SMC&PA Submission 110
Received: 13 May 2013

Submission to the Education and Innovation Parliamentary Committee
Parliament House, Brisbane Qld 4000
Email: eic@parliament.qld.gov.au
Inquiry into Assessment Methods for Senior Maths, Chemistry & Physics

Purpose of this submission… To identify significant problems with current senior syllabi in Physics, Chemistry and Mathematics. Particularly, the failure of these syllabi to provide valid and reliable judgments of student outcomes in these subjects.

Date of Submission: May 13, 2013

Please note: the following submission constitutes my personal views and does not represent the views of the school or university at which I teach.

Dear Committee Members,

I have been a senior secondary teacher in Physics, Chemistry and Mathematics in Queensland since 1978 and have for extended periods during that time held the positions of…

- A member of the Mathematics Subject Advisory Committee (SAC)
- A lecturer in Science Pedagogy at The University of Queensland
- A chairman of a Mathematics Syllabus Sub-committee
- A member of the district panel for Physics
- A member of the district panel for Chemistry
- A member of the state panel for Logic / Philosophy and Reason
- Head of Physics and Chemistry at St Rita's College
- Head of Mathematics and Logic at Marist College, Ashgrove
- A Chief Examiner for the QSA Senior External Examination team

My involvement in the late 1990s and early 2000s with the formation and development of the Queensland syllabi in Mathematics A, B and C, as well as my role in developing the current syllabus in Philosophy & Reasoning meant that my involvement in the two disastrous trial/pilots in Physics and Chemistry was minimal. It was only later, when an Extended Trial/Pilot was conducted with a second proposed syllabus in these subjects, that I raised my concerns with the QSA and highlighted their serious deficiencies and faults. Later, when a third syllabus was proposed for implementation without trial, I again registered my deep concerns. I was subsequently contacted by Mr Kim Bannikoff (Director of the QSA) who requested a meeting with me at my school (March 2007).

The meeting with Mr Bannikoff was attended by all the senior science teachers at my school and each outlined their concerns with the proposed syllabi. To help identify the sources and motivations for these worrying syllabus features, the attached overview [1] of the process by which the QSA had arrived at their senior science syllabi was presented and discussed. After a lengthy and frank discussion with Mr Bannikoff, I was invited to participate in the

[1] See Attachment 1

subsequent Focus Group in their attempt to correct the serious flaws in these syllabi before they were considered for implementation in Queensland schools.

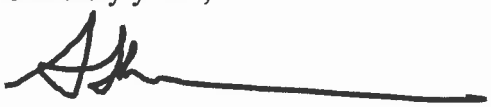
At the Focus Group meeting, seven major changes were proposed and agreed to, and the writers of these latest syllabi in Chemistry and Physics were directed to amend them accordingly. The final documents were not subsequently distributed for final comment and approval, but instead the syllabi were hastily introduced without trial. The resulting interpretation and implementation of these syllabi, unfortunately, fell well short of the principles which the QSA claimed were driving the curriculum review process [(2)].

My great disappointment with both the poor science pedagogy as well as the unbalanced and unreliable assessment methods that resulted from the flawed development and implementation of these syllabi, caused me to quit my involvement in teaching of senior science in Queensland, to sever my involvement with the QSA and to redirect my energies into the preparation of future teachers of science. I address those specific features and methods that are of immediate concern to this inquiry below.

My involvement in the development and implementation of the Mathematics A, B and C syllabi as well as the Philosophy and Reasoning syllabus provide a sharp contrast to my experiences with the senior science syllabi. My deep concerns with the validity and appropriateness of assessment based on extended assignments in senior Mathematics arise from the way in which these syllabi have been interpreted by district and state panels. I continue to teach Mathematics and look forward to the redressing of these issues, hopefully through the deliberations of this Inquiry.

My work in writing and lecturing the EDUC3292 course in Science Pedagogy at The University of Queensland allows me to help prepare future science teachers. My hope is that one day soon the current injustice done to science, to the teachers of science and to the senior secondary students of science, will be redressed. In this submission, my goal is to draw your attention to major failings of the current system, outlining where possible the causes and ramifications of those faults and deficiencies. I have not attempted to outline a prescription for their remedy, however once they have been identified it is my belief that reasonable people like yourselves will attempt to rectify these issues, even if to do so would require major changes to education oversight in Queensland.

Sincerely yours,



Austin Skinner
B.Sc., B.A., Dip. Ed.
[redacted]

[2] See Attachment 2

Five Specific Issues ....

Issue 1.

The current syllabi in senior Chemistry and Physics do not mandate any specific content that is to be included in all school work programs across the state. In previous syllabi, and in all other Australian states, the syllabi provide guidance on what content is to be included within the curriculum and the depth of coverage expected. The QSA syllabi only provide an appendix containing a non-exhaustive and non-compulsory list of possible topics.

In the absence of any external assessment instruments set by experienced and qualified examiners, as is present in all other Australian states, each Queensland school must construct its own unique assessment instruments in response to their interpretation of the requirements of these syllabi. The result is that different schools do different topics to different depths using different assessment instruments of different lengths and different marking schemes within different contexts. The outcome is that **such assessment cannot be vouchsafed as providing a reliable evaluation** of the level of student achievement in comparison to other students in the state, or to any other state.

The QSA syllabi provide only verbal descriptors of standards that are subjective and rely on teachers' shared expertise when making judgments of quality. Widely held concerns about the lack of teaching experience, especially with younger teachers, as well as the documented lack of subject expertise of a significant proportion of senior science teachers [3], raises **legitimate concerns regarding the validity and reliability of such judgments**.

In all other Australian states, external exams that are based on commonly studied content peculiar to the subject are used to moderate the results of the internal assessments of the individual schools for each student. Thus a moderation of the internal assessment of Physics students at a school is achieved by a common external Physics examination overseen by the educational authorities of that state.
In Queensland the QSA maintains that the Queensland Core Skills Test (QCST) performs the same function by externally moderating these school-based assessments for all students in the state. The reality is that the QCST is not designed to test the level of achievement of students within specific subjects, it does not contain questions specific to senior Chemistry, Physics or Mathematics, and it does not employ the standards of achievement applied within those subjects. The QCS is an external exam but it tests the scholastic skills of its examinees without using subject-specific content. Moreover, in sharp contrast to the requirement within senior syllabi, the performance of students in each of the four papers is judged by allocating marks rather than using subjective criteria. The result is that the instruments used to make decisions about student performance within subjects, are neither standardized nor universal, and the instrument used for moderating these decisions deliberately avoids using the content

[3] Harris, K., Jensz, F., and Baldwin, G., Who's Teaching Science? (2005)

that is the subject matter for these decisions.

To my knowledge, the QSA has never sought to validate its assertion of "world's best practice", which it claims for this system, by subjecting itself to a truly independent examination of the standards of achievement claimed for its students in comparison to the standards employed by other states or even international standards applied by, say, the International Baccalaureate. Significantly, the Queensland Government chose to employ this later curriculum (IB), rather than its own, when it established its Queensland Academy of Science for senior students. Furthermore, recent research brings into serious question what the QSA has historically claimed about the superiority of its standards as compared to those of other states [4, 5].

Issue 2.

The Chemistry and Physics syllabi redesign that started in 1998 chose to increase the emphasis on a "constructivist" approach to learning as compared to the historical model of a "hierarchical or vertical" structure. This shift in emphasis raised the importance of inquiry-based and discovery learning with the employment of open-ended and unstructured tasks as opposed to the traditional approach of employing a structured sequencing of knowledge elements and the designing of specific learning tasks with deliberate objectives. This shift was not confined to the pedagogy of learning that was to be applied, but also to the assessment that was to be used in judging student achievement. A clear example of this shift in paradigmatic emphasis and assessment is seen in the introduction of the Extended Response Tasks (ERT) and Extended Experimental Investigations (EEI) in the Chemistry and Physics syllabi. A primary requirement of an ERT is that "the management of the extended response task should be mostly the responsibility of the student" [6] and for the EEI, "the focus is on planning the extended experimental investigation and problem solving using primary data generated through experimentation by the student" [6].

Both EEIs and Supervised Assessments are required in each student's portfolio at verification and this is used as evidence of the level of achievement of that student. Although maximum word limits of 2000 for EEIs and 2500 for ERTs were stipulated in the syllabi, the principle that "more is better" has led many students to exceed these limits in the expectation of receiving better results and it is only comparatively recently that this issue has begun to be addressed. It is common for panelists to make comparisons of such tasks and investigations by acknowledging where greater content is present and since greater content requires longer responses, a pressure continues for students to exceed the stated word limits. The consequence of such a process is that students, who by their nature are inexperienced in the anticipated effort expected in such open-ended tasks and who are expected to be self-managing and self-planning

[4] Masters, G. (2009). A shared challenge: Improving literacy, numeracy and science learning in Queensland schools. Australian Council for Educational Research

[5] Thomson, S., Hillman, K., Wernert, N., Schmid, M., & Munene, A. (2012). Highlights from the TIMMS and PIRLS 2011 from Australia's perspective. (pp. 36). Melbourne: Australian Council for Educational Research.

[6] Queensland Senior Chemistry Syllabus (2007), p25 & 26 – same in Queensland Senior Physics Syllabus (2007)

for these tasks [6], often spend enormously disproportional amounts of time on these items, expending significant amount of money on tutors, and at the expense of study in their other subjects.

The validity of such tasks is thus brought into question by the unequal access to physical resources such as special apparatus and bespoke software, to human resources such as paid tutors and to guidance provided by knowledgeable associates and mentors. Hence the principles of authenticity, intellectual ownership, "equal playing field" and extent of scaffolding provided for the task make the validity and reliability of such tasks questionable, not to mention the risk to students' well-being through the often dangerously high stress levels caused by the inflated expectations of such tasks.

Furthermore, even where these tasks are well-supervised and appropriate scaffolding is provided to the student, the efficacy of such tasks with respect to long-term and valued learning by the student is questionable. It is my experience, and has been regularly reported to me by my colleagues, that students tend to learn less effectively through these constructivist approaches, that what they do in them is dissociated from the usual focus in the subject and thus is soon forgotten, and that it is a very inefficient means of developing the understanding of the student. These observations are supported by researchers such as Kirschner et al [7] who have found that "*research on this issue has provided overwhelming and unambiguous evidence that minimal guidance during instruction is significantly less effective and efficient than guidance specifically designed to support the cognitive processing necessary for learning.*" Similar issues to these lay at the centre of my objections to the claimed validity and reliability of assignment-based assessment as an indicator of student achievement, not only in senior science but also in senior mathematics.

Issue 3.

The reliability of the current assessment practices, as described in the QSA syllabi, is also brought into question when looked at from the viewpoint of the teachers of these senior subjects. Under the current requirements they are responsible for …

(i) the production of a school-specific work program that provides an appropriate interpretation of the syllabus

(ii) the selection of the content for this work program from a totally optional but acknowledged incomplete list provided by those syllabi

(iii) designing and providing learning experiences that foster students' learning of the subject

(iv) providing support for students through formative assessments that accurately and effectively inform them about areas that need improvement. This feedback, encouragement and support place the teacher in role of mentor necessitating frank

[7] Kirschner, P., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. Educational Psychologist, 41(2), 75-86.

communication about the weaknesses of the student

(v) design balanced summative assessments that reflect "best practice" and facilitate the students' demonstration of their achievements in that subject through employing a diversity of instruments, contexts, modes of response across a range familiarity and difficulty

(vi) assess the work submitted by students in such assessment tasks, collate them, report on them and submit them for verification. As a consequence, the teacher is required to put aside their mentoring role and now act as an impartially judge of the student based only on the standard of their submitted assessment. This clash of interests, when seen from a student's perspective, means that the person whom they trust with their shortcomings will be the one to judge them eventually. The teacher's task of acting as both the counselor and the judge is enormously stressful.

(vii) explain and justify the course, the learning experiences, the assessment task and the outcomes to school administrators, parents/guardians, tutors/aides, guidance counselors, district panels, and others involved in the education of students.

....to name just a few.

The extensive time, expertise and effort required for such tasks stands in stark distinction with the massive redundancy that results from the need for each teacher to "reinvent the wheel" every year with respect to course implementation and resourcing, tailoring of learning experiences to groups, updating or rewriting assessment items and course materials, and development of support and revision materials. This is not made any easier by the QSA who offer minimal examples of best practice to teachers. Unlike the IB which develops subject resources that enhance learning and provide extensive teacher in-service, support and guidance, the QSA has a singular focus on assessment.

The new syllabi have further intensified the demands on teachers by also requiring that "contextualization" be carried out on some of the major learning units over the course of study. Such insistence on a constructivist pedagogical approach is not commonly present in the majority of resources to which teachers have access and so this requirement adds even greater demands in terms of design and delivery.
To give just one example of this increasing, and I believe unnecessary burden, on teachers under these syllabi, consider the case of an EEI. The teacher with a class of 24 students will be responsible for the oversight of the diverse, student-specific and often original experiments of those students. Once the processes of guidance, support and formative response to drafting is complete, the teacher will face the grading of 24 × 2000 word (or more) submissions that have occupied the students for weeks of research, experimentation and composition, and are usually dense with information, evidence, reasoning, referencing and description. Typically such assignments take at least 1 hour each to read, to check equipment manifests, procedures and references, to confirm adequate support of claimed conclusions, to apply plagiarism detection software, to apply relevant criteria and outline justification of such judgments to future reviewers of this process. As such the teacher typically faces at least 24 hours of deliberations on these EEIs, on top of the usual requirements of teaching.

Assuming that the teacher can find a spare 2 hours per day in their heavy schedule, this will take about 12 days and reduce the time that they have for other duties and subjects. Remembering that such a teacher will usually have five such classes, is it any wonder that under these conditions that the reliability and validity of the assessment instruments, the grades allocated and the accuracy of interpretation of the criteria to be applied must be brought into question. This work intensification of both the teaching and student roles under these syllabi means that there is a systemic unreliability that cannot be discounted.

Issue 4.

At the other end of the process, important questions need to be asked about the validity of the system administered by the QSA. As the then QSA director, Mr Bannikoff, observed at the Focus Group meeting in 2007, over 30 years ago Queensland education took a previously untried fork in the road by choosing to go it alone and follow a path of exclusively internal assessment. Despite repeated claims that their system constituted world's best practice, they had undertaken no research to validate their claim, nor had any other state or country chosen to follow their example. Mr Bannikoff concluded his remarks by suggesting that the path taken by Queensland back then could justifiably be seen as a "wrong turn".

The Queensland experiment involving total internal assessment was a brave and innovative one. The effort needed to try to make it work and the enthusiasm with which the task was undertaken were remarkable. A serious concern arises however when it is pointed out that rather than seek to validate this decision by extensive, longitudinal and independent comparative studies with other states, the QSA has sporadically selected individual review agents with the brief of confirming the consistency of their processes. The outright rejection of stakeholders' concerns regarding the appropriateness, magnitude, reliability and validity of their assessment processes, prior to the announcement of this inquiry, bears testimony to the entrenched and recalcitrant attitude taken by the QSA regarding any perceived criticism. The poor results of Queensland students in recent national testing protocols would appear to confirm the suspicion that the QSA claims of Australian curricular superiority were at best unsupportable and at worse seriously in error.

It is difficult to have confidence in the ability of the QSA to reliably and consistently define and maintain standards for assessment of students that are comparable to the rest of Australia in the absence of genuine and independent comparative studies by which they can be informed about these factors. This is especially the case when major syllabus and assessment changes are undertaken in the manner in which they were for the senior Chemistry, Physics, and Mathematics syllabi.

Issue 5.

A central pillar of the assessment policy of the QSA has been the insistence on subjective "criteria" when forming judgments about the level of achievement of student work [8]. This insistence has broadened over time to require not just criteria to be applied at each student's exit from the subject, but to each of three dimensions of general objectives outlined in the syllabi [9], and then to individual items of assessment [10]. Even though the syllabi do not specifically outlaw the use of "numbers" or "marks" when forming judgments about student assessment, it has become an advocated position within not just the district and state panels of which I have been a member but also within QSA External Examinations where I was specifically instructed not to allocate marks to the responses to any individual questions or section or paper when marking external exams.

This issue was raised during the 2007 Focus Group as a major concern of the Trial/Pilot and the Extended Trial/Pilot schools and after consultation it was made clear by Mr Bannikoff that the QSA has never and does not ban the use of numbers in assessment. Apparently this information was not disseminated to all the various panels since the practice of disallowing or discouraging the use of marks has not been extinguished. The QSA continues to disavow any encouragement of this practice on its part but its failure to redress the earlier impressions received by the panels has meant the embargo on marks is believed by many of my colleagues to be still in force.

This matter is of great significance with respect to the validity and reliability of judgments of student outcomes. Numbers can either be used in a "Quantitative" or a "Categorical" manner. "Quantitative" numbers are those met everywhere, especially throughout science and mathematics. They can be manipulated arithmetically and are especially useful in statistical analysis of data. "Categorical" numbers are used to represent classes or qualities of things. An example of the use of categorical numbers would be postcodes like 4012 for Wavell Heights and 4014 for Virginia. It makes little sense to speak of a sum or product of such numbers or to say that the average of 4012 and 4014 is Northgate (i.e. 4013).

Tragically, it is extremely tempting to employ categorical numbers when storing or displaying results arrived at through the application of assessment criteria. This practice associates each QSA Level of Achievement (LoA) with a 5-point scale in which 1 = E = VLA up to 5 = A = VHA. This is often expanded to a 15-point scale from 1 = E- up to 15 = A+ when there is a need for a more fine-grained distinctions in results and reporting. To my knowledge this widespread practice has neither been condoned or decried by the QSA, however the employment of categorical numbers is

---

[8] Ref. Queensland Senior Chemistry Syllabus (2007), p28: Standards associated with exit criteria

[9] ref. Queensland Senior Chemistry Syllabus (2007), p4. These dimensions are: (1) Knowledge and conceptual understanding, (2) Investigative processes, (3) Evaluating and concluding. In Mathematics, the dimensions are (1) Knowledge and procedures, (2) Modelling and problem solving, and (3) Communication and justification.

[10] Ref. Queensland Senior Chemistry Syllabus (2007), p28. "Students' verification folios for Chemistry must contain:... a criteria sheet for each assessment instrument"

implicitly encouraged when teachers are asked to fill out forms such as the R6 [11] by the QSA. Disastrously, this categorical use of numbers or grades when coupled with the requirement to arrive at a cumulative result (for exams, progressive reports, end-point LoAs for dimensions and exit levels) results in serious errors through averaging or tallying of these numbers to arrive at a collective result. Syllabus statements such as "Awarding exit levels of achievement: VHA = A in any two criteria and B in the remaining criterion" [12] reinforce the arithmetic nature of these categories. Efforts by the QSA to eradicate the use of numbers or grades in assessment could be seen as an effort to outlaw this practice but in the absence of any other objective manner for combining the results of assessment criteria it has been unsuccessful. The problem, however, is the result of the QSA insistence on subjective criteria only and their refusal to recognize the legitimacy of objective data obtained by quantitative numerical marking, especially in subjects like Mathematics, Physics and Chemistry where this practice has universally employed since the Enlightenment.

The QSA's blanket requirement for all senior subjects to exclusively use subjective criteria at all levels of the assessment process, the failure to eradicate the erroneous use of arithmetic processes with categorical data, and the failure to provide any other objective means of combining diverse categorical results, necessarily results in overall judgments of student outcomes that lack reliability and validity.

---

[11] http://www.qsa.qld.edu.au/downloads/senior/snr_qa_mod_sample_completed_form_R6.pdf Viewed 12/5/13. R6: school proposal for levels of achievement.

[12] Ref. Queensland Senior Chemistry Syllabus (2007), p26

Attachment 1

SENIOR SCIENCE: THE REVIEW PROCESS – A TIMELINE
"HOW WE GOT TO THIS STATE OF AFFAIRS"

In the period from 1998 to 2007, two failed attempts were made by the QSA (formerly known as QBSSSS) to write new syllabi in each of Senior Chemistry and Senior Physics. The Trial/Pilots and the Extended Trial/Pilots for these syllabi resulted in such critical reviews that in 2007 another pair of syllabi were written and proposed for release without trial in 2008. Following the significant protests that followed these new releases, a Focus Group, of which I was a member, was assembled to review these latest attempts and salvage something from the process. This group identified seven major problems with the most recent syllabi. An example of the nature of these errors was the failure to include any of the actual content of these courses within these syllabus documents, a concept that had seemed unnecessary to the writers of previous documents. To overcome this fault a list of content had to be provided to them, since they were unsure what the content should be for the syllabi they had written [13]. The results of the subsequent rewrites were not made available for scrutiny or public comment, but were instead immediately implemented. No formal independent review process was established to subsequently evaluate the adequacy or efficacy of these hurriedly implemented final syllabi.

The Time Line:

1995 - Previous syllabi in Chemistry and Physics implemented

1998 - (ref: Memorandum 110/00)

- Science Subject Advisory Council (SAC) commenced work on major reviews
- Surveys conducted (Oct) – results not published
- QBSSSS announces 3-year phase-in plan
- Goal stated: "all schools must be offering the new syllabuses with Year 11 in 2007"

1999 – 2001 (Sources: Discussions with SAC members, State members, District panel chairs, Board & Curriculum officers, State Conferences, …). The motivation for new syllabi was given as…

- "Too much content" in current syllabi
  The conclusion: remove significant quantity of content from these courses
- Continuing drop in science enrollments across state. [14]
  The conclusion: need to "popularize" the courses
- QBSSSS stated that their goal for senior education was not to prepare students for tertiary studies but to provide a "broad, balanced, general education". This was understood by many to whom I spoke as meaning that <u>all</u> senior courses

[13] The content for these courses was subsequently included as Appendix 3 in these documents.

[14] As reported by Ainsley, J., Kos, J. and Nicholas, M. Participation in Science, Mathematics and Technology in Australian Education (2008): ACER Research Monograph No 63, Science enrolments (as a percentage of Year 12 students) have consistently dropped in the period from 1991 to 2007 as follows: Chemistry 23.3% → 18% and Physics 20.9% → 14.6%

should be available to all students. Subjects like Chemistry and Physics were thus seen as being exclusive and academically elite due to their high requirement in Mathematics

The conclusion: need to lower the academic rigor and the mathematical nature/content of these subjects so that "even Maths A students can do them".

- The falling percentage of students enrolling in Maths B and Maths C meant that fewer students saw themselves as capable of pursuing Senior Chemistry and/or Physics.

  The conclusion: need to diminish the assessment which involves higher level mathematical skills (e.g. exams) and increase the assessment that doesn't (e.g. assignments, experimental reports).

- Continuing fall in number of teachers who were "qualified" to teach senior science in Queensland [15, 16]

  The conclusion: need to have senior science syllabi that can be taught by non-specialist science teachers.

The influencing factors in this decrease in tertiary science trained teachers were given as…

- The average age for senior Chemistry & Physics teachers at that time was in the 50s, so high attrition through retirement was expected
- Increasing the Diploma of Education to 2 years for science graduates meant that this became a 5-year pathway to teaching. Students who chose to study for a Bachelor of Education were able to transition to teaching after 4 years. This actively discouraged potential science teachers from gaining tertiary qualification in their chosen scientific field of expertise prior to taking up teaching [17]
- High attrition rate among young science graduates entering the teaching profession through the pressures of senior science education and the lure of more lucrative career options elsewhere
- Funding for professional development of teachers focused on the administrative elements of this career (work program matters, assessment issues, panel training, etc) rather than enhancing the understanding of content, development of specific and effective teaching resources, improvement in teaching skills and dissemination of good teaching practices
- Plans to attract persons with high qualification in science to enter education by

---

[15] This concern was later reinforced by Harris, K., Jensz, F., and Baldwin, G., Who's Teaching Science? (2005): Report prepared for Australian Council of Deans of Science… "The age profile for teachers shows a bulge of 'baby-boomers' in the 45-54 year age bracket that is particularly prominent for males. With the impending retirement of this generation of teachers, a shortfall in teacher supply seems likely"

[16] The issue of qualified science teachers is both a state and federal issue: "Numerous reports (Goodrum et al 2001; Dow, 2003) recognise the self-evident fact that the quality of teachers affects the quality of student learning. While the supply and demand data for science teachers is difficult to obtain, there is sufficient indication (Dow, 2003) that the active recruitment of science teachers needs to be a priority, especially in the areas of physics and chemistry." … The Status and Quality of Year 11 and 12 Science in Australian Schools, 2012
[http://www.science.org.au/publications/documents/Year11and12Report.pdf - Viewed 6 April 2013]

[17] Harris, K., Jensz, F., and Baldwin, G., Who's Teaching Science? (2005): Report prepared for Australian Council of Deans of Science … "No matter how good their pedagogical skills, teachers who lack knowledge in their discipline are manifestly unprepared"

offering enhanced remuneration were never implemented – i.e. AST2 and AST3 never happened and then higher 'leading teacher' classifications failed to materialize [18]

- "Context-based learning", "Rich Tasks", "Discovery learning" and "Outcomes Education", were being trialed elsewhere and were being promoted as "attractive innovations" in education
  The conclusion: need to restructure senior science into a more "modern and less-traditional" pathway using such principles
- The students coming out of Yr 10 Junior Science have less knowledge of science than historically and are increasingly less able to make the transition to study in these senior sciences. It was seen by many as desirable to have a "seamless garment" of education for P-12 by lessening this gulf between junior and senior science
  The conclusion: need to lower expectations of senior students' prior knowledge and accommodate the low-content nature of the junior curriculum

2001 Trial-pilot syllabi released and a few dozen schools are signed up

2002-03 Trial-pilot carried out and evaluated (ref. Evaluation of the Chemistry/Physics Trial-pilot Senior Syllabus by Dr Keith Lucas [19]. The overall finding by Dr Lucas was: "the evaluator concludes that it would be unthinkable to release the current version of the syllabus for general implementation".
Some of his finding include…

- Excessive workloads and heightened stress levels for teachers
- Many trial-pilot teachers concluded that their students' knowledge was less extensive that that of former cohorts
- Syllabus deficiencies included vagueness, imprecision, inconsistency, ambiguity and redundancy
- Those teachers who lack suitable qualifications will have difficulty with the context based nature of these courses
- A lamentable reduction in the mandatory core of content knowledge
- Disturbing drop-out rate of Trial-Pilot students from Year 11 2002 to Year 12 2003
  Physics: 851 → 733, Chemistry: 799 → 691.
- This drop-out rate was higher for boys than for girls
  Trial-pilot Chemistry Yr11 2002 (45% female) → Yr12 2003 (51% female)
- While there was a growth in total enrolment for Chemistry statewide during the trial period of +3.2%, there was a decrease in Chemistry enrollments in the Trial-Pilot schools of –0.8%

---

[18] This concern about senior science teacher qualifications was made abundantly clear in the report by Harris, K., Jensz, F., and Baldwin, G., Who's Teaching Science? (2005). For example, it found that 40% of senior physics teachers had never completed any university study in physics.

[19] Lucas, K., Evaluation of the Chemistry Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee (2004) & Lucas, K., Evaluation of the Physics Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee (2004)

2004-06 Major changes made to Trial-Pilot syllabi and then an extended Trial-Pilot was conducted.
Significantly, unlike the earlier review for the Trial-Pilot, the QSA did not release the evaluation report of this extended trial-pilot. Instead it began again to significantly revise and amend these syllabi in light of the unreleased report.

2006 Release of discussion papers gives voice to the need for coherence and meaningfulness in the areas of Curriculum Planning as well as the Review Process utilized.

- "Knowledge, Skill and Disposition in the Organization of Senior Schooling", Peter Freebody
- "Blueprint for Future: Review of the syllabuses for the senior phase of learning", Prof. John Dewar

2006-07 (ref: Memorandum 077/06). The QSA announces its intention to revise and publish a new Chemistry and Physics syllabi (for April 2007) which will not be trialed prior to its staged implementation with Year 11 students in 2008. An incomplete draft syllabi was made available on the QSA website in January with responses to questionnaires on these syllabi required by 23 February.
The Queensland government announced that the syllabi to be used for their senior science students at the Queensland Academy of Science will be The International Baccalaureate. Federal minister at the time, Ms Bishop, observed that the Queensland Government "has no faith in the quality of its curriculum" (ref. Sydney Morning Herald, March 2, 2007).

2007 New incomplete syllabi scrutinized by QSA Focus Group with 7 major recommendations outlined. Syllabus writers were instructed to have the new syllabi ready for implementation, without trial or subsequent scrutiny, in 2008.

2008- Implementation of current syllabi in Physics and Chemistry. The QSA did not establish any independent review or evaluation processes by which the introduction, implementation and efficacy of these syllabi could be scrutinized.

Attachment 2

CONCERNS WITH THIS PROCESS AND THE OUTCOMES TO THIS POINT

Many of the current concerns with the senior syllabi are strongly linked to the discussion paper prepared by Peter Freebody for the QSA: "The Knowledge, Skill and Disposition in the Organization of Senior Schooling". In this paper, Freebody identified eight criteria for high-quality syllabi. In spite of the fact that his paper is cited by the QSA as "An independent expert paper" [20], almost none of these criteria are adequately met by the 2007 senior science syllabi.

Freebody's suggested Criteria: A HIGH-QUALITY SYLLABUS SHOULD BE…

1) **FOCUSED AND UNCLUTTERED**:
conceptual organizations of knowledge, skill and disposition, rather than topical collections

This is especially pertinent with respect to shift of the QSA towards a "constructivist" approach in science at the expense of the traditional "hierarchical" approach, as typified by its reinterpretation of "contextualization" within the Queensland senior science syllabi. The historic paradigm for teaching and learning science (as well as mathematics) recognized the hierarchy of scientific knowledge by sequencing and organizing the concepts so as to systematically develop understanding of this content. Development of this knowledge was enhanced through the use of contexts in which these concepts were evident. Since science seeks to investigate and explain the world around us, its examples come from situations found there.

In this "traditional/hierarchical" approach, content is sequenced and questions and investigations would present some aspect(s) of the content in a context which would enhance the students' understanding of the content, or exemplify its relationship to other concepts by providing an application of it in everyday situations.
This recognition of the utility of small, specific and familiar contexts in order to provide relevance for the content, was always present but the new syllabi has taken a "constructivist" approach instead by choosing to redefine "context" so that it now refers to an all-encompassing "*framework for linking contexts*", or a "*group of related situations, phenomena, technical applications and social issues*" [21]. These new syllabi insist that a context must be a large, multifaceted, topical collection of "*several key concepts and key ideas*". Such a redefinition is a misuse and misrepresentation of the usual meaning of the term. (Refer to "Appendix 3: 2007 Syllabi in Physics and Chemistry" for the epitome of misrepresentation of what a context should be.)

This insistence on "mega-contexts" as the only acceptable means of organizing and teaching a science course seems to be based on two fallacious forms of reasoning: From the 2007 Physics Syllabus: "*Students respond positively to tasks that they perceive to be*

[20] http://education.qld.gov.au/qcar/ - Viewed 3 May 2013
[21] Senior Chemistry & Physics Glossary (2007)

purposeful and interesting to them. Therefore science activities and investigations should be conducted within a context that has relevance to the students" (p4)

- "Black & White Fallacy": The argument in the syllabus is that contexts can be effective teaching tools, therefore you must use them to the exclusion of all other pedagogical approaches. This excludes the variety of other approaches that teachers have historically employed by fallaciously insisting that it's "all or nothing".
- "Non sequitur": The argument moves from "contexts can be good" to "only contexts are good" without recognizing the error of this form of reasoning.

The consequence this approach is that effective teaching and learning are impeded due to the unstructured, cluttered and unfocused approach that follows. The content can become lost in the complexity of the framework of its delivery and the non-specificity of its assessment.

2) **FLUID AND RESPONSIVE:**

with a clear and widely understood set of strategies for adaptation under certain conditions

Unlike the 1995 syllabi, which allowed for the use of small or large contexts according to their appropriateness to the content as judged by the teacher, the 2007 syllabi prescribes the method of structuring and teaching within these courses and insists that only these mega-contexts must be employed throughout.

Compared to the old syllabi, the new syllabi are unnecessarily restrictive in regard to pedagogical approach, course structure, assessment implementation and use, organizing principles and verification requirements.

3) **ANCIENT AND MODERN:**

acknowledging the ongoing growth and reconfigurations of knowledge; trans-disciplinary and disciplinary (as one mode of accessing and simulating real-world application)

By its insistence on this new "constructivist" approach the current senior science syllabi seek a revolution rather than an evolution in science pedagogy and structure. There is nothing in the new syllabi that could not be done under the old, but there is much in the old that cannot be done in the new.

4) **RIGOROUS IN ASSESSMENT:**

as a resolution of a potential tension between equity and excellence

The QSA Evaluation reports and the observations of teachers in the pilot and trial-pilot programs, on which the current syllabi are based, pointed to the manifold difficulties of assessment in these syllabi. The substantial and historically identified difficulties with the Extended Response Tasks (ERT) have only recently begun to be addressed. Similar difficulties with the size, scope, nature and appropriateness of the Extended Experimental Investigations (EEI) have still to be acknowledged by the QSA and are key issues at the heart of the current Parliamentary Inquiry.

The range and nature of these problems include:

- Insufficient access to relevant resources. Sufficient financial support and laboratory

facilities to properly conduct EEIs and ERTs are not currently available in all schools – financial, logistic and facility issues are all significant problems at present

- Variations in the ability of schools to offer access to computer and on-line resources means that the EEIs and ERTs must result in inequity and significant variation of standards across schools
- Insistence on qualitative "Criteria" as the only means of evaluating assessment (i.e. the refusal to recognize "marks" or other quantitative measures) significantly impacts on the nature of assessment processes. This "one size fits all" approach in assessment across all syllabi from Fine Arts to Science and Mathematics is neither conducive to equity nor excellence
- The significant increase in the role and importance of assignment-based assessment and the corresponding devaluation of more formal written tasks, means that the ongoing and unresolved problems of the authenticity and ownership of the submitted work will seriously erode the assessment rigor of these syllabi
- "Depth versus Breadth" remains an ongoing problem in the new syllabi. The failure to provide adequate specification of core content for students across all schools within the state, or to prescribe the depth of treatment of these concepts, means that neither comparability, equity nor excellence can be vouchsafed

5) **'VALID IN THE REAL WORLD'**:
providing recognizably 'thick simulations' that project the learner into both further educational/training and civic, vocational and domestic life

Both the 1995 and 2007 syllabi allow for "thick simulations". However the 2007 syllabi (due to their erosion of rigor in the assessment, their extreme variability of content coverage, their allowed variation in depth of treatment, their depreciation of traditional assessment modes and their minimalist verification requirements) have significantly lowered the utility of the senior science courses with respect to further education/training. Many in the tertiary sector already have a low regard for Queensland senior science due to such variability in standards and content coverage. Sadly, the current syllabi do nothing to restore confidence.

As noted in the Evaluation of the 2002-03 pilot, "Many trial-pilot teachers concluded that their students' knowledge of Physics may be less extensive than that of former cohorts". Such an observation is still commonplace and is a prime concern of many of my colleagues. If the shift to minimalist and enquiry-based science syllabi continues, the senior science courses may quickly become irrelevant for tertiary purposes. These new syllabi continue the principle demonstrated by the Maths 2 →Maths C transition, namely they risk "redefining themselves into irrelevance".

6) **COMPARABLE**:
applied in recognizable adaptations across provision sites

Under the new syllabi the vague and generic "Standard associated with Exit Criteria" become the only means by which "comparability" between different students and different schools can be gauged. The new syllabi are "bedeviled by vagueness,

imprecision, inconsistency, ambiguity, and redundancy" [22] and have already resulted in huge variability in the contexts used, the concepts encountered within these contexts, the richness in tasks set and the adequacy of resources available from school to school. The criterion of "comparability" is even less applicable in these new syllabi than it was in the old.

7) **ACCOUNTABLE**:
making comprehensible and compelling sense to governments, system authorities, parents, students, and the community at large as part of the social compact of educational governing bodies and their constituents, in the most general sense, the society at large

The current senior science syllabi through their pedagogical bias, their failure to specify either adequate content or depth of coverage, their reliance on assessment processes that fail to ensure valid and reliable judgments of student learning and their extensive use of equivocal subjective criteria ensure that stake-holders have little chance of understanding the science syllabi, let alone interpreting the results. To get a sense of the lack of transparency of these syllabi, I would direct your attention to section "5.2 - Course Structure" in either the Physics or Chemistry syllabi. A similar enlightenment can be found by reading "Appendix 3" of either syllabus, in which a list is provided of suggestions for content". No specific content is mandated, and the syllabi acknowledge that the provided list of optional content is not exhaustive. The issue of incomprehensibility by the broader community in the case of such content-optional syllabi is thus another of their major failings.

8) **SUCCESSFULLY APPLICABLE:**
across the entire system of schools intended to be served.

As pointed out in the trial-pilot evaluation (2004) and is still as relevant today, there are impediments to both teachers and students involved in these syllabi.
These include:

- Disallowance of traditional quantitative assessment metrics
- Inadequacy of qualitative metrics as the only allowable means of assessing standards
- Excessive workloads for teachers
- Heightened stress levels for teachers and students
- Scarcity of sufficient funds and resources
- Decreasing relevance of courses for tertiary entrance
- Difficulty of many less-qualified or experienced teacher with interpreting and implementing syllabi requirements and standards
- Limited applicability of conventional textual resources to these syllabi
- Decrease in the extent and quantity of scientific knowledge attained by students via

[22] Trial-Pilot Evaluation reports - Lucas, K., Evaluation of the Chemistry Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee (2004)
Lucas, K., Evaluation of the Physics Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee (2004)

these syllabi

- Structural, pedagogical, logical and pragmatic difficulties in the new syllabi documents and requirements
- The absence of adequate teacher education and support needed to equip them in implementing these syllabi
- The lack of rigor, richness and quality in the course
- Lack of support and guidance in work program writing and resourcing
- Failure to offer flexibility of pedagogical approach to allow for effective teaching, learning and assessment
- Inability of "criteria only" evaluation to providing the fine-grain distinctions required for R6 and SAI scaling.
- "National standards" in senior sciences highlight the deficiencies in the QSA syllabi in comparison to other states. The out-of-step Qld syllabi will need to be overhauled if they are to meet these standards.

References:

Dewar, J. (2005) Review of the Syllabuses for the Senior Phase of Learning: Consultation Paper for Queensland Studies Authority.

Dow, K.L. (2003) Australia's Teachers Australia's Future: Advancing Innovation, Science, Technology and Mathematics. Canberra: Commonwealth of Australia.

Freebody, P. (2006) The Knowledge, Skills and Disposition in the Organisation of Senior Schooling: A Discussion Paper Prepared for the Queensland Studies Authority.

Goodrum, D., Hackling. M., & Rennie, L. (2001) The Status and Quality of Teaching and Learning of Science in Australian Schools: A Research Report. Canberra: Department of Education, Training and Youth Affairs.

Harris, K., Jensz, F., & Baldwin, G., (2005) Who's Teaching Science?: Report prepared for Australian Council of Deans of Science.

Lucas, K. (2004) Evaluation of the Chemistry Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee.

Lucas, K. (2004) Evaluation of the Physics Trial-pilot Senior Syllabus 2002–2003: Final Report to the Science Subject Advisory Committee.

Masters, G. (2009) A Shared Challenge: Improving Literacy, Numeracy and Science Learning in Queensland Schools. Australasian Council for Educational Research.

Thomson, S., Hillman, K., Wernert, N., Schmid, M., & Munene, A. (2012) Highlights from the TIMMS and PIRLS 2011 from Australia's Perspective. Melbourne: Australian Council for Educational Research.