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OBSERVATIONS ON LONDON (EDEXCEL) 'A' LEVEL MATHEMATICS FROM 1960 TO 2004

In the early 1960s, pure and applied mathematics taken as one 'A' level comprised two 3 hour papers, each containing 10 long questions covering the whole syllabus, from which candidates were expected to answer 8.

Since then, the 'A' level mathematics syllabus has undergone several changes, the most deleterious following the abolition of the C.S.E. and the 'O' level and their replacement with the G.C.S.E. In 1992, modularization created four examination papers (modules) each of which could be taken at separate sittings, 6 months apart if the candidate wished.

Modularization broke the syllabus into smaller, easier to learn (cram) chunks, with some topics in a module never again to be encountered in a later module. This allowed candidates who possessed little, or only short-term, memory to obtain an 'A' level in mathematics which they could not have obtained under the old system.

Furthermore, by 1995 almost half of the pure mathematics topics had been removed (Appendix 1). In a study of the performance of first year students in an engineering department, K. L. Todd[1], reported that a student with a grade A in mathematics in 2001, on average obtained a score on his test which would have placed that student near the bottom of the cohort 15 years previously.

Since 1991, D. A. Lawson[2] has performed a diagnostic test on first year students on degree courses with significant mathematical content. He found that a student with a grade B in 'A' level mathematics in 1999 scored similarly to a student with grade N (a fail grade) in 1991.

In these studies by Todd and Lawson, the candidates reviewed had taken their 'A' level mathematics with whichever examination board their school had subscribed to, not particularly Edexcel.

The Chief Executive of the Qualifications and Curriculum Authority (QCA) agreed that there had been a "backsliding" of standards during the 1990s and that they would now be "reasserting earlier standards". To redress the situation, the QCA introduced Curriculum 2000. This applied to all examination boards and for Edexcel a small number of the topics which had been removed previously has been restored to the syllabus (topics 2, 7, 9, 10, 15 & 18 in Appendix 1) but the examination now has 6 modules (or units), involving even less content per examination paper – less to learn per module or per sitting.

The mathematical skills and topics, which previously formed part of the syllabus for children aged 14 to 16 years, and were examined at C.S.E. and 'O' level, are now set as questions in the early 'A' level units. In particular, finding areas and volumes using calculus, which used to be examined at 'O' level, are now examined in 'A' level pure mathematics units one (P1) and two (P2) respectively, but it is the 'O' level questions which are harder.

Some applied mathematics C.S.E. papers from the 1970s are almost indistinguishable from the mechanics unit one (M1) 'A' level paper, with some C.S.E. topics even overlapping with

unit two (M2). One calculus topic from 'O' level pure mathematics (variable velocity) is now to be found at 'A' level in mechanics unit two (M2).

On comparing the current 'A' level mathematics with the earlier, pre-modular examination, one observes several other worrying trends in the new examination. Its modular nature severely limits the variety and difficulty of questions, which are shorter and more predictable, less algebraically demanding and are often no more than a series of easy drill-type exercises. The examination routinely guides students through the questions with the liberal use of diagrams and splitting the questions into several ordered steps.

'A' level mathematics grades A & B are less reliable indicators of mathematical competence. Universities and employers are finding it very difficult to separate the wheat from the chaff.

Intelligent and mathematically-gifted students are now denied the opportunity of being distinguished from their less able peers. They are also denied the quality of education enjoyed by their forebears.

References:

1. Todd, K. L. 'An Historical Study of the Correlation between G.C.E. Advanced Level Grades and the Subsequent Academic Performance of Well Qualified Students in a University Engineering Department', *Mathematics Today* (IMA), **37**(5):152-156, Oct. 2001.
2. Lawson, D. A. 'What can we expect of 'A' level mathematics students?', *Teaching Mathematics and its Applications*, **16**(4):151-156, 1997, as updated in Mustoe, L. R. 'Papering over the cracks? Mathematics for engineering undergraduates.', *Mathematics Today* (IMA), **38**(3):67-69, June 2002.

Appendix 1: A Summary of Topics Removed From London (Edexcel) 'A' Level Mathematics by 1995

1. Complex numbers.
2. Vectors in 2 & 3 dimensions.
3. Mathematical induction.
4. Centroids and centres of mass.
5. Permutations and combinations.
6. Arithmetic and geometric means.
7. The equation of a circle.
8. Newton-Raphson iteration.
9. The trapezium rule.
10. The binomial expansion of $(1 + x)^k$ where k is rational.
11. The roots of quadratics equations without solving the equations.
12. Inequalities of the form $\frac{1}{(x-a)} > \frac{x}{(x-b)}$, $|x-b| > k|x-b|$.
13. The approximations $\sin x \approx x$, $\tan x \approx x$, $\cos x \approx 1 - \frac{x^2}{2}$.
14. The product formulae.
15. Expression of $a\cos\theta + b\sin\theta$ in the form $r\cos(\theta + \alpha)$.
16. The general solutions to trigonometric equations.
17. The summation of simple finite series, e.g. $\sum_{r=1}^{n} r(r+1)$

18. The inverse functions of sine, cosine and tangent, defined over suitable regions and the graphs of these functions.
19. The application of differentiation to small increments and approximations.
20. The integrals of $\frac{1}{1+x^2}$, $\frac{1}{\sqrt{1-x^2}}$.

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