland but it is valid to consider the potential impacts on the reliability, validity, consistency and equity of the grades in maths and science and tertiary entrance scores delivered to students and so where relevant is discussed. To consider this in detail I have broken this term down into six fundamental questions that need to be considered:

1. Does the education research support the QSA contention that the assessment and processes used by the current maths and science syllabuses produce consistent judgements on student grades across the state, i.e., is it reliable?
2. Do the processes used in designing and grading assessment instruments in Queensland give consistent, accurate results in student's ability in maths and science?
3. Does the use of marks and/or criteria provide reliable indicators of student ability?
4. Does the current system ensure the reliability & integrity of maths and science school-based assessment?
5. Are the forms of assessment used in Queensland similar to those in other states in terms of skills, scope and student workloads? Are the skills being assessed comparable to those in other states?
6. Are the assessment processes as reliable and consistent as those used in other states?

Research on the Consistency & Reliability of the of Science Assessment in Queensland

The QSA cites a range of publications to support its contention that current assessment processes in maths and science provide consistent results, examples being Matters, Pitman and Obrien in 1998 (*Validity and reliability in educational assessment and testing: A matter of judgement*), Pitman, O'Brien & McCollow in 1999 (*High quality assessment: We are what we believe and do*), the review prepared by Matters in 2006 prior to the introduction of the new syllabuses (*Assessment Approaches in Queensland Senior Science Syllabuses*) and Maxwell & Cumming in 2011 (*Managing without public examinations: Successful and sustained curriculum and Assessment reform in Queensland*), etc. All of these authors have concluded that the Queensland assessment system provides a high degree of reliability. It should be noted that only Matters' 2006 report focussed on maths and science education and that the work, rather than presenting original research, was largely a review of the proposed assessment practices for the new syllabuses.

Measures of reliability used in data analysis and research need to be explained in simple terms for those readers without a strong maths or statistics background. The most widely used measure is the correlation coefficient or r^2. In simple terms a correlation coefficient of 1.0 represents a perfect match between pairs of measurements – they form a totally reliable relationship – while a value of 0 implies no relationship at all. Keeping my explanation simple a correlation above 0.8 would suggest a fair degree of relatedness while one above 0.9 would suggest high relatedness or consistency. Another measure used in research on human judgement is the inter-relater reliability index. It is calculated in a somewhat different manner than the correlation coefficient but also indicates the degree of consistency between results. Readers with a strong base in statistics may take exception with my simplistic descriptions but should keep in mind I am writing for the general public.

The evidence cited on the reliability and consistency of assessment in Queensland by the QSA, Matters *et al*., Pitman *et al*., Matters, etc. can be traced back to a study conducted as a consequence of the Viviani Review of Assessment processes in Queensland. Prof. Viviani concluded that there was a lack of evidence on the reliability of school-based assessment and recommended that research be undertake. In response Masters and McBryde in 1994 published the results of their study titled *An Investigation of the Comparability of Teachers' Assessments of Student Folios* (http://www.qsa.qld.edu.au/downloads/publications/research_tepa_masters_mcbryde_94.pdf). From this study Matters *et al*., concluded that for the Queensland Assessment System '*the inter-rater reliability index was 0.94 … these estimates represent 'an exceptionally high level of agreement ... between [assessments]. These levels of agreement are significantly higher than the levels ... typically reported for independent assessments of student work - including independent assessments of [external] examination performances*' and

this conclusion has been repeatedly presented in papers on education research as evidence of the soundness of the Queensland system.

The study of Masters and McBride encompassed the examination of 546 folios of student work forming school-based assessment sourced from 62 schools, i.e., assessment instruments, in four subjects namely English, Modern History, Maths B and Chemistry in 1992. For each subject between 125 and 150 folios were examined. The folios were not selected at random but were those submitted to district review panels as school exemplars. The authors measured the consistency of grades assigned by pairs of experienced markers drawn from panels provided with copies of the marking criteria used by schools and without. The grades were awarded on a 50-pont scale (60 to 10), i.e., equivalent to the current VHA10 to LA1 scale. The authors also reviewed published results on the reliability of markers of assessments in other states of Australia and suggested acceptable levels of error in states using external exams (mostly English) at the time.

Masters and McBride did conclude that there was a high degree of consistency in the grades awarded between pairs of markers on the work of Queensland students which sometimes matched or exceeded that reported interstate. They also provided a number of qualifications about the validity of their comparisons with interstate performance which should be noted these being that **teacher's comments and marks awarded to specific questions were present on the instruments which was not the case in the interstate studies and that in the later 'holistic' grading was sometimes used:**

In most studies, each assessment of a student's work is made without knowledge of any other assessor's judgement of that work. Most studies of this kind are based on holistic judgements of written essays, folios of artwork, oral presentations, and performances of various types (e.g., dance, music performance, gymnastics). In the present study, assessments were made independently of each other, but each assessor had access to teachers' prior assessments of folios. Many folios consisted of collections of marked tests and assignments. Numerical scores were available to assessors, as were written comments made by teachers, although care was taken to remove any indication of teachers' allocated Levels of Achievement. ***In view of the marks and comments available to assessors of each folio, it is probably not surprising that the levels of inter-marker agreement were higher than usual****.*

A key point is that the interstate research was based on English and the performing arts whereas the Queensland research included two analytical subjects, Mathematics and Chemistry. At that time (1992) most of the assessment in maths and science consisted of school-based exams typically contributing about 80% to students final Level of Achievement: *In many cases, particularly* ***in some subjects, assessment folios were comprised mainly of tests*** *that had been marked in the school.*

Masters and McBride compared the reliability of markers between the four subjects investigated in their study. Two of their graphs comparing the results for Chemistry and English are presented below. It is evident that the Chemistry markers were far more consistent than those in English. The results for Mathematics 1 were similar to those for Chemistry and those for Modern History were similar to English:

Figure 11. First and second ratings of folios plotted against each other (Chemistry)

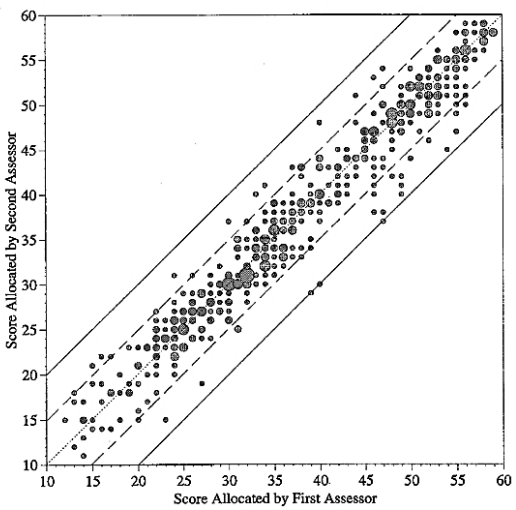
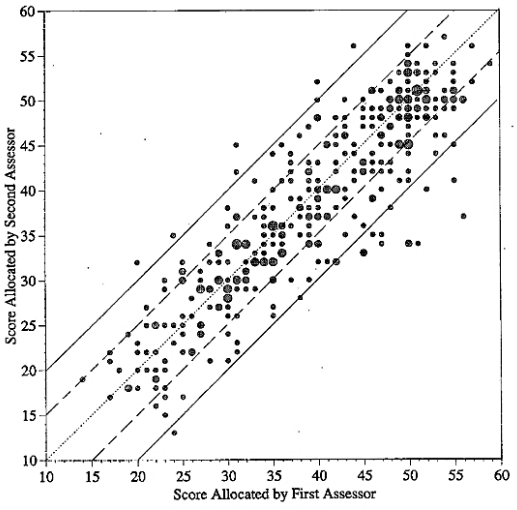


Figure 12. First and second ratings of folios plotted against each other (English)



The table below presented their overall findings on the reliability of markers between the four subjects. It demonstrates that Chemistry and Mathematics markers had higher reliability with percentages of grades within 5 rungs of 95% and 94% respectively compared to English and Modern History at 82 and 88%:

Table 4. Inter-marker agreement by subject

Subject	N	r	% within +/- 5 rungs	% within +/- 10 rungs
Chemistry	417	.96	95	100
English	372	.89	82	95
Mathematics I	468	.97	94	99
Modern History	381	.92	88	99
all	1638	.94	90	98

Masters and McBride concluded that: *there are differences in inter-rater reliability from subject to subject. The highest levels of agreement between assessors occur in Mathematics and Chemistry; lower levels of agreement occur in History and English.* ***This finding is broadly consistent with observations made in other studies, and may be explained in terms of the greater use of analytic rather than holistic scoring of assessment tasks in Mathematics and Chemistry****.*

Masters and McBride also compared the overall Levels of Achievement awarded by schools and those of the markers in the study noting at times that differences were apparent. The authors clearly indicated that to some degree the results of their study on the reliability of school-based assessment may have been compromised by the work already having been marked by teachers. In 1998 the NSW Board of Studies commissioned a review of assessment processes in that state (*A Review of the HSC Assessment Program New South Wales*. Board of Studies, 1998). In that study results on school-based assessment were compared to those achieved on the external state-wide exams. It was found that at times there were significant differences between exam and school results, that there was a tendency for school results to be higher than those achieved on exams and that sometimes significant differences existed in the grades provided between schools for comparable student work. This suggests that moderation process in Queensland schools were superior to those in NSW but also highlights the lack of comparison to an external assessment tool as a weakness in the Queensland study.

The NSW Board of Studies on its website provides some historical data on the consistency of their external exams used around the time of the Masters and McBride study and reporting correlation coefficients (r^2) values as a measure of their moderation processes. For example in 1996 the correlation coefficients for Biology, Chemistry, English, Mathematics, Modern History and Physics were respectively 0.92, 0.93, 0.85, 0.93, 0.89 and 0.92 (http://www.boardofstudies.nsw.edu.au/bos_stats/docs_hsc96stats/hsc_stats96.pdf) and similar results occurred in other years for which data is available. These results match fairly well the inter-marker agreement in Queensland in 1992 of 0.96, 0.89, 0.97 and 0.92 for Chemistry, English, Mathematics and Modern History school-based assessment (with the proviso that they may have been inflated by the presence of teachers marks on the samples) showing that in general the maths/science subjects exhibited higher marker reliability than the two humanities on external exams.

At the end of their paper Masters and McBride discussed the validity of assessment processes and recommended that 'reference tests' (= an external independent exam) be used in three possible ways:

A reference test is a subject-specific test which examines core knowledge and skills in a subject area. Sadler (1993, 23) defines 'core' as the combined body of subject matter and specific skills which are characteristic of and in some cases peculiar to a subject. ***The use of reference tests was supported in both the Radford and ROSBA reviews****. Reference tests could be developed in a small number of subjects (e.g., English and mathematics) and used as a component of Year 12 assessment on an ongoing basis. Alternatively, reference tests of this kind might be developed merely for the purposes of research into levels of comparability of school-based assessments.*

If a reference test is to be used on an ongoing basis, there are several ways in which such a test might be used. On one hand, a test in, say English, could be used as point of reference for the automatic rescaling of school assessments in English in an attempt to bring them to a common scale and to make them comparable. This use of a reference test is similar to the use that some Australian states make of an external subject examination as a point of reference for rescaling school assessments in a subject. An alternative use of a reference test (Hill, Brown & Masters, 1993) is as a frame of reference not for the automatic scaling of teachers' assessments, but for identifying and following up schools whose school-based assessments appear unexpectedly high or unexpectedly low in relation to results on the test.

I have read both the Radford Report (1970) and the ROSBA review (Scott 1978). The former was the seminal document that steered the Queensland education system in the direction of school-based assessment and was therefore revolutionary. It acknowledged that a final external exam typically provided reliable data on student ability but highlighted the stress they caused to students. It recommended school-based assessment expecting it to potentially offer the reliability of the previous one-off external exam in each subject. It did, however, in Recommendations 15 and 16 and Recommendations 34 and 35 raise the possibility of the limited use of model or reference exams to improve reliability and assist moderation process development.

The ROSBA review chaired by Scott was in effect an assessment of the effectiveness of the Radford reforms and highlighted the problems encountered, in particular the lack of public and tertiary institution confidence in the assessment procedures. Also identified was evidence that the new assessment regime involved frequent assessment of students which was increasing their stress, as well as that of the teachers, and the panel review process was regarded as inconsistent (e.g. *'superficial, subjective judgments', 'teachers being overwhelmed', 'reduction in time available for teaching', 'decline in teacher-student relationships'*). Scott, while strongly advocating the continuation of school-based assessment, made a very specific recommendation for the use of some form of external reference exam to improve the reliability and maintenance of subject standards: '*To assist in the maintenance of state-wide achievement standards and the maintenance of such standards across time, the spirit of para. 6.15 of the Radford Report should be endorsed.* ***A policy should be adopted by using Competency Reference Tests in Board subjects****. The sole objective of these tests should be to assist schools in determining standards of performance relative to each level of competency in a subject. Such tests will be an invaluable aid to teachers in determining competency standards in smaller schools'.*

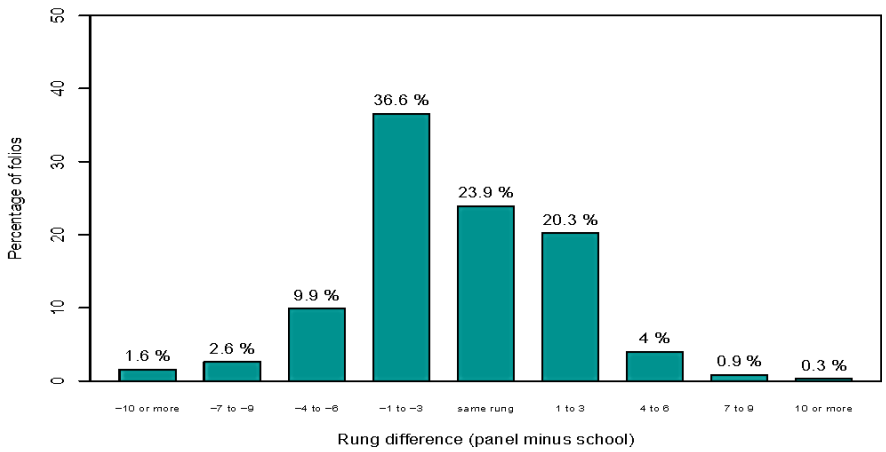
The following statements are sourced from a review of the Queensland assessment system between 1983 and 1990 (http://education.qld.gov.au/library/docs/edhistory/assess/assess-1983.pdf) and are comments made by teachers in the 1980s reproduced in the review:

- *Over-assessment still existed*
- *The quality and quantity of in-service education and support was inadequate, with the result that teachers suffered the same trauma as that experienced when the Radford Scheme was first implemented.*
- *Because of the evolutionary nature of implementation, the trail blazing schools experienced uncertainty, criticism, confusion and pointless hard work*
- *One commentator referred to the conflicting advice coming from the State Review Panels, co-ordinators, consultants, senior officials of the Department of Education and the Board as a veritable Tower of Babel while another described the exercises involved as reliving the Charge of the Light Brigade*
- *Some were strongly worried about 'too much variation' or 'lack of comparability' between schools or subjects in assessment practices or standards*
- *Achievement categories were too broad*
- *Numerical results in assessment were more manageable in large schools and preferred by students over verbal ratings*
- *The assessment system was over complex*
- *Manipulation of assessment ratings occurred in schools*

Does this sound familiar? All these issues lead to the Viviani Review in 1992 and the new science syllabuses introduced in 1995. Now after 40 years of totally school-based assessment moderated by panels the very same problems are being iterated by another generation of teachers with the new science syllabuses – its 'back to the future' all over again. Masters and McBride (1994) suggested using external reference exams to scale subjects and even the Radford Reforms and ROSBA review suggested at least a limited use of them – but these recommendations were never even trialled.

Has any recent research taken place on the reliability of assessment practices in Queensland since the introduction of the new maths and science syllabuses? One possible line of evidence to consider are the results from the random sampling processes undertaken be the QSA each year but subject specific data is very limited. In 2009 some schools completed Year 12 assessment under the new syllabuses with the three maths subjects undergoing random sampling. 2010 was the first year in which all schools provided Year 12 assessment folios to panels under the new syllabuses but only Chemistry and Maths C were included in the random samples. In 2011 Chemistry, Maths A, Maths B, Maths C and Physics were all included in random sampling. The results for random sampling (all subjects and not just maths/science) in 2011 are produced below from the QSA random sampling report:

Figure 2: Distribution of rung differences for folios



Masters and McBride reported that for the four subjects **in 1992 90% of folios had a difference of 5 rungs or less whereas in 2011 from random sampling 80.8% of folios had a difference of 6 rungs or less – a much lower level of accuracy and is typical of most years**. Another indicator that accuracy had been reduced compared to 1992 was that the average disagreement increased between the years 2007 and 2011. Apart from the very sparse data from random sampling the only other source are the anecdotes of teachers of which a significant number are of the opinion that the reliability of maths and science assessment has declined since the introduction of the new syllabuses – which has led to this inquiry. **Since the study of Masters and McBride in 1994 there has been absolutely no equivalent research on the reliability of senior assessment processes in Queensland and in particular the new science and maths syllabuses introduced progressively from 2004 onwards which are the focus of the current inquiry**.

From this review of the research the following conclusions can be reached:

1. **The research evidence suggesting that current assessment practices are reliable (show consistency) dates back to primary research conducted of student assessment in 1992;**
2. **The type of assessment conducted in 1992 in maths and science was principally exams and NOT assignments (EEIs & ERTs) with a focus on mathematical and analytical problem solving;**
3. **Criteria were used to develop marks which were used to grade instruments and award levels of achievement;**
4. **Maths and Chemistry, which focussed on school-based exams and used 'analytical' grading, showed much greater reliability than English and Modern History which focussed more on written assessment pieces and used 'holistic' grading;**
5. **External exams used in other jurisdictions in maths and science show high reliability;**
6. **Random sampling data in most years indicate that the levels of consistency in Queensland are much lower than the results reported by the research comparing assessment in 1992;**
7. **Starting with the Radford report in 1972, through to the ROSBA Review in the 1978 and the research of Masters and McBride in 1994 there have been recommendations that external 'reference' exams be used to improve the reliability and consistency of school-based assessment in at least some key subject (as has been the case in NSW and Victoria in recent years).**

Current Assessment Processes as Accurate Indicators of Student's Ability in Maths and Science

(a) Prof. Ridd has presented evidence suggesting that tertiary students with sound levels of achievement in Maths B are failing standardised Year 10 level maths tests. It has been suggested that the cause may be that students with OPs as low as 16 have been accepted into tertiary engineering, physics and maths courses. It must be kept in mind that for these courses a sound level of achievement in Maths B is a prerequisite. It is an entirely reasonable expectation that a student that has sound skills in Year 12 Maths B should have at least sound skills at a Year 10 level in maths.

I regularly encounter statistical evidence supporting the contention that subject grades are not accurate indicators of subject-specific maths/science skills. The QCS test is explicitly stated to be a Year 10 standard skills test and it contains maths question. Each year schools are provided with QCS Test data on how students performed on various skills including the Phi (ϕ) basket which contains exclusively basic maths skills (though other 'baskets' also contain skills related to maths). Presented below is QCS data for Maths B for three consecutive years from one school sourced directly from the QSA. The 'Av LOA' represents the average 'grade' in the subject while the 'Av Score ϕ' represents the average score on maths questions in that basket (the later have been rounded to the nearest whole number):

Av LOA State	3.3	3.3	3.4
Av LOA School	3.3	3.4	3.6
Av Score ϕ State	15	20	16
Av Score ϕ School	12	19	15

In **all three years the results for maths questions in the QCS test were lower than the state average yet in all three years the average grades in Maths B were at or above the state mean** and this trend exists over a much longer term at this school. Critics would correctly state that a detailed analysis would be required of the distribution of results, etc., to suggest that there is a significant difference in performance between that expected from the grades achieved and QCS performance. I have done this on the available data and it does suggest there is a consistent underperformance over an extended period of time (I will not present it here so as not to identify the school and panel concerned). As another example **I can cite a school where a group obtained a school record number of 'A' grades in Maths B, 85% of all of the Maths B students were awarded 'A' or 'B' grades on the QCS Test but failed to reach the state Maths B average in the ϕ basket of maths questions in the QCS test!** I also regularly encounter examples of schools where Chemistry & Physics student achieve better than average grades but perform below average in the maths basket questions in the QCS Test.

The QSA has always maintained that an 'A' in one subject is not the equivalent of an 'A' in another subject in terms of tertiary selection and this is the case in other states. But an 'A' or more for example say a VHA2 in Chemistry should reflect a similar level of ability in the subject and a similar tertiary entrance score component across schools if the assessment is valid and reliable. In Queensland there is a plethora of evidence that this isn't the case. One year a VHA2 in Chemistry was equivalent to a 'small subject score' of about 216 – this should be more or less the expected score for this level of achievement after scaling across the state. Data sourced from different schools the same year after the first stage of scaling produced approximate scores for individual students of 233, 220, 207 and 201 for a VHA2. This is a huge difference in ability in terms of an OP – from an outstanding OP1 (225 is about the minimum score to achieve this) down to an OP5 level of ability.

The disparate scores originate from differences in general ability measured in the QCS Test. I have regularly seen clear cut examples where maths and science groups in schools have been scaled up not because they were particularly good at those skills but simply because they performed very well on the English and humanities sections of the QCS Test, e.g., the Writing Task, which comprise a higher proportion of the test than maths questions. Similarly I have seen maths and science groups scaled downwards that excelled in those specific skills both in class and in the maths questions in the QCS Test simply because they did not perform as well in the other types of QCS questions. **In the ACT, which is the**

only other jurisdiction to use a generic test to scale subject results, there has been great concern over the reliability of the same process to accurately reflect subject grades and subject-specific skills. Correlation coefficients as low as 0.25 to 0.50 have been reported between grades in maths and science and those obtained by students on the ACT Scaling Test (http://members.webone.com.au/~markld/PubPol/Edu/UAIs/WPs/McGaw.doc). This may in part be due to the relatively small number of students involved – about 20 schools – but by any measure is a very poor correlation. **The QCS Test is acknowledge around the world as an outstanding general abilities test, however, there is solid statistical evidence that general ability tests such as the QCS can be poor indicators of subject specific knowledge and skills at Year 12 level.**

The Use of Marks Compared to Criteria

One issue that has been raised before the inquiry is the use of numerical marks, letter grades and standards criteria as reliable indicators of student ability. Another point of contention has been the use of assessment to test student ability in reproducing knowledge and correctly applying practiced skills compared the application of the higher order skills defined by Bloom's Taxonomy.

The opponents of marks make simplistic arguments often with a spurious claim that they are simply added to give a percentage, i.e., 8 marks out of 10 = 80% of the answers correct. While this may be the case at primary school levels of education this has not occurred in senior assessment such as external exams anywhere in Australia for a long time – if ever. Where marks are used in instruments such as exam questions or sections within exams they are effectively weighted – not all questions are at an equal level of ability and some marks are much harder to obtain than others. This in fact reflects the six levels of Bloom's Taxonomy progressing from recall of knowledge as the most basic level of cognitive ability through comprehension, application, analysis towards synthesis and evaluation representing the most difficult skills. Prof. Ridd and a number of other submissions have not been critical of the use of Bloom's Taxonomy in assessment in Queensland – it has been present in external exams worldwide for many years and is present in tertiary exams. What has been the point of contention has been the extent of its application and interpretation.

Allocation of marks to specific levels of cognitive ability was the rationale used in assessment in Queensland prior to the introduction of the recent science and maths syllabuses. For example the previous science syllabuses mandated about 45-55% of marks being allocated to knowledge of subject matter, 25-35% to scientific processes and 20-25% allocated to complex reasoning skills (these three being the General Objectives) reflecting a progressive increase in cognitive skills and levels of difficulty – not all marks were equal and some were very hard to obtain and gained only through the use of higher order skills. The types of skills comprising these syllabus objectives were clearly identified and criteria were used to identify the differences in ability. Teachers required the skill to provide balance within their exams in terms of the allocation of marks to the three General Objectives, to provide a range of questions within each of those objectives and within questions allocate marks progressively increasing in difficulty to obtain. **In the past science teachers successfully allocated marks in their assessment reflecting criteria differentiating the levels of cognitive ability as indicated by the study of Masters and McBride in 1994. In fact as repeatedly pointed out to the QSA its own QCS Test uses such an approach.**

With the elimination of marks in assessment in Queensland teachers have been restricted to a 15 point scale (A+ to E- or VHA+ to LA-) in their assessment instruments. At the end of Year 12 teachers (and panels) have to then place students on a 50 point scale – all of a sudden judgement becomes more accurate! The QSA has contradicted itself on this issue citing research that our judgement is limited to a 15 point scale but the very research they use to support this contention (Masters & McBride 1994) shows that we are capable of making finer grained judgements and are expected to do so at the end of Year 12. Victoria often uses a scale of 50 marks aligned to criteria in both school-based and external assessment while in NSW a 100 point scale is used in exams and commonly 50 marks in school-based assessment – so this freedom of accuracy is routine in other states. Once upon a time in science we used to teach a concept to students and that is accuracy is limited by the least accurate measurement. **The 15 point scale introduces a gross source of error in the whole process in Queensland. A 50 point scale (or 50 marks) as**

used in the other states doesn't guarantee greater accuracy but provides the potential, something that cannot occur here.

What is the potential impact? For students in small subjects (which are not scaled by the QCS Test) a difference of 3 rungs is a large error – let alone 6 rungs – and can a serious impact on their OP as the QCS Test scaling cannot provide a correction. Consider for example a student in Chemistry placed at HA7 last year. This rung provided a small subjects score of about 201 – equivalent to an OP of 5. If the result was raised 3 rungs to an HA10 the score becomes 209 – equivalent to an OP of 2. If the placement is lowered 3 rungs to HA4 the score becomes 192 – equivalent to an OP of 6. Thus the contribution that Chemistry could have made to the student's OP could have been anything from a 2 to a 6. Yes, it would have been one of five subjects used to calculate the final score for an OP but if this range of accuracy was applied across a number of small subjects – a not infrequent occurrence in smaller schools – it could cause serious discrepancies and therefore injustice.

Perhaps the greatest area of contention on the accuracy of science assessment in Queensland is the use of criteria (standards) for grading student work. The reality is that the other states also use criteria in their assessment though it is usual to allocate marks aligned to the standards to reflect the performance of the students. Presented on the next page is an example of the criteria for a Queensland Chemistry EEI provided by the QSA. It is derived from the standard template of criteria in the Chemistry Syllabus but modified to identify the context of the assessment. On the following page is an exemplar of a set of criteria provided to Victorian teachers assessing a Chemistry EEI in Year 12. Two things are apparent, firstly, the use of criteria to allocate marks in Victoria. Secondly, **the criteria in Victoria are far more explicit containing more fine detail about the work compared to the Queensland criteria which are vague and subject to endless argument at schools and panel.**

Descriptors such as 'correct, precise, accurate, justified' are used in the Victorian criteria but are rare or absent in the Queensland standards. When Queensland teachers have tried to incorporate a few additional words into the criteria in their instruments to improve clarity for students and those having to mark the work (as we were told we could when the syllabuses were introduced) we have been reprimanded by panel – **it appears that accuracy and precision are not valued attributes of student work in Queensland**. Some things are very difficult to interpret in the Queensland criteria, for example a 'D' is 'identification of simple scientific interrelationships' and an 'E' is 'identification of obvious scientific interrelationships'. The arguments are exacerbated by the restriction of teachers by the syllabuses in grade allocation to one third of a band, i.e., A+, A or A-, etc., with ticks. Other submissions have referred to the difficulties of interpreting ticks widely placed over a grid to produce overall grades implying that the result is 'guessed'. I also have found that **when interpreting the ticks within these grids which are dispersed that interpretation is difficult and would describe teacher judgements in these instances as 'impressions'.** A 50 point scale provides more flexibility and discrimination in the allocation of results.

I circulated copies of the Victorian criteria to 21 colleagues and the <u>unanimous</u> sentiment was that they would immediately adopt the Victorian version if they could even if they were unable to use marks as it has more explicit, better defined standards.

QSA Exemplar of Criteria used in a Chemistry EEI

(http://www.qsa.qld.edu.au/downloads/senior/snr_chemistry_07_as_eei_0510.pdf)

	Section of the report	Standard A	Standard B	Standard C	Standard D	Standard E
KCU Recall and interpret concepts, theories and principles	Introduction	Reproduction and interpretation of complex and challenging energy/corrosion concepts, theories and principles.	Reproduction and interpretation of complex or challenging energy/corrosion concepts, theories and principles.	Reproduction of energy/corrosion concepts, theories and principles.	Reproduction of simple energy/corrosion ideas and concepts.	Reproduction of isolated energy/corrosion facts.
KCU Describe and explain processes and phenomena	Discussion	Comparison and explanation of complex energy/corrosion concepts, processes and phenomena.	Comparison and explanation of energy/corrosion concepts processes and phenomena.	Explanation of simple energy/corrosion processes and phenomena.	Description of simple energy/corrosion processes and phenomena.	Recognition of isolated simple energy/corrosion phenomena.
KCU Link and apply algorithms, concepts, theories and schema	Discussion	Linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging energy/corrosion situations.	Linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex or challenging energy/corrosion situations.	Application of algorithms, principles, theories and schema to find solutions in simple energy/corrosion situations.	Application of algorithms, principles, theories and schema about energy/corrosion.	Application of simple given algorithms about energy/corrosion.
IP Conduct and appraise chemical research tasks	Introduction, journal	Formulation of justified significant questions/hypotheses which inform effective and efficient design, refinement and management of the energy/corrosion investigation.	Formulation of justified questions/hypotheses which inform design and management of the energy/corrosion investigation.	Formulation of questions and hypotheses to select and manage the energy/corrosion investigation.	Implementation of given investigation about energy/corrosion.	Guided use of given procedures for energy/corrosion.
IP Operate chemical equipment and technology safely	Materials and equipment	Assessment of risk, safe selection and adaptation of equipment, and appropriate application of technology to gather, record and process valid data about energy/corrosion.	Assessment of risk, safe selection of equipment, and appropriate application of technology to gather, record and process data about energy/corrosion.	Assessment of risk, safe selection of equipment, and appropriate application of technology to gather and record data about energy/corrosion.	Safe use of equipment and technology to gather and record data about energy/corrosion.	Safe directed use of equipment to gather data about energy/corrosion.
IP Use primary and secondary data	Discussion	Systematic analysis of primary and secondary energy/corrosion data to identify relationships between patterns, trends, errors and anomalies.	Analysis of primary and secondary energy/corrosion data to identify patterns, trends, errors and anomalies.	Analysis of primary and secondary energy/corrosion data to identify obvious patterns, trends, errors and anomalies.	Identification of obvious energy/corrosion patterns and errors.	Recording of energy/corrosion data.
EC Determine, analyse and evaluate the chemical interrelationships involved	Discussion	Analyses and evaluates complex energy/corrosion scientific interrelationships	Analyses complex scientific energy/corrosion interrelationships	Describes scientific energy/corrosion interrelationships	Identifies simple scientific energy/corrosion interrelationships	Identifies obvious scientific energy/corrosion interrelationships
EC Predict chemical outcomes and justify conclusions and recommendations	Conclusion	Explore scenarios linked to the research focus, suggesting possible outcomes, and generates justified conclusions/recommendations.	Explains scenarios linked to the research focus, suggesting possible outcomes, and discuss conclusions/recommendations.	Describes scenarios linked to the research focus, suggesting possible outcomes with statements about conclusions and recommendations.	Identifies scenarios linked to the research focus or suggests possible outcomes.	Makes statements about outcomes.
EC Communicate chemical information in a variety of ways	Method, Introduction, Results, Discussion, Conclusion	Discriminating selection, use and presentation of scientific data and ideas about energy/corrosion to make meaning accessible to intended audiences through innovative use of range of formats.	Selection, use and presentation of scientific data and ideas about energy/corrosion to make meaning accessible to intended audiences in range of formats.	Selection, use and presentation of scientific data and ideas about energy/corrosion to make meaning accessible in range of formats.	Presentation of scientific data or ideas about energy/corrosion in range of formats.	Presentation of scientific data or ideas about energy/corrosion.

Sample of EEI Criteria Transformed to Marks in Victoria

(From: VCE Chemistry Assessment Handbook 2013–2016)

https://www.google.com.au/#hl=en&gs_rn=12&gs_ri=psy-ab&cp=43&gs_id=4&xhr=t&q=VCE+Chemistry+Assessment+Handbook+2013%E2%80%932016&es_nrs=true&pf=p&output=search&sclient=psy-ab&oq=VCE+Chemistry+Assessment+Handbook+2013%E2%80%932016&gs_l=&pbx=1&bav=on.2,or.r_qf.&bvm=bv.45960087,d.dGI&fp=77dc2791e5ffcb2f&biw=1280&bih=657

MARK RANGE	DESCRIPTOR: typical performance in each range
41–50 marks	Demonstrates comprehensive knowledge of the experimental techniques and calculations involved in the determination of chemical and energy changes in chemical reactions related to calorimetry and/or electrochemistry, and applies this knowledge with understanding and accuracy. Works independently and collaboratively to collect and record insightful and detailed quantitative and qualitative observations with correct units, including the use of tables. Accurately explains the appropriateness of the safe, responsible and ethical work practices used in the three practical activities. Effectively and accurately evaluates the procedure and the reliability of the data, including the impact of sources of uncertainty. Draws precise and accurate conclusions consistent with the questions investigated and the results obtained. Demonstrates comprehensive knowledge and understanding of the chemical and energy transformations occurring in chemical reactions. Draws accurate, detailed and insightful links between the concepts and ideas from the three practical activities completed. Communicates information clearly and concisely, using scientific language and conventions accurately.
31–40 marks	Demonstrates detailed knowledge of the experimental techniques and calculations involved in the determination of chemical and energy changes in chemical reactions related to calorimetry and/or electrochemistry, and applies this knowledge with understanding and accuracy. Works collaboratively to collect and record accurate, clear, detailed quantitative and qualitative observations with correct units, including the use of tables. Relates the safe, responsible and ethical work practices used to the three practical activities completed. Accurately evaluates the procedure and discusses the reliability of the data, including the impact of sources of uncertainty. Draws accurate conclusions consistent with the questions investigated and the results obtained. Demonstrates detailed knowledge and understanding of the chemical and energy transformations occurring in chemical reactions. Draws accurate and detailed links between the concepts and ideas from the three practical activities completed. Communicates information effectively, using scientific language and conventions accurately.
21–30 marks	Demonstrates satisfactory knowledge of the experimental techniques and calculations involved in the determination of chemical and energy changes in chemical reactions related to calorimetry and/or electrochemistry, and applies this knowledge with understanding and accuracy. Works collaboratively to collect and record accurate, detailed quantitative and qualitative observations with correct units, including the use of tables. Links the use of appropriate, safe, responsible and ethical work practices to the three practical activities completed. Evaluates most of the procedure effectively and discusses many aspects of the reliability of the data, including the impact of sources of uncertainty. Draws sound conclusions consistent with the questions investigated and the results obtained. Demonstrates appropriate knowledge and understanding of the chemical and energy transformations occurring in chemical reactions. Draws many accurate links between the concepts and ideas from the three practical activities completed. Communicates information with adequate use of scientific language and conventions.
11–20 marks	Demonstrates some knowledge of the experimental techniques and calculations involved in the determination of chemical and energy changes in chemical reactions related to calorimetry and/or electrochemistry, and applies this knowledge with some understanding and accuracy. Works collaboratively to collect and record quantitative and qualitative observations with some correct units, including some use of tables. Links some of the safe, responsible and ethical work practices applicable to the three practical activities completed. Evaluates some of the procedure and/or discusses some aspects of the reliability of the data, including the impact of a few sources of uncertainty. Draws some conclusions consistent with the questions investigated and the results obtained. Demonstrates some knowledge and understanding of the chemical and energy transformations occurring in chemical reactions. Draws some accurate links between the concepts and ideas from the three practical activities completed. Communicates information with some accurate use of scientific language and conventions.
1–10 marks	Demonstrates very limited knowledge of the experimental techniques and calculations involved in the determination of chemical and energy changes in chemical reactions related to calorimetry and/or electrochemistry. Records few quantitative and qualitative observations. Provides limited reference to the use of safe, responsible and ethical work practices in the three practical activities completed. Provides limited evaluation of the procedure and/or reliability of the data and/or sources of uncertainty. Draws few conclusions consistent with the questions investigated and the results obtained. Demonstrates limited knowledge and understanding of the chemical and energy transformations occurring in chemical reactions. Draws limited links between the concepts and ideas from the three practical activities completed. Demonstrates limited use of scientific language and conventions to communicate information.

The QSA claims that the standards-based approach it employs is world's best practice – in this state we use letter grades as proxies to represent standards. **No evidence in the educational literature has been presented that the assessment processes used in Victoria and NSW are less accurate than those in Queensland despite the fact that marks are used as a proxy for the standards**. Matters (2006) in her review of the drafts of the maths and science syllabuses now in use in Queensland clearly iterated that there were valid alternatives to the Queensland approach. I would not wish to misrepresent her views on the Queensland system as her writings indicate that as a generalisation she supports much of what has transpired in this state over the past four decades. She clearly dislikes terms like 'accurately' and 'consistently' so from her perspective would describe the allocation of a score out of 50 marks based on the Victorian criteria as holistic or impressionistic marking. I would put to this inquiry that **interpretation of ticks on a grid limited to a 15 point scale is nothing more than grading by impression – unless teachers convert the grades to numbers and average them as is covertly done across this state.**

I would highlight a key difference between the statements of the QSA and the report of Matters being that she acknowledges alternative views and the limitations of all assessment approaches:

There are other ways of assigning grades apart from the procedure set down in the syllabus:
1. Setting numerical boundaries for grades;
2. Applying composition rules;
3. Using fuzzy descriptors such as 'many', 'several', 'few', 'adequate', 'satisfactory', or 'acceptable';
4. Stipulating quality criteria for individual pieces of work or academic episodes.

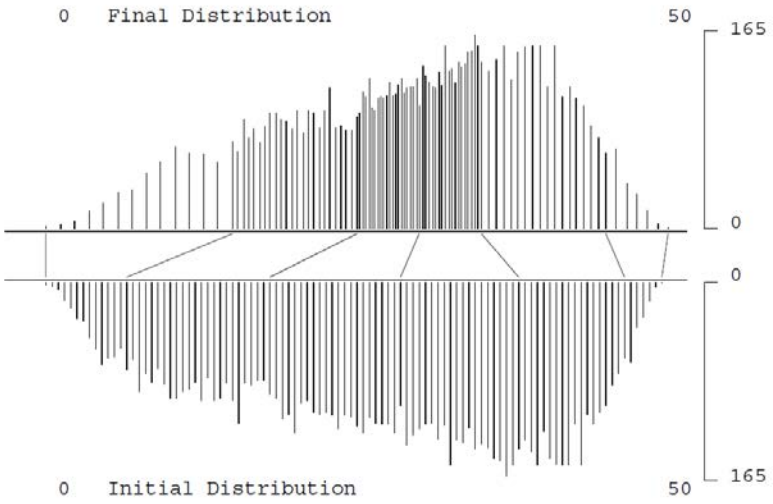
The question also needs to be asked as to whether there has been a fair portrayal of science teachers in the education community, given that they are often caricatured as troglodytes attached to marks and numbers. The long tradition of education has all teachers 'marking' (as witnessed in their conversations about marking loads). A confident approach to educational assessment is gained through familiarity with numbers, scales and measurement. This is not to deny that being fixated on (perceived) objectivity could signal an absence of workable alternatives but it does highlight an essential point: Teachers have to make judgments about qualities and quality. ***Sometimes counting or measurement will form an essential step in determining quality or competence.*** *On the other hand, too great a preoccupation with numbers and scores may get in the way of determinations of quality. …* ***The discourse surrounding the senior science syllabuses tends to demonise traditional assessment instruments such as formal tests and examinations, and glorify large integrated tasks****. …* ***Students with agentic learning styles (typically boys) are likely to be outperformed by students with typically communal learning styles (typically girls).***

A key point which Matters touches upon is that maths and science teachers are comfortable using marks and numbers – it would be a reasonable contention based on theories of different forms of intelligence that their thought processes could be very different from teachers who have to assess the humanities – yet current Queensland practices force them into judging student work in a manner in which they often are much less confident. Why not let them use numbers as successfully employed elsewhere?

Prof. Ridd has suggested that the current assessment processes in Queensland are an experiment in progress on our students, a fairly harsh contention. Matters made the following statements regarding the syllabuses now in use and the Queensland assessment system in general which suggests that Prof. Ridd's statement has some basis: ***The Queensland system of criteria-based assessment developed, not so much underpinned by theory but more so as a theory-building exercise in itself*** *… The standards issue in the senior sciences cannot be satisfactorily resolved by setting numerical boundaries for grades. Cut* ***scores are not part of the culture****.*

Matters clearly identifies that the reason for not using numbers as proxies for student grades in Queensland are largely philosophical (and her referral to it supports the statements of teachers that QSA has told them that the use of marks is not permitted). She correctly states that a percentage in isolation is not a standard. In NSW the external exams are marked after which exemplars are reviewed by a state panel. They match the exam results to the criteria standards to identify the points at which student work becomes representative of the standards of work of A, B, C etc. quality. Those points are then used as 'pegs' to anchor student grades across the state. An example for Chemistry illustrating the principle was

in use in 2000 is illustrated below sourced from a NSW report: (http://www.boardofstudies.nsw.edu.au/bos_stats/pdf_doc/sc00_statistics.pdf).



A similar process is used in Victoria. In these states the numbers on the scale are simply used as proxies for the standards and are just as valid as identifying the standards as letters. It should be pointed out that **the QSA reports student performance on the QCS Test with letter grades defined by a set of complex predetermined mathematical rules the practice of which strongly contradicts its own philosophy** and the viewpoint of Matters (https://www.qsa.qld.edu.au/downloads/senior/te_op_fp_procedures.pdf). **The practices used in NSW and Victoria in allocating grades to external exams are far more representative of a standards based approach than that used in the QCS Test – the QSA in this respect is being extraordinarily hypocritical.**

From this review of assessment accuracy the following conclusions can be reached:

1. **The 15 point scale used in Queensland introduces a gross source of error in the assessment process. A 50 point scale (or 50 marks) as used in the other states doesn't guarantee greater accuracy but provides the potential, something that cannot occur in Queensland at the present time;**
2. **The use of ticks on a grid representing a 15 point scale results in the allocation of overall grades through teacher impressions;**
3. **The current Queensland assessment system developed not as a result of solid education research but as a belief that such an approach would be superior to the alternatives;**
4. **The use of broad descriptors in maths and science to assign grades rather than marks aligned to standards has been driven by adherence to a philosophy rather than education research on reliability or validity. The use of marks is not a part of and is unacceptable to this philosophy, however, the QSA reports student performance on the QCS Test with letter grades defined using complex mathematical rules contradicting its own philosophy;**
5. **In other states external exam results are recorded as marks which are matched to the criteria standards to create numerical proxies identifying the points at which student work becomes representative of the different levels (grades) in the standards. It is just as much a standards-based approach as that used in Queensland with the advantage that the common reference exam ensures that the same standard is being applied across the state.**

Integrity of Science School-Based Assessment

School-based assessment runs a much higher risk of 'assessment fraud' than external exams. Writers in the educational research literature highlight the fact that external exams are not always secure. They tend to ignore the fact that unethical practices by students and teachers in school-based assessment are far easier to perpetrate and harder to detect than interference with an external exam if appropriate security measures are in place. Queensland is rightfully respected for pioneering the use of school-based assessment in this nation and while most jurisdictions now use it as a significant proportion of their

assessment programs only this state and the ACT use it solely. It is generally acknowledged that school assignments are open to plagiarism and it is difficult to validate the authenticity of student work. It is also generally accepted that teachers believe that school-based assessment should be a component in determining the grades of students. Prof. Ridd, while advocating the use of external exams, has also supported the continued use of school-based assessment – it is its sole use for assessment in Queensland with which he takes issue.

When I started teaching in the Queensland system I was extremely lucky that my first appointment was to a school (government) that had a large number of very experienced, highly competent science teachers. They not only had a comprehensive knowledge of the system, with active panel members and a District Panel Chair, but had a belief in the system and strong values of propriety – something very necessary for school-based assessment to work. Under the previous Chemistry Syllabus on no occasion did I have a student's placement moved downwards by the District Review Panel even though we did not have a representative on the panel (on a number of occasions they were moved up) and only once did I have a placement of a VHA student in Biology lowered. The local panels had many teachers with post-graduate degrees in science and there certainly was an esprit de corps amongst the members. I am aware that this was not always the case in other districts and I have had recounted to me many 'horror stories' from panels elsewhere supporting those reported on the 'Plato' website.

Since that time I have worked in other schools where at times staff members have shown far less propriety than in my early experiences. **I have seen instances where teachers routinely hand out to their students revision sheets that contain most or all of the key questions on the exams they are about to sit – sometimes with the solutions. Middle managers have collected exams and altered classroom teacher's grades. Assignments can be drafted three or four times. Students, sometimes selected students, may be given more time to complete papers than that indicated on the instrument.** There have been instances where staff charged tuition fees to 'help' students with their assignments after school. **When the work goes to the District Review Panel the panellists are totally oblivious to what has actually transpired – and the work is accepted.**

The psychology of the relationship between teachers and students in Queensland is different to that in NSW and Victoria. In the southern states teachers are the allies of students who work collaboratively to get the best results on the external exam. In this state with 100% school-based assessment from the student's perspective the teacher is the judge, jury and executioner a burden which is difficult for teachers to carry and fosters a poorer relationship with students than elsewhere. Teachers are under enormous pressure to deliver good grades to their students, particularly those in private schools where parents are paying fees to obtain what they perceive will be a better outcome for their children. The State Government recently announced that monetary incentives will be provided to outstanding teachers yet under the current system those obtaining the rewards are likely to be teachers that write good revision sheets rather than good classroom practitioners. **In Victoria and NSW external exam results are statistically matched to school-based assessment and if serious discrepancies are identified the exam results are used exclusively. This is a major disincentive to teachers who might try to 'teach the test' or write student assignments as these practices may well be identified resulting in intervention.**

The peer review process through District Review Panels is the QSA alternative to validation through external exams but has always been contentious. Supporters of the Queensland system argue that it effectively maintains standards across the state. I have been involved in peer review processes in science and the first contrast I would draw is that in many cases when presenting research for publication the review process is anonymous – the author is not identified to the reviewer who also remains anonymous to the author. **The panel review process for school submissions is not anonymous with the names of students, their teachers and the school being present on the assessment instruments – raising serious questions about its independence and credibility**. School administrators actively encourage teachers to join District Review Panels openly stating that they believe this can influence the outcomes for their students – and panellists acknowledge one of the reasons they serve on panels is to 'protect' the students at their school. At times they receive advice on new interpretations or points to be focussed on during the review of submissions unknown to schools without teachers on the panel, clearly an inequitable situation. The lack of anonymity creates an environment for nepotism to flourish.

The QSA maintains that the panel system provides two points of appeal that can rectify contentious panel decisions – intervention by the District Panel Chair and adjudication by the State Review Panel. When schools contest District Panel decisions they negotiate with the District Panel Chair who then makes a ruling based on conversations with the senior panellist that made the original decisions and the school concerned. The issue is that **District Panel Chairs make their decisions when schools dispute decisions without any hard evidence – by the time they are called to adjudicate the submissions containing all of the student work have been returned to the school**. In some instances panellists have provided some notes but this represents a point of view and not evidence. A judge during a trial has to consider evidence to reach their verdict but District Panel Chairs must make decisions without the key evidence – the student's work. **The reality is the adjudication of the District Panel Chair during disputes is nothing more than a bartering process when the key evidence is unavailable to them.**

In my experience schools are often reticent to challenge the decisions of District Panel Chairs. This appears to stem from a lack of confidence in the process, the additional work involved and the fear of potential retribution by district panellists and chairs in the future. To a fair degree District Panel Chairs are viewed as omnipotent and people not to irritate. Most of them conduct themselves professionally but some make it well known that they do not view favourably schools that challenge them. I have a copy of an 'R3' form (used to provide feedback to schools from panels at the end of Year 11) where the panellists recorded that they supported the assessment of the school and the student placements but the chair wrote statements on the form contradicting their decision. Witnesses to this incident state that the chair did not read the school submission. Until a few years ago the decisions by panels and their chairs were recorded in their handwriting on the QSA forms but now are generally typed and sticky taped to the forms. I had a panellist report to me that a newly arrived District Panel Chair changed the comments made by panellists on 'R3' forms without their consent so as to impose the way he believed the relevant syllabus should be interpreted.

If the panel system of moderation is to be retained in any shape it needs to be reformed in four ways:

1. **Submissions from schools need to be anonymous to the panellists without the identification of the students, school or district by name. The same protocol needs to apply to the State Review Panel;**
2. **Submissions should be reviewed by a panel in a district outside of that containing the school;**
3. **Panel Chairs should have access to school submissions until the student placements have been agreed so that they can peruse them when decisions are challenged by schools. Once agreement has been reached they can then be returned to the school;**
4. **If a school wishes to challenge the decision of a District Panel Chair they can forward the submission to the State Review Panel anonymously without advising the District Panel Chair.**

If the process is really consistent and reliable then say high profile academic schools in Brisbane could have no objection to the work of their students being reviewed by teachers in a district in western Queensland, could they? I suspect in fact they would object due to a lack of faith in the current system.

Other submissions and the Plato website have recounted incidents where school instruments and submissions have been supported for several years by a District Review Panel only to be suddenly rejected. I have experienced this under the new syllabuses where near identical instruments marked by the same teachers have been submitted to panels for several years and supported only to be criticised by different panellists. In one case an assessment package supplied by the school had been presented to the State Review Panel as an exemplar of the best work in the district without negative feedback yet was rejected the following year and a new District Panel Chair refused to support the school. The perception of many teachers is that with the introduction of the new science syllabuses in Chemistry, Physics and Biology the consistency of the comments and decisions by panels has markedly declined. They attribute this to the difficulties in interpreting the new standards, constant re-interpreting of the syllabuses and the exodus of many experienced teachers from panels.

Members of the inquiry would be well aware of the principle of legal precedence and understand the implication of panels supporting the grades allocated by schools to students for say three years only to have them lowered by different panellists in the fourth year. **It is only a matter of time before parents take panellists and the QSA to task in the courts. 'Professional judgement' will not be a suitable defence for the two panellists delivering a negative decision when three panels comprising six people**

have decided that the instruments used by the school were suitable. The inquiry should seriously consider this issue and the potential exposure of teachers, the QSA and the State Government to litigation. In NSW and Victoria the use of external exams to moderate and scale school results is defendable in the courts as the same standard is being applied across the state.

From what I have observed there is a growing push by the QSA to make science assessment tasks more 'open-ended' by reducing the level of teacher scaffolding as early as Year 11. For example a comment recorded in 2010 by a panel on a Year 11 Chemistry R3 form was: *The EEI is a good assessment instrument and the criteria sheet is well designed for analysis of vitamin C. The task is well structured to guide responses that demonstrate the full range of standards.* Last year the following comment was received from panel for exactly the same EEI: *The EEIs are both scaffolded with focus questions being given. Students need the opportunity to formulate their own questions.* Quoting from the QSA Senior Chemistry Syllabus on this issue:

Scaffolding must be provided. When an extended experimental investigation is undertaken for the first time, the scaffolding should help students complete the assessment by modelling the extended experimental investigation process and familiarising students with the expectations for the written scientific report. However, the scaffolding provided should not specify the chemistry, or lead the student through a series of steps dictating a solution. Scaffolding should be reduced from Year 11 to Year 12 to allow the student to better demonstrate independence in the research process. When an extended experimental investigation is revisited (most likely in Year 12), the scaffolding should be reduced and could be a series of generic questions.

The comments from the panel last year contradict the official guidelines issued by the QSA in their governing document (the Chemistry Syllabus) with respect to the execution of EEI's in Year 11. They have made a pronouncement which differs significantly from that of the syllabus – implying that the students should not be scaffolded and must create their own questions something which is not expected even in Year 12 let alone in Year 11. There seems to be a constant push in this state to make these projects more and more 'open-ended' to the point where the outcome even to a very experienced teacher cannot be certain. By comparison schools and teachers in Victoria do have the choice to make their EEI's less structured and more 'open-ended' if they choose but they are generally well scaffolded (as will be discussed shortly). Here we have no choice and are subjected to the whims of individual panellists – just when we seem to have an EEI well developed somebody throws a spanner in the works through new interpretations of the syllabus documents.

In defence of panellists I would point out that their workload has increased dramatically under the new syllabuses – when it comes to EEIs and ERTs student's work often ranges from 6,000 to 10,000 words with each folio containing at least one of each (In recent statements the QSA has indicated that ERTs are not mandated in Chemistry and Physics – that is not what we have been told in the past). At monitoring (Year 11) five folios of student work must be reviewed and at verification (Year 12) nine are examined – even a fast reader would require 20-30 minutes to assess each of these scripts. To assist panellists 'pre-reading' occurs where one panellist obtains a school submission and makes a preliminary assessment prior to the day of the official meeting. Last year during Year 11 moderation pre-reading was not available to at least some District Review Panels for reasons which have not been satisfactorily explained by the QSA. One anecdote provided to me by two panellists independently was that at one meeting with a shortage of panellists and no pre-reading **the school submissions were thrown into piles on two tables. One pile represented the 'reliable' schools and the other those that were less so. One panellist flicked through the submissions from the 'reliable' schools while the rest concentrated on the other pile of submissions. Does this represent world's best practice in assessment validation?** You cannot blame the panellists for their action – they were required to do an impossible job and did their best in the circumstances.

The interpretation of the new syllabuses has been a nightmare for both teachers and panellists. The problems have originated from the very loose nature of the standards (compared for example to those in use in Victoria), the use of extremely 'open' assignments in the form of EEIs and ERTs and the use of genres many science teachers are uncomfortable with in ERTs and exams such as persuasive essays,

stories, cartoons, etc., for which there is now a strong push from the QSA for us assess. In their study Masters and McBride (1994) highlighted the fact that:

The comparability of school-based assessments depends essentially on the extent to which teachers share a common understanding of criteria and standards for assessment. From this perspective, the comparability question is a question not so much about the reliability of the Board's review process as a question about the extent to which teachers throughout the system would allocate the same levels of achievement to samples of student work.

Teachers as a whole have a high level of integrity and are generally well regarded by the community. Disturbingly, from my observations and discussions with other teachers the introduction of the new science syllabuses have resulted in an increase in 'assessment fraud' not due to science teachers being inherently dishonest but as a result of them being forced to grade genres they are not comfortable with (see the following section) and interpret a series of standards which are ill defined and open to wide interpretation. One semi-retired colleague who has worked in a number of schools on contract commented to me that he 'hadn't seen an honest school' making reference to revision sheets 'over-preparing' students for exams and excessive drafting of EEIs and ERTs. Open criteria applied to extended written and other genres are entirely appropriate for subjects such as the languages, humanities and performing arts where a great deal of subjective judgement and opinion is required. Maths and the sciences are disciplines where accuracy in processes and answers are valued rather than opinion and nuance. The practises that have flourished such as revision sheets 'teaching the test' and multiple drafting of assignments are products of the desire of teachers to ensure that justice is delivered to their students in when they are using assessment processes they are not comfortable with.

My personal practice is that I do not accept any drafts for review or feedback of EEIs and ERTs in Year 12. Revision sheets for exams are generic and never present the 'complex and challenging' questions that discriminate 'A' and 'B' levels of ability on exams. When students ask what they need to know for their test I simply reply 'everything'. As a consequence I am acutely aware that my student responses to assessment lack the 'polish' of those from students of other teachers and schools and so I rarely hand out 'A's for assessment so as to reduce the risk of panels lowering the placements of my students. This is an injustice but I find solace in the fact that my students acquire good skills and perform well on the QCS Test giving them better OPs than their grades would predict.

Critics of scaling and moderation through 'high stakes testing' (external reference exams) argue that the process causes teachers to teach to these instruments but as correctly pointed out in other submissions this takes place in the current Queensland assessment system with the QCS Test. **In some schools QCS preparation time in Year 12 may rival that of the accredited subjects. What the current science syllabuses have fostered is an elaborate facade of assessment presented to panels. At least in an external exam it is almost certain that the work is that of the student.**

<u>Suitability & Comparability of the Science Assessment Instruments</u>

A key difference between Queensland and the southern states is a lack of a final external exam. One negative consequence of this in this state is the development of a culture of 'disposable' knowledge in students: once a unit of work is completed and assessed from their perspective they believe that they no longer need to retain that knowledge. Where final exams are held students understand that any concept over their two years of senior study can be assessed and as a consequence they are more inclined to develop better study and revision skills than their Queensland counterparts.

In its submission to the inquiry the QSA has stated that similar forms of assessment used in science assessment in Queensland are employed in other states and that the assessment workload of students here is comparable. This is in direct response to criticism of the use of EEIs and ERTs as forms of assessment and suggestions that the size of these works is stressing both students and teachers. The use of EEIs in school assessment in Australia has been driven by what is known as a 'constructivist' view on learning science – students learn best when they discover things through trial and error to develop their understandings. Another advantage put forward by proponents of this viewpoint is that students enjoy

experiments and practical work, stimulating interest in science, a view which I think all science teachers would concur with. Constructivist theory has a philosophy that devalues traditional expository teaching where knowledge is delivered to students but rather advocates teachers as facilitators of learning. The theory has spawned a new generation of school programs and textbooks based of 'spiralling' – concepts and knowledge are not taught sequentially in a manner that scaffolds the learner but are scrambled so that they have to develop their own 'meanings'. It has made the textbooks we now use of limited value and added to the stress of science teachers without strong backgrounds in science.

Constructivist theory has dominated education 'research' in the sciences for several decades and is favoured by educators despite the fact that some disadvantages or flaws have been at times clearly demonstrated as pointed out in a number of other submissions to the enquiry. **I have had to read a lot of education 'research' and so much of it is based on questionnaires, surveys, feelings and opinions.** An example exists in the form of the submission to the current inquiry by the QUT where they provide six references to support their case one of which has been submitted but not yet published (Fensham & Bellocchi, 2013) so is not accessible. Of the remaining five of I have located and read four of these references; the fifth I have read only an abstract and will not comment on. Two are historical reviews (Clark 1987 & 1990) one of which I have used myself – and in places reports teachers expressing historical concerns about the reliability of assessment practices in Queensland. A third is a review of the philosophy, semantics and approaches to constructivist teaching in response to criticism (Ritchie 1998). The fourth records research conducted on the emotions of young teachers using EEIs to teach analysed using observations about thoughts and attitudes, changes in voices and photographs of facial expressions to determine feelings and emotions (Ritchie *et al.* 2013).

Where is the hard evidence about what students can actually do measured in those four papers? Where is the hard evidence on assessment reliability which is the focus of this enquiry? They were very poor examples to submit particularly when I know there are some good studies that have measured student ability linking it to teaching methods. Ignoring the two papers that I can't access the key research available to support the QUT submission is Ritchie *et al.* 2013 with the title of '*Emotional arousal of beginning physics teachers during extended experimental investigations*' which was a study of teacher and student emotions and feelings during EEIs. If members of the inquiry don't believe me then read it: (http://eprints.qut.edu.au/56452/2/56452.pdf).This is typical of the material constantly placed in front of science teachers used as support for constructivist theory and to denigrate older teaching practices. Most science teachers, including the author, see the advantages at times of using a constructivist approach but in general we think differently to the radical constructivist ideology forced upon us by some education theorists. In my experience **when independent quantitative data is presented to education researchers, such as standardised testing in the NAPLAN or international tests, it is all too often dismissed as flawed.** Science and maths teachers with strong backgrounds in these disciplines are very sceptical about research on opinions, beliefs and feelings of small groups of people – we are analytical and interested in hard data in the form of numbers that are statistically valid derived from large samples.

The most often touted drawback of EEIs is that the time spent on enquiry-based learning, while perhaps enhancing skills and one area of knowledge, comes at the expense of the development of a broader base of knowledge and skills given the time available in schools. The science syllabuses in Queensland indicate that a minimum of four weeks should be allocated to an EEI but that it is permissible to spend a whole unit (term) on one and this does take place in some schools in this state where all their learning is confined to the EEI. This can produce massive shortcomings in student's knowledge and skills base but we are told that this is acceptable by the constructivists – the journey is what is important and not the destination. We are regularly told by constructivist researchers that correct answers are not important and that all beliefs are equally valid.

The inquiry has been told that the word limits for EEIs are 1000-1500 words in Year 12. This is indeed what the originally syllabuses stated, however, it has to be kept in mind that the 'word limits' are a recommendation and what actually determines the standards are the teachers on panels. **Due to the vague nature of the criteria both teachers and panellists found that 1500 words were insufficient in a report for students to satisfy the senior science criteria.** The result, particularly after student work was criticised by panels in the initial few years, was effectively an 'arms race' where the assignments got larger and larger to satisfy both teachers and panels. The problem is exacerbated by the fact that these

projects contribute a significant proportion to the final grade in the subject. As marks are not being used all forms of assessment are equally weighted and both students and teachers have used EEIs and ERTs as a means to produce better grades.

More recently the QSA have amended the 'word limit' of 1500 to being defined as that for the analysis of the project's results, (the discussion/conclusion/recommendations) so the size of the total report has been effectively increased. Given that students have to provide suitable background to the project in an introduction, justify the design of the project in a method and present & process their results to satisfy the criteria 2,500 to 3,500 words is more typical of the body of the final report of good students, without the references or any appendices. That might have been acceptable BUT in addition they usually have to provide a journal detailing their planning, collation of results, summaries of all their secondary research, etc., to satisfy other criteria. That often amounts to at least another 3,000 words. Biology is particularly bad in this regard as in some projects the students have to evaluate the usefulness of sources for bias, positioning, etc. **In my experience to satisfy panels when both reports and journals are included an average Chemistry or Biology EEI exceeds well over 6,000 words and those of 'A' grade students sometimes do approach or exceed 10,000 words**. All this is done in order so panellists can be satisfied that the student's work 'displays the full range of standards' in the syllabuses. As a scientist I understand that the language of science is concise and I constantly have confrontations with students and their parents about the word limits I try to impose which they believe are too restrictive.

The inquiry has been presented with an exemplar of an EEI for Physics:
http://www.parliament.qld.gov.au/documents/committees/EIC/2013/QldAssessment/tp-20Mar2013-Task.pdf
I showed this document to a very experienced Physics teacher at the school I currently work in. Her reaction: she laughed! Another Physics teacher with decades of experience expressed the sentiment 'if only'. The sample provided to the inquiry is really not indicative of the amount of work needed to satisfy some District Review Panels to achieve an 'A' standard based on the Physics teachers I have spoken to. I am certain that as a Chemistry or Biology EEI it would probably be a 'B', though without the journal with the planning, internet research, etc., not included it would fail in some criteria! Absolute proof of the size of these assessments is provided by the QSA on their website where they have presented a sample of an 'A' grade chemistry EEI:
(http://www.qsa.qld.edu.au/downloads/senior/snr_chemistry_07_as_eei_0810.pdf). It amounts to 6,000 words without a journal. If a journal is included I am certain it would push the word count to well over 10,000 words. **A word count of a journal of one of my students last year accepted by a District Review Panel as satisfying a number of specific criteria as being of an 'A' standard exceeded 7,000 words. The word count for the report (without the references) was 2,600 words.** From my own experience restricting a student to below 3,000 words in a report (and a similar number for the journal) and achieving an 'A' is very difficult and our best students are indeed frequently executing pieces of assessment amounting to 10,000 words when all aspects are included. **The huge science assignments are no myth and can involve considerably more written work than in the humanities subjects.**

In Queensland school-based assessment in the sciences in Year 12 is mandated to be from 4 to 6 tasks with limitations placed on the number of Written Tasks (exams). The inquiry has been told by the QSA that assessments such as the EEIs performed in Queensland are used also in other the other states in Australia. This is true, however, seeing examples provided to me from colleagues interstate the EEIs are nowhere near as onerous in terms of workload, often far less open-ended and more directed – students clearly understand the extent of the task and they are executed in manageable bights at a steady pace throughout a semester. The role of the journal is to foster good record keeping in students and help validate student ownership – it does not form part of the assessment. **In Queensland incorporating journals as part of the assessment of EEIs (and ERTs) has greatly added to the assessment burden of students and reduced their usefulness as learning tools**.

Both Victoria and NSW have moved towards a significant proportion of school-based assessment but unlike Queensland the teachers are not subjected to constant and erratic criticism by a panel. In Victoria school assessments undergo regular audits but the auditors do not have the power to alter the results of individual students. The relationship between the auditors and the school is a constructive one where the auditors play an advisory role. In NSW schools usually have an internal panel that reviews assessment

making comparisons to the mandated state criteria. As a consequence **of the absence of panels with powers to change student's grades interstate teachers feel under much less pressure to get students to prepare large assignments than their Queensland counterparts**.

Presented below is an extract from the current Victorian VCE Chemistry Syllabus as an exemplar of school-based assessment during the final semester of Year 12. Rather than the giant projects undertaken in Queensland they can consist of a series of smaller semi-directed experiments combined to produce an overall project folio. The Victorian Chemistry Teachers Association defines an EEI as 'a range of experiments linked by a common theme' (http://www.cea.asn.au/sites/default/files/uploads/documents/vcaa/examples/2009_useful_material_for_teachers_of_units_3_and_4.pdf). In addition there is often a short test at the end of the EEI which is incorporated into the overall result helping in part overcome the problems of plagiarism and outside assistance:

Outcome 2 Analyse chemical and energy transformations occurring in chemical reactions.	50	A summary report including comparative annotations of four practical activities relating to energy transformations occurring in spontaneous and non-spontaneous chemical reactions: • calibration of a calorimeter • measurement of heats of reaction • testing of predictions related to the products of electrolysis • application of Faraday's laws.

In the example 'Outcome 2' is an 'EEI' based incorporating short reports on four straightforward experiments in thermochemistry and electrochemistry – they are in effect a folio of work progressively created. This is in fact what many Queensland schools did prior to the introduction of the new syllabuses and we were explicitly told that it would take place in the current syllabuses – they were termed SEIs for Short Experimental Investigations. This was changed without consultation and we are now prohibited from doing this – the 'EEI' must be large, 'open-ended' and not 'teacher directed' – and this is where critics such as Prof. Ridd have rightly pointed out that the application of constructivism and Bloom's Taxonomy has become excessive. I have viewed examples of 'EEI' work from Victoria and have physically laid them side by side with Queensland EEIs and there is no comparison. **An 'A' grade 'EEI' in Victoria is under 4,000 words of assessment in the form of a report while a Queensland EEI can amount to 10,000 words in the form of a report and a journal sometimes created in a very short time frame of 4 weeks. The size of the projects, open ended-ness, lack of resources and often limited available time are a source of great stress for Queensland students compared to those interstate.**

In NSW school-based assessment is recommended to be 3 to 5 tasks including exams which cannot exceed 50% of the marks (http://www.boardofstudies.nsw.edu.au/syllabus_hsc/pdf_doc/chemistry-assessment-reporting.pdf). An exemplar from the NSW HSC website is presented below:

Schools may use this assessment grid without modification, or change it to suit their particular needs, being mindful that the weightings for each of the assessment components in the HSC course are mandatory.

Chemistry sample HSC assessment grid

Component	Task 1	Task 2	Task 3	Task 4	Weighting
	Secondary Sources Investigation	Planning and Performing a Practical Task	Performing and Reporting a First-hand Investigation	Examination	
	Term 4 Week 7	Term 1 Week 8	Term 2 Week 7	Term 3 Week 5	
	H1, H5, H12, H13, H14	H11, H12, H13, H14, H15	H2, H9, H11, H12, H13, H14	H3, H4, H6, H7, H8, H9, H10, H13, H14	

The first point of note is that assessment includes one internal exam and three investigations the first being in the final term of Year 11. **In this NSW exemplar there are only three pieces of school-based assessment in Year 12, a practical assessment of skills in Term 1, an EEI in Term 2 and an exam in Term**

3 which helps prepare students for the end of year external exam. **A practical assessment involving planning, one major investigation and one exam is a considerably lighter workload than the minimum of four pieces of assessment that have to be completed in Queensland prior to panel review at the end of Term 3**. The EEIs performed in NSW ('First-Hand Investigations') are somewhat closer to their counterparts in Queensland than the SEIs used in Victoria. Discussions I have had with colleagues in NSW indicate they are also proving to a source of concern (particularly with regard to authenticity: there are a range of 'providers' that advertise assistance in writing up these projects!) but they don't seem to feel as stressed. Again, this appears to stem from the lack of outside interference in the development of these tasks. Students keep journals to validate authenticity, but are not directly assessed. **I have sighted several final reports for EEIs conducted in NSW and they are about 3,000 words in length**.

In Queensland EEIs have a tendency to focus on one specific area of Chemistry, Physics or Biology at the expense of other equally important areas. This is of great concern to some teachers as the time that must be devoted to an EEI as required by the syllabuses reduces the time available for teaching other skills and knowledge. In some school work programs the EEI is the sole teaching for the term. This is clearly of concern to tertiary educators worried about significant gaps and skills which some students entering university appear to have in the science disciplines.

Around 2000 the predecessor of the QSA (the Queensland Board of Senior Secondary School Studies) expressed its intention to develop new senior science syllabuses to replace those due for review or replacement in the middle of the decade. At the time it published a number of documents and delivered professional development to teachers on the directions it believed in which senior science education and assessment needed to move towards. I retain copies of the documents one in particular being *Complimentary Assessment in Science***. QBSSSS presenters indicated the clear intention to reduce the amount of mathematical problem solving in science assessment** (which they called a non-literary genre) towards a much greater component of assessment based on language (literary genres) citing science education research indicating language was the key to learning science. The document identified the following tasks as being suitable for <u>senior</u> science assessment: *Bibliography, short science story or play, personal recount, comic strip, cartoon, debate, interview/questionnaire, list of instructions, description, information report, science magazine article, note making and annotated bibliography, explanation, persuasive argument, analytical argument, analytical explorative essay, analytical comparative essay, discussion, book/literature review.* I have included an example from their document:

2. SHORT SCIENCE STORY/PLAY/...

Function To entertain and inform.

Structure
* orientation -setting, time, place.
* complication(s) - problems(s) to be solved by characters
* resolution - solution to the problem or story ending

Features
* action and mental verbs, usually past tense
* personal and emotive
* direct speech is commonly used

Science tasks using the Narrative Genre

General
Students could be asked to write a short story/play/film script..., describing some scientific processes or relationships where participants in the story adopt human characteristics.

Students could be asked to write a story about:
* life on another planet
* life in the future when the earth's temperature has risen significantly due to the Greenhouse effect
* an environmental disaster - man-made or natural
* ...

My recollection of the meeting was that the science teachers present were strident in their criticism and informed the QSA presenter that such forms of assessment were totally unacceptable to them. One District Panel Chair informed the presenter that the types of assessment proposed contravened the BSSS's grid of Common Curriculum Elements (the CCEs). **The 49 CCEs are the skills set students acquire across all subjects with specific ones allocated to individual subjects.** I have included a copy of the original CCEs grid as Appendix 1. **It should be noted that skills such as *empathising, gesturing,***

expounding a viewpoint **and** ***creating/composing/devising*** **are skills not to be taught and certainly not assessed in Chemistry and Physics in Queensland.** From what I have been told the reaction of science teachers at the meeting I attended was reflected in other areas of the state. **The BSSS was clearly informed that these genres were completely unacceptable as forms of assessment of the skills most valued in science education by experienced teachers and the CCEs involved were not supported by their pivotal document around which the whole system is built – yet they were ultimately implemented by the QSA and incorporated into science assessment in the form or Extended Research Tasks (ERTs) and in questions in school based exams.**

Apart from the fact that some of these genres are not appropriate for science assessment in terms of the CCE's their use lowers the reliability of the assessment of science and maths specific skills. Analysis of data from the QCS Test by Matters *et al*. 1998 indicates **a very low correlation of 0.48 between the extended writing skills in the π basket (create & present) compared to the maths skills in the ϕ basket (apply mathematical techniques and procedures).** Therefore **a shift in maths and science teaching and assessment towards genres utilising extended writing must according to the QCS Test evidence disadvantage students with a high ability in maths**. In addition maths and science carry a significant responsibility for delivery of a number of CCE's which are rarely taught in other subjects. These include the mathematical skills in the ϕ basket as well as some others such as 'structuring a mathematic argument', 'applying strategies to trial and test ideas', 'deducing' and 'interpolating' in other CCE baskets. When the new syllabuses were introduced one QSA presenter stated to a large gathering of teachers *'We have cut all of the maths out Physics; the students won't have to do any maths in the new program', 'The same with Chemistry'* (details on this are provided in the section on teacher support). I have attended two other meetings where **representatives from the QSA have publicly stated that one of the intentions of the new senior science syllabuses was to lower the level and extent of use of maths in science teaching and assessment**. **Devoting more time in maths and science to literary skills and genres must come at the expense of maths-science CCEs lowering student ability in these skills in Queensland – which should be a source of concern considering testing indicates that they already have a lower ability at these skills than many of their interstate counterparts**.

ERTs have also been introduced in NSW and Victoria but in those states the focus is on the science involved in a topic and not the genre it is to be delivered in. Reproduced below are the guidelines for ERTs in Victoria (VCE Chemistry Assessment Handbook 2013–2016). The example is very explicit and again as in their EEIs Victorian students and teachers have a clear indication of what has to take place:

Designing the assessment task
Teachers should develop an assessment task that allows the student to:

- *demonstrate and apply knowledge of the principles and applications of chromatographic techniques*
- *interpret and analyse qualitative and/or quantitative data from thin layer chromatography (TLC), and/or high performance liquid chromatography (HPLC) and/or gas chromatography (GC)*

OR

- *demonstrate and apply knowledge of the principles and applications of spectroscopic techniques*
- *interpret and analyse qualitative and quantitative data from atomic absorption spectroscopy (AAS) and/or infrared spectroscopy (IR) and/or mass spectroscopy and/or nuclear magnetic resonance spectroscopy (NMR) and/or visible and ultraviolet spectroscopy (visible-UV)*

AND

- *interpret and analyse first and second hand data and evidence related to the technique/s and/or instrumental analysis*
- *demonstrate knowledge of the suitability of an analytical technique to a particular task*
- *process information and apply understandings to familiar and new contexts*
- *communicate chemical information and ideas accurately and effectively*
- *have the opportunity to demonstrate the highest level of performance.*

Presented below is an exemplar from the NSW HSC website representing part of an ERT illustrating how very directed and scaffolded they are – the focus is clearly on the chemistry and mathematical analytical processes. It is very different to Queensland ERTs which typically have one or two focus questions, are very 'open ended' and incorporate a strong literary genre. Also as in their EEIs teachers may include a

short test to validate student knowledge of the concepts and skills; something frowned upon by the QSA. **Even though ERTs are used in Victoria and NSW and are strongly focussed on science knowledge and skills interstate colleagues have indicated to me that this is the form of assessment they think is least valid**:

Detailed example 2

RESPONSE TO STIMULUS MATERIAL RELATED TO CHEMISTRY AT WORK

B. Which raw material is more efficient?

One of the factors that needs to be taken into account when designing a chemical plant, is the cost of raw materials and the chemical's selling price. A variety of suitable raw materials may be available.

Phenol, C_6H_5OH, is an important industrial chemical. Large amounts are produced mostly as an intermediate in the production of other chemicals used in manufacture of resins for the plywood, construction, automotive, and appliance industries. It is also used in the manufacture of nylon and epoxy resins. Phenol is used as a disinfectant, and in ear and nose drops, throat lozenges, and mouthwashes and in the manufacture of pharmaceuticals. It is also used in the manufacture of dyes, fertilisers, explosives, paints and paint removers, and textiles and coke.

It can be prepared from a number of raw materials including benzene, C_6H_6, methyl benzene $C_6H_5CH_3$ and 1-methylethylbenzene $C_6H_5CH(CH_3)_2$

1. Calculate the mass of reactant needed to produce 1 tonne of phenol from each of these raw materials. Assume that there is 100% conversion of the raw material to phenol.
2. Which raw material would be the most economical if the cost per tonne was the same for each?
3. In reality a 100% conversion is not always possible. What other factors must be taken into account when selecting the best raw material for the manufacture of phenol?
4. Some reactions produce by-products which can also be sold. For example, the process using 1-methylethylbenzene also produces propanone, $(CH_3)_2CO$, as a useful by-product which can be sold. The common name for propanone is acetone.

   $C_6H_5CH(CH_3)_2 + O_2 \rightarrow C_6H_5OH + (CH_3)_2CO$

   1-methylethylbenzene phenol propanone

   (i) What mass of propanone is produced for every tonne of phenol?

   (ii) Use the web to find out about the uses of propanone.

Would this method of phenol production be economical if there was no market for propanone?

<u>Are the assessment processes as reliable and consistent as those used in other states?</u>

On a number of occasions the QSA has commissioned reviews of its assessment procedures usually calling upon representatives from interstate – educational theorists – to assist. They laud the use of criteria, school-based assessment, open-ended investigations, etc. Inevitably they report favourably on what is occurring in Queensland. Their views are not necessarily shared by the broader education community interstate. Recently a communique by the Deans of Science of some interstate universities called into question the principles upon which the science syllabuses in Queensland are founded upon. I have a close association with some senior secondary and tertiary teachers and education administrators going back many years – it was a Deputy Director of Education that talked me into becoming a teacher. Those that I regularly converse with, while recognising some of the innovations developed in Queensland, have serious misgivings about the validity of the assessment processes and are fairly concerned about the direction of science and maths education in this state. The question has to be asked **if the assessment processes and syllabuses in maths and science are so good in Queensland why hasn't the rest of Australia adopted them?**

Prompted by education research Victoria for a time introduced 'Common Assessment Tasks' (CATs) consisting of two exams and two school-based projects for senior assessment. That state encountered some of the problems being experienced in Queensland now and they have moved away from those large school-based tasks in favour of smaller pieces of assessment incorporating a greater variety of practicals as outlined earlier. It is my contention that while other states have to some degree moved towards the Queensland model in assessment tasks **this state is in fact moving away from the others in terms of the open-endedness, the size of the assessment and having a lower focus on science-specific knowledge and skills.** The examples of EEIs and ERTs from interstate are nowhere near as onerous in terms of workload, far less open-ended and more directed: students clearly understand the extent of the task.

In 2006 the NSW Board of Studies commissioned a study of maths programs around Australia and internationally to compare their strengths and weaknesses so as to better inform the development of their new HSC maths syllabuses (*A critical analysis of selected Australian and international mathematics syllabuses for the post-compulsory years of secondary schooling*

http://www.boardofstudies.nsw.edu.au/manuals/pdf_doc/maths_st6_lit_curr_rev_pt1.pdf). The study reviewed the draft Queensland maths syllabuses then in the final stages of development and concluded: ***The disadvantage for Queensland students is that their preparation for university level calculus depends on the choice of option topics provided at their school****. … Strengths include the provision for project work and extended investigations and problem solving tasks in unfamiliar contexts. These are required as part of the NSW internal assessment as Component B, a minor part of the final assessment.* ***Weaknesses include the issue of guaranteeing authenticity and ownership of such work****.*

Ultimately the NSW Board of Studies rejected the Queensland model for maths education for two principle reasons. The first was that the Queensland syllabuses provided schools too little direction in terms of what they had to teach – there was too much choice in terms of what could be omitted – potentially reducing the range of skills acquired in maths. The second was that without an external reference exam there were serious concerns about the validity of assessment particularly when a significant component of our maths assessment is investigations. This is the key criticism which everybody levels at the Queensland system. There is no truly independent method used to measure subject-specific knowledge and skills – in the other states an external exam is used to improve reliability of the final grades of students and detect anomalies in subject performances in individual schools.

One significant issue in Queensland is that of schools shortcutting the amount of time devoted to classroom teaching of subjects. The senior syllabuses in this state mandate that a minimum of 55 hours of teaching must be delivered to students each semester, as does the current versions of the senior Australian Curriculum science syllabuses. In the highly competitive environment that now exists between schools many incorporate a range of 'pastoral activities' (e.g., camps, team building, guest speakers, etc.) to improve their attractiveness to parents. In some schools these activities are occurring at great expense to classroom teaching. **I have encountered instances where students have received less than 80% of the mandated minimum teaching time. The response of teachers is of course to reduce the material that they teach consequently reducing the skill and knowledge base of their students. They can do this in Queensland as schools write their own programs and decide what they will teach – without an external exam to detect the loss of knowledge and skills as takes place interstate**. Technically the students should not be awarded OPs as they did not satisfy the mandated requirements. Schools legitimately need to provide extra-curricular activities to their students but it is getting to the point in some where it is completely over the top and to the detriment of the academic education of the students – if a minimum of 55 hours is mandated then that is what must occur.

Following the implementation of the senior science syllabuses the QSA developed junior syllabuses for maths and science with grades based on standards criteria. Like their senior counterparts the criteria are vague and difficult to interpret. The QSA introduced QCATs (Queensland Common Assessment Tasks) to help educate junior science teachers in constructivist science teaching and developing assessment based on criteria standards. Similarly, they have created much argument and confusion amongst teachers. I can recall in the first year of their introduction sitting around a table with all of the members of a school science department looking at the questions and model answers for a science QCAT. It was agreed by the staff that the QSA exemplar answer provided representing a 'B' grade student was of a higher standard than the exemplar provided of 'A' grade work! Science and maths teachers in government schools have recently seen the introduction of the C2C resource ('Curriculum into the Classroom') to support the introduction of the junior Australian Curriculum. It has been another nightmare with more vague criteria and open ended inquiries and investigations. Many junior science teachers lack the experience of their senior counterparts and it has fallen onto the shoulders of the latter to oversee the introduction of the Australian Curriculum and C2C adding greatly to their stress levels.

Initially the implementation of the Australian Curriculum for junior science had a strong input from educational theorists including much Queensland 'expertise'. This included the criteria to define the standards which, like their counterparts in Queensland, are now causing growing concerns interstate. **Original drafts of the Australian Curriculum for Years 11-12 mandated that an EEI had to be undertaken every term over the two years, i.e., eight EEIs. The current versions make no reference to EEIs – they were removed at the instigation of the other states. It would appear that the rest of Australia have independently assessed what is taking place in Queensland and reached a negative conclusion.** My contacts interstate have told me that, in anticipation of a change of Federal Government within the next

six months, they are developing submissions to have both the junior and senior Australian Curricula reviewed and the introduction of the senior version delayed.

This term of reference questioned '*the ability of assessment processes to support valid and reliable judgments of student outcomes*'. The answer is without independent tests of student ability in the senior sciences it is hard to provide a conclusive answer – save for the evidence from the QCS Test that grades agreed to by schools and panels sometimes do not correlate well with school performances on the maths questions in the QCS Test. State-wide data indicates that there is a huge range in student performance on the QCS Test compared to measures of their ability reported in all of their subjects at school (polyscores). I have viewed these Queensland graphs and some from interstate comparing senior science school grades with those achieved on the external exams and believe that the interstate graphs show a much tighter fit. This suggests that assessment processes in schools in those states are more consistent than those in Queensland. Unfortunately I am for obvious reasons not in a position to present them here as they are not publicly available.

Another submission has made reference to the amount of 'norm referencing' (statistical processing) employed by the QSA to take school results and turn them into tertiary entrance scores. To varying degrees equivalent data processing and scaling is performed in other states. It in effect provides protection for students who may by chance have a bad day on the QCS Test or the external exams interstate – the group performance. It is my opinion that the basis of the data processing and scaling used by the QSA is sophisticated and well thought through – the people in the data analysis section of the QSA are highly regarded both by their interstate peers and the teachers here that work with them. The QSA scaling of subjects employs the use of group means and spreads and is so good it is capable of minimising some of the many potential negative impacts of school-based assessment in effect taking highly variable data and smoothing it. It does have a tendency statistically to dampen variation in the school data. By comparison in NSW the scaling of school subjects using the external exam has a tendency sometimes to be quite harsh – the top student result on the external exam becomes the top result for the school as is the same at the bottom so the results at this first step are not smoothed at all. Due credit must be given to the data analysis people at the QSA who should not be blamed for the current situation but it is more like curing a disease than preventing it in the first place. **Some education theorists and unionists have argued for the abolition of the QCS Test but from what I have seen it is the only thing holding the Queensland system together and delivering any sort of justice to students**.

The only other jurisdiction that uses the Queensland approach of 100% school-based assessment, review by panels and a generic scaling test is the ACT. The socio-economic environment of the ACT is very different to that of Queensland. With only about 20 secondary schools, highly educated parents and a prominent university providing a ready source of teachers it lacks some of the disadvantages present in Queensland. Despite these advantages the system used in the ACT has come under significant criticism for the same sorts of issues as its Queensland counterpart – the fairness of the assessment processes, at times poor correlation between subject results and the general abilities test and an inability to produce tertiary entrance scores equivalent to those in NSW are the points of contention (http://members.webone.com.au/~markld/PubPol/Edu/UAIs/WPs/McGaw.doc).

The predecessor of the QSA, the QBSSSS, by defining the CCEs as a common set of skills to be taught as a foundation for the senior education and assessment system is an innovation that is highly respected elsewhere. I have had discussions at length with both secondary and tertiary administrators over the merits of scaling subjects using a generic test such as the QCS Test. I can inform the inquiry that **it has been closely examined interstate and that it is recognised that using one general abilities test and eliminating subject exams is attractive to NSW and Victoria administrators as it could provide significant financial advantages. <u>After careful consideration both states have rejected it as an unreliable approach for ensuring the maintenance of standards in subjects</u>.**

A fundamental decision has to be made by the inquiry: Is Queensland satisfied with students being competent at a generic set of skills (the CCEs) or should students complete their secondary studies with a comprehensive set of knowledge and skills which are subject specific? The QSA might argue that they already do. Well then put it to the test – introduce external reference exams at the end of Year 12 in maths and the key sciences (Chemistry, Physics AND Biology) to scale school subjects. The high school

maths teachers I work with in the last year or two have commented about observing improved basic maths skills in the students arriving from primary school. They are explicitly linking this to the introduction of NAPLAN driving primary schools to improve their maths education. Teachers do have concerns about NAPLAN being used as 'league tables'. The measure of a good school is not their average results for NAPLAN but the improvement that is produced between tests. Most secondary maths-science teachers I know are very happy that NAPLAN came along. We now need a similar tool in the senior sciences and maths in Queensland to clearly define our standards and drive improvement in student knowledge and skills.

I would offer one serious warning about introducing external exams in science. **The only thing I can imagine being worse that the current situation are external exams incorporating cartoons, persuasive essays, evaluating issues and the other forms of assessment that belong in the humanities. The same applies to the use of 'open-ended' questions. This means the exams being designed without input from the QSA personnel and the education constructivist theorists who have reduced science education in this state to the farcical situation it now finds itself in.**

Ensuring assessment processes are supported by teachers.

<u>The Previous Science Syllabuses (1995 -2005)</u>

I have taught senior science in Queensland under two successive sets of syllabuses, those dating from around 1995-2005 and the most recent versions. When I commenced teaching here I was impressed with the structure and scope of the exams that teachers were setting. There was a nice balance between recall of knowledge, skills and challenging problems with the latter never being 'open ended' and always leading to a definitive correct answer. The emphasis in Chemistry and Physics was on mathematical problem solving and even in Biology solid mathematical skills were required. Recently I compared some of the old exams I have kept from schools in this state and compared them to recent external exams from interstate. It is pretty clear that at least in some schools the quality of those exams matched or exceeded that elsewhere. From teachers I know that started work in Queensland in the 1970's they state that the era from 1995-2005 represented the best science syllabuses in their teaching careers – the pinnacle of science education in this state in their lifetimes. That is not to say that things were totally rosy. As presented earlier in this submission teachers have repeatedly expressed concerns about the reliability and fairness of assessment practices and the stresses placed on themselves and their students.

<u>Introduction of the New Syllabuses c2000 – Present Day</u>

The QSA has informed the inquiry about how much it values teachers and their opinions. The following may be instructive as to what has occurred in practice.

The BSSS started planning for the new syllabuses around 2000 and the QSA eventually drafted trial syllabuses for Biology, Chemistry and Physics which were introduced in a number of 'pilot' schools. Biology was the first syllabus to be widely implemented across the state in 2005 and caused shockwaves – it immediately ran in into so many problems due to errors and inconsistencies that the document had to be rewritten in 2006.

I attended a QSA professional development day in 2006 convened to educate panellists and classroom teachers on the implementation of the new Chemistry and Physics Syllabuses. There was a fair degree of apprehension amongst those present as by that time there was much angst about the previously introduced Biology Syllabus. In addition teachers at a local 'Pilot' school which was involved in trialling drafts of the new syllabuses had some significant concerns. They reported that planning of the documents had dragged on through disagreements between them and the steering groups writing them. The following is my recollection of what took place confirmed recently in conversations I have had with other attendees.

The meeting was chaired by a QSA representative who played a pivotal role in the development of the new Physics Syllabus and also I am told had input into the Chemistry Syllabus too. After a brief introduction she informed the gathering ***'We have cut all of the maths out Physics; the students won't have to do any maths in***

the new program'. A teacher asked *'What about Chemistry?'* and the reply was *'The same with Chemistry'.* This of course initiated a lively discussion and the presenter eventually clarified the position by stating *'they will have to do some basic maths but nothing like that in the past. The focus will be on their enquiry skills and not getting the right answer'.* It was then explained how teaching was going to be *'contextualised'* into themes with an example in Chemistry provided. The unit of work was called 'Shipwrecks' and the presenter explained how rather than teaching sequentially (from easier to harder concepts over the two years of senior study) traditional units of work were now to be jumbled (an educational theory called 'spiralling' which has been discussed in another submission to the inquiry). Next, the presenter explained how the teaching of the units was to be totally 'open-ended' with students designing their own experiments (Extended Experimental Investigations or EEIs) – teachers were now to be '*facilitators'* to their students. The experimental enquiries were to be a whole term of work and *'traditional teaching'* was to be minimised and restricted to that needed to support the investigation. The presenter stated ***'We have cut a lot of the theory out. You will have much less to teach'***.

The QSA presenter then explained that 'Written Tasks (exams) were permitted but the number was now to be severely restricted. We were also informed that the other form of assessment to be performed were Extended Research Tasks (ERTs) about which she provided some examples of the types of tasks these could be. A number of these tasks were the same as those in the document prepared in 2000 I referred to earlier in my submission. One person at the meeting made the comment *'We are going to write stories in Physics?'* and another *'That is not science, that's SOSE!'* These questions and comments were ignored by the presenter. Another teacher made the comment '*With these assignments, what is going to stop them cheating?'* We were told that we had to maintain monitoring checklists and multiple drafts of work to validate them. A teacher asked *'What about the SEI's? We were told they would be in the new Syllabuses'* (SEIs or Short Experimental Investigations consist of a portfolio of related experiments). The presenter sternly responded *'No, you won't be doing anymore cookbook experiments, only authentic student investigations'*. The teacher responded *'That's not what we were told!'* but the presenter ignored his comment.

The QSA presenter then showed a powerpoint of the criteria that were to be used in grading students. At that point one of the teachers asked *'Aren't we going to use marks?*' The presenter responded by saying ***'Since ROSBA you were not meant to use marks, it was supposed to have been criteria since that time. You are lucky that you have been allowed to use them this long!'*** Somebody else asked *'Why can't we use marks?'* and the strident reply was that ***'Well the <u>dinosaurs</u> will have to get used to it. Marks are not to be used at all!'*** We were also told it was unacceptable to convert grades into numbers and use a calculator to come up with an overall result. The QSA has submitted to the enquiry that it has not 'banned' the use of marks but at the meeting and every other I have attended it was made quite clear that they were never to be used. In the powerpoint were examples of assessment grids with criteria for the new standards that were to be implemented. In one example a test question had a maximum grade of 'HA' (= 'B'). Someone asked if this was a mistake and the presenter replied *'No, not all tasks have to have an 'A' standard*'. Another teacher asked *'How can we determine an overall grade when some questions can't give a student an 'A'? What's the point of a question like that?'* the reply being *'You have to use your judgement'*. **The current QSA website contains examples of exam questions including those where the maximum possible grade for a perfect answer is an 'HA' (B grade) – no matter what students do they can't obtain a 'VHA' (A grade).**

We were shown a program developed by a school for the 'Shipwrecks' unit and it involved a huge amount of practical work that could go in many different directions. I was sitting next to the Science Head of Department of my school, with 30 years of teaching experience having served on a number of science panels and at the time a District Panel Chair. At this point in the meeting he commented that this would be a nightmare in terms of workloads for the lab assistants and resources at schools. He asked the QSA presenter *'What about the schools that don't have lab assistants'* to which the presenter responded *'Well, the teachers will have to do it!'* My boss then pointed out that the EEIs could take more time than that available in class. The presenter stated *'The students will have to complete them after school*'. My boss then asked *'What about the kids that have to catch buses?'* but his question was ignored. From elsewhere in the room came the question *'So we will have to mark a report and a journal? How big are these things going to be?'* and were told that the syllabuses provided guidelines for reports but that journals, bibliographies had no prescribed size.

Shortly afterwards the meeting closed which was fortunate as there were a lot of disgruntled, no, actually very disillusioned teachers in the room. They had raised legitimate concerns and had been treated with contempt. A teacher from a school that had trialled drafts of the new syllabuses was quite upset. They had suggested

modifications based on classroom experience and had been totally ignored by the QSA. In fact some changes present in the final versions of the syllabuses had caught them totally unawares – they had never been consulted on them. They had mistakenly believed that their opinions were valued, as did the rest of us present, but it was a fete accompli. I have spoken to a number of teachers in other regions of the state who recount similar stories of what took place in their districts – in fact **I am told that at more than one meeting the teachers raising legitimate concerns were derogatorily called dinosaurs by QSA presenters and it certainly happened at the meeting I attended**. The teachers at lunch went over the new Physics and Chemistry Syllabuses with a fine tooth comb. **The new syllabuses clearly had been hurriedly put together through cutting and pasting – in places they had the names of the wrong subjects in the documents!** Another mistake was that one of the standards for a grade of 'LA' was the same as that for a 'VLA' and it is present to this day (though one QSA official told me it was not a mistake!). If the QSA had consulted widely with teachers those sorts of mistakes would not have been prevented. There were aspects present in the syllabuses that had not before been flagged by the QSA with science teachers at all. **I know a number of highly regarded teachers, including some from the pilot schools, decided to travel to Brisbane to air their concerns directly to senior QSA staff. They told me they were totally ignored**. The general talk in the room after the meeting was to go through the unions to get the implementation of the syllabuses delayed. This was so that we could have more input into them on the basis of greatly increased teacher workloads and the potential disadvantages to students in small and regional schools.

At this point in time each region had long-established District Review Panels but with the introduction of the 'Pilot' schools for the new syllabuses new panels were established. It was generally assumed that experienced panellists would transfer from the old panels onto the new ones. Some chose not to nominate for the new panels as they were so disillusioned with the new syllabuses. Disturbingly I know of a number of cases in several districts where panellists with excellent backgrounds and highly respected by their peers were politely intimated that they were not required. The outcome was that with the changeover to the new syllabuses some panels lost a lot of expertise – both in reviewing school submissions and in technical expertise of the subject area – and have never fully recovered. A number of submissions have referred to the shortage of panellists in senior science across the state but in 2006 it appears that experienced panellists were expendable in order to create compliant panels.

Senior science teachers have been repeatedly told since the introduction of the Biology Syllabus in 2004 that we would be provided with many exemplars of assessment tasks that we could use but even today the number available on the QSA website is quite pitiful – and does not cover the range of assessment undertaken in this state. In fact in Biology some teachers circulated exemplars to assist schools before the QSA provided any. I would draw the inquiry's attention to the situation in Victoria and the implementation of their most recent senior science syllabuses. In that state there was extensive collaboration and consultation with teachers and the Victorian Chemistry Teachers Association maintains a website which has a comprehensive range of activities available for teachers.
Support materials in Victoria for Chemistry from the governing authority:
http://www.vcaa.vic.edu.au/Pages/vce/studies/chemistry/chemindex.aspx
Support Materials from the Victorian Chemistry Teachers Association:
http://www.cea.asn.au/vce-chemistry
http://www.cea.asn.au/vce-chemistry/school-assessed-coursework/school-assessed-coursework-examples
The key difference is that in this state the QSA at the outset alienated a significant proportion of its most experienced senior science teachers with the intent of implementing predetermined goals irrespective of the views of the very people it has told the inquiry it consults with and values.

From what I have outlined above I will tender the following conclusions to the Parliamentary Inquiry:

1. **The BSSS/QSA made a conscious decision over a decade ago to reduce the extent of mathematics and mathematical analytical skills in the senior sciences towards a much greater emphasis on literacy skills, particularly in assessment;**
2. **The QSA did not consult widely with experienced science teachers in the writing of the new syllabuses and consistently ignored their genuine concerns. The development of the new syllabuses was determined by philosophical objectives which were then imposed upon teachers;**
3. **At times representatives of the QSA have been rood to teachers and made derogatory comments, e.g. 'dinosaurs' though the term now has become a badge of honour representing conscientious objection;**
4. **The panels established to monitor the implementation of the new syllabuses and school assessment did not always reflect a broad range of views and expertise on senior assessment and in some instances**

there was a move to ensure that only those compliant towards the new QSA philosophy were appointed;

5. **The QSA poorly resourced the implementation of the new syllabuses and that lack of resources was compounded by the alienation of experienced science teachers who could have made major contributions in this area.**

Support of the Syllabuses by Teachers Today

The immediate aftermath of the implementation of the new senior syllabuses in Chemistry and Physics was the early retirement of a number of highly experienced science teachers and science Heads of Department that I knew. Speaking to teachers in other districts it is apparent that this occurred across the state. After the first year of the new Biology program in the school I worked in two of the senior Biology teachers, with post-graduate qualifications in Biology, refused to teach the subject further. They believed that the new Biology Syllabus had dramatically lowered the standard of science taught, had become a defacto 'SOSE' course with an over emphasis on 'issues' and 'beliefs' rather than science and analysis and that the assessment processes were seriously flawed. At the time of the introduction of the new Chemistry and Physics Syllabuses in four schools I am familiar with long serving heads of science departments chose to resign from their positions rather than support the new syllabuses. Over the next few years several others chose to bow out. These were highly competent individuals with strong science backgrounds who realistically should have kept teaching for at least another five to ten years. Similarly I am aware of quite a number of excellent teachers who at that time opted out of senior science teaching to focus on junior science, maths and even music education. So from the outset there was a core group of experienced science teachers vehemently opposed to the QSA's new syllabuses.

Since then I have seen teacher after teacher opt out of senior science education due to the same causes – disillusionment with what they have to teach, frustration with the interpretation of standards (exacerbated by the erratic pronouncements of panellists) and crushed by the workload of the huge assignments they have to mark and exams with open questions marked by vague criteria. In discussion with a colleague a few days ago she indicated that on the previous weekend it took her 3½ hours to mark four Year 12 Chemistry EEIs. Based on the number of students in her class to get them all marked will take at least 16 hours and then the two classes of assignments will have to be moderated adding at least another couple of hours of work. Most teachers do not enjoy this additional workload and many hate it – causing the exit over the past few years of more experienced teachers. Last year at the school I work one senior science teacher resigned and moved to Victoria to teach. Another was so stressed she could not mark one batch of assignments as well as her exams and was asked to be taken off senior teaching duties in the future. These are common stories across the state.

I believe that at the present time senior science teachers fall into three groups in terms of their views of the QSA syllabuses and assessment procedures. The first group, of which I am a member, are the **dinosaurs**. Usually members of the baby boomer generation we were educated in an era when science was very much the focus of society and often possess post-graduate qualifications in science. Also in this group are science teachers from other states that have moved to Queensland – they are younger but also philosophically are dinosaurs from the QSA perspective. We do not embrace the QSA philosophies of focussing on generic skills and language but value subject specific knowledge, skills and mathematical analytical ability – it was those skills that sent humans to the moon, discovered the structure of DNA and developed our modern technologies. Our perspective does not mean that we are not prepared to change when there are clear benefits for the students and most of us supported the previous syllabuses. We are highly stressed because we endeavour to jump through the QSA hoops with large assignments but still try to teach our students the science knowledge and skills we believe they need for tertiary study. We are also the teachers creating the stress on students as we attempt to maintain our standards resulting in our students not only having to do the huge assignments but do what students did in the past before the assignments.

The second group is supportive of the new syllabuses and the educational theory behind it – the constructivists. They have embraced the philosophy of the QSA that what is most important is the development of a good set of generic skills developed through enquiry. They don't particularly like marking the large assignments but find the workload less stressful than the dinosaurs because they don't to the same extent teach the additional theory and skills. Their students are less stressed because the EEI or the ERT is the focus of the term – they don't carry the burden of having to learn a lot of extra material.

The third group is typically made up of young teachers without strong backgrounds in science now having to teach senior sciences. Over the past few generations we have seen 'waves' of teachers from different disciplines come through the teaching community based on the popularity of those fields in our society. In the 1960s and 1970's it was science teachers followed by in the next few decades social science teachers and the current wave is that of physical education-sport science teachers. Many of the practising Biology teachers I know did not have a strong science focus at university and now I am regularly encountering teachers of senior Chemistry and Physics who did nothing in these areas since leaving high school. From what I have seen they have mixed views of the current Senior Science Syllabuses. If a school has embraced the QSA philosophy then they are sometimes relatively comfortable with them as they only need sufficient skills and background to deliver the teaching necessary to support the assessment program. On the other hand where a school expects the delivery of more comprehensive science teaching then members of this group are the most stressed of the science teaching fraternity and rely heavily on the support of the experienced science teachers – who are steadily exiting from the profession. These teachers are the meat in the sandwich.

Attitude of the Teachers Unions & Employers

I indicated earlier that after the QSA professional development day on the new science syllabuses a group of teachers decided to approach the Queensland Teachers Union to get the implementation delayed. They were long serving union representatives and elected to take their case to the union leadership at the next state conference. Discussions were held with one of the most senior officials in the QTU. I was not present but what was reported back to me was that the official had absolutely no interest in the case that was put. Reportedly the official did not want to upset things (QSA, the minister, the ALP??) and suggested that the science teachers should not be complaining as they would have less teaching to do under the new syllabuses. I understand that several other approaches were made to the QTU leadership who rebuffed all of the concerns raised. Disillusioned, several experienced teachers I knew with long affiliations to the QTU and the ALP chose to exit teaching.

The enquiry has been presented with a survey conducted by the Queensland Independent Education Union: http://www.qieu.asn.au/news/archive/2013/march/teachers-satisfied-with-qsa-processes/
It should be noted that **two key statements issued by the QIEU about the views of their members are strongly contradicted by their own survey results**:

'Of the 764 senior teachers who responded, a significant majority of all senior teachers in non-government schools indicated that they were satisfied with the core structures and processes of the Authority'.
I don't think the system of moderation through district panels and the assessment criteria can be considered anything other than core processes and structures of the QSA yet **the majority of Maths teachers responding disagree with the QSA criteria and the majority of Science teachers disagree with both the criteria and the panel processes. What is striking is the level of disagreement compared to English teachers:**

Question	Subject	StronglyAgree Agree	Neutral	Disagree Strongly Disagree
The range of criteria covered is appropriate in the subjects I teach.	Maths	39.7%	16.4%	**40.4%**
	Science	46.8%	16.2%	**35.3%**
	English	61%	17.6%	**20.1%**
Current external moderation processes (district and state panel processes) are working well in the subjects I teach	Maths	33.6%	21.2%	**41.8%**
	Science	32.9%	24.3%	**39.3%**
	English	41.5%	28.3%	**22%**

'A significant number of Maths and Science teachers have however, highlighted concerns with implementing QSA requirements. There is also a notable drop in satisfaction across all subjects when the focus in the questions shifts from QSA requirements to the implementation and operation of those requirements at the school level'.

The questions below specifically relate to the processes which occur internally within schools and for both Maths and Science teachers in no case do the majority disagree with the statements though there is higher dissatisfaction than the English teachers:

Question	Subject	StronglyAgree Agree	Neutral	Disagree Strongly Disagree
Current internal moderation processes are working well in the subjects I teach.	Maths	43.8%	19.2%	32.2%
	Science	45.1%	19.7%	31.2%
	English	54.1%	21.4%	22%
I am confident that the processes used in my department(s) to arrive at the exit grade for students and their placement on the SAI delivers accurate grades and placements for my students.	Maths	43.2%	23.3%	29.5%
	Science	48.6%	17.3%	26%
	English	54.1%	18.9%	20.1%

The QIEU survey reveals clearly that the majority of science teachers responding are dissatisfied with the QSA's criteria and panel moderation processes and when the whole survey is perused for many questions Maths and Science teachers show much higher levels of disapproval than their English counterparts. I would suggest that if the survey had occurred a few years earlier an even stronger negative response would have been obtained – in the interim many experienced teachers have opted out. It has to be born in mind that the QIEU undertook this survey under duress – a member contacted a senior official querying the union's support of the QSA syllabuses and was so disgusted with the response leaked it amongst other members who indicated their displeasure initiating the survey.

The attitude of the leadership of the two teachers unions in this state seem to be at odds with the aspirations of the members they purport to represent – at least the science and maths teachers. I had a discussion recently with one union official who was sympathetic to the complaints of science teachers and he outlined the rationale for the behaviour of the leadership of the unions as being due to the following:

1. The syllabuses and moderation processes protect members by lowering the level of accountability. 'Professional judgement' protects members much better than external exams – it is easier to 'hide' less competent teachers under the current system;
2. A growing number of Maths and Science teachers lack the skills of their predecessors. The use of syllabuses with a lowered maths and science content and open criteria reduces the levels of skills needed by classroom teachers;
3. Union officials are philosophically opposed to all forms of 'high stakes testing' (external exams) whether they be the QCS Test, NAPLAN or external subject exams;
4. Some officials have strong ties to the education 'establishment' including the QSA and some sections of the tertiary sector, specifically the education faculties of some universities. They philosophically have different views on education to those of older science teachers;
5. Senior officials do not wish to politically 'rock the boat' to upset future career aspirations.

Science teachers through various forums have tried to voice their concerns but have been rebuffed at every turn. Prior to the introduction of the new science syllabuses some of the most experienced Heads of Department attempted to work through Education Queensland to get the introduction of the syllabuses delayed so that they could be reviewed but their requests fell on deaf ears. Another submission has pointed out that the QSA has cited results from a survey of teachers yet everyone I have consulted with was unaware that they had conducted a survey. Catholic Education Services forwarded an email to their employees indicating they were going to prepare a submission for the inquiry. At the time of writing (less than a week before submissions close) all of the science teachers and science Heads of Department I have spoken to that work for CES have indicated that they have not received any further contact or been asked to have input.

It is recognised that nationally there is a growing shortage of maths-science teachers. In Victoria there still exists the requirement that a pre-service teacher completes four semesters of tertiary study in subjects of their senior teaching area. There have recently been inquiries and audits in Victoria focussing on the recruitment of science teachers and student retention rates in the senior sciences. Even though there is a science teacher shortage in that state last year all vacancies were filled by person with this prerequisite (http://www.audit.vic.gov.au/publications/20120606-Science-and-Maths/20120606-Science-and-Maths.pdf). This highlights the serious negative impact of the exodus of experienced science teachers from the Queensland system which has occurred in recent years. Increasingly I have to train senior science teachers that don't have a strong

background in their subject areas. It is generally acknowledged that the quality of the classroom teacher has a major effect on the interest and performance of students. Older discipline-competent science teachers are what we should be trying to retain but their views in this state have been treated with contempt by the QSA, educational theorists and the unions that are supposed to represent them. One of the most experienced and respected Maths B teachers in the district I work in made the statement recently that if we start now it might take twenty years to repair the damage done to maths education by the maths syllabuses. If things are to be turned around then it better start immediately while there is still enough expertise left in the teaching workforce – five years from now it may not be possible.

Student participation levels

There is a general concern across Australia about a decline of enrolments in tertiary science, maths and engineering courses. No doubt much of this can be attributed to changes in Australian society. When I was in school we were trying to send people to the moon and science was to the fore in education. Today sport dominates our society and science is considered to be 'nerdy'. Some people advocate making science more 'sexy' to attract students to it. I would express caution about that sentiment as though I view positively anything that increases students' interest in science and improves enrolments it should not take place at the expense of quality teaching of science knowledge and skills.

It has been suggested to the inquiry that enrolments in senior Chemistry, Physics and Biology have declined in Queensland. The QSA has attempted to counter these claims with the graphs it has submitted. What is not clear from the graphs and data they have supplied is if they represent the percentages of all Year 12 students or the percentages of all OP eligible students. The latter is relevant for over the last five or so years the percentage of Year 12 students being OP-eligible has declined markedly reducing the sample size for the calculation of these percentages if the latter is the case. In the past virtually all Chemistry and Physics students were OP-eligible but in Biology there was certainly a presence of OP-ineligible students. If the sample size has been reduced then the use of percentages may be masking declines in terms of the total student population in Year 12.

It might be more relevant to compare the percentage enrolments in the sciences between the eastern states. Presented below are the approximate percentages of student enrolled in Biology, Chemistry and Physics sourced from data and graphs available on the web and the QSA graphs (http://www.boardofstudies.nsw.edu.au/news-media/media-guide-2012/numbers.html ; http://www.audit.vic.gov.au/publications/20120606-Science-and-Maths/20120606-Science-and-Maths.pdf). It is notable the percentages are lower in Queensland in all three sciences:

Subject	Qld (2012)	NSW (2012)	Vic (2010)
Biology	19%	24%	22%
Chemistry	14%	16%	17%
Physics	9%	14%	14%

As other submissions have indicated the primary factors influencing senior subject selection by students are their future career choices and tertiary prerequisites, their ability in subjects, workload and intrinsic interest and enjoyment they gained from studying them in their junior years. Most students study Chemistry because it is a prerequisite for a large range of tertiary health and science degrees and I would expect enrolments to be relatively stable. The lower percentage enrolling in Physics could be caused by several factors. It may be that there are fewer universities in Queensland that require Physics as a prerequisite or recommended for tertiary courses than compared to interstate. An alternate explanation may be that students in Queensland who have a lower average ability in maths compared to their interstate peers (as demonstrated by national testing) are intimidated by the subject.

EEIs are claimed to stimulate interest in science which may be true up to a point but in Queensland in some cases they have become so onerous that students can have a negative view of them. EEIs have a tendency to focus on one specific area of Chemistry, Physics or Biology. While students generally enjoy practical work the investigation of a single project which they are not particularly interested for an extended period (e.g., investigating wine

fermentation in Chemistry, collisions in Physics or plant structure in Biology) can actually lower student interest in science. This is where SEIs – a series of pracs – have an advantage. Even though some of them might be 'boring' to students others may spark their interest. This has been recognised by Victorian educators who having implemented large CATS (Common Assessment Tasks) changed their syllabuses so as to favour diverse practical activities.

Some teachers claim science enrolments are declining while others and the QSA say they are not. From my observations what is happening is this. Students in schools having programs where EEIs and ERTs are the basis of the teaching and assessment of the units each term don't appear to be excessively stressed. They still don't like the large assignments but they don't feel overwhelmed as additional knowledge and skills don't have to be learnt. Where teachers believe that skills other than those directly delivered in those projects are important and will be assessed on later exams then the workload can overwhelm many students, i.e., dinosaur teachers such as the author. I have worked in a school where the former was the case and I admit that it was much less stressful to myself and students than now where I work in a school expecting that the students develop comprehensive knowledge whether it is needed for EEIs and ERTs or not. I left the former school, however, though frustration at the low standard of education I believe I was providing to my students. So I think to some degree there is a case of swings and roundabouts here – in some schools where teachers are trying to maintain the previous standards the study workload is influencing the number of science subjects that students do. In schools that have embraced the new philosophy with a reduced emphasis on knowledge and exams enrolments may be stable or increasing.

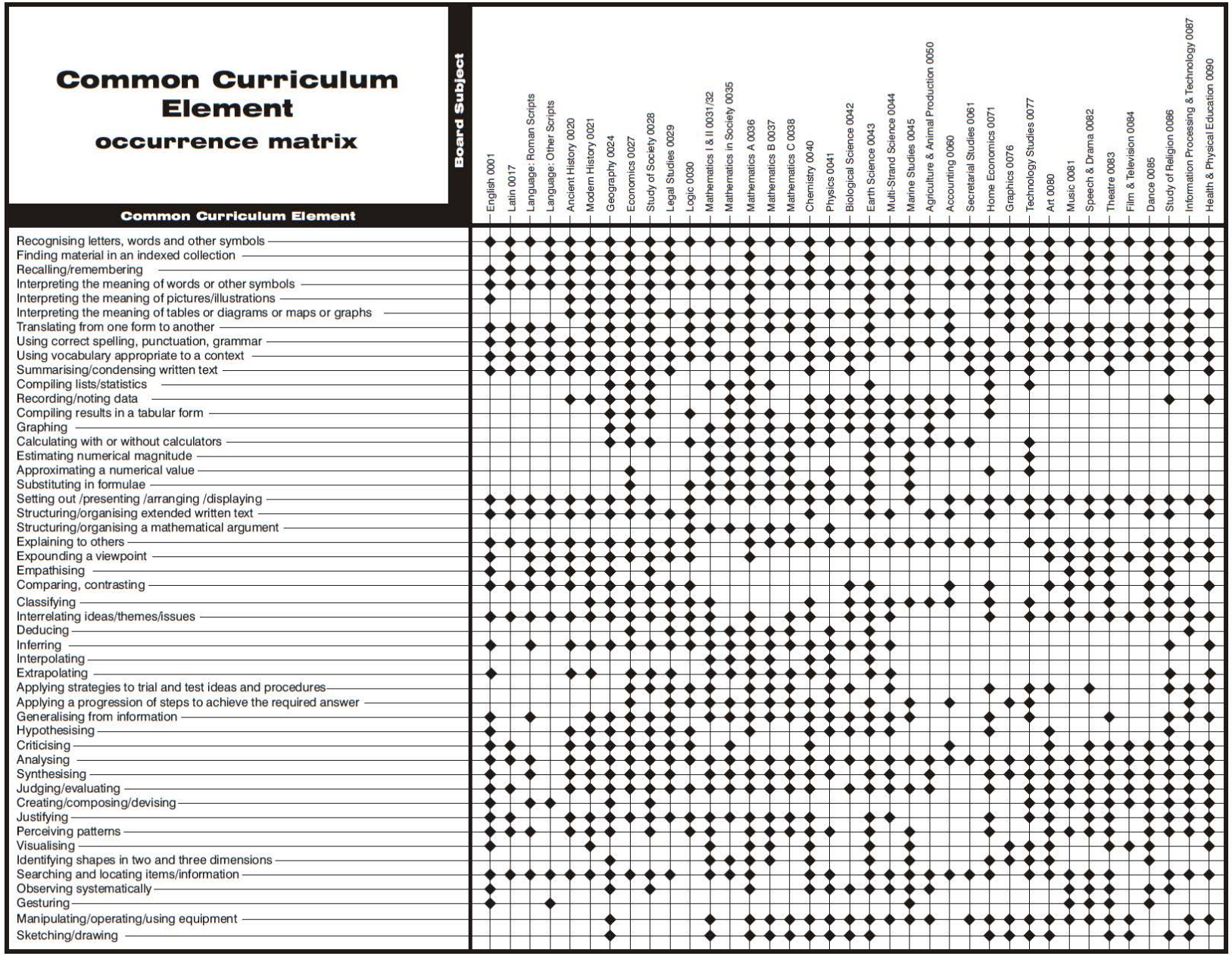
My experience is that the senior science being most impacted by the new assessment regime is Biology. It has always been an optional subject in that tertiary courses do not demand it as a prerequisite. In the past many students desiring to enter medicine, dentistry and veterinary science would study Chemistry as it is a prerequisite and Biology; even though Biology is not mandated for those courses it provides a good foundation for them. Under the new syllabuses time and time again I see students avoiding Biology even when they are going to study a biological science at university such as zoology or environmental science. The students provide two reasons. Firstly the assignments (EEIs and ERTs) are at times even bigger than those in Chemistry. One third of the Biology assessment is devoted to evaluating issues and meanings so in their journals students often have to evaluate information sources for bias, positioning, etc., adding greatly to the workload.

Secondly, students are now enjoying the content of Biology less than they used to. One comment placed on the 'Plato' website is that Biology has been 'reduced to a science-themed humanities course' and that is how many students see it too. **Biology students absolutely despise evaluating sources, meanings, issues, etc**. Mention 'global warming' and you get howls of protest from them. Most of us teach Biology because we care about the future of the planet and our society. Resolving the issues that face us requires the community being scientifically literate – not from the point of view of language but from the perspective of experimental design, data validity, data analysis etc. Biology students in my experience are sick of evaluating issues but if you teach them the skills of analysing of ice core samples as evidence of climate change they switch on. Evaluating sources of information for bias, positioning etc. are valuable skills but they are taught in great detail in the humanities. To help our society teachers will of course discuss the issues around topics but the teaching and curriculum of Biology needs to be focussed on the science. **Time and time again I have heard students iterate that they won't enrol in Biology as they don't want to do the 'stupid SOSE assignments'**. **Mainstream science and medicine students are turning away from Biology**. Enrolments might be stable because Biology is attracting a different type of student with more of a humanities focus but we are losing some of our best and brightest from the subject. What makes things worse is the heavy 'SOSE' influence that has been introduced into the junior science Australian Curriculum. It will turn even more students off studying science in later years.

Even his critics would concede that former Premier Peter Beattie showed wisdom in focusing science research and innovation in Queensland in the direction of biotechnology. Today for a modest investment schools can provide the facilities for students to extract and study their own DNA, genetically engineer microorganisms, things that were only done in universities a decade ago and are being undertaken widely in high schools in the other states – but not in Queensland. And what are we doing in Biology in Queensland? We have our students on the internet researching social issues and in their journals evaluating sources for positioning, bias, etc. It is an absolute disgrace.

So I would like to make a plea to the Parliament of Queensland. If you reform Chemistry and Physics education in Queensland then please include Biology. What is happening to Biology education in Queensland is breaking the hearts of a lot of older teachers.

Appendix 1


Common Curriculum Element
occurrence matrix
Board Subject
Common Curriculum Element
English 0001
Latin 0017
Language: Roman Scripts
Language: Other Scripts
Ancient History 0020
Modern History 0021
Geography 0024
Economics 0027
Study of Society 0028
Legal Studies 0029
Logic 0030
Mathematics I & II 0031/32
Mathematics in Society 0035
Mathematics A 0036
Mathematics B 0037
Mathematics C 0038
Chemistry 0040
Physics 0041
Biological Science 0042
Earth Science 0043
Multi-Strand Science 0044
Marine Studies 0045
Agriculture & Animal Production 0050
Accounting 0060
Secretarial Studies 0061
Home Economics 0071
Graphics 0076
Technology Studies 0077
Art 0080
Music 0081
Speech & Drama 0082
Theatre 0083
Film & Television 0084
Dance 0085
Study of Religion 0086
Information Processing & Technology 0087
Health & Physical Education 0090
Recognising letters, words and other symbols
Finding material in an indexed collection
Recalling/remembering
Interpreting the meaning of words or other symbols
Interpreting the meaning of pictures/illustrations
Interpreting the meaning of tables or diagrams or maps or graphs
Translating from one form to another
Using correct spelling, punctuation, grammar
Using vocabulary appropriate to a context
Summarising/condensing written text
Compiling lists/statistics
Recording/noting data
Compiling results in a tabular form
Graphing
Calculating with or without calculators
Estimating numerical magnitude
Approximating a numerical value
Substituting in formulae
Setting out /presenting /arranging /displaying
Structuring/organising extended written text
Structuring/organising a mathematical argument
Explaining to others
Expounding a viewpoint
Empathising
Comparing, contrasting
Classifying
Interrelating ideas/themes/issues
Deducing
Inferring
Interpolating
Extrapolating
Applying strategies to trial and test ideas and procedures
Applying a progression of steps to achieve the required answer
Generalising from information
Hypothesising
Criticising
Analysing
Synthesising
Judging/evaluating
Creating/composing/devising
Justifying
Perceiving patterns
Visualising
Identifying shapes in two and three dimensions
Searching and locating items/information
Observing systematically
Gesturing
Manipulating/operating/using equipment
Sketching/drawing