SMC&PA Submission 250
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Submission to Education and Innovation Committee Inquiry into Assessment Methods for Senior Maths, Chemistry and Physics.

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We have formulated this submission from the perspective of two individual academics who are experienced tertiary science educators and who recognise practices in the secondary sector in our own teaching and assessment. We have developed and implemented assessment for students of Science and Engineering across the tertiary physics and chemistry curricula and our chemistry, physics and engineering classes range from small to large (including 1st year cohorts of up to 1400 students). This submission conveys our personal views and does not represent a submission on behalf of the disciplines of Physics and Chemistry at the University of Queensland.

The motivation for our submission is to encourage the committee to consider current assessment of Queensland senior sciences and mathematics in a broader context of undergraduate practices and the shifting assessment paradigm of the lifelong learner and professional skills.

Key points:

- **Assessment 'for learning' rather than 'of learning'**

As tertiary educators, we are the next 'stop' on the continuum of learning for many students leaving high school and the majority of our students' most recent prior experience in learning is the Senior Chemistry and Physics curricula. It would be easy for us to regard our context as the most important destination for secondary students, thereby presenting our views here in terms of assessment to meet the entry standards for tertiary study for the minority of students who continue into tertiary science. However, the reality is that we face parallel challenges to those of the senior science teachers where we face large classes of students addressing diversity in academic ability, interest and career aspiration. Only a few of our first-year students intend to progress to higher level chemistry or physics studies. Rather than teach to the few potential Chemistry and Physics majors, our own assessment practices have evolved in recent years to be inclusive aiming to enhance student engagement and measure their knowledge and skills through assessment beyond summative exams. We progress through reference to science education literature and the excellent scholarly teaching and learning practices demonstrated by our colleagues.

Current first-year assessment, implemented by ourselves and our colleagues across multiple science disciplines at UQ, builds directly on that currently delivered in the secondary sector and includes both open inquiry-based laboratory experiments (physics) and undergraduate research experiences (chemistry). Our aim is to extend the skills and independence that we assume students have acquired through Extended Experimental Investigations in the senior sciences.

Since 2009, in chemistry, large cohorts (up to 1400 students) have been managed through a collaborative inquiry task where they work in groups of four to write a 10-12 page report.

Assessment is based on integrative and interdisciplinary thinking, use of evidence and quantitative data to support an argument and written communication skills. Students also peer review the submissions of other groups and find this very informative as feedback. This form of task is underpinned by the prior experience of students in written communication and application of evidence to support an argument (aligned with the Extended Response Task in senior sciences).

We would be disappointed to see the secondary sector take a backwards step towards delivering only high-stakes summative assessment reducing the broader range of skills students currently have opportunity to develop.

- **Standards-based assessment and articulation into tertiary studies**

The current emphasis on authentic science tasks (EEI, ERT) in the secondary science curricula prepares students well for similar learning activities when they transition into first year at UQ (in Physics, Chemistry, and Engineering). We observe that students who focus on calculating the marks they require to achieve high grades in assessment tasks (often international students) typically struggle to understand the requirements of tasks that are not focussed on the final answer. Standards based assessment criteria are becoming increasingly prevalent in the tertiary sector and are often published as part of our course profiles. The intrinsic usefulness of assessment criteria is that they provide students with feedback on how they can improve. Students who have prior experience of applying criteria are more likely to understand the expectations of the task and achieve successful outcomes. They are also more self-regulated and recognise learning objectives – it is important that this experience is gained in their secondary education and hence any suggestion that standards criteria are discarded in senior science is alarming.

The committee is encouraged to consider the role of assessment in Queensland high schools in the wider context of development in standards based/benchmarking evaluation of graduate students. The Tertiary Education Quality Standards Assessment framework is evolving into statements for learning threshold outcomes (TLOs) against which institutions will be measured. These minimum achievement standards in Chemistry and Physics contain one statement (out of five) that relates to mastery of concepts (typically measured through summative exams). The role of assessment of inquiry-based learning is endorsed through one TLO statement which emphasises related skills such as critical appraisal, data display and problem-solving. Independence, self-direction and communication skills form the basis of another two TLO statements. While these are directed at graduate achievement, they are attributes that employers value across their workforce and hence important for graduates of secondary science courses.

- **Equity in assessment outcomes**

At university, and in life, there will always be multiple opportunities for students to bypass individual assessment. Tertiary students complete a large component of their assessment 'at home' with potential assistance from other students or family members – the only way to validate that a student has completed a task is supervised assessment (exams or in-class submissions). At UQ, students are expected to act professionally and with integrity by completing and submitting their own work. Our only weapon against plagiarism is the software program, Turnitin – the learning community should be built on trust rather than remove assessment which is completed outside the classroom. Indeed, lack of confidence in the origin of a student's work may be presented as an argument for

implementing summative exams as the only indicator of concept mastery but even exams are not equitable, large numbers of students do not perform at their best in such high-stakes assessment. The issue lies more with raising awareness in students (and their family/peer support team) that bypassing assessment will result in subsequent failure in a different context such as a workplace. Employers are typically less concerned with knowledge than they are with skills and the latter cannot be faked, so it is essential to measure student outcomes in team-work skills, manipulative skills, and communication skills.

There is no doubt that current assessment practice in the secondary sector has become very complex in terms of moderation and equitable outcomes for students in different settings. A lot of the concerns that we have heard expressed by teachers ourselves, and through questions appearing on Education Queensland listservs, appear to be related to a desire to establish a common understanding of the expectations in applying benchmarks. While provision of exemplars of standard pieces of works supports a common understanding, there also needs to be better support for teachers in adapting this to their own context.

- **Perceived workload issues**

One of the terms of reference that the committee is considering is 'ensuring assessment practices are supported by teachers'. As academics who manage assessment in class sizes that are often equivalent in scale to entire high school cohorts, we have experience in working in teams. Simple statements in standards criteria are required and if the complexity of the criteria increases, the time required to apply the criteria to an individual student submission increases. Our experience is that it is possible to deliver authentic assessment but this requires a shared understanding – the issue is not to avoid/remove these tasks but to develop sound support networks and professional development for colleagues in their practice. Our understanding of current secondary practice is that teachers submit exemplars of their student's assessment tasks and outcomes to panels that evaluate then provide feedback and recommendations. The committee is asked to consider whether a possible solution to current concerns in the sector is to establish an improved infrastructure to support assessment development and delivery thereby formalising and resourcing support they are already seeking through listserv activities. A community of practice where secondary and tertiary educators share perspectives and experiences to develop best practice is an international model and requires a hub.

Recommendations

- Greater interaction between tertiary and secondary sector, so both are aware of each other's assessment practices and potential student destinations.
- Continue to include skills-based assessment and lower the emphasis on assessment that promotes rote learning to pass hurdles. Raise the value of individual performance by students (reducing potential parental input) by making the purpose of assessment explicit and link to authentic professional skills.
- Establish a formal hub to deliver professional development and support teachers in writing and applying standards-based assessment criteria.

- Improve outcomes by increasing emphasis on developing and evidencing skills in combination with concept mastery. For example, through peer feedback and self-assessment promoting self-regulation.

Final Statement

Almost all current educational research points to improvements in engagement with science, motivation to continue in scientific careers, and cognitive outcomes as a result of the current authentic assessment practices. These outcomes are not associated with exams as the primary measure of student learning outcomes.

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