

The big subtract: Can we improve our maths performance?

In the NZIER Insight, *Why do we care about maths?* we saw that New Zealand's Year 9 maths students are underperforming by international standards, and the problem is getting worse. The international surveys 'Trends in International Mathematics and Science Study' (TIMSS) and 'Programme for International Student Assessment' (PISA) show New Zealand's maths scores falling over time across all school deciles. This matters because a good understanding of maths can increase our capability for innovation as a country and improve individual employment prospects and wellbeing.¹ But what can we do to improve maths learning? The Royal Society Te Apārangi Expert Advisory Panel was commissioned to investigate that question in light of these statistics. In this Insight, we dig deeper into the evidence behind some of the Panel's recommendations – and make some recommendations of our own.

What *isn't* to blame?

Maths learning is a complex problem. There are so many components affecting education, including the curriculum, teachers, schools, housing, parenting, and macro-factors in New Zealand like colonisation, poverty, and mental health. A good place to start is ruling out factors which we can't blame for the declining maths performance.

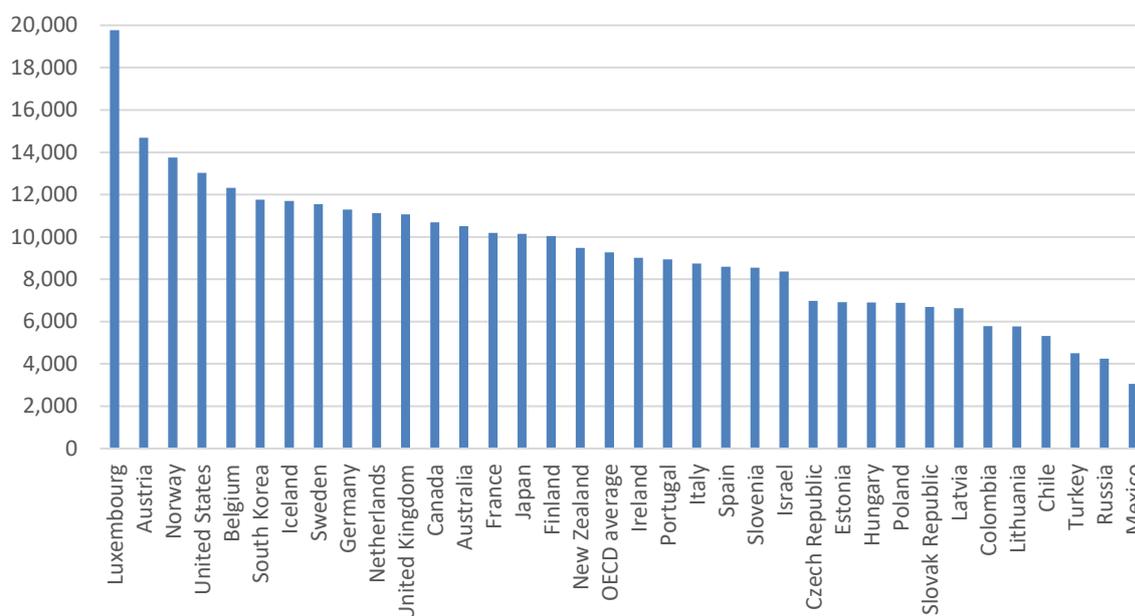
First, despite NCEA causing a stir when introduced in 2002, we are not dealing with a problem caused by our qualification system. PISA and TIMSS, the international tests which supply the disappointing statistics, both test students before they reach NCEA years.

Second, while this can't speak to how money is spent in the education sector, the total amount is not the problem. 2016 data shows that we are just above the OECD average for government spending on primary and secondary education (see Figure 1).

Between 2006 and 2019, New Zealand increased per-student spending by about 16%, a faster rate than our OECD counterparts (Law and Hernandez 2021). With a thirteen-year period of spending increases coinciding with a steady decline in maths performance, it seems fair to conclude the money isn't being spent in the right places. One of the usual suspects for education performance driven by spending is class size, but the OECD shows that New Zealand has a good staff-to-student ratio in primary and lower secondary schools (about 16:1) (OECD 2021).

¹ Read NZIER's Insight 'Why do we care about maths?' for more detail.

Figure 1 Total expenditure on educational institutions per full-time equivalent student, in equivalent USD, converted with PPPs (2016)



Source: NZIER, based on OECD data

Specialisation may be key

We know it’s important for teachers to understand and be passionate about their subject, to inspire students and get the best results (Hattie 2003). For many students in maths classrooms, that is not the case. Anecdotally, we hear that teachers struggle with their maths confidence, particularly at the top end of primary school (TVNZ 2021). This is backed up by the data, which shows 79% of Year 5 students are taught by teachers with no specialisation in maths, and only 59% were taught by teachers with any mathematics content training in the past two years (IEA² 2019).

Something needs to change for those who teach maths. The Panel recommends a professional support and learning programme to increase teachers’ mathematics knowledge for teaching; recognition for teachers who have or will develop specialist expertise; and the recruitment into the

teaching profession of more people with strong mathematics knowledge (Royal Society 2021).

As economists, we can’t help but notice the argument for more specialist expertise. Ever since Adam Smith described the separate steps to make pins in the pin factory in 1776, economists have sought to increase productivity through specialisation. While in theory secondary schools hire specialist teachers, The Panel observes that this specialisation appears to fall down in practice: in many schools, there are not enough specialist teachers in maths, English and science, so the subject gets covered by non-specialists (a problem for over 40% of schools in 2018).

New Zealand secondary trained teachers are specifically trained to teach from Year 7 up, meaning specialist maths teachers already exist for the upper primary/intermediate level. But primary and intermediate schools rarely compete with secondary schools for those teachers, and it’s unclear which schools would get them if they did. With specialisation presenting a challenge in secondary schools, it’s hard to imagine a world

² International Association for the Evaluation of Educational Achievement.

where there's also specialisation in primary schools. But primary school is where we first formally interact with maths, and our ideas and subject preferences begin: this is a time when some degree of specialisation is likely to be critical to prevent a lack of confidence being passed on from teacher to student and to ensure a wider range of skills are developed. Alternatively, 'expert teachers' who receive substantially higher pay could keep on top of evidence in maths pedagogy and develop the capability of other teachers in the school.

Last year, the New South Wales Department of Education announced mathematics strategies separately targeting primary and secondary education. For primary maths, the strategy includes increasing maths requirements for all teacher trainees and recruiting specialist maths teachers. While some teachers are opposed to specialisation in primary school, where students are believed to benefit from the emotional support of year-group specialisation, an hour a day with dedicated maths teachers as a stop-gap would likely boost maths skills at this level.

The scheme addresses teacher shortages for secondary maths by introducing scholarships targeting mathematicians as an incentive to retrain as secondary school maths teachers. Before becoming a teacher, people with solid maths skills are more likely to have expert knowledge of the subject, a passion for it, and first-hand experience of its application. The challenge will be setting a scholarship and a starting salary high enough to attract maths experts (including scientists, engineers, and economists) away from their likely lucrative employment. We think the investment is worth making.

The role of digital learning still needs to be addressed

One area not addressed by the Panel is the impact of technology in the classroom. This is an important issue for New Zealand, with TIMSS 2019 showing that we have the highest proportion of students (72%) reporting that teachers do computer activities to support learning in maths lessons once a week or more. Yet, there is nothing to suggest these computer activities are translating into maths learning (Karlsson 2020).

Some may even argue that the use of computers in classes is *hindering* learning. The OECD notes that the best performing countries tend to use less technology in the classroom. Parents working in Silicon Valley, likely spending their days developing the newest cutting-edge technology, are sending their children to schools that are entirely tech-free, which focus on creative learning and exploration. Some have concerns that using technology to learn actually prevents critical and innovative thinking (Jenkin 2015).

But it's not simply a matter of whether technology is used; it's also how it's used. PISA 2019 data shows that 58% of teachers either disagree or strongly disagree that teachers have sufficient time to prepare lessons integrating digital devices. And TIMSS 2018 shows that, while 61% of students had teachers with training in maths pedagogy over the last two years, only 26% had teachers trained in integrating technology into maths lessons. This may help explain why Sutcliffe (2021) finds New Zealand maths scores were lower for students who used devices during mathematics than those who did not. We recommend a rethink of how technology is used in the classroom, with training on making the best use of it.

Housing is a particular challenge for education

Another issue not addressed by the Panel is that New Zealand's housing problem is partially to blame for many New Zealand children falling behind in school. Insecure tenancies move families from house to house, which in turn can mean bouncing around schools. Students are much more likely to be 'transient', defined as changing schools twice or more during a school year if they attend lower decile schools (Figure 2). Interestingly, transience declined sharply in 2020. This decline may be due to the COVID pandemic, where people were more restricted in their ability to relocate, and school happened online, so a move did not necessarily mean a school change. Evidence from The Treasury shows that frequent school changes for 8-14 year-olds are associated with lower NCEA achievement (Dixon 2018).

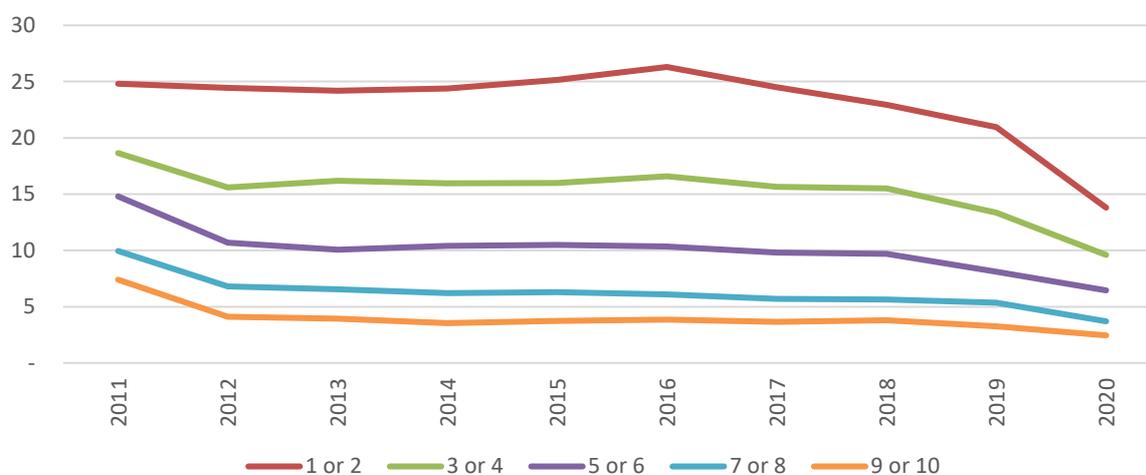
Insecure, unaffordable housing does not just affect students – it affects the teachers too. Anecdotally, there are reports of teachers unable to afford

housing near their schools (Harris 2021) and even of schools purchasing houses to rent to teachers at cheaper rates (Hill 2016). With rising house prices and stagnant wages, teachers can be priced out of buying property in areas where teachers are in high demand. This leaves teachers facing the rental market, where the insecurity of tenancy can

prevent teachers from staying at schools long enough to establish themselves and become more effective educators.

The importance of housing may be such that the success of educational interventions will be limited, particularly for students from low-income families, unless housing issues are also addressed.

Figure 2 Transient rate (per 1000), by school decile



Source: Ministry of Education

Long term impacts versus short term politics

While the Ministry of Education is ‘taking into consideration’ the Panel’s report, the Panel’s Chair, Professor Gaven Martin, estimated we wouldn’t see results for ten years (Henry 2021). Such long timeframes don’t present much incentive for a short-term government. When voters want quick results, the non-urgent, long-term problems are left for future governments to worry about (Boston 2019).

And while the Panel bring expertise and wisdom to the issue, we cannot be certain which changes will drive improvements in the complex, changing environment of education. This presents an opportunity for politically popular but potentially ineffective interventions that offer short-term visible change to win funding over longer-term, well-designed interventions that may be too subtle to appeal to the masses before the next election.

Monitoring and evaluation are critical

Given the complex and long-term nature of investment in the education sector, it will be critical for this government – and future governments – to make sure we are monitoring change. Consistent, evidence-based assessment tools at the primary and secondary levels will provide much-needed data to indicate whether we are on track to turning the decline around.

But we also need substantial investment into external monitoring and evaluation of interventions, from implementation to impact, to ensure we can attribute causality and inform decisions. With some costly interventions recommended, it’s crucial to understand if they are worth extending or scrapping ten years down the track.

This monitoring will be more successful if combined with greater accountability for schools. While NCEA reporting focuses on a certificate achievement over retaining knowledge and skills, publicising results gives one imperfect way of holding schools accountable. Aside from this, no part of the system is accountable for student achievement. A body like the Education Review Office, which already helps schools identify areas

of improvement, could be strengthened to play a greater role in this respect. With dedicated funding, schools could implement their evidence-based interventions on the condition they are externally evaluated, and results are shared so more schools can benefit from knowing what does and does not work.

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