We thank the committee for the opportunity to contribute to the enquiry regarding the "Review of the Annual Report 2002-2003 of the Department of Education, Science and Training". We believe competence in 'the enabling sciences' in students entering universities is critical to their success in many disciplines, and that lack of adequate competence makes university training a difficult, inefficient and frustrating process. Whether any lack of competence in 'the enabling sciences' is a consequence of ill-informed subject choices at school (viz Outcome 2, priority 3), or of weak teaching (presumably Outcome 2, priority 2), it certainly has a major impact on universities' capacity to transfer new knowledge (viz Outcome 3 priority 1).

We are biologists teaching and undertaking research at James Cook University. Within the overall field we represent a range of subdisciplines, including ecology, population and system modelling, population genetics, biometrics and biotechnology.

Biology is a quantitative science. We are dependent on background training in the empowering sciences, and most critically in mathematics, to enable students to study and to understand the patterns and structures of the biological disciplines. This foundational requirement is reflected in entry to biology in this university being dependent on performance in English, Mathematics and Chemistry, rather than on any biological prerequisites.

Because of the reduced resources available at tertiary level through the shift to mass education it is important that we work efficiently (viz Outcome 3, priority 1). Unfortunately the reporting of school results does not enable us to do that. Our entry requirement (Sound in Maths B (QLD) or equivalent) is almost totally uninformative. A Sound grade covers a range of student performance from 30% to 70%. At one end a strong remedial program is almost certainly needed, at the other are students who should be more than competent. We have no way of separating out the weaker students until we discover them ourselves, which is long after remedial teaching should have been provided, and is then a major disruption to their progress and to our integrated course structures.

By comparing exam scripts we are able to evaluate the entering standard in mathematics and chemistry over a period of more than fifteen years. We have found a marked decrease in general standards. At the same time some students continue to have a very high level of achievement and general competence. There is structure in this pattern, on which we comment below.

The dependencies we have on mathematical background are many and various. At first year, but again in all succeeding years, we expect a total mastery of arithmetic. With a significant body of students this can no longer be taken for granted. Basic arithmetic is conducted on the pocket calculator, but with no feeling for the operations being done … there is no 'common sense' running check of results conducted 'in the head' and no apparent realisation when the numbers on the screen are preposterous. At all levels we require a capacity for rapid and painless manipulation of algebraic equations to rearrange models or explanations into forms more useful for interpretation. An ability to draw and interpret graphs is important for understanding developing patterns. At all levels we are dependent on a basic comprehension of fundamental calculus. We do not require a detailed knowledge of the more arcane parts of that discipline, but a knowledge of the principles of derivatives and a recognition of the information contained in gradients. A conceptual knowledge of the principles of integration underlie statistical inference, where integrated densities allow the calculation of probability levels. Again we require principles, not the capacity to conduct the operation from first principles. All these requirements seem fairly basic and reasonable, and are within the syllabus in all States.

We do not seem to be the only ones to have noted this collapse in mathematical competence. In 'The Australian' Higher Educational Supplement of 4 August 2004, accompanying an article on the proposed 'Graduate Exit Test', is a fragment showing what appears to be a 'time of journey' problem involving different means of transport. Twenty years ago such competence was expected in pupils leaving primary school.

There are many potential causes for any drop in general competence: shifts to mass education at upper secondary schools and universities without equivalent resourcing, changes in syllabus, changes in teacher training, changes in community expectations. That said, some students continue to excel. Correlates of performance include different state of origin and different syllabi. Discussing matters with students, we also find evidence for a strong teacher effect, where teaching by teachers competent in the subject has a marked, positive, impact. Out-of-state students who have taken the International Baccalaureate syllabus are well-prepared, but a high level of self-selection applies to this group and they might be expected to do well. Students from some foreign education systems are also well-equipped in the enabling sciences, but again there may be significant self-selection.

Talking to students a 'hidden' problem is identified in that poor or weak teaching in the earlier years may make pupils less willing to accept advice to study the enabling sciences in senior high school (viz Outcome 2, priority 3), or else they may be unable to build on a weak foundation. We are talking to those who overcame this hurdle, but they indicate the existence of the problem. Students without the basics are precluded from taking options, no matter what the 'advice'.

That the ability to do simple arithmetic cannot be taken for granted in today's first year cohort indicates that problems lie deep in the school system. It is surely time to determine why this collapse in preparedness has occurred, and to fix it. Good teachers, competent in their academic discipline, were once presumed to be every schoolchild's right. Perhaps it is a good recipe.

Despite representing what is often seen as 'the other side of science' we regard mastery of the techniques and understanding of the principles of 'the enabling disciplines' as fundamental to becoming a scientist. The committee should be in no doubt that we are seeing a substantial reduction in the mathematical ability of students entering universities relative to a decade ago, and that this weakness has implications both to the individuals betrayed by the education system and to the development of Australia's scientific capabilities. We urge the committee to consider ways to reverse this decline,

Yours faithfully,

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