Some Thoughts on the 2018 Exams - Post Results

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General Comments (All Boards)

This document contains some musings (not all fully formed) on the 2018 exams and what can be learnt from them. As I teach AQA the focus will be on the AQA papers.

Grade Boundaries

As expected the grade boundaries were significantly different across the boards.

For AS Level we had the following (in %s, see Appendix for Raw scores):

Board	A	B	C	D	E
AQA	52.50	45.00	38.13	31.25	24.38
Pearson	65.63	56.25	46.88	38.13	29.38
OCR A	63.33	56.00	48.67	41.33	34.67
OCR B (MEI)	67.14	59.29	51.43	43.57	36.43

And, for A-Level we have the following grade boundaries. (in %s):

Board	A*	A	B	C	D	E
AQA	76.67	60.33	52.67	45.00	37.33	30.00
Pearson	76.33	61.33	51.67	42.00	32.67	23.33
OCR A	80.00	65.67	54.00	42.67	31.33	20.00
OCR B (MEI)	79.27	71.64	64.00	56.36	49.09	41.82

Grade Award Profile

AQA:

3006 students were entered for AS Mathematics with the below cumulative grade distribution

A	B	C	D	E	U

22.6	34.8	48.7	63.2	77.4	100

Many more students failed this AS than the old specification.

232 students sat A-Level Mathematics with AQA, with the below cumulative grade distribution:

A*	A	B	C	D	E	U
17.2	42.2	54.3	61.6	69.4	75.9	100

Pearson:

12525 students sat AS-Level Mathematics with Edexcel (Pearson) with the below cumulative grade distribution:

A	B	C	D	E	U
24.9	37.8	52.4	67	79.9	100

1604 students sat A-Level Mathematics with Edexcel (Pearson) with the following cumulative grade distribution:

A*	A	B	C	D	E	U
30.0	60.6	75.9	85.3	91.0	94.8	100

OCR A:

1974 students sat AS-Level Mathematics with OCR A with the below cumulative grade distribution:

A	B	C	D	E	U
31.86	45.80	59.47	72.54	83.18	100

113 students sat A-Level Mathematics with OCR A with the following cumulative grade distribution:

A*	A	B	C	D	E	U
39.82	69.03	79.65	92.92	97.35	100	100

OCR B (MEI):

1459 students sat AS-Level Mathematics with OCR B (MEI) with the below cumulative grade distribution:

A	B	C	D	E	U
23.65	38.11	52.50	67.85	79.37	100

36 students sat A-Level Mathematics with OCR B (MEI) with the following cumulative grade distribution:

A*	A	B	C	D	E	U
27.78	52.78	72.22	80.56	88.89	91.67	100

AS-Level Cumulative Grade % Summary Table

Board	A	B	C	D	E	U
AQA	22.6	34.8	48.7	63.2	77.4	100
Pearson	24.9	37.8	52.4	67	79.9	100
OCR A	31.86	45.80	59.47	72.54	83.18	100
OCR B (MEI)	23.65	38.11	52.50	67.85	79.37	100

A-Level Cumulative Grade % Summary Table

Board	A*	A	B	C	D	E	U
AQA	17.2	42.2	54.3	61.6	69.4	75.9	100
Pearson	30.0	60.6	75.9	85.3	91.0	94.8	100
OCR A	39.82	69.03	79.65	92.92	97.35	100	100
OCR B (MEI)	27.78	52.78	72.22	80.56	88.89	91.67	100

Lots of interesting insights on grade distributions etc can be found by exploring the Ofqual interactive map: https://analytics.ofqual.gov.uk/apps/2018/Alevel/County/

AQA AS Papers - Examiner Comments

The examiner comments for the AQA AS papers were an interesting read - You can find them here: http://bit.ly/AS_2018_AQA_Examiner

The overall comments for Paper 1 and Paper 2 are very similar.

Paper 1:

As the first examination for the new AS Mathematics specification, this paper presented challenges. The most significant challenge was the new assessment objectives which led to changes in the demands placed upon the students. To further support this, a new type of mark, an R mark, was introduced to be awarded for mathematical rigour, particularly in a 'show that' or 'prove' question.

Students showed confidence and competence in carrying out routine procedures, as in questions 4, 9(d), 10 and 13(a). However, when a method had to be selected from various options or original thinking was required, as in questions 5, 6, 7 and 15(b)(i), many struggled.

The quality of algebra was lower than expected, which hampered the solution of correctly formed equations. There was evidence of the intelligent use of the newer calculator functions, but also of a lack of appreciation of their limitations.

Paper 2:

This first paper 2 of the new specification proved challenging to the students, especially in Section A. The students seemed more comfortable with the statistics content of Section B, and in many cases were able to pick up a significant proportion of the marks available. Students appeared confident in their use of the statistical functions and distributions on their calculators.

In many of the Section A questions, students lacked the algebraic fundamentals to be able to make significant progress, despite often formulating the basis of their solutions correctly. Method marks were available in these cases, but it was a shame that careless errors and poor algebra hindered accessing all of the marks available. Good work was seen in Q3, Q5, Q6 and Q7a in Section A and in Q15a and b, Q18 and Q19 in Section B.

In the multiple choice questions it is vital that students follow the given instructions carefully as there were cases where no choice was clearly identified and also where two choices were identified.

It was pleasing to see that in some questions, eg Q10, students persisted when their initial method proved to be unsuccessful, and they were able to improvise and find a way of getting to the correct solution. Students should always be encouraged in multi-part questions to attempt all parts, as often marks can be picked up despite not making any progress in the earlier parts.

Question 17, which was based upon the data set, was very poorly attempted. Less than 8% of students picked up any marks. It seemed that many students were unaware of the data set or had not spent much time familiarising themselves with it.

Note the following advice:

- students should know when to use their calculator and when they must show every step of their working (and assume the examiner does not know what to do), especially when questions includes the words 'Fully justify your answer'
- students need to use a range of checking techniques to see whether their answers look sensible, not least when they obtain a probability answer greater than 1
- students should work to 4 dp for probability values in hypothesis tests.

A few particular things that caught my eye in the examiner reports:

- Paper 1, Question 6: My students struggled with this in their mocks and this seems to have been the same nationally where "The quality of explanation was poor". Action: I'm intending to focus more on proper, written mathematical exposition next year and possibly track progress.
- Paper 1, Question 9: It seems many are still not being taught differentiation from first principles explicitly - this seems strange to me as it is explicit in the DfE context document.
- Paper 1, Question 14: Students lost marks due to premature rounding, especially when not choosing the correct SUVAT equation (and so having to use two to obtain the desired quantity). I try to emphasise that it is important to choose the SUVAT equation in order to be efficient, but some of my students still chose the two equation approach - all of the students who did this also take physics where they would have covered SUVAT equations before the maths scheme does. Action: Emphaise this even more. Questions on just choosing the correct approach.
- Paper 1, Question 15: Action: More focus during teaching on assumptions and modelling.
- Paper 2, Question 4: Many errors in rearranging, eg $\tan^2(2\theta) - 3 = 0$ becoming $\tan^2(\theta) = \frac{3}{2}$. This was a common error that I saw in my mocks this year. Action: Focussed practice of rearranging trig equations before actually solving (isolate this technique maybe?)
- Paper 2, Question 6: Poor knowledge of geometrical properties and lack of a rigorous statement to enable the award of the final R mark. Action: Emphasis on structure of proofs, isolating what key things need to be proved to arrive at a result (I certainly didn't break this down enough this year).
- Paper 2, Question 7: The errors I observed with completing the square for a non-monic quadratic were observed nationally. Action: Spaced practice of these key algebra skills in homework throughout the year.
- Paper 2, Question 8: Candidates asked to sketch two possible positions for a circle. The examiner report says "it would be preferable if students

used a compass to draw a circle". Action: Query this with AQA - to me using a compass is not a sketch.

- Paper 2, Question 10: "It was surprising that more students did not resort to using the equation solver on their calculator to solve their algebraic equation". Action: Emphasis on calculator use in lessons.
- Paper 2, Question 11: "This type of question is one of the most challenging demands of the new specification, and schools and colleges will need to take every opportunity to consolidate the skills required to attempt these questions." Action: Produce a sheet of similar questions. Include these questions regularly in homework once calculus has been studied.
- Paper 2, Question 16: Poorly answered in my mock too. "Schools and colleges need to encourage their students to use their calculators to obtain random numbers." Action: Change delivery of sampling methods content.

AQA A-Level Papers Examiner Reports

Again an interesting read - find them here:

Overall comments reproduced below.

Paper 1:

General

The paper discriminated well between students of varying abilities. While the cohort was reasonably small, students were fairly evenly spread across nearly the whole range of available marks. Students found the multiple-choice questions very accessible and many made good progress on some of the less structured, new style questions. There was no evidence that students were short of time with the majority making a complete attempt at all questions.

Some of the topics which caused greatest difficulty to students are new to the A-level maths specification. These included (8bi) Newton-Raphson, (14) proof of compound angle formulae and (15b) understanding of differentiation from first principles.

There was evidence of allowed calculator technology being used well by some students, but most missed opportunities to reduce the amount of routine manipulation required. This was most evident in questions 9, 10, 11, 12, and 13. Students (and teachers) should be confident that if a calculation can be done or an equation solved using allowed calculator functions then they will not be penalised for doing so, provided they are answering the question they have been asked. In cases where an exact value or a proof is required, calculators may be less useful but still provide a valuable check.

Some students had clearly understood the implications of the instruction "Fully justify your answer", and there were very good examples of reasoning being explained and justifications for calculations used. Students who ignored this instruction often gave partial solutions and while they were able to score method and accuracy marks, they lost marks for explanation or reasoning.

Paper 2:

General

The paper discriminated well between students of varying abilities. While the cohort was reasonably small, students were fairly evenly spread across nearly the whole range of available marks. Students found the multiple-choice questions very accessible and many made good progress on some of the less structured, new style questions. Students seemed to find most questions on this paper accessible, but many struggled when it came to interpretation of results or criticising models. There was no evidence that students were short of time with the majority making a complete attempt at all questions.

One of the topics which caused greatest difficulty to students was variable acceleration, in question 15, which is new to the A-level maths specification.

There was evidence of allowed calculator technology being used well by some students, but most missed opportunities to reduce the amount of routine manipulation required. This was most evident in questions 3, 8bi, 9, 15, and 16. Students (and teachers) should be confident that if a calculation can be done or an equation solved using allowed calculator functions then they will not be penalised for doing so, provided they are answering the question they have been asked. In cases where an exact value or a proof is required, calculators may be less useful but still provide a valuable check.

Some students had clearly understood the implications of the instruction "Fully justify your answer", and there were very good examples of reasoning being explained and justifications for calculations used. Students who ignored this instruction often gave partial solutions and while they could score method and accuracy marks, they lost marks for explanation or reasoning.

Paper 3:

General

The vast majority of students appeared to have sufficient time to tackle the paper, and scores were achieved throughout the possible range.

A few particular things:

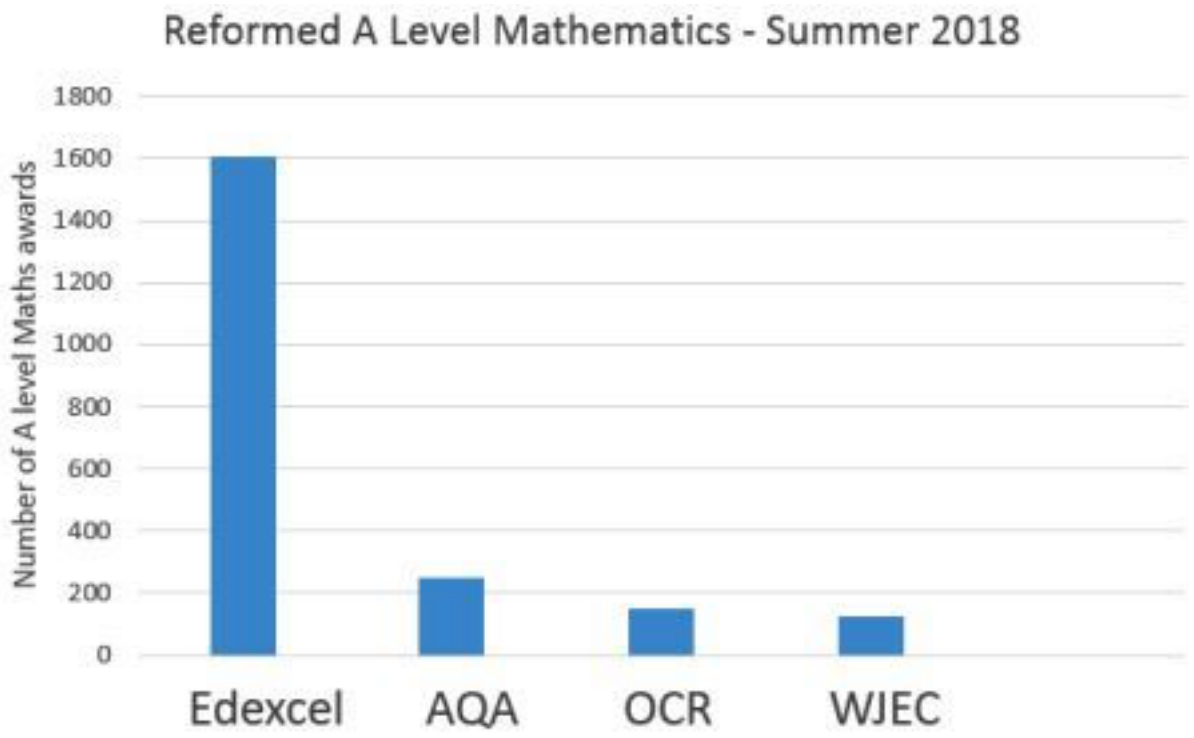
- Paper 1, Question 5: Differentiation of 2^t caught people out - this is new to the specification. Action: Ensure resources available for this.
- Paper 1, Question 7: Students generally didn't provide the rigorous statement required to complete the question. Action: Focus on mathematical exposition throughout.
- Paper 1, Question 8: Students not realising that Newton-Raphson solves equations of the form $f(x) = 0$ and didn't rearrange. Action: Focus on resources for N-R and other numerics.
- Paper 1, Question 14: Proof of compound angle formulae was found to be very challenging. Action: Inclusion of Geogebra / card sort style resource for this topic into the scheme of work. Some MEI resources on this available too.

- Paper 2, Question 3: "Scripts showed evidence of algebraic integration from many students, whereas it had been expected that they would simply evaluate using allowed calculator functions." This question here was really testing understanding of the need to spilt into two intervals, not actually integrating. Action: Use calculators for definite integration more in class. Emphasis on appropriate use will be needed.
- Paper 2, Question 5: "Most students realised that proof by exhaustion was required and the majority achieved the first mark for starting to check for factors. The second mark could only be achieved through a rigorous proof and a variety of approaches ranging from very efficient to very inefficient were seen. Some students checked every integer between 1 and 23 with the consequence that missing out one number lost a mark. Others explained they only needed to check prime numbers and a few realised they only needed to check the two prime numbers less than $\sqrt{23}$ and, provided this was explained, full credit was given."
- Paper 2, Question 15: In part (a) there was a significant proportion of students who scored zero marks and, in many cases, this was because they incorrectly used constant acceleration equations." Action: Exercise on selecting between variable or non-variable given a situation. Students often seem to find this hard.
- Paper 3, Question 6: Action: Emphasis on rigorous notation for domain and range when studying functions.
- Paper 3, Question 10: This is essentially bookwork. Action: Should we encourage memorisation of standard proofs or focus on giving differing proofs to develop skills?

General Thoughts

The full A-Level boundaries are much more consistent across the boards, which matches my assessment of the comparable difficulty of the papers when I worked through them all. I feel that the A-Level paper for AQA was much more closely aligned with the other boards than their AS papers.

Edexcel remain the market leader for A-Level maths, Graham shared the the summary graph below on Twitter.



The grade profiles for the different boards are significantly influence by the type of centres they have and shouldn't be used as justification for changing board. For instance, Edexcel have a large number of independent schools.

The A-Level boundaries for AQA fit fairly closely with the boundaries that I used for my Year 12 mocks in July (shown below), where I used the first sit AQA AS Papers - I shall update my mock results to allow for the differences at the top and bottom.

Year 12 Mock Boundaries					
	A	**B**	**C**	**D**	**E**
AQA	63%	53%	43%	32%	23%

My intention is to use the 2018 papers for Year 12 mocks in 2019 with the real boundaries.

As Ofqual have said (in this blog post: https://ofqual.blog.gov.uk/2018/03/16/setting-standards-in-the-new-a-level-maths-qualifications/) the cohort who sat the full A-Level in Mathematics this year is likely to be very different ot a standard cohort (for example many will be going on to do Further Maths in Year 13) and so these grade boundaries **cannot** be relied upon to be reflective of the grade boundaries next year.

Not having UMS marks feels fairer (especially when you think of the scaling used by Edexcel for the FP2 papers for the last couple of years).

Students who were well prepared did well, those who didn't have enough understanding or intuition about the underlying mathematics, struggled, as expected. Key item for thought: How to effectively develop mathematical intuition?

More use of the questions contained in the AQA teaching guidance would likely improve outcomes. Action: Need to write solutions and group together questions in PowerPoints to use in Lesson.