**WP series of the Math Stagnation Nation series, for New Zealand (over the past 15-20 years and how to overcome this with MMU series)**

By Dongchan Lee (Date: February 11, 2017, Version 2)


## Abstract

In this short paper, the author concisely demonstrate the math stagnations of the national average of New Zealand over the past 12 years (for PISA math) and 20 years (for TIMSS math) and provide the evidence-based solution that can overcome the math stagnations completely within 1 administration using MMU 1 (to raise the worst half math average to the best half math average) or MMU 0.5 (with the half of the capacity of MMU 1). The highlights of the demonstrations are:

1) New Zealand – along with virtually all other English-speaking developed countries – have been in deep math EDU growth stagnations (and even declines) over the past 15 to 20+ years.
2) Almost uniform math stagnations and declines of all 8 jurisdictions in PISA math
3) A set of solution proposal called MMU 0.5 or 1 (roughly boosting the jurisdiction or national math average by 0.6-0.7 Standard Deviation or 1.2-1.4 Standard Deviation respectively) compared to the traditional reforms in New Zealand, which have failed to bring the concrete math EDU rise for the past 15-20 years at least.
4) MMU1 can raise the national or provincial math average boosts equivalent of what takes more than 1 century.
5) The counterfactual boost by MMU1 (indicated in yellow arrows) compared to the past 15-20 years of the math EDU declines or saturations of New Zealand.

Throughout the presentation, the author put the yellow arrows that indicate roughly the equivalence between the math growths from the math's 25 percentile to 75 percentile, which is the typical MMU1 operation targets. This is to demonstrate that the currently ongoing math stagnations in most of the developed (OECD) countries – not just New Zealand - have been real and persistent according to the math parts of the PISA or TIMSS or at least the NAEP (the Nation's Report Card) which is the longest-running national assessments of the USA that have participated in all major international math assessments such as TIMSS, PISA and others before them. As such, the yellow arrows are meant to imply the math growths with the hyper-rapid math reforms in just 2-4 years which is totally impossible otherwise by all means in the history of math education. For the average jurisdictions, the MMU-led reforms may take 2-3 years and for the entirety of New Zealand, this may take 3-4 years, depending on the levels of commitments and collaborations.



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**Key words:** Math stagnations, math crisis, USL, MMU1, math education innovation, Education reforms

# Tabla de contenido



# The visual evidences: math stagnations are here to stay unless some radical solutions like MMU1 are embraced.

## The math stagnations exclusively from the international math assessments' points of view (those of PISA 2000-2015 and TIMESS 1995-2015), focusing on the English-speaking countries

Throughout in this paper, I included the yellow arrows (which signifies the principle of MMU1 to rapidly boost the math poverty of the 25 percentiles (from the math poverty half) to about 75 percentile (to the math richer half). If the rapid supports and collaborations, we can make this happen in 2-3 years for a district or city and 3-4 years for state or 4-5 years for a country.

**The color schemes I will use:**

- **the yellow arrow** for the MMU1 (to boost the math share 25 percentile – or the average of the math poorest half of the student population – to about 75 percentile share (or the average of the math richest half of the student population).
- **The orange arrow**: for 1/2 of the MMU1 (to boost from about 25 percentile to about 50 percentile), which is roughly about the math gains of the USA national average in 1995-2015 (for 20 years) although the past 10 years had almost no gains in NAEP math.

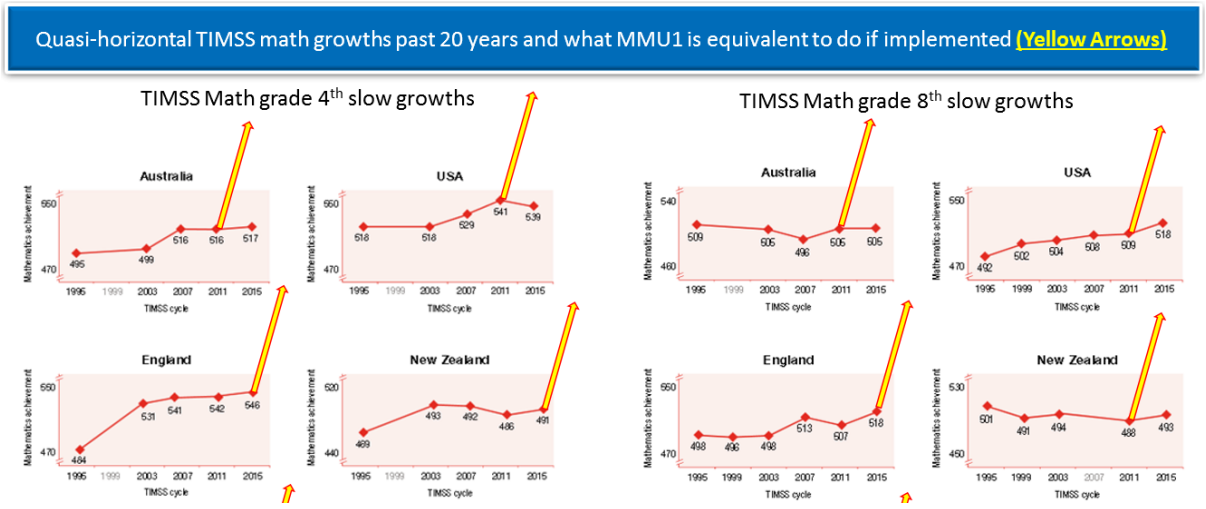
The main reason that the author used these arrows is that the normal jurisdiction or national level math boosts take many decades at least if not over a century. Since the timeline data from the PISA and TIMSS of 15-20 years are long enough to see the overall trends quickly, which are typically almost flat (due to the math growth stagnations) and even declining in PISA in most of the OECD countries, the yellow arrows can show the stark contrasts between the traditional reforms of the nations over 1-2 decades (basically flat) vs. what MMU 0.5 or 1 can do (achieving what is normally

needed half or over a century) in just 2-4 years in each jurisdiction or for the entire New Zealand if there are committed supports and collaborations.

The yellow arrows are consistently used throughout in this series because to see is to believe instead of using the fancy jargons and equations, this will explain what has been done and what is possible without the excuses of the status quo.

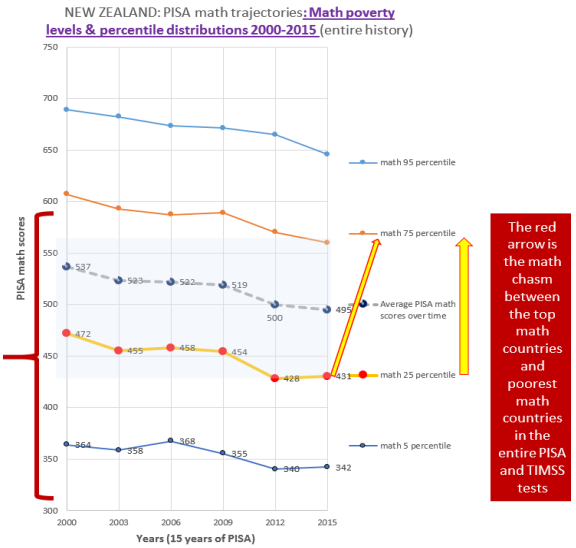
## The math stagnations from the English-speaking developed countries' point of view

1) Very little math growths of the national math average, especially for the past 10 years for both 4th and 8th grades **NOT just for the USA, but for all of the English-speaking countries**.




2) The math de-growths of almost all English-speaking countries (Not just the USA) in PISA math 2000-2015.[1]

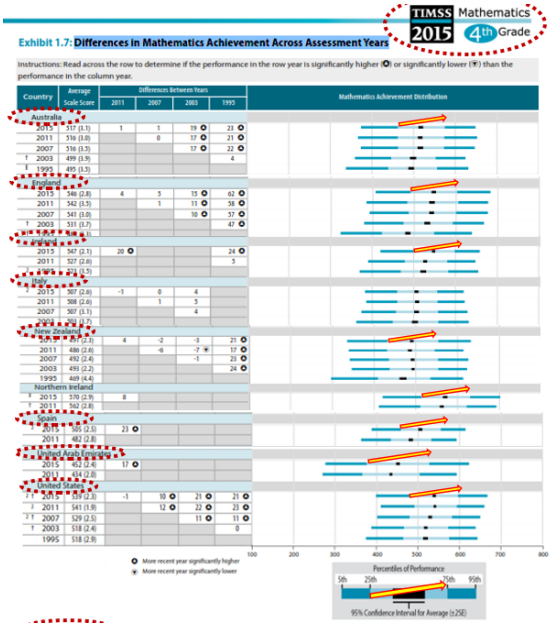
Source: PISA website (accessed December 28, 2016)

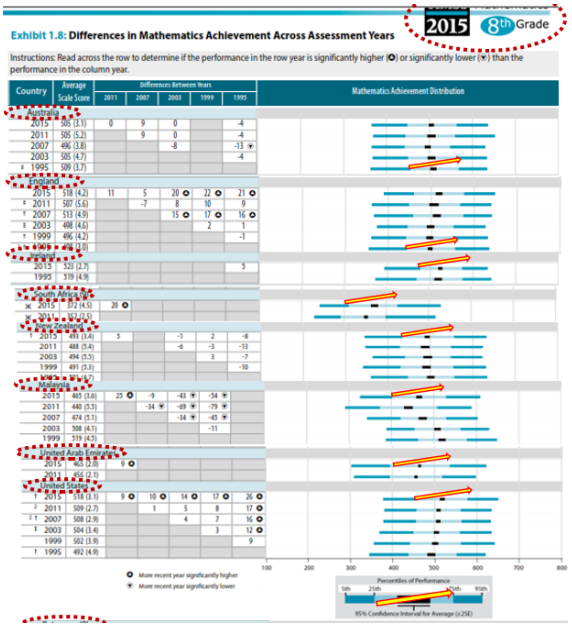



3) Math stagnations are here to stay and the tiny gains are illusions. Over the 2 decades (vertically), there are little changes as you can see in these percentile diagrams. The yellow arrows indicate the magnitude of math growths from the 25th percentile to the 75th percentile. Normally, this may take 50-100-200 years, but MMU1 can make this happen in 2-3 years for a district; in 3-4 years for a state; in 4-5 years for a country. (You can see the little changes in 20 years here. All of

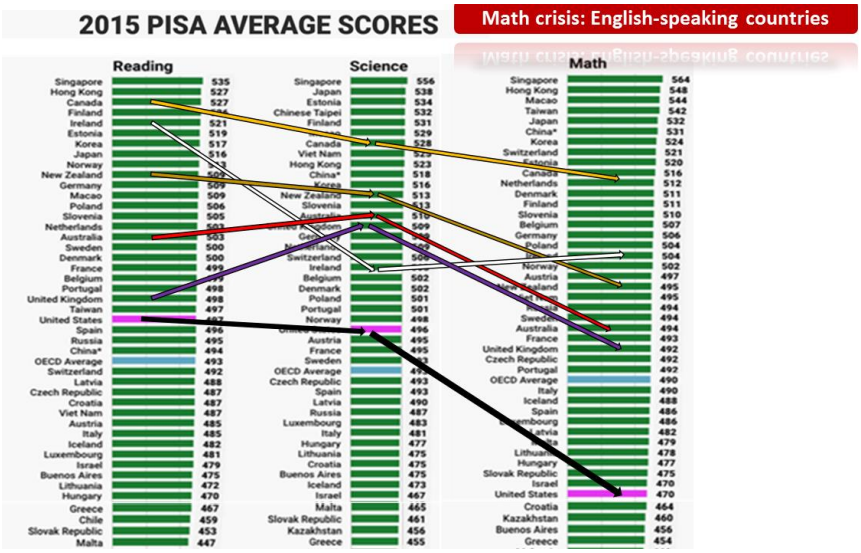
[1] For the entire English-speaking or Latin American countries' visual data, please refer to author's other paper.

the countries listed here seem to be quasi-vertically straight.)




4) In all English-speaking developed countries (Canada, Ireland, Australia, New Zealand, and the USA), Math is much worse than Reading according to PISA. Here from the PISA 2015.




5) All developed English-speaking countries and most of the Latin American countries have (much) stronger reading scores than math scores by large margins, especially for the USA , Chile, Brazil,

Costa Rica, and Colombia in the stark contrasts against the top math Eastern Asian countries.

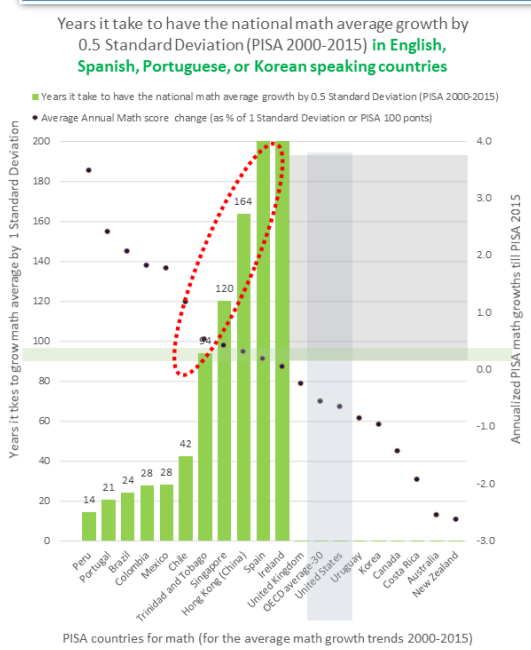
**PISA 2015: Math dominance vs. others' by regions: English or Spanish speaking countries vs. the North-Eastern Asia**

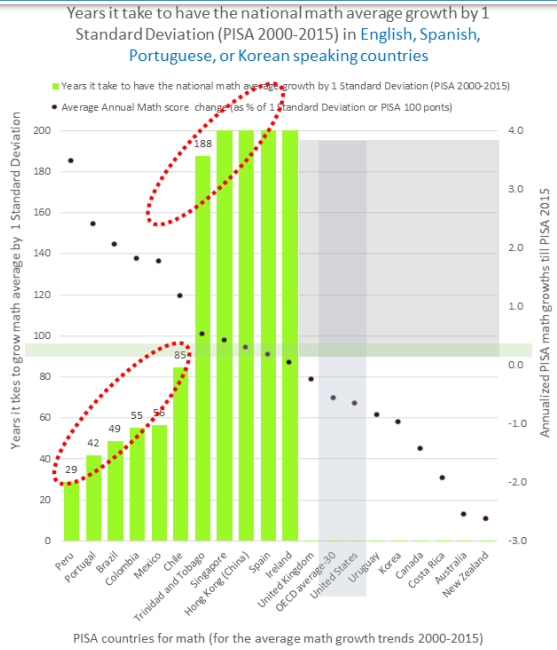
| Mean score in PISA 2015 | Math -Reading (PISA 2015) | | Math - Science | | Math - Science & reading average | |
|---|---|---|---|---|---|---|
| Chile | | -36 | | -24 | | -30 |
| Colombia | | -35 | | -26 | | -31 |
| Brazil | | -30 | | -24 | | -27 |
| Dominican Republic | | -30 | | -4 | | -17 |
| Costa Rica | | -27 | | -19 | | -23 |
| CABA (Argentina) | | -19 | | -19 | | -19 |
| Uruguay | | -19 | | -17 | | -18 |
| Mexico | | -15 | | -8 | | -11 |
| Peru | | -11 | | -10 | | -11 |
| Trinidad and Tobago | | -10 | | -7 | | -9 |
| United States | | -27 | | -27 | | -27 |
| Ireland | | -17 | | 1 | | -8 |
| New Zealand | | -14 | | -18 | | -16 |
| Canada | | -11 | | -12 | | -12 |
| Australia | | -9 | | -16 | | -13 |
| United Kingdom | | -5 | | -17 | | -11 |
| Spain | | -10 | | -7 | | -8 |
| Portugal | | -7 | | -9 | | -8 |
| Korea | | 7 | | 8 | | 7 |
| Japan | | 16 | | -6 | | 5 |
| Hong Kong (China) | | 21 | | 25 | | 23 |
| Singapore | | 29 | | 9 | | 19 |
| Macao (China) | | 35 | | 15 | | 25 |
| B-S-J-G (China) | | 37 | | 14 | | 25 |
| Chinese Taipei | | 45 | | 10 | | 28 |

Source: OECD, PISA 2015 Database, Tables I.2.4a, I.2.6, I.2.7, I.4.4a and I.5.4a.

6) If the math stagnations are real, how long it takes even to reach 40-80% of what MMU1 aims to do (assuming the math growth patterns of PISA math 2000-2015)? Here is my answer. In virtually all developed OECD level nations, this will take 100-200 plus years according to history.

These show how many generations are needed to even boost the national math by 40-80% of what MMU1 can do.




Over the past 20 years of math performance distributions have barely changed and since 2002, it has gotten worse at least for the grad 4 math, if MMU1 is implemented (with the yellow arrow), the radical no change in the quasi-vertical alignments can be suddenly quasi-horizontal change within 4 years.

| Year | Mean mathematics score | Distribution of mathematics achievement | Range from 5th to 95th percentile | Inter-quartile range from 25th to 75th percentile |
|---|---|---|---|---|
| 2014 | 491 (2.3) | | 296 | 121 |
| 2011 | 486 (2.6) | | 274 | 113 |
| 2006 | 492 (2.4) | | 284 | 117 |
| 2002 | 496 (2.2) | | 273 | 114 |
| 1998 | 481 (5.5) | | 312 | 126 |
| 1994 | 469 (4.4) | | 316 | 125 |

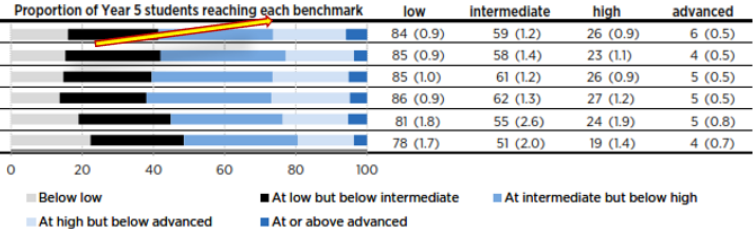




Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

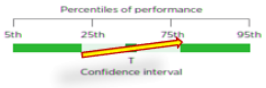
TIMSS math grade 4 (or year 5) distributions between the 5$^{th}$ to 95$^{th}$ percentiles.

| Year | Proportion of Year 5 students reaching each benchmark | Cumulative proportion of Year 5 students: At or above low | At or above intermediate | At or above high | At or above advanced |
|---|---|---|---|---|---|
| 2014 | | 84 (0.9) | 59 (1.2) | 26 (0.9) | 6 (0.5) |
| 2011 | | 85 (0.9) | 58 (1.4) | 23 (1.1) | 4 (0.5) |
| 2006 | | 85 (1.0) | 61 (1.2) | 26 (0.9) | 5 (0.5) |
| 2002 | | 86 (0.9) | 62 (1.3) | 27 (1.2) | 5 (0.5) |
| 1998 | | 81 (1.8) | 55 (2.6) | 24 (1.9) | 5 (0.8) |
| 1994 | | 78 (1.7) | 51 (2.0) | 19 (1.4) | 4 (0.7) |




**Note:** "At or above" means that the proportion of Year 5 students at the benchmark includes those that achieved at higher benchmarks also.
Standard errors are presented in parentheses.

Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

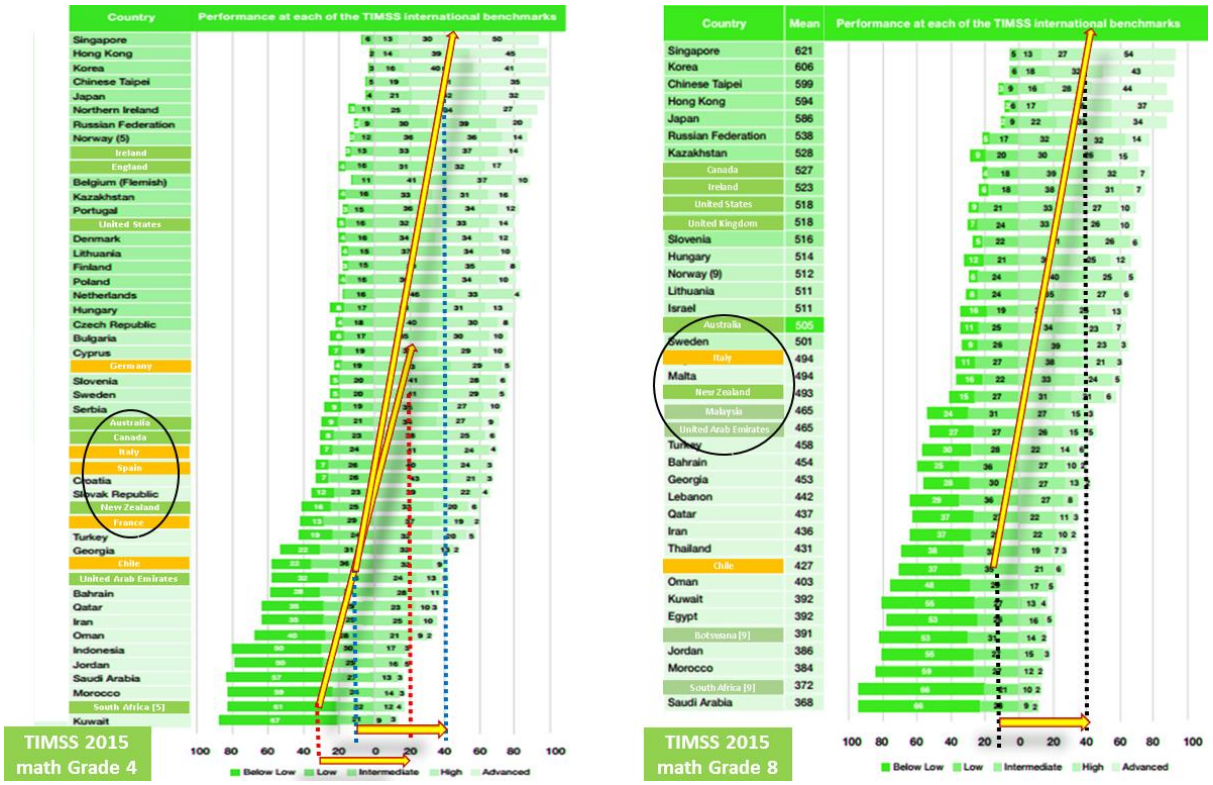



TIMSS math grade 4 (or year 5) distributions between the 0$^{th}$ to 100$^{th}$ percentiles.

## A most efficient and fastest solution to overcome the math stagnation nationwide if implemented

If MMU 1 or MMU 0.5 is implemented nationwide in New Zealand, Australia, or Canada, the seemingly impossible math growths are possible.

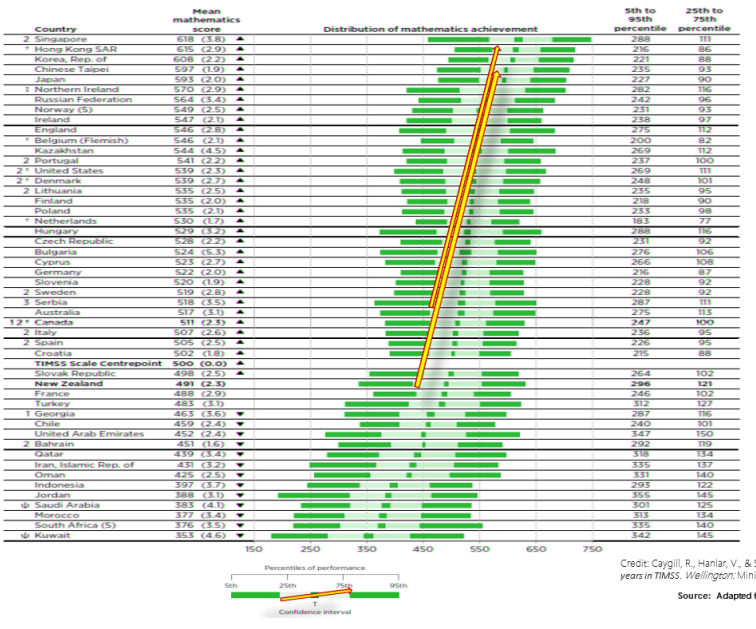
## How MMU1 can impact the math grade 4 and 8 using the math performance distributions from TIMSS 2015




Source: TIMSS website (accessed December 2016)

In the following TIMSS math performance distribution charts, the author shows that the average of the math worst half (about 25 percentile) of New Zealand, Australia, and Canada can quickly rise to roughly the average of the top 5 TIMSS math countries, all from the Eastern Asia if MMU1 is nationwide implemented with the strong commitments and supports.

If MMU1 is implemented nationwide in New Zealand, Australia, or Canada, we see this change.



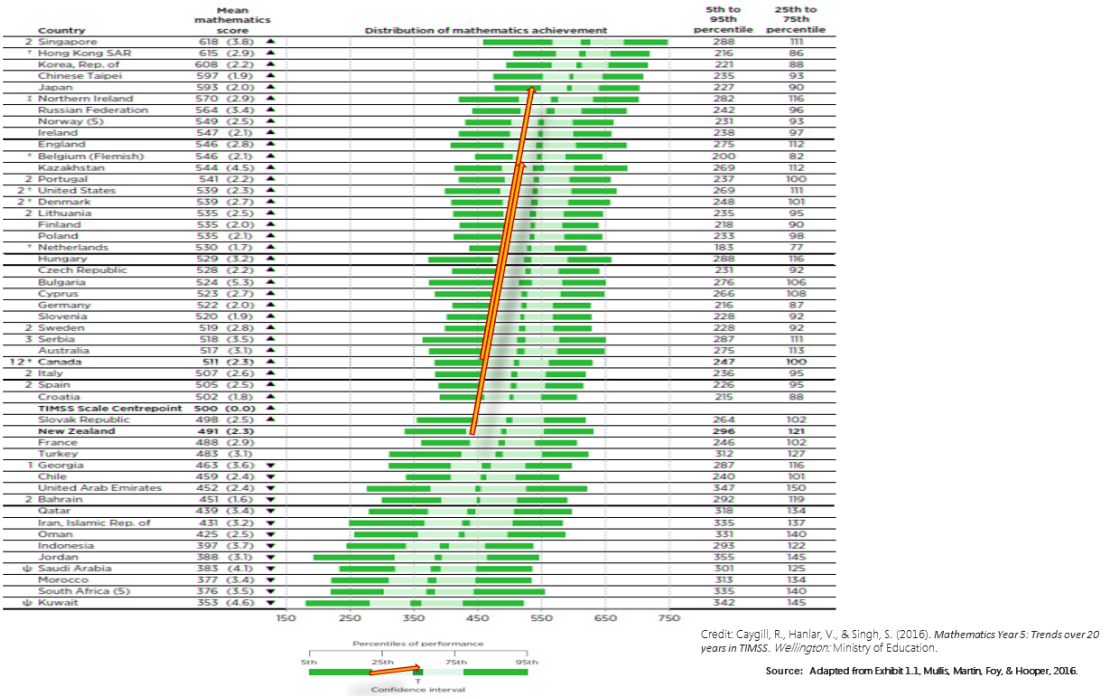

Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS*. *Wellington*: Ministry of Education.

Source: Adapted from Exhibit 1.1, Mullis, Martin, Foy, & Hooper, 2016.

Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

Source: Adapted from Exhibit 1.1, Mullis, Martin, Foy, & Hooper, 2016.

If MMU 0.5 is implemented nationwide in Australia, New Zealand or Canada, we still can see this much change.



| Country | Mean mathematics score | 5th to 95th percentile | 25th to 75th percentile |
|---|---|---|---|
| 2 Singapore | 618 (3.8) | 288 | 111 |
| † Hong Kong SAR | 615 (2.9) | 216 | 86 |
| Korea, Rep. of | 608 (2.2) | 221 | 88 |
| Chinese Taipei | 597 (1.9) | 235 | 93 |
| Japan | 593 (2.0) | 227 | 90 |
| 1 Northern Ireland | 570 (2.9) | 282 | 116 |
| Russian Federation | 564 (3.4) | 242 | 96 |
| Norway (5) | 549 (2.5) | 231 | 93 |
| Ireland | 547 (2.1) | 238 | 97 |
| England | 546 (2.8) | 275 | 112 |
| † Belgium (Flemish) | 546 (2.1) | 200 | 82 |
| Kazakhstan | 544 (4.5) | 269 | 112 |
| 2 Portugal | 541 (2.2) | 237 | 100 |
| 2 † United States | 539 (2.5) | 269 | 111 |
| 2 † Denmark | 539 (2.7) | 248 | 101 |
| 2 Lithuania | 535 (2.5) | 235 | 95 |
| Finland | 535 (2.0) | 218 | 90 |
| Poland | 535 (2.1) | 233 | 98 |
| † Netherlands | 530 (1.7) | 183 | 77 |
| Hungary | 529 (3.2) | 288 | 116 |
| Czech Republic | 528 (2.2) | 231 | 92 |
| Bulgaria | 524 (5.3) | 276 | 106 |
| Cyprus | 523 (2.7) | 266 | 108 |
| Germany | 522 (2.0) | 216 | 87 |
| Slovenia | 520 (1.9) | 228 | 92 |
| 2 Sweden | 519 (2.8) | 228 | 92 |
| 3 Serbia | 518 (3.5) | 287 | 111 |
| Australia | 517 (3.1) | 275 | 113 |
| 12 † **Canada** | **511 (2.3)** | **247** | **100** |
| 2 Italy | 507 (2.6) | 236 | 95 |
| 2 Spain | 505 (2.5) | 226 | 95 |
| Croatia | 502 (1.8) | 215 | 88 |
| **TIMSS Scale Centrepoint** | **500 (0.0)** | | |
| Slovak Republic | 498 (2.5) | 264 | 102 |
| **New Zealand** | **491 (2.3)** | **296** | **121** |
| France | 488 (2.9) | 246 | 102 |
| Turkey | 483 (3.1) | 312 | 127 |
| 1 Georgia | 463 (3.6) | 287 | 116 |
| Chile | 459 (2.4) | 240 | 101 |
| United Arab Emirates | 452 (2.4) | 347 | 150 |
| 2 Bahrain | 451 (1.6) | 292 | 119 |
| Qatar | 439 (3.4) | 318 | 134 |
| Iran, Islamic Rep. of | 431 (3.2) | 335 | 137 |
| Oman | 425 (2.5) | 331 | 140 |
| Indonesia | 397 (3.7) | 293 | 122 |
| Jordan | 388 (3.1) | 355 | 145 |
| ♆ Saudi Arabia | 383 (4.1) | 301 | 125 |
| Morocco | 377 (3.4) | 313 | 134 |
| South Africa (5) | 376 (3.5) | 335 | 140 |
| ♆ Kuwait | 353 (4.6) | 342 | 145 |



Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

Source: Adapted from Exhibit 1.1, Mullis, Martin, Foy, & Hooper, 2016.

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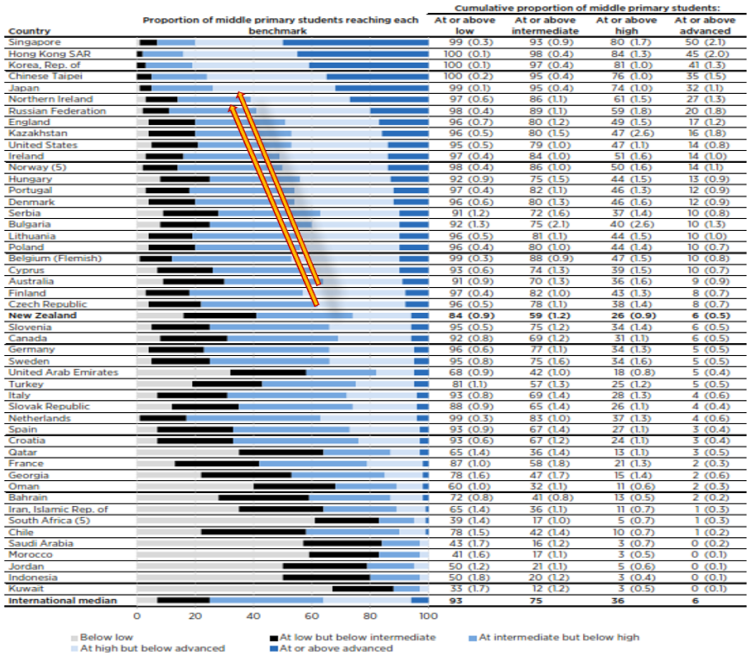



Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

Adapted from Exhibit 2.2, Mullis, Martin, Foy, & Hooper, 2016.

Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS. Wellington:* Ministry of Education.

Adapted from Exhibit 2.2, Mullis, Martin, Foy, & Hooper, 2016.

In these charts where the yellow arrows are MMU1 targets by roughly boosting the math percentiles by about 50 percentiles (e.g. 25 percentile to 75 percentile). For the yellow arrows (or roughly the MMU1's estimated impacts of boosting the math poverty to the math prosperity levels), the level of Chile for instance would rapidly rise to the best in the world, the top 5 Eastern Asian countries levels or for the bottom countries in the TIMSS math such as South Africa can rapidly rise to about the level of Germany if fully implemented and committed.

As everyone in the education history knows, to raise the math average or to reduce the math poverty is normally exceedingly time-consuming with little changes in most of the countries even after decades of reforms. So the proposition of MMU1 may well be very hard to swallow. So, even if we get the worst case scenario and even if only roughly half of its promise is fulfilled practically, say 25-30 percentile advancement instead of the 50 percentile rises, still this growth is roughly the distance between the math average of countries like Australia or New Zealand to the top of the word, about the average of the top 5 Eastern Asian countries' if we use TIMSS math grades 4 or 8 as the anchors.

## Conclusion

We observed that the math stagnations or declines in all English-speaking countries, including New Zealand nationally based on the PISA and TIMSS math results over the past 12-20 years at least till 2015. The chances are, this trend will continue and unlikely to reverse in the traditional manner in a manner that the governmental operations nationally or by jurisdictions as the reforms of the past haven't succeeded or failed almost universally. Furthermore, as the author shared some math trends in almost all OECD countries, the situation will get only worse as time goes on and the technology-based experiments so far for the past 5-10 years haven't born fruits either. So the author suggests

the policymakers to seriously consider the MMU1 alternative starting as a pilot study because otherwise there will be too much suffering without much change at all.

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