NZ Engineering Science Competition Judges Report 2019

The eleventh annual "NZ Engineering Science competition" was held from 10am to 6pm on Saturday August 3rd, 2019. We had 212 teams take part with entries from 77 schools throughout New Zealand.

The question

The question posed was **"If you had a million dollars to spend on online marketing, what percentage of the NZ population could you persuade to sign a petition that you wanted championed?"**

The question was designed in part to get students thinking about the impact of online marketing, particularly in the wake of the recent revelations around how much of a role online marketing played in the outcomes of Brexit and the election of Donald Trump as the President of the United States (you may find the Netflix Documentary "The Great Hack" enlightening if you want to explore these ideas further).

The choice of question surprised many teams, with a large number of people anticipating a physics-based question. It should be remembered that the NZ Engineering Science competition is a **mathematical modelling competition** and that it is themed around the diverse kinds of issues we grapple with in Engineering Science**.** In Engineering Science we use mathematical models and advanced computing to simulate real-world processes, systems, and solutions to solve the complex problems posed by industry and society. While **many** of these problems are heavily physics-based, many others relate to what is termed "Operations Research" where we look at optimizing outcomes and exploring how systems behave, dealing with big data and finding efficient ways to solve problems across a broad range of industries. These kinds of questions can look quite different from what secondary student may view as a mathematics problem but modelling is a powerful tool that can be brought to bear in many different contexts. This year's question as certainly the kind of issue we would expect our graduates to be able to explore and there is a very significant amount of mathematical modelling that can be applied to exploring social networks and online marketing.

Judging

Judging was blind, so that judges could not tell which school an entry had come from. The identity of each team was only revealed to the judges after they had finished selecting the winning entries.

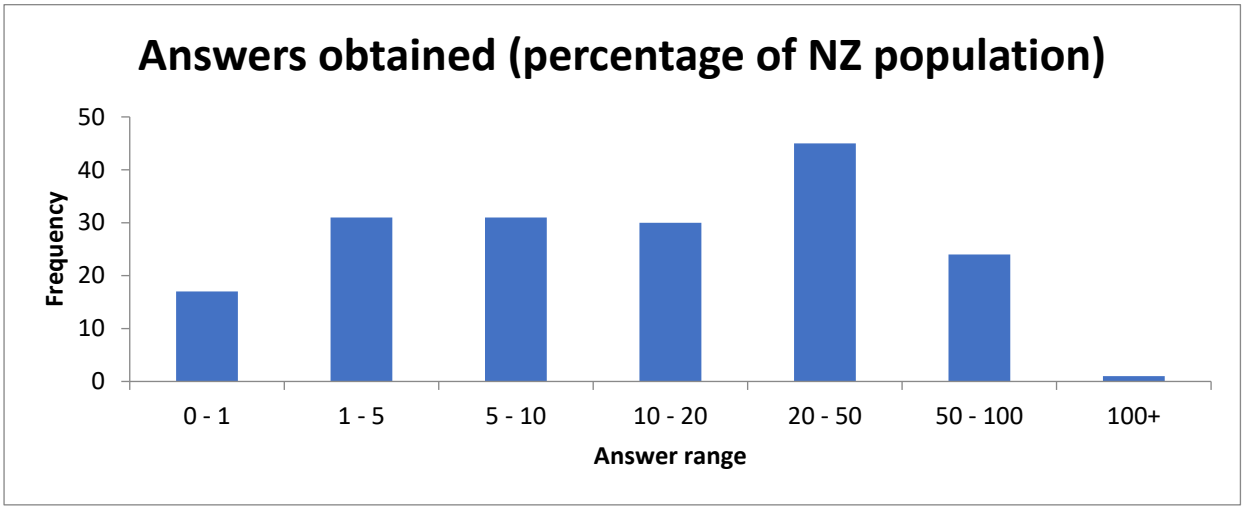
Judging was done in several rounds. For the first round, each judge was allocated a selection of reports to review, from which they identified the best reports amongst their allocation to put forward into the final round. During the final round, a smaller panel of judges reviewed the finalists and then reached a consensus on the placegetters.

Comments

The winning teams made sensible, realistic assumptions and discussed the implications of these assumptions. The quality of their writing was excellent, being easy to follow and understand. The top entries also made good use of images, diagrams, tables and graphs to get across their points. Importantly their answers were not only based on research but they had done some actual mathematical modelling.

Not all teams gave their answers in the requested format of a percentage (or even found an answer). A summary of the results for those teams who did submit a percentage answer is shown below. Where a team submitted a range, we have included them in the histogram by using their upper range value. Answers to the problem covered a huge range from 0% through to 123.49%

Judges were less concerned with the exact answer found and more concerned with how you obtained that answer. With that being said our own analysis suggested the likely answer is around the 1 to 5% range (around 30 teams had answers in this range).



As in previous years, a large number of reports either lacked a summary at the start or had a summary which failed to mention the answer found. Reports should begin with a summary that outlines the key findings of the report, INCLUDING THE ANSWER obtained. **A "summary" that keeps you in the dark about what the answer is isn't actually a summary.**

Some teams decided to focus on a particular cause for their petition while others did not choose a petition topic. Either approach was fine to pursue but remember this is a modelling competition and the focus should be on the modelling. Some teams spent several pages explaining in detail what their particular petition was on and why the issue was important to consider, which was a waste of valuable time and space. The bulk of your report should have focused on your model, not your petition subject. **Don't get distracted!**

Another common mistake was to focus extensively on modelling factors that were largely irrelevant or peripheral to answering the question. For example, if you were asked to estimate the weight of a fellow student, spending half of your efforts on modelling the weight of the buttons on their shirt isn't a wise way to use your resources. Many teams fell into a similar trap, spending lots of time

producing complicated models of things which would make very little difference to the final outcome. A big part of creating a successful model is to identify the key factors and discard the ones that make little difference to the outcome so that you can forcus your efforts on modelling the key factors.

Some teams spent significant time discussing population modelling to determine the population of NZ. This approach has some merit if the time scale of gathering signatures is large (as the population will change somewhat over a timescale of years) but it would be largely irrelevant when dealing with a timescale of a couple of weeks. If dealing with a short time period it is perfectly reasonable to assume the population remains roughly the same, as the population growth will be relatively insignificant compared to other factors.

Many teams ignored the potential overlap of the reach of various forms of online advertising. Typically people are on multiple platforms, e.g. a user may spend time on facebook, youtube and Instagram, rather than limiting themselves to using just one platform. Very few reports accounted for this.

A good proportion of the top teams had written computer programs to help in reaching their answer. While writing code isn't essential to doing well in the competition, computer programs can be an excellent tool for simulating the behavior of systems and it was great to see teams doing this.

Many teams did not explain their models at all, simply writing down equations without telling the reader where the equations from or what the terms or variables in the equations represented. If you are going to write down a model, make sure you define all the terms so that someone can understand what the model represents.

Comparing your results to reality is a vital part of the modelling process. Relatively few teams looked at existing petitions to see what kind of levels of engagement are typical for popular recent petitions. Getting a sense of a realistic real-life figure is a very good idea as it gives you something to compare and contrast your model against. On the NZ government petition site the upper limit would appear to be in the neighbourhood of around 100,000 people (e.g. the petition on www.parliament.nz with the most signatures "Better Cancer Care for all New Zealanders" which gained 98,261 supporters). Petitions hosted on Change.org appear to have a higher upper limit, with a number of petitions currently close to their goal of 200,000 signatures (e.g. "STOP water bottlers from taking up to 9 Billion litres per year from aquifer.") This would indicate that an upper figure of around 4% of the population would be entirely plausible for a petition that gained traction.

Results

The Pullan Prize for first place ($6000)

Team 1049 from Kristin School, Auckland (Year 13): Haoshu Wang, Chris Brand, Casper Wong, James Baker

Runners Up ($2000 for each team)

Team 1140 from Riccarton High School, Christchurch (Year 13): Leah Albrow, Aislinn Rogers, Angus Howden, Daniel Bruerton

Team 1079 from Macleans College, Auckland (Year 13): Isabel Li, Nicholas Yao, Kevin Hou, Richard Jiang

Highly Commended

- Team 1017 from Epsom Girls Grammar School, Auckland (Year 12/13) Els Jermyn, Asiya Katamat, Jessica Ou, Sharon Susanto
- Team 1026 from Westlake Boys High School, Auckland (Year 13): Kaiwen Zhu, Matthew Lai, Yiming Xu, Simon Lai
- Team 1100 from ACG Parnell College, Auckland (Year 13): Mina Cullen, Dexter Tan, Sidhaarth Kumar, Travis Manning
- Team 1109 from Takapuna Grammar School, Auckland (Year 13): Libby Lord, Hannah Kim, Kyubin Lim
- Team 1121 from Rosehill College, Auckland (Year 12): Ramandeep Singh, Jasmeet Singh, Gabe Jonson, Harrison Carnahan
- Team 1152 from ACG Parnell College, Auckland (Year 12): Andrew Evans, Zachary Amir, Antony Razzell, Aarnob Guha
- Team 1157 from Rangitoto College, Auckland (Year 12): Julia Zhang, Anna Hua, Sisya Jiang, Andrew Lee
- Team 1197 from Auckland Grammar School, Auckland (Year 13): Kefei Zheng, Yusef Wilson, Sumukha Viswakarma, Alexander George Hornung
- Team 1203 from Buller High School, Westport (Year 12/13): Rata Roa, Michae Suleman, Conor Dunlop, Lottie Stevenson

Participation

We had 212 teams from 77 schools participate this year.

We had many “Action shot” photos submitted during the course of the day. These photos were uploaded to our department facebook page and can be viewed at: www.facebook.com/engsci

ACG Parnell had the most entries from a single school, with thirteen teams competing. They were followed by Rangitoto College and Epsom Girls Grammar with nine teams competing. See overleaf for a complete list of schools (and how many teams they entered).

ACG Parnell College	13
ACG Strathallan College	4
ACG Sunderland	1
Albany Senior High School	2
Aorere College	1
Aquinas College	1
Auckland Grammar School	6
Auckland International College	1
Avondale College	1
Baradene College	1
Bethlehem College	1
Birkenhead College	1
Botany Downs Secondary College	3
Buller High School	1
Burnside High School	2
Cambridge High School	2
Cashmere High School	1
Christchurch Girls' High School	1
Dunstan High School	4
Epsom Girls Grammar School	9
Fraser High School	1
Glendowie College	5
Hamilton Boys' High School	3
Hillcrest High School	5
Hutt International Boys' School	1
James Hargest College	4
John Paul II High School	1
Kaiapoi High School	1
King's College	3
King's High School	1
Kristin School	7
Liston College	2
Long Bay College	4
Lynfield College	5
Macleans College	4
Massey High School	2
Matamata College	1
Melville High School	2
Mount Albert Grammar School	4
Mount Maunganui College	2
Mount Roskill Grammar School	3
Nelson College for Girls	1
Nelson College	1
One Tree Hill College	3
Otumoetai College	2
Palmerston North Boys' High School	1
Palmerston North Girls' High School	1
Rangitoto College	9
Rathkeale College	1
Riccarton High School	1
Rosehill College	3
Rosmini College	1
Rototuna Senior High School	1
Saint Kentigern College	2
Samuel Marsden Collegiate School	2
Scots College	1
Selwyn College	3
St Cuthbert's College	3
St Dominic's Catholic College	3
St Kevin's College	4
St Matthew's Collegiate	1
St Paul's Collegiate (Hamilton)	1
St Peter's College Palmerston North	1
St Peter's School, Cambridge	4
St. Bede's College	1
St. Peter's College (Auckland)	2
Takapuna Grammar School	6
Tauranga Girls College	5
Te Kura Maori o Nga Tapuwae	1
Waikato Diocesan School for Girls	1
Waitaki Boys High School	3
Western Springs College	1
Westlake Boys’ High School	8
Westlake Girls High School	5
Whangaparaoa College	8
Whangarei Boys High School	3
Woodford House	1