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I am pleased to forward QUT's submission to the Education and Innovation Committee's Inquiry into Assessment methods for Senior Maths, Chemistry and Physics.

The submission has been prepared by staff in our Faculty of Education's School of Curriculum and addresses important matters for consideration by the Committee.

Regards,

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Queensland University of Technology

Submission to the Queensland Parliament's Education and Innovation Committee

Inquiry into Assessment Methods for Senior Mathematics, Chemistry and Physics

May 2013

Chemistry and Physics

Secondary teachers in Queensland have engaged in school-based assessment since the 1970s, developing very sophisticated skills in evaluating student performance that have proven to be both valid and reliable. The first major review of assessment in Queensland schools, tabled in 1970 (i.e., The Radford Report; see Clarke, 1987, 1990), revolutionized assessment policy and practices to address major concerns with external examinations controlled by the University of Queensland. Subsequent reviews refined these policies and practices, leading to the criterion referenced assessment scheme—as opposed to the norm referenced scheme of the 1970s—in operation now. Every review noted some opposition to school-based assessment, but the advantages of school-based assessment outweighed the external-assessment option on each occasion.

Recent changes to chemistry and physics QSA syllabi that have led to a greater emphasis on contextualizing the content, and implementation of Extended Experimental Investigations (EEI) and Extended Research Tasks (ERT) have provoked further concern and opposition from some teachers, science academics, and parents. The concerns of teachers should not surprise given that most secondary chemistry and physics teachers have not had science research careers nor have they received formal science research training that would assist the supervision of extended student projects. In fact, Ritchie and Rigano (1996) cautioned widespread adoption of open-ended inquiry for this very reason, despite the observable benefits to the students who participated in such extended research projects supervised by highly qualified researchers. As noted more recently (i.e., Ritchie, Tobin, Sandhu, Sandhu, Henderson & Roth, 2013), new teachers begin their careers alongside resilient and experienced teachers, some of whom fear the supervision of EEIs because they have not been trained to supervise the projects and perceive there is an additional workload involved in such supervision.

Science education researchers at QUT have conducted high quality projects directly related to the implementation of context-based approaches to chemistry teaching, EEIs in physics classes, and assessment of higher order thinking in chemistry across four Australian States. Even though these studies do not address directly the terms of reference of the Committee, they do provide important insights into the lives of teachers and students who experience these new approaches. For this reason, we identify the most salient outcomes from each study and provide the relevant references so that the Committee could undertake further perusal should they be so inclined.

In relation to the study on implementing a context-based approach in a Queensland Year 11 chemistry class that involved students undertaking an ERT (King & Ritchie, 2013), the most salient outcomes were:

1. Real-world connections are necessary for students to see the relevance of science and improve students' interest in science. The ERT can provide opportunities for these important links. As an assessment task, the ERT afforded students the agency for making connections between concepts and context where students demonstrated links between concepts and context in their conversations and written work.
2. The ERT required students to adopt higher-order thinking skills such as synthesising information, hypothesising, solving problems and drawing conclusions that are difficult to assess through examinations.
3. Students experienced academic success through completing in the ERT.

When new physics teachers implemented EEIs in their first year of teaching (see Ritchie et al., 2013):

1. Three of the four teachers were surprised by the positive outcomes from their supervision of EEIs for the first time in the context of negative rhetoric expressed by their senior colleagues.
2. Two of these teachers experienced high intensity positive emotions in response to their students' success.
3. When student actions / outcomes did not meet their teachers' expectations, frustration, anger, and disappointment were experienced by the teachers.
4. Over the course of the EEI projects, the teachers' practices changed along with their emotional states and their students' achievements.
5. Descriptions of the successful supervisory practices of the new teachers could be used to guide their more experienced colleagues who fear EEIs.

With reference to the outcomes of their comparative study of the assessment of higher order thinking in chemistry in Queensland, New South Wales, Victoria and South Australia, and their own experiences as scientists and science educators, Fensham and Bellocchi (2013) note:

1. Queensland's assessment procedures ensure that more of the declared learning intentions are assessed and thus heeded to by teachers. In comparison, only three of the eleven aims/objectives for chemistry in year 12 are assessed in any way. Hence, they tend to be neglected by those teachers.
2. The assessment of investigative skills and knowledge is only nominally assessed in Victoria and New South Wales whereas in Queensland it is given its own status in the assessment schema through the assessment of EEIs. Hence, this becomes a key element in the learning of all chemistry students in Queensland.
3. All state and territory curricula for the science give lip service to assessing higher order thinking, but most fail to reinforce this type of learning in the assessment system. Again, Queensland stands out as having built this higher order thinking

into its assessment system because of its criterion-referenced character, and because students are made aware explicitly of the learning expected.

4. The variety of assessment tasks in Queensland enables appropriate pedagogies to happen, whereas in other states the use of a composite numerical mark and statistical moderation destroys this possibility.

References

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Mathematics Education

With a focus upon Mathematics education, we have responded to the three issues to be considered by the Inquiry and make the following comments:

- **Teacher support for the assessment processes.**
  Teacher support for the current assessment processes is best judged by organisations that represent teachers, as has been done in the public briefings and by submissions from individual teachers. QUT recognises that the effectiveness of any education system, including the methods of assessment, will be mediated by the resources (both time and financial) that are expended upon providing teachers with effective and timely professional learning. In this case, professional learning that equips teachers with the skills and understandings to make the Queensland system of school-based assessment work effectively will positively impact upon the level of teacher support.

- **Student Participation in Senior Mathematics.**
  Questions regarding student participation should be answered based upon enrolment data, and so should be directly responded to by the Queensland Studies Authority. Anecdotally, compared to thirty years ago, there is now a wider variety of senior subjects for students to choose, which would naturally lead to a reduced participation across the subjects. However, QUT would venture that participation in senior maths is still high, but many students may now be opting for Maths A rather than Maths B or C, and this is usually because Maths A is more suited to their career aspirations.

- **The ability of the assessment processes to support valid and reliable judgements of student outcomes.**
  Queensland has long history of conducting a school-based senior assessment system, which is deemed to be effective. It provides a system in which learning can be tailored and adapted to the diversity of students and learning communities across Queensland. The Queensland system of senior school assessment is based upon six core principles that promote equity for all students and multiple opportunities for students to demonstrate their proficiency. Within this system, teachers make evidence-based professional judgements regarding student achievement. The only potential disadvantage of the Queensland system relates to the moderation process and the possibility of subjective rather than objective decisions. Embedded within the Queensland system is the use of criteria-based assessment. To be effective, the use of criteria-based assessment requires appropriate resources and professional learning to equip and support teachers' implementation of the system.

Additionally, we have reviewed some of the inquiry submissions and have made the following observations:

- Concerns have been raised around lack of teacher participation in moderation panels and inconsistency in judgements. These claims need to be further investigated. If found to be substantiated, QUT reaffirms the claim that to make the system work effectively, teachers need to be adequately supported both in terms of professional learning and the resources (time and remuneration) allocated to participating teachers.

- Some concerns have been raised regarding the increased workload, for both students and teachers, associated with extended assessment tasks. Student and teacher workload is an issue for all schools to monitor across all subject areas. In our opinion, such extended tasks in Mathematics do not generally seem to be causing an overload of work for either students or teachers.

- Some respondents perceive that standards of student learning are dropping whilst others indicate that students are now completing more highly sophisticated and complex tasks. At QUT we are focused on educating teachers who will provide challenging and appropriate learning opportunities for all students and are researching methods for this to be done more effectively. New opportunities in technology mean new ways of learning and teaching. The teaching profession needs to work towards providing equitable opportunities where teachers and students alike are supported as they embrace these changes and bring about the best outcomes for all students. Claims regarding the standard of education should be made with reference to the demands of current society and career aspirations.