SMC&PA Submission 228
Received: 13 May 2013

Submission to the Education and Innovation Committee of the Queensland Parliament Inquiry

into

Assessment Methods for Senior Maths, Chemistry and Physics

By

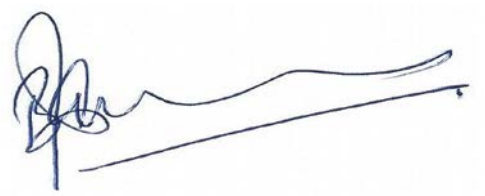
Dr B. J. Arnison OAM

Contact Details

[redacted]

[redacted]

[redacted]



I have pleasure in providing this submission to The Education and Innovation Committee concerning Queensland Studies Authority (QSA) assessment methods for senior mathematics, chemistry and physics. This is a personal submission and does not represent the views of any association or organization with which I am involved.

Brief Personal Details and Experience of the Submitter

My professional experience in education spans more than forty years during which I taught mathematics, physics and chemistry at secondary and tertiary level before taking up the position of principal of a school in Queensland.

- I hold research degrees in Education (PhD) and in Chemistry/Physics (MPhil)
- I served as a board member of QSA from its inception in 2002 until 2008.
- From 2002 until 2008 I was Chair of the QSA Curriculum Committee.
- I served as a member of the QCAR board from its inception.

Introduction

Since 1972, Queensland has followed a radically different approach to other jurisdictions (in Australia and overseas) in the way pupils are assessed and ranked. In Queensland all assessment is completed within school and without any formal, external examination in the specific subjects being assessed.

There are no external public examinations, even for those wishing to qualify for university entrance.

In place of external subject examinations, Queensland employs a complex system of school moderation panels and processes. In Queensland a single test consisting of 4 papers (the QCS) is used to test common curriculum elements from all subjects offered by QSA. Statistics derived from the QCS are used to adjust moderated school results to produce university entry scores. Only the group values of the QCS test are used in the calculation of a candidate's university entry score. The personal QCS score of the candidate is not used to calculate that individual's OP score.

> 'A student's individual QCS Test result is not used on its own in the calculation of their OP — instead, group results are used as part of the statistical scaling processes. A student's individual result on the QCS Test (from A to E) is reported on the student's Senior Statement or Statement of Results.'[1]

QSA, and supporters of the school based assessment approach, have claimed that Queensland leads the world in assessment and ranking processes. From as early as the 1970's supporters of the system have noted interest taken by other national and international jurisdictions in the Queensland experiment.[2],[3]

However, forty years down the track only the Australian Capital Territory has followed Queensland's example.

Significantly the ACT as a small, very well funded jurisdiction. Apart from its funding level, the ACT can be only compared in pupil numbers and geographical area to, say, the Gold Coast. Other major Australian Jurisdictions such as NSW, Victoria, South Australia and Western Australia retain subject based, external /public examinations to underpin school based assessments of up to 50% of matriculation assessment. In all other states the candidate's outcome is heavily influenced by the candidate's personal score on the public examinations.

How do others see the QSA Assessment Model?
(An example of an international review of the QSA approach)

[1] http://www.qsa.qld.edu.au/2318.html#2350
[2] Pitman, J. A. & Dudley, R. P. (1985). *The Queensland experience of criteria-based assessment*. Paper presented at the 11th annual conference of the International Association for Educational Assessment. Oxford, England.
[3] Pitman, J. A., O'Brien, J. E., & McCollow, J. E. (1999). *High-quality assessment: We are what we believe and do*. Paper presented at the 25th annual conference of the International Association for Educational Assessment. Bled, Slovenia.

The 2008 review of QSA methods by the **Scottish Qualification Authority** is informative.[4]

The SQA review is titled ' **The Assessment Systems of Finland and Queensland'**.

Finland is similar to Queensland in that there is no formal external examination associated with completing year 12.

However, to gain entry to a university in Finland students must pass the **National Finnish Matriculation Examination**, administered by a government board. The stated purpose of the Finnish Matriculation Board is;

> *'to discover whether pupils have assimilated the knowledge and skills required by the curriculum for the upper secondary school and whether they have reached an adequate level of maturity in line with that school`s goals. Passing the Matriculation Examination entitles the candidate to continue his or her studies at university. The examination is arranged in upper secondary schools.*
>
> *The Matriculation Examination is regulated by Section 18 (766/2004) of the Upper Secondary School Act, the Act on the Organisation of the Matriculation Examination(672/2005) and the Government Decree on the Matriculation Examination (915/2005).*
>
> *The Matriculation Examination Board is responsible for administering the examination, its arrangements and execution. The Board issues guidelines on the contents, the arrangements and the assessment of the tests. The Ministry of Education nominates the chair of the Board and its members (about forty in number) at the suggestion of universities'*[5]

The Scottish Qualification Authority report notes the degree of externality in the QCS test would go some way to giving credence to the QSA OP but;

> *'Anecdotal evidence, however, tends to indicate that there might be a perception in Australia in general* ***that those emerging from the Queensland internal assessment system will always be seen as less well qualified than those who have been through an external assessment system in other states.'***

In its final analysis the Scottish Qualifications Authority report rejects the QSA approach on the basis of the **greater workload** involved for schools and **lower credibility** of the QSA's 'in school' credential .

> *'Both Queensland and Finland agree that a system composed entirely of internal assessment* needs to have some external form of exit assessment*. This appears to be necessary to confirm that the internal assessment was not an easy option for the students.* ***It would be essential in Scotland to ensure that any such external exit assessment was immediately credible with its end-users****, without the need for any further assessment such as the university entrance examination required in Finland****. Candidates having***

[4] http://www.sqa.org.uk/files_ccc/PNP_ResearchReport1_TheAssessmentSystemsFinlandQueensland.pdf
[5] http://www.ylioppilastutkinto.fi/en/

undergone an internally-assessed system must not be disadvantaged by a perception that it is less rigorous than other systems that are externally assessed.
If Scotland were to embark on internal assessment with a confirmatory external examination, the Finnish approach would certainly have the benefit of familiarity. However, developing control systems for internal assessment (eg the Finnish evaluation, the QSA's programme approval) takes up resources. This would need to be factored in to any proposals to operate an internal assessment system in Scotland. '

The issues of credibility and workload identified by the Scottish Qualifications Authority go to the heart of the assessment problem for QSA. Unfortunately these issues have not been resolved by QSA and its predecessors in four decades of the Queensland school based assessment experiment.

A Premature Leap into the Abyss ?
(The even more Radical New Queensland 2005 Model for Science Assessment)

Further problems for QSA arose in 2005 - 2006 when new syllabuses for Physics and Chemistry were trialled in Queensland schools.

These syllabuses demanded a new **'holistic'** style of grading pupils where the allocation of marks, a method universally used elsewhere in science education, was banned and replaced by one where teachers were required;

> ***To make an holistic judgement of students' responses to each task and assign a 'level of achievement' of achievement' to each task[6].***
>
> Noting that **'*Science teachers have traditionally relied heavily on the allocation and the addition of numerical marks to arrive at exit levels of assessment*'** the Deputy Director, Curriculum for QSA engaged Dr Gabrielle Matters, Principal Research Officer of the Australian Council for Educational Research (ACER) to;
>
> ***'Investigate the theoretical underpinnings of the two approaches to criteria-based and standards-referenced assessment in the Senior Sciences and make a recommendation as to which approach is the more applicable in the current context.'***

The Deputy Director added;

> ***'It would also be useful to model the proposed approach and to provide advice about implementation'[7]***

[6] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 46.
[7] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 46.

Dr Matters responded that the Queensland system of criteria-based assessment **was not underpinned by theory but was in fact a theory building exercise in its own right**. In other words, the Queensland system was purely experimental and had not been based on theory tested in Queensland - or anywhere else in the world![8]

It is also clear from this letter to Dr Matters from the Deputy Director, Curriculum for QSA, that senior officers of QSA were ill informed, perhaps even ignorant, of the relationship between criteria-based and standards-referenced components of assessment rubrics.

Also the request for Dr Matters to '***make a recommendation as to which approach*** (criteria-based **or** standards-referenced) ***is the more applicable in the current context*** ' invites more apprehension about QSA's level of understanding of its own assessment processes

The request to advise on whether 'criteria-based' or 'standards-referenced' is best is akin to the Deputy Director, Curriculum for QSA asking if it is better to clap with the right hand or the left!

The current QSA syllabus documents for Chemistry and Physics reference 5 STANDARDS of pupil achievement (A,B,C,D, E) based upon 3 CRITERIA (knowledge and understanding, Investigating, Evaluating and Concluding)

That is, the Queensland assessment model claims to be standards-referenced and criterion-based. Standards-referenced and criterion-based are not alternatives.

Dr Matters also raised other important problems with the QSA Chemistry and Physics Syllabuses;

- They did not, in her opinion, contain sufficient material of a suitable nature to provide the discrimination vital for assigning Subject Achievement levels necessary for the calculation of OP'S[9],
- The syllabuses were likely to involve teachers in a higher work load, and
- The approach required under the new model would advantage girls and disadvantage boys[10]

The points above raise questions on the validity of the current QSA methods of assessment in Chemistry and Physics and consequently the credibility of the Queensland OP as a university entrance indicator (*echoing concerns raised in the Scottish Qualifications Authority review*)

It is clear that the new assessment methods were implemented before they had been properly considered, and without evidence for their likely success in high stakes assessment of Queensland school leavers

Teachers were to be subjected to a unnecessary extra work load on an untried assessment system *(also echoing concerns raised in the Scottish Qualifications Authority review*)

[8] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 5.
[9] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 14.

[10] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 32.

QSA received the ACER report on Year 11 and 12 Science assessment but proceeded with the new syllabuses gesentially unchanged, and frequently contrary the recommendations of the report.

Teacher and Public Support for QSA Assessment Processes

QSA provides assessment processes covering the full range of subjects, which can contribute to an OP score.

As far as possible, QSA has realigned assessment so that they involve common processes across the Humanities, Sciences, Mathematics, Business Studies, Arts and so on.

For most teachers of subjects such as English and the Humanities, holistic assessment and the use of standards-referenced and criteria- based methods have been widely used for many years. Indeed there is a credible body of research which underpins holistic assessment methods in these subjects.[11] Indeed the use of an holistic style of assessment was well researched for the writing element of QCS test operated by QSA and from which statistics are used in the calculation of OP scores.

However, the research base for the QSA assessment approach is not anywhere as compelling in Mathematics, Physics and Chemistry which involve, in some ways, a more factual body of knowledge.

Perhaps an illustration of the way differences in the body of knowledge for different subjects calls for different approaches might be useful ,at this point ,

From **history,** different scholars might hold a variety of opinions of the causes and implications of the Punic Wars (264 -146 BC). The final outcome is not disputed (Rome 1, Carthage 0) and a replay is highly unlikely so predictions based on precise calculations of elephant mobility and centurion deployment are not really useful.

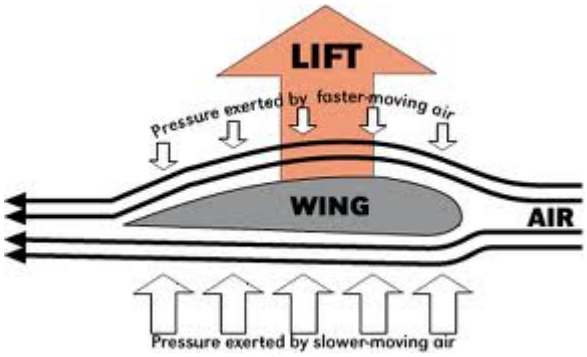
A constructivist perspective will do no harm here and there is no problem with the aspiring scholar 'constructing their own meaning' about what value the events of the Punic Wars have to inform the common knowledge of mankind.

11

http://www.eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED286920&ERICExtSearch_SearchType_0=no&accno=ED286920

From Physics/Engineering, the Bernoulli Principle upon which the operation of an aircraft wing depends can be considered a solid law of nature which must be used to make precise calculations about the safe operation of passenger aircraft.

A constructivist view of science education with each pupil constructing their own models of the principle may not be so reassuring for potential passengers,



Mathematics, Physics and Chemistry teachers are not well served by assessment approaches which do not give them sufficient scope to test knowledge and computation skills which are essential elements of the disciplines they teach.

In year 11 and 12 Mathematics, Physics and Chemistry courses with an overemphasis on a constructivist view of education are problematic for many specialist teachers in Maths and Science

The Constructivist Approach [12]to science and mathematics education including emphasis on enquiry learning strongly informs the QSA view on pedagogy in these subjects.

This is confirmed in the 2011 QSA 'Report to the Queensland Education Performance Review Implementation Steering Committee'[13] where it is stated;

> *'.....preparing students to perform well on a pencil and paper test, an aim that could limit the science curriculum in ways that would not encourage a love of, and interest in science in an engaging way (Fensham 2009)[14].*
>
> *This is especially relevant when we consider the need for* ***balance between positivist and constructivist learning paradigms.*** *The pen and paper, point in time test — if it becomes the focus of learning — will tend to encourage* ***the positivist approach, in which there is a correct answer*** (Although one might ask what is so completely wrong with getting the correct answer ! - author comment)
>
> .
>
> ***These changes to the purpose of science education*** *— and the corresponding focus on students learning science through inquiry, and on teaching science as contextualised and interdisciplinary (Tytler 2007)[15] —* ***require an associated change in pedagogy and assessment,***

A Damming criticism of the constructivist perspective of QSA Chemistry and Physics Courses and their assessment processes was delivered by the collective voice of the deans of science representing all Australian Universities in a report by Justine Ferrari in the Australian of July 10th 2012.

> *'SCIENCE as taught in Queensland is a "social and cultural activity that generates explanations of natural phenomenon based on "personal experiences', (is) a view rejected by the nation's deans of science as fundamentally misunderstanding the nature of scientific inquiry'*

The passage quoted above and which the deans objected to is, contained in the introductions for the QSA syllabus for Chemistry, Physics for pupils in years 11 and 12 entitled: "A view of science and science education".

---

12 http://books.google.com.au/books?hl=en&lr=&id=q90BpBRBsjoC&oi=fnd&pg=PA3&dq=The+Constructivist+Approach+science+education&ots=P4f5U4fPE_&sig=QgTc0iC56-4OxljRLsBM5ElrOaI#v=onepage&q=The%20Constructivist%20Approach%20science%20education&f=false

13 http://www.qsa.qld.edu.au/downloads/senior/report_sci_tst_analysis.pdf

14 Fensham, PJ 2009, "The link between policy and practice in science education: The role of research", *Science Education*, vol. 93, iss. 6, pp. 1076–95.

15 Tytler, R 2007, "Re-imagining Science Education: Engaging students in science for Australia's future", *Australian Education Review No. 51*. Australian Council for Education Research, (ACER) press

- **These matters, which stem from overemphasis of constructivist pedagogy and the changes to pedagogy advocated by (Tytler 2007) and others have resulted in dissatisfaction and a decline is support for QSA among experienced specialist teachers in Chemistry and Physics . Similar concerns exist among experienced specialist Maths teachers.**

- **It was this lack of confidence by teachers in QSA processes in Year 11 and 12 Maths and Science which lead to the Queensland Minister for Education asking for the Premier to refer these matters to this Parliamentary Inquiry**

- **The strong public criticism by such groups as the Australian deans of science is likely to further erode support for QSA and the OP qualification in Queensland**

- **Such criticism will do little to improve the low interstate and international opinion of Queensland OP's implied in the report Scottish Qualifications Authority and mentioned earlier in this submission**

What qualifications are required to teach Mathematics, Chemistry and Physics in Queensland?

There really aren't any, other than possessing a teacher registration.

Queensland's teachers' registration body, the Queensland College of Teachers does not maintain a register of those qualified to teach in particular, subject areas.

There appear to be no formal requirements for employing authorities, such as EQ or non-state schools, to require minimum levels of knowledge or experience to teach Mathematics, Chemistry or Physics or any subject for that matter.

Education Queensland (EQ) is the largest employer of teachers in Queensland. Of those teaching in their specialist area in secondary level 95.4% are;

1. **either** qualified
2. **or** have five or more years of experience in the specialist area.[16]

EQ advised the Productivity Commission that it has difficulties in placing qualified teachers in some locations especially in specialist subject areas including; Maths B, Maths C, Physics and Chemistry.

[16] http://www.pc.gov.au/__data/assets/pdf_file/0013/112702/sub040.pdf

In the 2011 QSA 'Report to the Queensland Education Performance Review Implementation Steering Committee'[17] in respect of science achievements, the authors conclude that;

> *.....that the area of greatest weakness is in the lower to mid primary years(up to Year 6). This would come as no surprise to researchers in the field of science education,* ***since this period of schooling is most frequently identified as the time when negative attitudes to science teaching and learning can be established****.*
>
> ***At this stage of schooling, research has identified that science teaching is least effec****tive.*
>
> *This is generally* ***attributed to teachers of these years having less content knowledge than is needed to teach the subject effectively****.*
>
> *Primary teachers have identified science as a content area in which they lack confidence and consequently score poorly on self-efficacy scales that measure the extent to which primary teachers feel capable of teaching science effectively*

One the basis of the nature of the Queensland teaching workforce one is drawn to the inescapable conclusion that;

- **Queensland primary teachers need to upgrade science content knowledge if pupils are to avoid forming negative attitudes to science teaching and learning which will carry on right up to YEAR 11 AND 12 and beyond.**
- **Teachers need to know exactly what science content is required to be effectively taught at each grade (The Finnish Curriculum is an excellent example in this respect)**
- **All teachers of Mathematics, Physics and Chemistry in front of year 11 and 12 classes should hold a qualification in the subject to be taught (for an unqualified teacher even 5 years experience teaching matriculation Physics, Chemistry or Mathematics is unacceptable**
- **Teachers qualified to teach high level matriculation courses in Mathematics, Chemistry and Physics (or any other subject) should be identified within the normal Queensland teacher registration arrangements**
- **If the College of Teachers maintained public records of the size of the teaching workforce available to teach each subject it would possible to improve teaching workforce planning.**
- **Accountability in Queensland education would be improved if those being taught, and the community at large could be assured that those teaching classes held the necessary subject qualification.**

[17] http://www.qsa.qld.edu.au/downloads/senior/report_sci_tst_analysis.pdf

Gauging the level of teacher support and student enthusiasm is a vexed issue. More appropriate questions might include;

1. What is the level of support for the QSA assessment model among experienced teachers fully qualified in their subject area and are the QSA models respected across Australia and internationally?

2. Are student participation levels in Maths and Science in the final years of schooling impacted more by year 11 and 12 curriculum or by the negative outcomes of being exposed, in the formative years of primary school, to teachers who have poor or no knowledge about Maths and Science?

In relation to the former, there is some evidence that '*there might be a perception in Australia in general* ***that those emerging from the Queensland internal assessment system will always be seen as less well qualified than those who have been through an external assessment system in other states.'(SQA REVIEW 2008)***

In addition the letter from the Deputy Director, Curriculum for QSA to Dr Gabrielle Matters, Principal Research Officer of the Australian council for Educational Research ACER indicates that the number of teachers coming to Queensland from interstate and abroad is increasing[18]. These teachers provide a useful reference group, generally more sceptical of the QSA model with its 'red tape' workload and radically different approach to other jurisdictions in the way it assesses and ranks pupils.

A group of very experienced group of teachers, mostly with graduate qualifications in Chemistry, Physics and Mathematics, has been attracted to the Queensland group known as PLATO[19] and they have expressed very serious doubts about the QSA assessment experiment in Maths and Science.

Regrettably, there have also been reports that very experienced and well qualified Maths, Physics and Chemistry QSA panellists, who have expressed criticism or doubts about the QSA assessment processes being removed from their positions by QSA and replaced by less experienced persons. There are also credible reports of university academics being 'counselled' by their universities after having made public criticism of QSA processes.

In relation to the latter (student participation**);** it is unfortunate that Maths, Chemistry and Physics course completion data tabled by QSA at the Inquiry hearing [20] do not extend back beyond 2002. The subjects detailed have employed 'in school 'assessment back as far as the 1970's.

However, even on the data provided, there is evidence of a steady decline in participation.

The hopes that a greater emphasis on constructivist pedagogy and associated changes in assessment practices introduced by QSA in 2005 -2006 would improve participation rates have not been realized.

In fact, apart from frustrating some university lecturers, who have complained that undergraduates are inadequately prepared to undertake first year science and maths courses, the outcomes and improvements have been unremarkable.

[18] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 46.
[19] http://www.platoqld.com/
[20] http://www.parliament.qld.gov.au/documents/committees/EIC/2013/QldAssessment/tp-7Mar2013.pdf

Are QSA Processes for Assessment of Mathematics, Physics and Chemistry Valid and Reliable?

Assessment of year 11 and 12 Mathematics Physics and Chemistry falls in the **High Stakes** category of assessment associated competition for entry to courses of university study.

In 2009 the UK Qualifications and Curriculum Authority commissioned Professor Gordon Stanley, and others of Oxford University, to report on school assessment processes.[21]

The Stanley report emphasizes the special importance of **reliability** in high stakes assessment

> *High stakes assessment for students takes place in a competitive environment where the precision or reliability of the assessment is crucial. The resulting indices of achievement are typically used for selection purposes, forming a gatekeeper function for entry into sought-after tertiary courses.*

QSA Failure

- **The QSA curriculum and assessment processes in Physics and Chemistry fail to meet the publicly expressed standards required by the Deans of Science in all Australian universities as to what constitutes a study of science. The Deans utterly rejected the QSA approach and described the QSA syllabuses for Chemistry and Physics as *'fundamentally misunderstanding the nature of science'* and that the QSA science syllabuses (which include the assessment processes) *'fails to understand the way in which science grounds itself in observation and testable hypothesis'.***

- ***Whatever the QSA might think they are assessing in year 11/12 Chemistry and Physics courses, those responsible for science education in universities say it is not Physics or Chemistry***

- ***The QSA spokesman's response to the criticism, ignorantly reiterated the QSA view of the nature science and simply disregarded the expert criticism of the QSA science curriculum.***

- ***The QSA assessment processes for Chemistry and Physics are clearly invalid in that that they are not testing the fundament content of these subjects and therefore the grades awarded to students are an unreliable indicators of the standards of student's knowledge in these subjects.***

[21] http://oucea.education.ox.ac.uk/wordpress/wp-content/uploads/2011/01/2009_03-Review_of_teacher_assessment-QCA.pdf

Exactly What is meant by 'Reliability' and 'Validity' ?

Reliability in everyday language carries the general meaning consistency of outcome. If you are driving a reliable car it should stop whenever you brake or whenever anyone else driving the car applies the brake.

Assessment is pretty much the same, in a sense, as something like driving a car. When a student is assessed it is best if the same result is obtained each time the student is assessed regardless whoever applies the assessment.

A useful, more scholarly and formal definition of reliability is provided by an Oxford study commissioned by the UK government.

> **Definition of reliability** *In a school-based setting, reliability refers to the extent to which multiple measurements of the assessments tend to agree. It is conventionally based on the concept of a true score (or latent trait) that underlies a given measurement. In practice, each measurement inevitably contains some error that makes the observed score differ from the true score*[22]

A report by Masters and McBride[23] is the most frequently quoted study to support the reliability of the teacher judgement processes involved in QSA assessments. This study found that teachers could rank whole folios (containing; examination results and written assignments) in Chemistry and Mathematics with a high degree of reliability into 5 grades (VHA, HA, Sound, LA,VLA)
However, this study may not be strictly applicable to the current situation for the following reasons;

- **In 1994 adding marks was almost invariably used to grade Maths and Chemistry tests and assignments (in 2013 marks based assessment approaches of this type are no longer allowed by QSA)**
- **There was really no equivalent to some of the current instruments such as the Extended Experimental Investigation (EEI)**
- **The overwhelming weight of assessment was from supervised tasks such as examinations or assignments completed under supervision where the authorship of the students work was not in question**
- **The study only used overview ranking of whole portfolios – not individual tests or instruments.**

[22] http://oucea.education.ox.ac.uk/wordpress/wp-content/uploads/2011/01/2009_03-Review_of_teacher_assessment-QCA.pdf ,Page 43
[23] http://www.qsa.qld.edu.au/downloads/publications/research_tepa_masters_mcbryde_94.pdf

Validity in everyday language implies that a judgement is sound or defensible and follows logically from evidence. For instance to prove that you are entitled to drive a car it would be necessary to be able to show the police officer a driver's licence – a pilot's licence is unlikely to be acceptable .

A 'valid judgement'[24] needs to take into account a number of types of dimension

Content Validity The student needs to know exactly what they are expected to know about particular subject before they are examined and assessed and then assessment task needs to be able to show a direct link to the content. This might include demonstration of particular facts, skills or understanding processes.

> **The QSA syllabuses in Chemistry and Physics are exceptional (exceptionally poor?) in that details of the content students are to be taught are attached to the syllabus as 'APPENDIX 3: Indication of Depth of Treatment,[25][26] These Appendices are not included in what are described in section 7.1.3 (of each of the Chem. and Phys. syllabus documents) as Mandatory aspects of the syllabus.**
>
> ### *7.1.3 Mandatory aspects of the syllabus*
> *Judgment of student achievement at exit from a two-year course of* ***study must be derived from information gathered about student achievement in those aspects stated in the syllabus as being mandatory, namely:***
> - *the general objectives of Knowledge and conceptual understanding, Investigative processes, and Evaluating and concluding*
> - *the key concepts.*
>
> *The exit criteria and standards stated in Sections 7.6 and 7.9 must be used to make the judgement of student achievement at exit from a two year course of study*

The actual **subject specific details of chemistry and physics content are not contained in mandatory sections** 7.6 or 7.9 of the syllabus but are listed instead as 'suggestions' in the non-mandatory Appendix 3, attached at the back of the syllabus

The senior scientist on the advisory panel which reviewed the proposed syllabuses insisted that to exclude the content details from the syllabus was completely unacceptable.

This advice from the senior university scientist but was rejected by QSA officials.

The criticism of the QSA constructivist view of science by the Australian deans of science relates, in large part, to this defect in the QSA chemistry and physics syllabuses.

- **The QSA syllabuses in Chemistry and Physics are probably the only 'high stakes' documents of this kind in the world which do not specify details of content as mandatory elements of the syllabus.**
- **The QSA syllabuses in Chemistry and Physics fail to define the mandatory subject content in sufficient detail to make valid assessments in these subjects**

[24] http://oucea.education.ox.ac.uk/wordpress/wp-content/uploads/2011/01/2009_03-Review_of_teacher_assessment-QCA.pdf ,Page 439

[25] http://www.qsa.qld.edu.au/downloads/senior/snr_physics_07_syll.pdf Page 49
[26] http://www.qsa.qld.edu.au/downloads/senior/snr_chemistry_07_syll.pdf Page 48

Construct Validity The qualities of Chemical or Physics understanding QSA assessment is supposed to be investigating are only described in the most generic of terms.

In section 7.9 of each syllabus the tables (given in part below) are identical even though they are to be used for different subjects.

- **Teachers having undergone specific training may have a common understanding of the intent of the assessment to <u>but for students and parents without specialist training, the assessment rubric is likely to be meaningless.</u>**
- **The fact that the <u>identical assessment</u> criteria are being <u>applied to two different subjects</u> is likely to result in students and their parents being completely confused about point of the assessment**
- **The last two of the three criteria are not specifically dependent on particular Knowledge of Chemistry or Physics**
- **In many instances the difference between an A and a B standard turn on the way a teachers interprets a particular word such complex or challenging as in ;**
    - **Complex <u>and</u> challenging (A standard)**
    - **Complex <u>or</u> Challenging (B standard)**

The Chemistry and Physics assessment processes involve describing the standards of student performance outcomes according to three criteria. The three QSA criteria for Chemistry are identical to those for Physics. Examples of the criteria and standards are given below.

The 3 Criteria (Chemistry or Physics)

1. *<u>Knowledge and conceptual understanding</u>*
2. *<u>Investigative Process</u>*
3. *<u>Evaluating and Concluding</u>*

The 'A Standard' descriptor (Chemistry or Physics) for each of these criteria

<u>Knowledge and conceptual understanding</u>

The student work has the following characteristics:

- reproduction and interpretation of complex and challenging concepts, theories and principles
- comparison and explanation of complex concepts, processes and phenomena
- linking and application of algorithms, concepts, principles, theories and schema to find solutions in complex and challenging situations.

<u>Investigative processes</u>

The student work has the following characteristics:

- formulation of justified significant questions/hypotheses which inform effective and efficient design, refinement and management of investigations
- assessment of risk, safe selection and adaptation of equipment, and appropriate application of technology to gather, record and process valid data
- systematic analysis of primary and secondary data to identify relationships between patterns, trends, errors and anomalies

<u>Evaluating and Concluding</u>

The student work has the following characteristics:

- analysis and evaluation of complex scientific interrelationships
- exploration of scenarios and possible outcomes with justification of conclusions/ recommendations
- discriminating selection, use and presentation of scientific data and ideas to make meaning accessible to intended audiences through innovative use of range of formats.

Cheating and Authenticity of student work

The process of unequivocally establishing authorship of work submitted in a student folios is essential in arriving at valid and reliable assessments.

Since the implementation of the 2007 syllabuses the proportion of student assessment tasks not completed under supervision has increased.

Cut and paste from the internet, agencies offering to prepare assignments for payment, tutors completing work for students and parent assistance in completing assignments simply cannot be policed under QSA arrangements for ERT's EEI's and assignments.

Gender Equity

In a 2007 report commissioned by QSA Dr Gabrielle Matters, Principal Research Officer of the Australian council for Educational Research ACER [27] warned QSA that assessment processes proposed by QSA were likely to result in girls achieving higher scores in Mathematics, Chemistry and Physics and boys scores would be artificially lowered by the assess methods QSA was advocating.

This year 2013 Dr John Ridd published data in the web publication On Line Opinion which confirms the outcome Dr Matters predicted[28]

> The uneven gender effect in year 11 and 12 Mathematics, Chemistry and Physics outcomes is unacceptable and this matter, about which QSA had been warned more than 5 years ago, should be addressed urgently.

[27] http://www.qsa.qld.edu.au/downloads/publications/research_qsa_science_assess.pdf , page 32.

[28] http://www.onlineopinion.com.au/view.asp?article=14942

What Makes an EEI a valid and reliable Assessment Task ?

Regrettably the EEI tabled at the Education and Innovation hearing on 20th March 2013 illustrated many of the pitfalls mentioned above. The tabled document can be found at the link ; http://www.parliament.qld.gov.au/documents/committees/EIC/2013/QldAssessment/tp-20Mar2013-Task.pdf

- The student script, as presented contains a number of factual errors in calculations including;
    1. The average in the last set figures in table 1,(for 25 degrees temperature data set), is incorrect. The correct average of 0.91, 0.92 and 0.51 is 0.78 (not 0.51 as shown)
    2. The coefficient calculated from the straight line plot of the data is 0.306 (not 0.36 as given in the student script)
    3. The coefficient of restitution is dimension less (the student script shows in given in units of length (**m)**
- Authorship is difficult to establish. It is impossible to tell if the student designed this experiment or simply 'adapted' a very similar investigations published on the web at; http://hypertextbook.com/facts/2006/restitution.shtml , at the pdf in http://iopscience.iop.org/1757-899X/36/1/012038 , or http://www.quintic.com/education/Case%20Study%203%20-%20Coefficient.pdf
- The word length requirements of the EEI are substantially exceeded
- 'Curve fitting' graphs appear to have been obtained from some sort of graphics calculator but are poorly or inaccurately interpreted by the student.
- The assessor appears to have located the EEI in the 'A standard category' for each of the criteria (see example at page 14 above).However , the question of whether this represents '*interpretation of complex and challenging, theories and principles'* or adaption of other published investigations really cannot be determined on the evidence provided.
- For the '*Evaluating and Concluding'* criterion drawing correct conclusions from incorrect data and calculation is problematic.

The person providing the material to the committee was described as a very experienced QSA panel advisor in Physics. At the presentation he appeared to be unquestionably professional, highly motivated and well intentioned. Notwithstanding the unquestioned integrity of the presenter, it is highly improbable that his assessment of this particular exemplar would be confirmed by other highly qualified and experienced Physics teachers.

On the evidence presented in this exemplar, the highly problematic issue of obtaining valid and reliable assessments from an EEI under these circumstances is clear.

Perhaps even more remarkable is the fact that such a seriously flawed example of criterion based, standards referenced assessment should have been presented by QSA to the committee investigating QSA assessment.

Conclusions

The radically different and experimental approach to assessment and, curriculum pioneered by Queensland's education system in the 1970'2 has been followed with interest by education academics in Australia and elsewhere.

The rejection of public external examinations and their replacement with moderated school based assessment even for high stakes assessment, such as matriculation, has been brave and adventurist The experience gained, has improved some important aspects in the delivery of school education.

However, the approach is still not accepted as mainstream best practise in Australia or elsewhere around the world. Almost without exception, all other major jurisdictions in Australia and internationally employ external public examinations to underpin the credibility of high stakes, final assessments for school leavers.

Increasing globalization of competition in education standards means that it is important now for Queensland to realign itself with international standards for school leaver credentials.

A system involving up to 50% of school based assessment coupled with public examinations similar to the other Australian states would seem to be the most logical way ahead.

Such a realignment would dispel doubts about the legitimacy of OP scores and provide school leaver credentials that did not disadvantage Queensland students moving interstate or overseas.

Criteria and standards verses numerical marking methods

The Queensland experiment to restrict judgements about student performance to the use of criteria and standards descriptors alone in the empirical sciences (physics, chemistry) and mathematics has failed because this approach is too imprecise to produce valid and reliable decisions on student performance in these subjects.

Using marks and numerical methods to generate achievement grades is a more valid and reliable way of assessing performance in Mathematics, Chemistry and physics than the holistic method of indentifying imprecise standards and criteria.

QSA should immediately remove any restrictions on the use of numerical methods as evidence for awarding levels of achievement in science and mathematics subjects in years 11and 12

Teacher Workloads

The assessment 'red tape' of the 'criteria and standards' approach erodes teaching time.

Also after years of application of the criterion/standards assessment and constructivist education theories there has been no discernible improvement in performance or outcomes for Queensland year 11 and 12 students in Mathematics Chemistry and Physics relative to other jurisdictions.

General numerical reporting scales are widely used for assessment by most major international and national year 12 reporting schemes, and achieve similar or better outcomes.

One might well ask why burden the teachers with additional workload for no benefit to students?

Student participation levels

QSA has advocated a 'constructivist view of education' where pupils are encouraged to construct their own meaning for phenomena they encounter in their world. QSA predicted that this would be more engaging for pupils and that it would raise participation rates in mathematics and science.

However, there is no evidence from the participation rates tabled before the Inquiry that participation rates in Chemistry, Physics and Mathematics that participation rates have improved.

In fact since these methods were given increased emphasis in the 2005-2006 syllabuses participation rates in these subjects have remained stable or declined slightly.

An alternative view of poor participation has been put forward which suggests that students have already formed negative attitudes these subjects before they enter high school.

The reason given for the early alienation of pupils in these subjects was linked to the fact that many of the primary school teachers pupils are exposed to, lack knowledge of science and mathematics and consequently they lack confidence teaching these subjects.

Teacher Qualifications

In an EQ report to the Productivity Commission up to 50% of teachers are described as '**qualified**' **the remainder being described as 'experienced'** (as opposed to qualified?).

The Queensland College of Teachers does not maintain any list of qualified science teachers or qualified mathematics teachers so these statistics are apparently self reported.

There is also a shortage of qualified mathematics and science teachers in difficult staffing areas across the state.

In addition there appear to be no formal requirements for employing authorities, such as Education Queensland or non-state schools, to require minimum levels of knowledge or experience to teach Mathematics, Chemistry or Physics

Urgent measures are required to ensure that Queensland classrooms are staffed with a properly qualified workforce of Mathematics, Physics and Chemistry teachers.

Teacher registration records should be upgraded to identify details of subjects teachers are qualified and competent to teach.