Department of Mathematics and Statistics

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

Junior Mathematics Competition

The University of Otago Junior Mathematics Competition 2020

2020 Competition Report

General Comments

The 2020 competition was heavily disrupted by COVID-19. Due to lockdown restrictions the competition was held a month later than initially planned on the 13th of May. Pupils sat the competition more or less as a 'take-home' examination, although a few pupils were able to sit the competition at school under a more traditional supervision model.

The number of pupils taking part in the competition in 2019 was 1944 from 73 schools, a clear drop from last year, when 6975 pupils entered from 175 schools. Due to the conditions under which the competition was sat, most papers were submitted digitally. This proved to be a vigorous test of our systems, and it has become clear that receiving a large number of competition papers via digital submission will not be feasible going forward. As such the structure of the competition will have to change from next year onward (see the following section for more on this).

As a result of the low number in this year's competition, this year we will be producing only Top Three, Top Thirty, and Merit awards — there will be no Top 100 nor Top 200 awards. It seems likely that in future years we will only award Top 200 certificates in a year level if there are sufficient candidates to justify it. There are no monetary prizes this year as a result of the way the competition was sat.

As a whole most candidates found the competition relatively easy, and marks were high across the board. This did make grading the competition harder than in previous years, so in several places (particularly in Questions Five and Six) answers had to be particularly well explained in order to achieve full marks. For the overall scores in 2020 see the table on page 3.

We continue to emphasise that doing as much as possible in a question before moving onto another question is better than jumping back and forth between questions. Another good idea is to write the answer down with the minimum working possible. Students can return to 'pad' the working out when they have done as much of the competition as they can do. Once again several 'capable' students answered the early questions nearly perfectly but ran out of time and could not do justice to the later ones, mainly because they wrote too much at the beginning. There is a fine line between explaining and over-explaining your answers.

Next Year's Competition

Next year we will be changing the structure of the competition. We will hold the competition in two parts, held roughly a month apart.

The first part of the competition will be held on the **14th of April**, and will be an online test featuring multi-choice and short answer questions and lasting one hour in duration.

The second part of the competition will be held on the **12th of May**, and will have the same structure as this year's competition. Entry to the second part of the competition will be restricted to those pupils who place in the top 15 percent of their year level in the first part of the competition.

(Due to COVID-19 the dates listed above are subject to change.)

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Schools may opt to do either both parts of the competition, or only the first part — there is no direct entry into the second part alone.

There are several good reasons why we are moving to a two part competition next year. As costs (both financial and administrative) continue to rise, we have to streamline more of the processes used to run the competition, and automatic marking of the competition helps in this regard.

Furthermore, an online assessment that is marked automatically allows entrants in the competition to receive almost immediate feedback about how well they have performed.

Finally, the full results of the first part of the competition can be announced within a month of being sat, and the second part of the competition should take less time to mark (assuming the total number of entries overall is similar to that in 2019.) Traditionally the competition has been sat in April, and then there is a roughly four month wait for results.

We plan to offer monetary prizes for both parts of the competition, and do not intend to raise the cost to enter beyond the $5 per pupil it is for schools currently. Full details are yet to be determined, but next year's initial invitation will detail the full structure of the competition, including costs to schools and what prizes will be awarded.

Brief Comments on Individual Questions

Question One (Year 9 and below)

The first two parts of this question were well answered. Part (c) on the other hand was less well answered — many pupils failed to use their answer from (b) here, which was unfortunately a common theme in this year's competition. This question can be adequately answered in a few lines, but far too many pupils took a page (or more) to answer, a pattern repeated in Question Two.

Question Two (Year 10 and below)

A similar pattern to Question One appeared here. Quite a few candidates were not able to use estimation as a check against their answers — in part (a) answers in the billions were not uncommon.

Question Three

This question was very well answered on the whole, and was probably the easiest Question Three for many years.

In parts (c) and (d) candidates used non-prime numbers like 1 and 9 far too often for our liking, which was disappointing as we provided a list of almost every prime they would need to answer the question. When asked in part (f) "Is 83 prime?" a few pupils gave contradictory statements like "No, 83 is a prime number", a pattern repeated in (g).

Question Four

This proved to be the hardest 20 mark question in the competition. Many students were unable to count the triangular numbers correctly, such that in part (a) 28 was frequently listed as the eighth triangular number.

Question Five

This was a question were it was quite easy to find a correct answer (as many candidates did), but quite hard to show that it was the *only* correct answer.

In part (a) a few pupils were able to produce either the left hand or right hand side of the equation, but not both. In part (b) identifying prime numbers was beyond a few entrants (who could nonetheless factor 325 to a reasonable degree), which was a bit surprising since said students were able to get the prime number parts of Question Three correct.

In part (c) many candidates could produce $y = 13$ and $x = 11$, but it was rare to see any demonstration that this was the only answer — few candidates could state facts like 'y must be a multiple of 13', and even fewer could show that (for example) $y = 26$ did not work.

Question Six

Much like Question Five, here many students could provide the answer without explanation, or with minimal explanation. Here however we did see a better class of answer overall, and full marks were commonplace for those who used an algebraic approach. (We deliberately chose to award those candidates over others who used arithmetic in order to better differentiate between papers.)

As in Question Two (but less frequently) some pupils failed to use estimation as a check against their answers, and as a result Joe (in particular) would take rather more cherries than would have been sensible.

Question Seven (Years 10 and 11)

This was a reasonably well done question this year. In part (a) most Year 10 and 11 pupils who attempted the question could identify at least 1 triple. Some were able to spot a pattern rather quickly, which was heartening. The only disappointment in (a) was the fact that so many candidates did not confirm their answers, which we hope was due to a lack of time.

Part (b) was less well done — many pupils could show that $2a^2 = c^2$ for example, but could then not explain that this would mean that c would be irrational. We did see a few students discuss the ratios of the sides being $1{:}1{:}\sqrt{2}$, although once again there were too many candidates who attempted to prove a general case using a few examples.

Question Eight (Year 11)

This question was very hit and miss. Students who understood combinatorics generally did pretty well (although some lost marks for inadequate explanation), while others had to work for marks or did not get anywhere. Top scholars were able to solve the more general part (a) and then draw on that to more succinctly answer part (b).

There were too many pupils who failed to remove the fixed numbers from the 'unknown' number, meaning they multiplied their possible combinations by 10 instead of 7. Due to the relative easiness of the competition we had to penalise students for this.

Percentiles

The percentiles at each level are given below. (The total possible marks for all candidates was 100.) Note that the top papers (about 18% at each level) have been check-marked by experienced members of the Mathematics and Statistics Department of the University of Otago. This does use up considerable time in returning results, but we feel that the greater accuracy in final marks makes the check-marking justified.

	2020			**2019**		
	Year 9	**Year 10**	**Year 11**	**Year 9**	**Year 10**	**Year 11**
Merit	59	65	76	47	55	58
70%ile	48	56	66	38	44	51
60%ile	42	50	59	33	39	46
50%ile	36	45	53	30	35	42
25%ile	24	32	39	21	26	30

A direct comparison to last year's competition is difficult because the number of entrants differs so much between the two, but it should be clear that this year's competition was indeed easier overall. There does seem to be some evidence that the difference between more and less capable students was more stark this year than last, but of course this could also be due to the marking structure we employed to grade contestants.

A Note on Calculators

We continue to stress how difficult it is for students without calculators to cope in a Mathematics competition. Even a simple calculator with the 'four basic functions' would save much time. Certainly Years 10 and 11 students cannot be expected to work out the more complicated problems towards the end without a calculator.

Explanation of the Symbols on the Mark-Sheets

The following symbols have been utilised on the mark sheets:

Questions 3, 4, 5, and 6 (up to 20 marks each):

(blank)	No work presented.
0	Work presented, but ungradeable, or fundamentally incorrect.
-	Minimal partial credit (1 – 5 marks).
+	Significant partial credit (6 – 13 marks).
✓	Near complete solution (14 – 17 marks).
✓✓	Full, or near full credit (18 – 20 marks).

Questions 1, 2, 7, and 8 (up to 10 marks each):

(blank)	No work presented or not applicable.
0	Work presented, but ungradeable, or fundamentally incorrect.
-	Minimal partial credit (1 – 4 marks).
+	Significant partial credit (5 – 8 marks).
✓	Near complete solution (9 – 10 marks).

Our Website and email

Please remember to check our website regularly for updates on the availability of results, as these will be typically available weeks before we sent out the results packs to schools. You should monitor the website before emailing us for information which is already on there. We have emailed results to all schools. Many thanks to those who continue to use email – we have found this to be the most effective form of communication by far, and has reduced our administrative burden no end.

Final comments

This year the competition faced several challenges — there is no longer a formal manager, and so the burden of running the competition has landed on several shoulders within the Department of Mathematics and Statistics. Furthermore COVID-19 meant that we had to place an increased responsibility on schools that wished to enter. It was impressive to see the capabilities of those schools that did manage to enter their pupils under such difficult circumstances. We applaud your efforts on this front!