Submission for Parliamentary Inquiry into Assessment Methods for Senior Maths, Chemistry and Physics

I am a science teacher of 16 years standing, having taught in state schools in Northwest Queensland and metropolitan Brisbane. Prior to becoming a teacher, I was a research scientist, completing my PhD at the Queensland University of Technology. I currently work in an educational outreach facility that connects school communities with medical researchers. It is my opinion that the unique system of senior assessment in Queensland is an excellent method of preparing and selecting students for a career in science related disciplines.

Externally Moderated School-based Assessment

The Queensland schooling system covers a wide area and caters to a diverse range of students. Queensland's system of school-based, externally moderated assessment allows schools to tailor their assessment tools (within the guidelines of the syllabus) to their own student body. The range of assessment tools available to teachers ensures that students are tested on a wide variety of skills, not just recalling and applying knowledge in a test, and these skills are more appropriately applied to real-life situations. People who work in science are not likely to have to complete exams on a regular basis, however devising experiments, writing reports and grant applications and delivering presentations are a daily reality for scientists. The use of a diverse range of assessment tools also allows students to achieve in the items which suit their own particular learning style.

The alternative to this system is one where assessment is derived from an outside source. Such forms of assessment tend toward the examination style – either short or extended answer. While the use of such instruments to test recall, application and synthesis of knowledge are valid, they should not form the majority of assessment, as they test only a narrow range of skills and may not allow students who "do not test well" to demonstrate their true understanding of a subject. In addition, external setting of assessment pieces leads to homogenous teaching, a practice which does not take into account individual situations or settings of schools, or the learning styles and interests of the students.

Some educational authorities use a "hybrid" system, where a student's final grade is calculated from a combination of school-based and external assessment. While this is preferable to "external only" systems, in many cases, the school-based assessment is considered to be of a lower quality, and the higher stakes external examination becomes the be all and end all in the minds of the students.

School-based assessment encourages professionalism and accountability among teachers. The fact that Queensland teachers of senior science subjects must develop, implement and grade assessment items to a high standard which is regularly monitored from experienced teachers outside their school, means that teachers are deeply involved in the entire process of teaching, from instruction right through to assessment. Removal of this through the introduction of external assessment effectively dumbs down the teaching profession.

Standards Referenced Assessment

The Queensland system assesses students on a set of qualitative standards laid out in the syllabus. These measure student achievement through the demonstration of skills and qualities which are regarded in both the scientific and educational fields as important for the development of a well

rounded, scientifically-thinking individual. Such a method of assessment is especially useful in judging a level of achievement for extended response-style items, where a great depth of knowledge and understanding can be demonstrated. The absence of quantitative standards in the Queensland syllabi do make the development of shorter answer items more difficult, but not impossible. In the long run, the assessment one makes of a student's capabilities using a standards referenced criteria sheet gives a much more authentic indication of that student's understanding, than a limited assessment based on the accrual of marks.

Some criticism has been leveled at standards-referenced assessment on the grounds that it is more subjective than a system which compares student's responses to a pre-determined set of numerical standards. It is certainly easier to be able to point to such a set of standards and tell a student "You didn't get an A because you only got 83% overall", rather than explain the finer points of the difference between stating a concept and explaining one. However, there has always been a level of subjectivity involved in examiners assigning a grade to any piece of student work. Under the standards-referenced system, it is far more useful to be able to show a student where they "made links between complex concepts" than it is to say "that's a good essay, it deserves 9/10 because they said 9 of the 10 things I was thinking about when I set the piece". Regardless of how much easier it is for teachers to add together accrued marks to arrive at a level of achievement, using a set of carefully chosen standards descriptors to show where a student has demonstrated a skill is much less artificial than assigning an arbitrary numerical value.

If there is a valid criticism of the current system, it is that the selection of the standards descriptors has skewed assessment towards extended response style items. None of the standards currently in the senior science syllabi lend themselves easily towards creating assessment items based around short responses or numerous discrete problems as may be found in a short answer exam. Some schools have managed to crack this problem, and most schools still use short answer exams as assessment tools (although they can be tougher for teachers to set and grade). Most of the problems which schools find with doing this form of assessment arise from a lack of guidance in developing them – once you've seen an example of how these sorts of exams can work, it becomes much easier to devise new ones.

The introduction of the new standards-referenced system with the recent suite of syllabus revisions represented a massive change in the way assessment is done. Most teachers were not assessed in their schooling under such a system, and much of the general public still thinks in assessing through marks and percentages. It has been my experience (both in my teacher training and in supervising a large number of pre-service teachers) that teachers are not taught the way to do this properly at University. Most have to pick it up during their practicum or in their first few years of teaching. It is left up to the QSA, with its limited funding for professional development and limited access to teachers through restrictions in professional development time to pick up the responsibility for instructing teachers in how to use the new system.

As the developer of the new syllabi, it is entirely appropriate for the QSA to meet this responsibility. However they need to be given the resources to support it, and teachers must be given time to be trained in the new methods of assessment. The time for the implementation of these new syllabi is long past, however support can still be given to new teachers (as well as teachers who have had trouble adjusting to the new system) through the use of examples of assessment types and

exemplars of student works. In the past, the QSA has been reluctant to provide such resources, however it is pleasing to note that, following extensive consultation with teachers and other education stakeholders, sample assessment pieces and exemplars which match the syllabus requirements are now available through the QSA's website.

As an aside, it is interesting to note that some universities, long having been consistent users of numerical standards and marking schema, are now starting to use forms of standards-referenced assessment criteria in grading extended response style items, as well as relying on assessment tools other than the 100% end of semester theory content exam. Whether this is due to cross fertilization from the schools sector, or whether it is change to meet the needs of students educated under this system, anecdotal feedback from the teaching academics with whom I regularly interact suggests that they would be reluctant to abandon a standards referenced mode of assessment.

Student Engagement in Science

The educational outreach facility that I coordinate was established as a way of addressing the decline in students pursuing science studies in senior and tertiary education. By putting students in contact with working scientists and allowing them to contribute to the research that these scientists perform, it was hoped to encourage students to embark on a career in science. Since starting in this position, I have become aware of a large body of research which has looked at the reasons why students do not continue on in science. One thing that should be remembered is that the decline in students studying and working in STEM fields is a global phenomenon, occurring in all developed nations. If Queensland does have a problem in retaining students in science and mathematics, they are not alone in this, and therefore it unlikely to be solely due to Queensland senior assessment system.

One of the most extensive Australian studies was performed by Lyons and Quinn ("Choosing Science", http://www.une.edu.au/simerr/pages/projects/131choosingscience.php). This study was conducted, based on surveys of students in primary and secondary school, as well as teachers in STEM subjects. It was done around the time that the senior Physics and Chemistry syllabi were being revised (2007-2009) and shows that the problems with students choosing science predated the introduction of these new documents. Lyons and Quinn found that the reasons why students do not pursue studies or a career in science are complex. They certainly do not stem from disinterest in the field, or a belief that science does not offer a rewarding or secure career path (which was contrary to the opinions of many of the teachers surveyed). There was some belief among students that science was exciting, interesting and rewarding, however it was difficult and something done by "other people" rather than themselves. This underlines the need for scientific institutions to emphasise their community outreach operations.

Lyons and Quinn also tracked the decline in science enrolment in the senior years in Australia to a particular period in the early 1990s. At this time, educational authorities around Australia were changing the way that they assessed tertiary entrance. In the past, certain subjects (particularly chemistry, physics and the academic mathematics subjects) were weighted heavily in the calculation of tertiary entrance scores. Students wanting to tilt the balance in their favour were encouraged to study these subjects as getting an A in Physics was "worth more" towards their tertiary entrance than say, an A in Drama. This changed across Australia, with the introduction of systems where all subjects were treated "equally". Students were now told that an A was an A regardless of the

subject they got it in. Faced with a choice of doing a subject with a “difficult” reputation like Physics, or another which was seen to be softer like Drama (regardless of how wrong that perception may be), students took the latter option.

Compounding this issue, at the same time, universities removed science subjects as prerequisites for many of their courses and offered bridging courses over the summer vacation (fee paid) for new students to catch up. This removed another incentive for students to study science and academic mathematics in senior. My own undergraduate course undertaken in the late 1980s and focusing on the biomedical knowledge and skills needed to work in a pathology laboratory, required passes in English, Maths I (B), Maths II (C), Physics and Chemistry as well as a minimum TE score. Very few tertiary courses now have similar requirements.

If students do not engage with science from an early age, they are unlikely to pursue science in their later studies, or choose it as a career. In addition, some students see science as a relatively hard slog to get anywhere. When jobs in the resources sector or careers requiring a simple business degree can provide salaries far exceeding those of even experienced scientists with a fraction of the education and training required, you can’t expect students to take the harder option unless they are really passionate about the field.

Workload and Stress

The introduction of the new senior science and mathematics syllabi has certainly changed the landscape in which students study science. Gone are the days when assessment was weighted heavily in favour of end of term exams which concentrated on the recall and application of knowledge. Students are now assessed on a range of authentic tasks which reflect the skills needed for working in a science field. There is no doubt that this change has suited some students better than others, however to claim that more students are leaving the subjects due to these changes or increased workloads is simply not supported by the evidence. The QSA has released figures which show that enrolments in Physics, Chemistry, Maths B and Maths C have remained constant or even increased slightly since the introduction of the new syllabi, despite continuing declines in enrolment globally.

The new syllabi encourage fewer, richer assessment instruments. They place strict limits on the length of assessment tasks which should be seen as decreasing workload for both teachers and students. Unfortunately, the QSA has only belatedly provided student exemplars which meet these criteria, however the new resources show that quite a deep demonstration of knowledge and understanding can be achieved with the simplest of instruments. As a teacher, I know that a “tick and flick” exam is easier to mark than an extended project with numerous drafts and reviews. However I also understand that in an information age, it is more important for students to show me that they can understand something, rather than just remember it.

Extended response style tasks carry with them the danger of narrowing the curriculum – having fewer assessment tasks that cover a limited range of topics can mean that some topics are not covered in assessment. However a well-designed assessment program should have a variety of assessment tasks which run the gamut of skills and content, and the syllabi themselves require this.

I do not agree with the claim that the system in Queensland has resulted in increased stress for students, nor that introducing a system of external assessment would reduce this stress. I believe that anyone who holds this view should travel to New South Wales or Victoria and ask the students there how relaxed they are feeling on the eve of the HSC.

Conclusion

In summary, the issues that teachers and students have faced in the introduction of the new syllabi have not been the fault of Queensland system of school-based, externally moderated and standards referenced assessment. While the new standards may have been first mandated in the recent revisions, Queensland has used school-based, externally moderated assessment for many years. In that time we have continued to produce world leaders in the scientific disciplines and we have grown an economy which relies heavily on contributions from STEM fields. While the introduction of the new syllabi could have been handled better with proper support from the QSA and educational sectors, both the QSA and the Government have responded to the concerns of teachers and students. It is this involvement of practitioners and stakeholders in the development and review of syllabi and assessment that has made the Queensland system so strong, unique and successful. I can't see a similar level of engagement coming from a system where assessment is externally mandated and applied.

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