SMC&PA Submission 35
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Personal submission to the Education and Innovation Committee on assessment methods in senior mathematics, chemistry and physics in Queensland schools

Section1: Personal Background: Who I am and why I am writing

I make this submission as a Chemistry teacher of some experience and also as the father of four children who have gone on to study science at University. I have taught year 11 and 12 Chemistry for 23 years and have been a district panel member for most of that time. I have written work programs for the last two Chem. Syllabi and have worked in small and large state schools. I currently manage the senior Chemistry program at a leading North Queensland Independent school in which 80 to 100 students enrol in year 11 Chemistry each year.

I have always attempted to present Science to my students and to my own children as an enjoyable and worth-while field of endeavour. I believe my efforts have been generally successful because of feedback from former students and because my own children have all studied science related fields at University. Two of my children have graduated in medicine, one in medical imaging, and one is currently studying dentistry. One child won the [redacted] University Medal for medicine at [redacted] University.

I write this not to boast but to demonstrate that Science and Science education has always been central to my life and that of my family. I therefore feel saddened to be teaching a Chemistry syllabus that is so complex and clumsy that it seems to me to reduce student interest in Science rather than stimulate it. Further, I have seen my youngest son struggle with poorly designed assessment instruments at the State High School he attended in year 11 and 12. Assessment in Science and Maths at that school was so unfriendly to students that it almost caused my son, who is no less intelligent or diligent than his siblings, to abandon studies in Science. Yet the assessment used at that school was completely consistent with the current QSA syllabi.

In the following section of this submission I have written brief summary points of my response to the different terms of reference. These points are expanded upon in section 3.

Keith Smith

25th April 2013

Section2: Summary of my response to Terms of Reference issues.

(a) Term of reference: *The ability of assessment procedures to support valid and reliable judgements of student outcomes.*

I have dealt with this under two headings, firstly considering the effect of the mandated types of assessment and secondly the effects of the mandated assessment criteria. All comments pertain to the 2007 QSA Chemistry Syllabus.

<u>The effect of assessment instruments</u>

(i) Limit of assessment types to 3 set forms prevents the use of other valid assessment types.
(ii) Mandated assessment types do not match those used by University Science courses.
(iii) Year 11 work, which comprises half the course, can't be used to contribute to a student's rank at year 12 exit.
(iv) EEI's and ERT's are not good methods of assessment.
(v) QSA rules and the realities of the panel system do not allow district panels to provide advice to schools on use of student-unfriendly forms of assessment.

<u>The effect of assessment criteria</u>

(i) Nine sub-criteria produce an overly complex system.
(ii) Assessment criteria are not consistent with the QCS test or with University assessment.
(iii) Criteria are unclear and the interpretation of these by teachers is often subjective.
(iv) The complexity of criteria descriptive statements make them difficult to understand by students and parents.
(v) The method of attaining a holistic judgement of student performance demanded by the syllabus is unworkable for a cohort of more than a few students and is generally not followed by schools when determining student exit rankings.

(b) Term of reference: *Ensuring assessment processes are supported by teachers.*

(i) Syllabus expectations regarding teaching and assessment are vague and open to subjective interpretation, thus causing anxiety in teachers.
(ii) QSA judgements on what constitutes an acceptable work program are inconsistent between schools.
(iii) QSA representatives are reluctant to give clear advice to schools.

(c) Term of reference: *Student participation levels.*

(i) The "contextual approach" to Chemistry teaching was unnecessary and has done nothing to increase student participation in the subject.
(ii) The 2007 syllabus has not increased student participation in Chemistry.

Section 3: Detailed response to Terms of Reference issues.

(a) Term of reference: *The ability of assessment procedures to support valid and reliable judgements of student outcomes.*

<u>The effect of assessment instruments</u>

(i) Although section 7.4 of the 2007 Chemistry syllabus implies that a range of assessment types are acceptable, in practice the QSA acting through district panels, will not permit many valid and useful forms such as quizzes, short laboratory reports, multiple choice tests and short oral presentations. This is because weighting of different assessment instruments is not possible because of the stipulation that the verification folio must contain no more than six summative pieces of assessment. This restriction on assessment type means that it is difficult to make reliable judgements of a student's ability at Chemistry. This point is further explained in section 3 (a) part (iv) on the effects of EEI's and ERT's, and also in the next section on the mismatch between high school and University assessment.

(ii) Forms of assessment advocated by the syllabus do not match assessment used in University Science and applied science courses. This seems foolish as most students undertaking senior Chemistry do so as a pre-requisite for tertiary studies. The following comparison illustrates this point.
Here is the year 12 assessment plan from the example Chemistry work program on the QSA website. All assessment is equally weighted in it's contribution to the year 12 exit level of achievement.

Course assessment plan (Year 12)

	Unit	Length *(hours)*	Assessment		
			Category	Criteria assessed	Description
Year 12 Semester 3 (55 hrs)	#5 Energy and rates of reaction	30	#5 Extended Experimental Investigation	KCU, IP, EC	Time allowed: 4 weeks 1000-1500 words for Discussion/conclusion/evaluation/recommendation Access to resources: Open Collaboration: Group or individual data collection, individual written scientific report Authentication: Teacher observation, Journal (if used), declaration
			#6 Supervised Assessment	KCU, IP, EC	Time allowed: 90 minutes Techniques: Practical exercises, stimulus response Access to resources: Closed Conditions: supervised
	#6 Corrosion (context)	25	#7 Supervised Assessment	KCU, IP, EC	Time allowed: 120 minutes Techniques: Short items, paragraph responses, practical exercises, short responses to unseen stimulus materials Access to resources: Closed Conditions: supervised
Year 12 Semester 4 (55 hrs)	#7 Equilibrium and Acids and Bases	28	#8 Supervised Assessment	KCU, IP, EC	Time allowed: 90 minutes Techniques: Practical exercises, paragraph responses Access to resources: Closed Conditions: supervised
	#8 Gas Laws	27	#9 Supervised Assessment	KCU, IP, EC	Time allowed: 90 minutes Techniques: Practical exercises, paragraph responses, responses to seen stimulus materials Access to resources: Closed, stimulus given one week prior Conditions: supervised

And here are assessment overviews from some tertiary science courses for which Chemistry is a prerequisite.

University course	Institution	Assessment
CH1001 - Chemistry: A Central Science	JCU(Townsville)	end of semester exam (60% - 70%); laboratory work and reports (20% - 30%); assignments (0% - 10%).
EG1000 - Engineering 1	JCU(Townsville)	end of semester exam (50% - 70%); on-course assessment, some of which may be invigilated (30% - 50%).
MD1010 - Introduction to Integrated Medical Studies Part 1 of 2	JCU(Townsville)	end of semester exam (60%); other exams (20%); assignments (20%).
CHEM1010 - Sem 1 2013 (general Chemistry)	Univ. of Qld(St Lucia – internal)	*Exam - Mid Semester Outside Scheduled Class*22%; *Laboratory* Five Practicals 20%; *Computer-based Assessment* Three Computer Quizzes 10%; *Computer-based Assessment* Online Laboratory Quiz 4%; *Exam - during Exam Period (Central)*End Semester Examination 44%
CHEM1020 - Sem 1 2013 (Chemistry for Engineers)	Univ. of Qld(St Lucia – internal)	*Computer-based Assessment* Computer Quizzes7.5%; *Exam - Mid Semester Outside Scheduled Class* Mid-Semester Exam 20%; *Report* IS-IT Research task 12.5%; *Practical* Laboratory 20%; *Exam - during Exam Period (Central)* 40%.

As can be seen, University courses give different assessment items different weightings and use forms of assessment which differ significantly from the QSA model. Consequently, assessment currently used in high school Science does not prepare students adequately for University courses and does not allow school students or their teachers to make valid judgements about their potential to succeed at University.

(iii) Under QSA directions to district panels, year 11 work cannot be included in the year 12 verification folios. I think that this detracts from making valid judgements of student outcomes because a student's level of understanding will vary from topic to topic and hence also will their ability to achieve at different assessment instruments. By not allowing half of the course of study to contribute to overall achievement some students will be disadvantaged.

(iv) EEI's and ERT's are not good methods of assessment and the use of these will not result in reliable or valid judgements of student achievement. This is especially true if these instruments are poorly designed. The school year is crowded. Public holidays, sports days, reporting deadlines, co-curricular activities, QCS practice, pastoral care initiatives, together with shortened lessons for school assemblies and ceremonies all cut into the time available for teaching and learning. It often seems

> that there is barely time available for the minimum 55 hours per semester required by the Senior Science syllabi. This is especially true of the second semester in year 12 when seniors finish early in order to fit in with state reporting deadlines. Emphasis on long duration non-test assessment such as EEIs and ERTs mean there is less time available for basic concepts and skills. There is a danger that students will not develop a good grounding in writing formulas, balancing equations, stoichiometry, periodicity, and structure and bonding.

If the recommended minimum time of four weeks for an EEI is adhered to then available time for teaching other topic in Chemistry is significantly reduced. ERTs have a similar effect on student learning although the requirement of two weeks minimum class time is less. Having tutored students from schools where the assessment is divided evenly between test and non- test I can say that their grasp of fundamental concepts definitely seems weaker than students from schools where the emphasis is on exams. For this reason I have always advocated a minimalist approach to non – test assessment in schools where I've taught Chemistry. I believe this leads to enhanced student outcomes. In my experience students suffer less stress and learn more Chemistry when they are not asked to spend many hours constructing EEI reports and ERT essays. Evidence that supports my belief are the high proportion of my Chemistry students who achieve VHA's (usually over 20% of the cohort) and comments from former students that their high-school Chemistry gave them an excellent grounding for first year University Chem.

As Science teachers we will always face the dilemma of what aspects of our subject to continue to teach as being 'fundamental' to its understanding and which aspects have to be left for later specialised studies. I do not believe emphasising EEIs and ERTs in a Chemistry teaching program is a solution to this. Too often students have to investigate concepts in Chemistry or Physics that are beyond the scope of high-school Science or are trying to collect data of detail or precision beyond the limits of school laboratory equipment. Good design of EEI tasks will avoid this; however I have seen students from other schools struggling with concepts such as the detailed Chemistry of marine artefact restoration or of the Physics of resonance of wine glasses. The danger of poor design of ERT or EEI tasks is that students are faced with the predicament of either dealing with a topic in a superficial way or of going into depth beyond their understanding and quoting formulas and research articles that neither they nor their teacher can understand. The net result of such tasks is that students spend a lot of time learning about a very narrow aspect of Chemistry or Physics and that they may not even understand what they are investigating. They would gain a far better understanding of Chemistry or Physics by spending the time on broader, more guided studies.

Lastly, an ironic consequence of EEIs is that even though they are an 'experimental' investigation, they can result in limiting the amount of practical laboratory manipulative skills a student will experience during the two year course. A term spent on spectroscopy or wine-making means less time for titration or gravimetric analysis. In contrast, a regular program of small experiments mean students can incrementally build their lab skills over the two year course.

In summary, I believe that many Chemistry work programs have too much emphasis on non-test assessment. Many EEIs and ERTs are poorly designed and cause undue stress to students while limiting their overall understanding of Chemistry. While formulating hypotheses, designing experiments, researching literature, and learning practical skills are essential aspects of a high-school Chemistry course, there are much better ways to cover these than by the current QSA emphasis on EEIs and ERTs.

(v) There are no grounds, under the QSA's rules' for district panels to criticise schools that have unwieldy and student-unfriendly assessment and marking. Neither are there mechanisms which allow criticism of school's where grading obviously favours non-test assessment. In my time on district panel I've seen profiles of year 12 results which are very similar to the following. *These examples are obviously hypothetical but I have written them to imitate those of actual schools I have seen in my work as a district panel member.* Legal and ethical constraints prevent me from naming these schools.

School #1:

Year 12 Assessment	**Summary Grades**		
	KCU	**IP**	**EC**
ERT	B	B	B
EEI	B	B+	A-
SA	D	D	E
SA	D	D+	D
Interim LOA	C	C+	C
Verification	**SA**		
ERT			
LOA			
Exit			

School#2:

Year 12 Assessment	**Summary Grades**		
	KCU	**IP**	**EC**
ERT	C	C-	D
SA	C+	B-	B-
EEI	C-	C-	C-
SA	B-	C	B-
Interim LOA	C+	C	C
Verification	**SA**		
SA			
LOA			
Exit			

School#3:

Year 12 Assessment	**Summary Grades**		
	KCU	**IP**	**EC**
SA	C-	C	C
EEI	C+	B-	C-
SA	C+	C	B-
SA	C-	C	C
Interim LOA	C	C+	C
Verification	**SA**		
SA			
LOA			
Exit			

The “hypothetical” example from school#1 has student LOA’s inflated by non-test assessment. This could be due to poor control of student ownership or because of excessive coaching by the teacher. This pattern was seen in most of the verification sample folios from this school, and resulted in a student with an obviously poor understanding of Chemistry being rated as competent to undertake tertiary studies in the subject. As the post-verification assessment was also non-test, this student could exit as an SA+.

“Hypothetical” school #2 has poorly designed EEI’s and ERT’s and student work in most verification sample folios reflects this, with students typically doing better at exams. This was particularly true of boys and some girl students seemed to be rewarded for writing excessively wordy reports that went beyond the written requirements of the task. On the basis of understanding of Chemistry this example student would be better placed as a SA+ at verification.

“Hypothetical” school #3 uses a minimum of non-test assessment and keeps this as simple and clearly written as possible. There is no obvious bias in the sample folios in favour of or against non-test assessment or between boys and girls. Of the three schools, this is the only one which produces a valid and reliable judgement of student achievement in Chemistry.

Despite the obvious problems outlined above, submissions from each of these schools have been given the stamp of approval by district panel. I think that this is partly due to district panels always being in a hurry to review school submissions due to time restrictions and partly due to the advice from the QSA that district panels have the job of *“Supporting school decisions, or providing advice, justified using evidence matched to syllabus standards (and/or to the requirements of a syllabus).”*(QSA monitoring review notes 2013) Too often the emphasis is placed on supporting school decisions rather than providing advice to change student LOA’s. The bank of appropriate comments supplied by the QSA push panels in this direction as does the knowledge by panellists that syllabus statements are so vague and open to interpretation that panel decisions can be easily overturned. I strongly believe that the QSA ethos, as exemplified by its “panellists comment bank”, the rushed nature of the review panel process, and the vagueness of the syllabus combine to drive down standards in high school Chemistry courses.

The effect of assessment criteria

(i) These are too complex. Three criteria each with 3 sub criteria produce 9 areas students have to be assessed in. This distorts assessment programs as teachers strive to give their student's opportunities to achieve in as many of these as possible. For example, not all Chemistry topics are suitable for assessing "exploration of scenarios and possible outcomes with justification of conclusions/recommendations" (EC 2), yet it is in a student's best interests for their Teacher to include this in as many assessment pieces as possible. This can lead to the unwieldy assessment discussed in point (v) above or to a further weakening of the content of a Chemistry course. That is, instead of including topics which help prepare a student for tertiary studies in Chemistry, a teacher may spend valuable class time on action research projects of dubious merit in order meet assessment criteria such as EC2.

(ii) Despite excessive complexity, not all useful forms of assessment fit the assessment criteria. For example, multiple-choice questions are very difficult to match to the range of assessment criteria, especially at an A or B standard of achievement. Yet multiple-choice questions comprise half of the QCS test and University Chemistry courses do not use such complex criteria. (see section(ii) above) Once again the QSA Chemistry syllabus fails to prepare students for tertiary education.

(iii) The language of syllabus exit standard descriptors allows for an open interpretation and so reduces the reliability of judgements of student outcomes. For example, KCU exit standard descriptors use the word "challenging" for A and B standards but it impossible for anyone but the class teacher to know if a method of solving a problem has been taught, so reducing the "challenging" aspect of an exam question. In IP1, to distinguish between an A and a B standard of response teachers must decide if the formulated hypothesis was "significant" or not, and who could tell what "significant" means in this context? There are several other examples of ambiguous language to be found in the exit statements and this causes disagreement between teachers and results in poor reliability of judgement of student outcomes.

(iv) Students and their parents have even more difficulty understanding syllabus assessment criteria than teachers do. It is very difficult to explain to a student that they were given a B for EC2 in their EEI because the conclusion of their report was more of a "discussion" and less of a "justification". Students may be accustomed to such semantic hair-splitting from English teachers but it was the last thing they were expecting when they enrolled in Chemistry. Parents find it even more confusing. They usually imagine that if their child is getting a C in a knowledge test in Chemistry, they are getting correct answers to about half of questions put to them. Instead the QSA expects teachers to tell parents their child is able to "reproduce concepts, theories, and principles, explain simple processes and phenomena, and apply algorithms, principles theories and schema to find solutions in simple situations." No wonder parent's eyes glaze over at parent-teacher interviews! How reliable and useful can judgements of student progress be when students and their parents can't understand what a student's weak points are and what they must do to improve?

(v) At the end of year 12 teachers are expected to place each student at a particular level on a 50 rung ladder. The advice given by the QSA to assist with this process is given in the following statement which must be included in any Chem. work program.

> "An on-balance judgment must be made about the student's achievement in each criterion of the exit standards. It is not an appropriate practice to 'add-up' or aggregate grades to arrive at an overall judgment about the level of student achievement within each criterion. An on-balance judgment will be made in each criterion based on each student's responses to the assessment instruments. This judgment is informed and validated by matching the student's responses to the standards associated with the exit criteria (Senior Syllabus Chemistry 2007, p28-29)."

This is another example of the QSA being out of touch with reality and which further results in poor reliability of judgement of student outcomes. For cohorts of 50 -100 students this method of ranking students is impracticable. Most schools with cohorts of 20 or more use spread sheets and some form of numerical formula to at least roughly rank students yet all must pretend to use the vaguely stated 'holistic' judgement of student achievement mandated by the QSA. This exit level ranking has a direct impact on a student's OP score and hence on their future University and career options but because the QSA neglects to give clear and realistic advice on the method of assigning it, the reliability of this judgement is dubious.

(b) Term of reference: *Ensuring assessment processes are supported by teachers.*

(i) Expectations regarding teaching and assessment as given in the syllabus are so vague and open to interpretation that expectations of district and state panels continually change over the lifetime of a syllabus. This means that assessment procedures may vary considerably from one school to another. For example, a school that has its work program approved early in the lifetime of the syllabus may have year 11 assessment included in the year 12 verification folios or may have some assessment instruments weighted differently from others. Another school seeking to have the same features included in its work program may have them rejected because the program was submitted at a later date. This often makes work program submission a galling and frustrating process for teachers.

(ii) This gradual changing of syllabus expectations with time also applies to assessment instruments and is another source of frustration for teachers. For example the interpretation of the term “systematic analysis” in IP3 has gradually come to be interpreted as requiring data from more than one source be analysed in exam questions and for EEI’s to investigate more than one variable. This means that assessment instruments which are considered satisfactory for one cohort of students may no longer be considered satisfactory for the next.

(iii) QSA representatives are notorious for not giving clear judgements on questions of syllabus interpretation. The standard response is “Write down what you want to do and we’ll tell you if it’s satisfactory or not. If it’s not satisfactory we won’t tell you clearly what you should do, so just do it again and we’ll tell you when you eventually get it right” This attitude, together with the complex and ambiguous language used in the syllabus make many teachers loath to support the current syllabus any more than they have to in order to get their students through the course.

(c) Term of reference: *Student participation levels.*

(i) So called “contextual units” have done nothing to change student enrolment numbers. All effective Chemistry teachers have always included ‘real world’ examples in their teaching and there was never a need to mandate contextual units of work. In addition, many contextual units of work are poorly designed and lead to a disorganised approach to teaching Chemistry. Chemistry, like maths, should be presented as a focussed and sequential series of topics with the learning of one providing the foundation for the next and poorly designed contextual units may disrupt this. For example, a contextual unit may have an attention-grabbing title such as “The Chemistry of fire and explosives” but the substance of this unit is a confusing jumble of organic chemistry and thermochemistry covered to very little depth with a little extra on fire safety thrown in for good measure. Reports of ineffective and confusing units of work like this quickly spread between students and do little to encourage the next year level to choose Chemistry in year 11.

(ii) There has been no increase in numbers of students enrolling in Chemistry since a work program based on the 2007 syllabus was introduced in my school. This is because students enrol in Chemistry because they see it as a necessary prerequisite for University courses and not because of whatever form the syllabus happens to take. Students expect teachers to interpret the syllabus in a way that is interesting and which teaches them the Chemistry they need for their further education. They also expect the course to be assessed in a way that allows a hard-working intelligent student to achieve a good grade. Effective Chemistry teachers always strive to meet these expectations and the form the syllabus takes determines the degree of difficulty of this task. The current syllabus makes this very difficult indeed.