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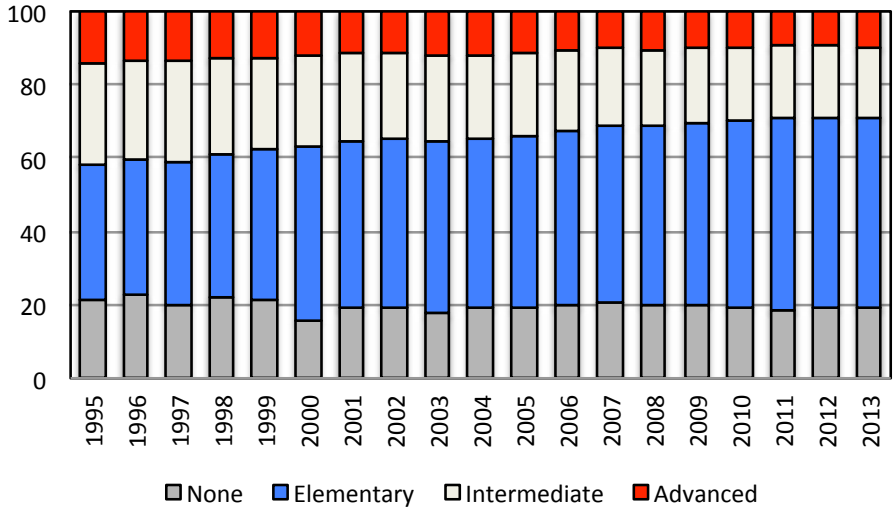
Editorial

Dear Readers

Welcome to our first fully online issue of *Parabola Incorporating Function*.

There has been a lot of press coverage and concern over recent months about the declining proportion of students taking intermediate and advanced mathematics subjects in senior years at high school. There has been a corresponding increase in the proportion of students studying elementary mathematics. A major reason for the concern is the possible downstream impact, with fewer students prepared for tertiary studies involving mathematics. This is a particular concern in the science, technology, engineering, mathematics (STEM) disciplines. Elementary mathematics does not provide adequate preparation for tertiary subjects involving mathematics. Intermediate mathematics provides satisfactory preparation for some tertiary subjects involving mathematics but is generally not adequate preparation for physical sciences and engineering. Advanced mathematics provides preparation for tertiary mathematics subjects, including physical sciences and engineering. The descriptors, elementary, intermediate and advanced, relate to the syllabi and perceived difficulty of the material (Barrington and Brown, 2005).

The figure below shows the percentage of the overall cohort of senior secondary students in Australia who have been studying no mathematics, elementary mathematics, intermediate mathematics and advanced mathematics, using data from a report published for the Australian Mathematical Sciences Institute (Barrington and Brown, 2014).



There has been much speculation about the reasons for the trend away from intermediate and advanced mathematics and towards elementary mathematics. One of the most concerning suggestions is that students are opting for elementary mathematics subjects rather than intermediate and advanced subjects mathematics subjects because they believe that this will enable them to obtain a higher ATAR. A careful statistical analysis was recently carried out by Associate Professor David Pitt, Macquarie University, to examine if there was evidence to support the view that a higher ATAR could be expected by a good student if they opted for General Mathematics (Elementary) in the NSW HSC rather than Mathematics (Intermediate). Professor Pitt examined the relative performance of students in mathematics in the School Certificate in 2011 and estimated scaled scores in HSC General Mathematics or HSC Mathematics in 2013. The scaled scores feed into the ATAR score. Professor Pitt concluded that, on average, those students who studied HSC General Mathematics would have obtained higher scaled scores, relative to their year 10 School Certificate scores, than those who studied HSC Mathematics. An article by Eryk Bagshaw in the *Sydney Morning Herald* (May 19) picked up on this and reported that "the current scaling mechanisms that determine university admissions unfairly advantage general mathematics students, who study a simpler form of practical mathematics than those who undertake the calculus-based two-unit course". This is interesting. Why would the scaling algorithm advantage students studying the easier course? After all, the very raison d'être of scaling is to ensure that there is no advantage in taking easier subjects.

It is an axiomatic fact that students with similar mathematical abilities would be able to perform better on easier exams in elementary mathematics than on more difficult exams in intermediate mathematics. But the scaling counters this. The scaled mark attempts to estimate the mark that the student would have received in a subject if all students had studied all subjects. *The Report on the Scaling of the 2014 NSW Higher School Certificate*, which is available for download from the website `uac.edu.au`, seems to support that easier subjects are scaled down more than harder subjects. In particular, results in both Mathematics and General Mathematics were scaled down and results in General Mathematics were scaled down more than results in Mathematics. So where does the advantage come from? The scaling algorithm, which is outlined in *The Report on the Scaling of the 2014 NSW Higher School Certificate* essentially works as follows. A linear transformation is applied to the raw marks in each subject setting the top mark of 50 (on a one unit basis) to be the same. The distribution of marks in each subject is then standardised to have a mean of 25 and a standard deviation of 12 (on a one unit basis). The scaling algorithm rescales the mean in a given subject so that it is equal to the average academic achievement of all students who did that subject. The average academic achievement of a particular student is the average scaled mark in all subjects completed. There is more to it than this but this is a sufficient description to understand the possibility that good students could be advantaged by opting for General Mathematics rather than Mathematics as it may free up more time for the cohort undertaking General Mathematics to obtain higher marks in their other subjects. But it is certainly not clear cut. It would be wrong to suggest that the scaling methodology is itself conferring an advantage. If there is an advantage it would be greater in the

absence of standardisation and scaling.

There are many optimisation strategies that might be adopted if your aim is to maximize your ATAR. There are websites dedicated to this sort of thing. But your ATAR is just one of many variables that contributes to your future possible options, and surely it is your future options that you should try to optimize. If you know what future possible options you might wish to pursue then your optimisation strategy should be based around this and it will no doubt be a multivariable optimisation. If you wish to become an engineer, a physicist, a quantitative analyst, an actuary, a mathematician, a statistician, an economist, a research scientist, a computer scientist, a data analyst, or one of the many other professions in the engineering, physical, and mathematical sciences, then a good ATAR score will help you to gain entry into these areas but your future success will be highly compromised if you have opted for elementary mathematics rather than intermediate or advanced mathematics. If you don't know what you want to do then good advice is to keep your options open. In a world that is becoming more digital and less analogue, the relevance of mathematics and statistics is becoming more ingrained across more professions. For most students it would make sense to include studies in intermediate mathematics or advanced mathematics. Your optimization should also bear in mind that many universities offer bonus points to ATAR scores for good performances in intermediate and advanced mathematics.

Editor

Bruce Henry

F. Barrington and P. Brown (2005)
F. Barrington and P. Brown (2014)