WP series of the Math Stagnation Nation series, for Australia (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 Australia and her 8 jurisdictions 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) Australia – 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) Both for the TIMSS math grades 4 and 8, except ACT (the highest) and NT (the lowest), the rest 6 of the Australian jurisdictions have been roughly the same higher than the Intermediate (say Math Prosperity) and lower than the Intermediate (say Math Poverty) nationally, roughly close to the national average.
4) Roughly 0.7-0.8 Standard Deviation differences between the Non-Indigenous vs. the Indigenous math gaps in both of the TIMSS math grades 4 and 8 have barely changed over the 20 years history of TIMSS.
5) 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 Australia, which have failed to bring the concrete math EDU rise for the past 15-20 years at least.
6) MMU1 can raise the national or provincial math average boosts equivalent of what takes more than 1 century.
7) The counterfactual boost by MMU1 (indicated in yellow arrows) compared to the past 15-20 years of the math EDU declines or saturations of the entire 8 jurisdictions and Australia as a nation.

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 Australia - 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 Australia, 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

Table of Contents

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

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The color schemes I will use:

- <mark>the yellow arrow</mark> 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 Australia 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.
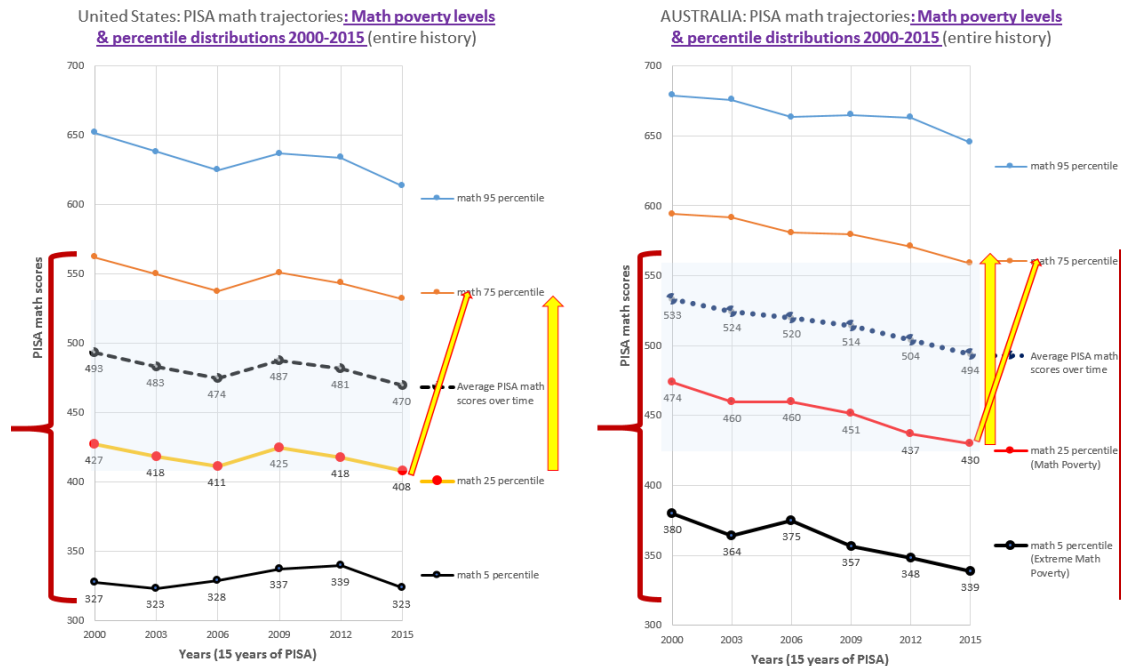
The math stagnations from the English-speaking developed countries' points of views and the proofs

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**.
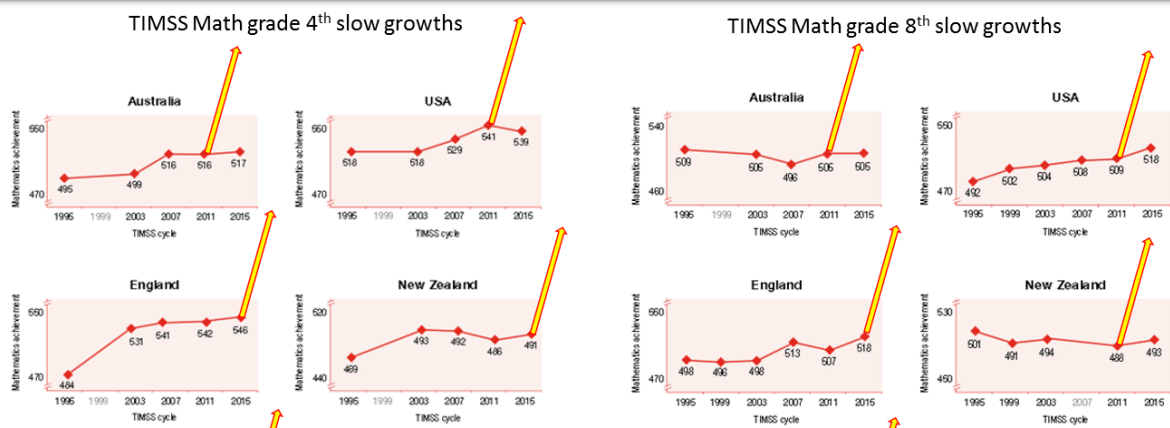
2) The math de-growths of almost all English-speaking countries (Not just the USA) in PISA math 2000-2015.[1] Source: PISA website (accessed December 28, 2016)

United States: PISA math trajectories: **Math poverty levels & percentile distributions 2000-2015** (entire history)

AUSTRALIA: PISA math trajectories: **Math poverty levels & percentile distributions 2000-2015** (entire history)

The red arc is the math chasm between the top math countries and poorest math countries in the entire PISA and TIMSS tests

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 25the 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 quasi-vertical straight.)

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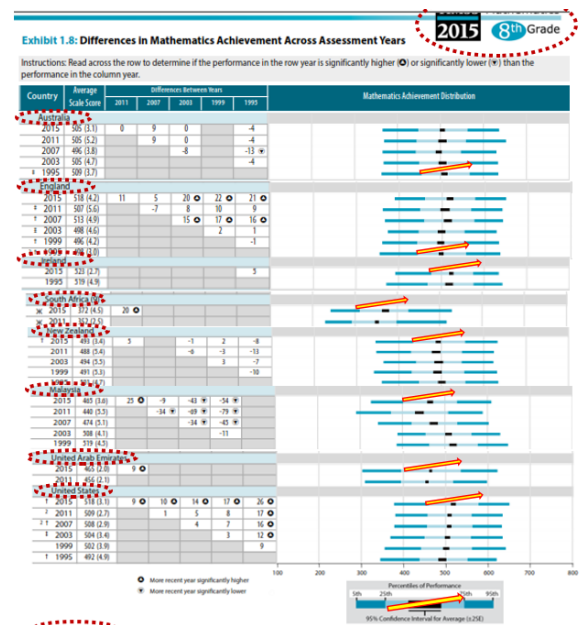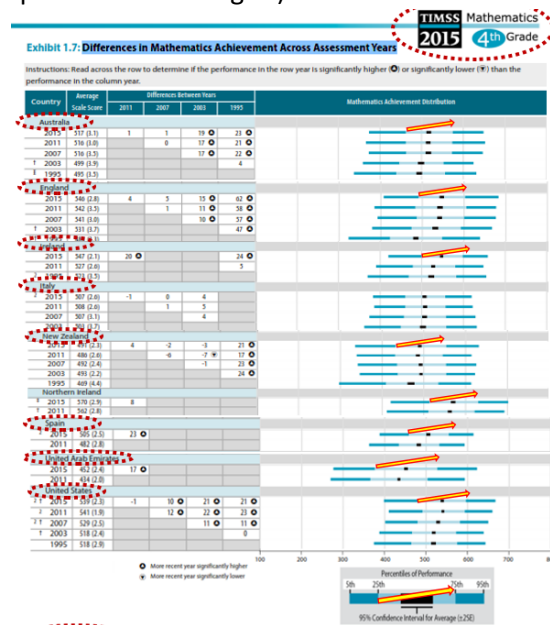
[1] For the entire English-speaking or Latin American countries' visual data, please refer to author's other paper.

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.
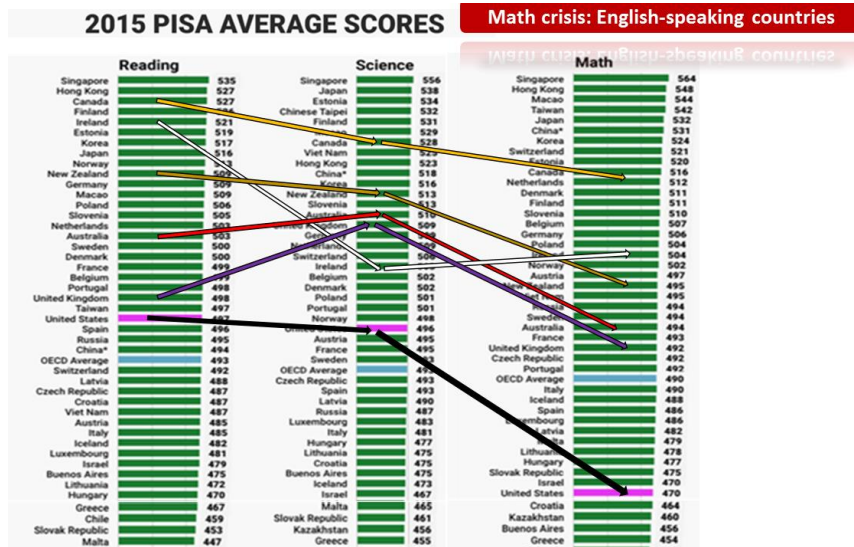
5) All developed English-speaking countries and most of the Latin American countries have (much) stronger reading scores than math scores by large margins, especially for the USA , Chile, Brazil, Costa Rica, and Colombia in the stark contrasts against the top math Eastern Asian countries.

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.

Years it take to have the national math average growth by 0.5 Standard Deviation (PISA 2000-2015) in English, Spanish, Portuguese, or Korean speaking countries

Years it take to have the national math average growth by 1 Standard Deviation (PISA 2000-2015) in English, Spanish, Portuguese, or Korean speaking countries
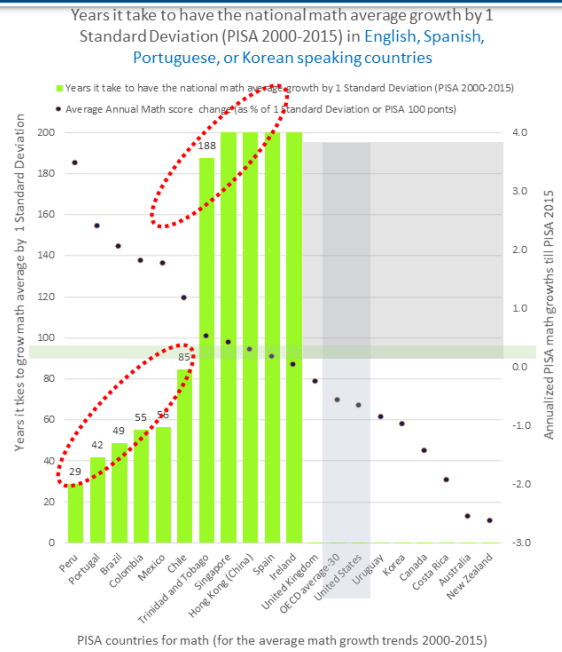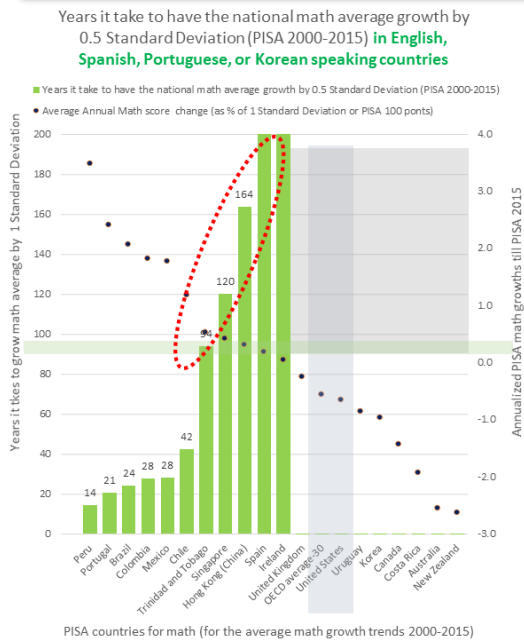
A most efficient and fastest solution to overcome the math stagnation nationwide if implemented

If MMU 1 or MMU 0.5 is implemented nationwide in Australia, New Zealand, 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
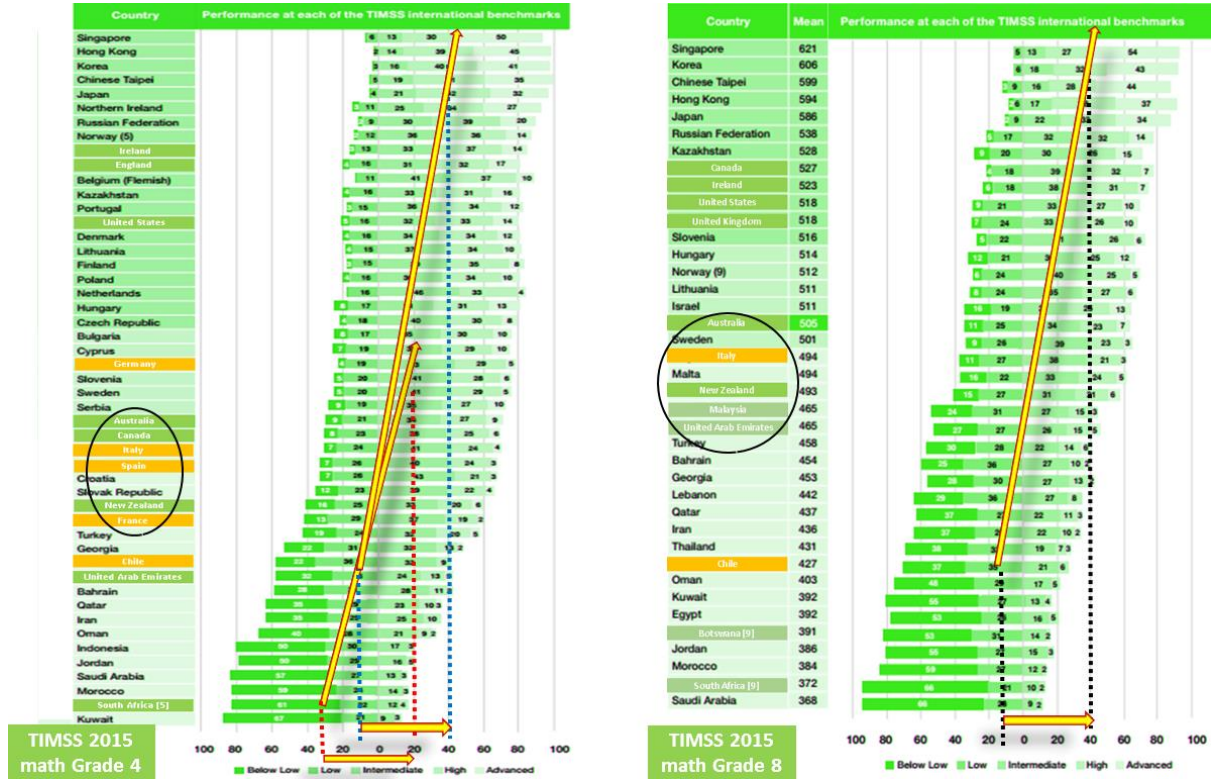
Source: TIMSS website (accessed December 2016)

In the following TIMSS math performance distribution charts, the author shows that the average of the math worst half (about 25 percentile) of Australia, New Zealand, 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 Australia, or New Zealand or Canada, we see this change.
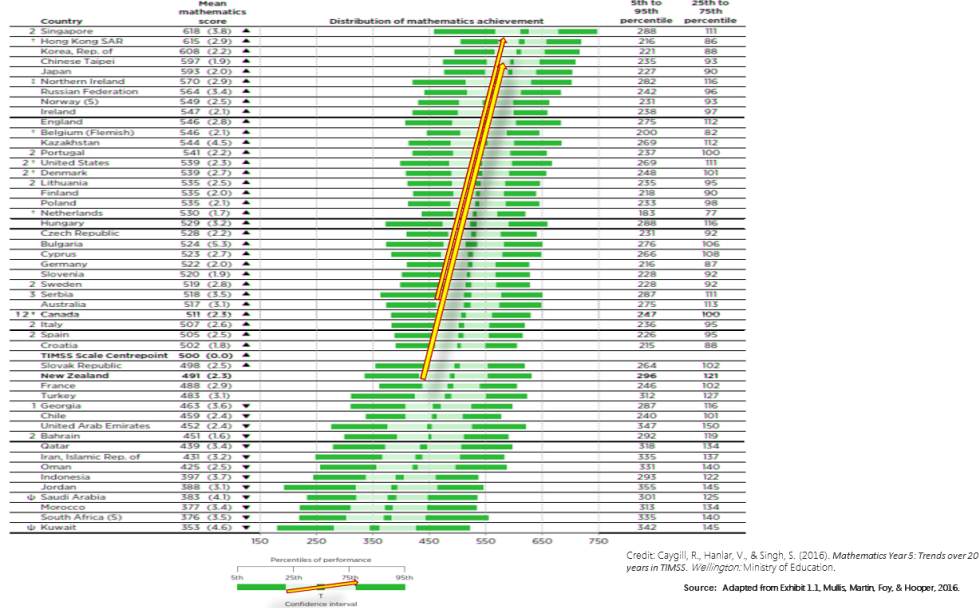
Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS.* Wellington: Ministry of Education.

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, or New Zealand or Canada, we still can see this much 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.

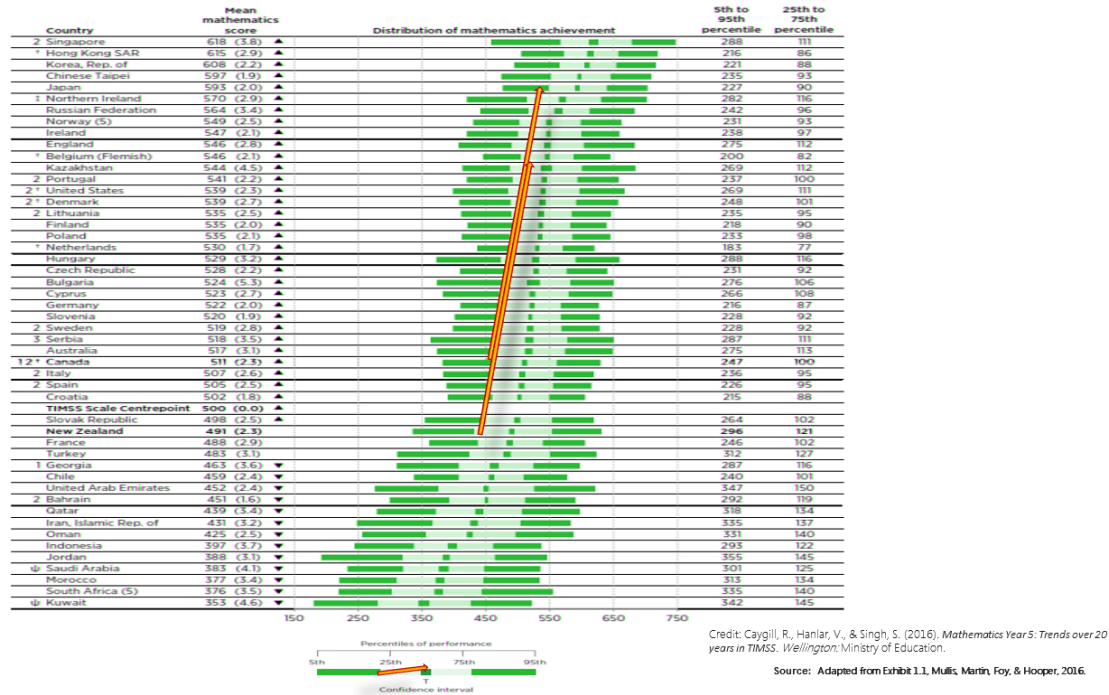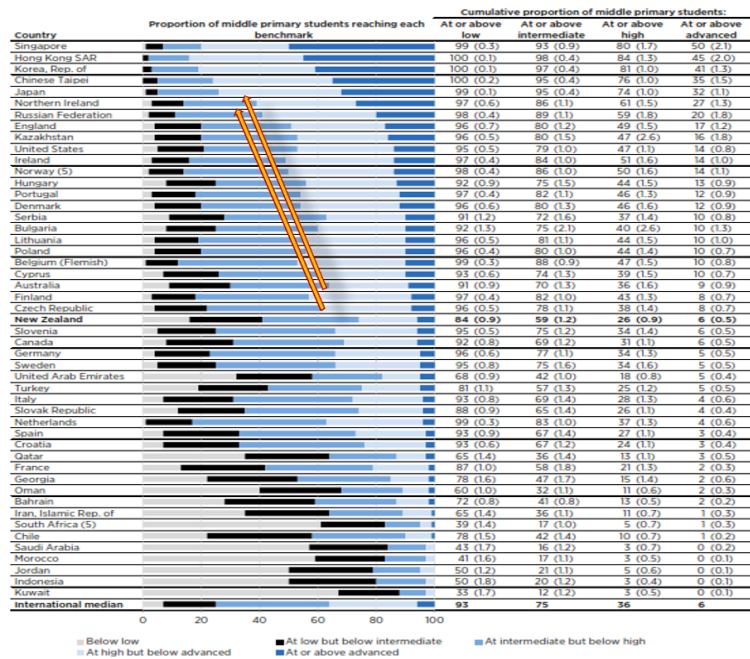| Country	Cumulative proportion of middle primary students:			
	At or above low	At or above intermediate	At or above high	At or above advanced
Singapore	99 (0.3)	93 (0.9)	80 (1.7)	50 (2.1)
Hong Kong SAR	100 (0.1)	98 (0.4)	84 (1.3)	45 (2.0)
Korea, Rep. of	100 (0.1)	97 (0.4)	81 (1.0)	41 (1.3)
Chinese Taipei	100 (0.2)	95 (0.4)	76 (1.0)	35 (1.5)
Japan	99 (0.1)	95 (0.4)	74 (1.0)	32 (1.1)
Northern Ireland	97 (0.6)	86 (1.1)	61 (1.5)	27 (1.3)
Russian Federation	98 (0.4)	89 (1.1)	59 (1.8)	20 (1.8)
England	96 (0.7)	80 (1.2)	49 (1.5)	17 (1.2)
Kazakhstan	96 (0.5)	80 (1.5)	47 (2.6)	16 (1.8)
United States	95 (0.5)	79 (1.0)	47 (1.1)	14 (0.8)
Ireland	97 (0.4)	84 (1.0)	51 (1.6)	14 (1.0)
Norway (5)	98 (0.4)	86 (1.0)	50 (1.6)	14 (1.1)
Hungary	92 (0.9)	75 (1.5)	44 (1.5)	13 (0.9)
Portugal	97 (0.4)	82 (1.1)	46 (1.3)	12 (0.9)
Denmark	96 (0.6)	80 (1.3)	46 (1.6)	12 (0.9)
Serbia	91 (1.2)	72 (1.6)	37 (1.4)	10 (0.8)
Bulgaria	92 (1.3)	75 (2.1)	40 (2.6)	10 (1.3)
Lithuania	96 (0.5)	81 (1.1)	44 (1.5)	10 (1.0)
Poland	96 (0.4)	80 (1.0)	44 (1.4)	10 (0.7)
Belgium (Flemish)	99 (0.3)	88 (0.9)	47 (1.5)	10 (0.8)
Cyprus	93 (0.6)	74 (1.3)	39 (1.5)	10 (0.7)
Australia	91 (0.9)	70 (1.3)	36 (1.6)	9 (0.9)
Finland	97 (0.4)	82 (1.0)	43 (1.3)	8 (0.7)
Czech Republic	96 (0.5)	78 (1.1)	38 (1.4)	8 (0.7)
New Zealand	84 (0.9)	59 (1.2)	26 (0.9)	6 (0.5)
Slovenia	95 (0.5)	75 (1.2)	34 (1.4)	6 (0.5)
Canada	92 (0.8)	69 (1.2)	31 (1.1)	6 (0.5)
Germany	96 (0.6)	77 (1.1)	34 (1.3)	5 (0.5)
Sweden	95 (0.8)	75 (1.6)	34 (1.6)	5 (0.5)
United Arab Emirates	68 (0.9)	42 (1.0)	18 (0.8)	5 (0.4)
Turkey	81 (1.3)	57 (1.3)	25 (1.2)	5 (0.5)
Italy	93 (0.8)	69 (1.4)	28 (1.3)	4 (0.6)
Slovak Republic	88 (0.9)	65 (1.4)	26 (1.1)	4 (0.4)
Netherlands	99 (0.3)	83 (1.0)	37 (1.3)	4 (0.6)
Spain	93 (0.9)	67 (1.4)	27 (1.1)	3 (0.4)
Croatia	93 (0.6)	67 (1.2)	24 (1.1)	3 (0.4)
Qatar	65 (1.4)	36 (1.4)	13 (1.1)	3 (0.5)
France	87 (1.0)	58 (1.8)	21 (1.3)	2 (0.3)
Georgia	78 (1.6)	47 (1.7)	15 (1.4)	2 (0.6)
Oman	60 (1.0)	32 (1.1)	11 (0.6)	2 (0.3)
Bahrain	72 (0.8)	41 (0.8)	13 (0.5)	2 (0.2)
Iran, Islamic Rep. of	65 (1.4)	36 (1.1)	11 (0.7)	1 (0.3)
South Africa (5)	39 (1.4)	17 (1.0)	5 (0.7)	1 (0.3)
Chile	78 (1.5)	42 (1.4)	10 (0.7)	1 (0.2)
Saudi Arabia	43 (1.7)	16 (1.2)	3 (0.7)	0 (0.2)
Morocco	41 (1.6)	17 (1.1)	3 (0.5)	0 (0.1)
Jordan	50 (1.2)	21 (1.1)	5 (0.6)	0 (0.1)
Indonesia	50 (1.8)	20 (1.2)	3 (0.4)	0 (0.1)
Kuwait	33 (1.7)	12 (1.2)	3 (0.5)	0 (0.1)
International median	93	75	36	6

Legend: Below low · At low but below intermediate · At intermediate but below high · At high but below advanced · At or above advanced

Percentiles of performance: 5th, 25th, 75th, 95th — Confidence interval

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.

The math stagnations across all 8 jurisdictions of Australia and to what extent MMU series can impact if implemented in each of the jurisdictions

If the MMU series can be implemented in Australia in jurisdiction levels instead of the nationwide all at once, we can see the change as follows.
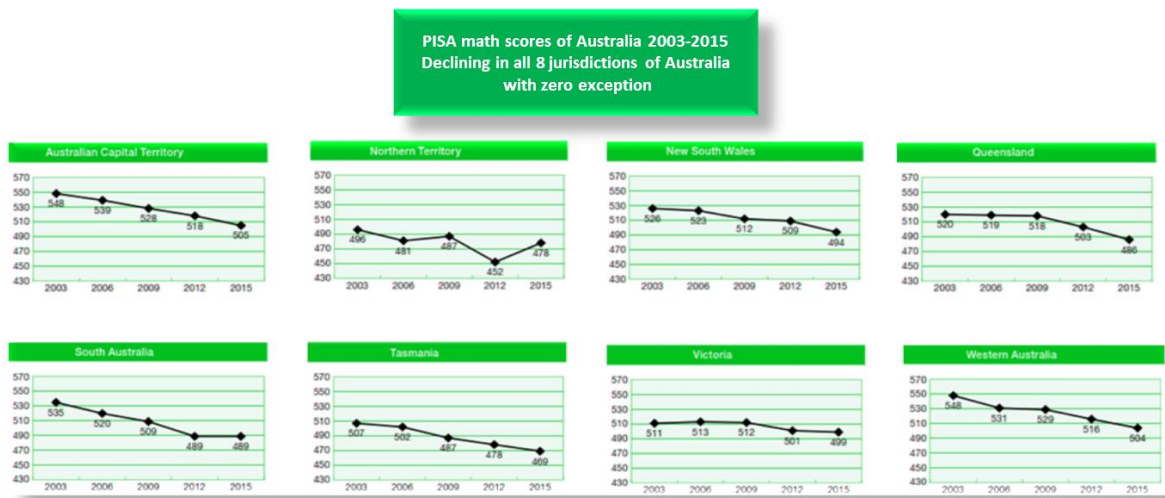
All of the 8 jurisdictions of Australia have declined in PISA math almost uniformly (2003-2015) for 12 years except one last rise by the NT in 2015.

At this point, it is hard to deny that all the math reforms in Australia at least for math haven't achieved the fruitions and it is time to seriously consider radical, alternative math revolutions, not the never-ending fruitless reforms.
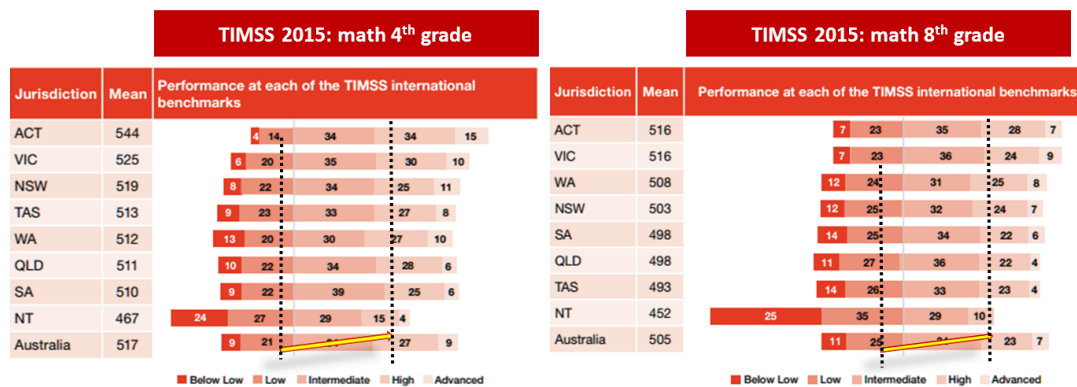
Source: Thomson, Sue, Nicole Wernert, Elizabeth O'Grady, and Sima Rodrigues. 2016. "TIMSS 2015 : A First Look at Australia's Results," TIMSS 2015, http://research.acer.edu.au/timss_2015/1

As the yellow arrows show basically to boost the Low performers to the High performers, and this is impossible to achieve in the traditional math education reforms, the policymakers need to change their mindsets and need to consider the MMU1 option seriously.

The overarching historic comparisons between the math growths traditional vs. MMU1 shakeup.
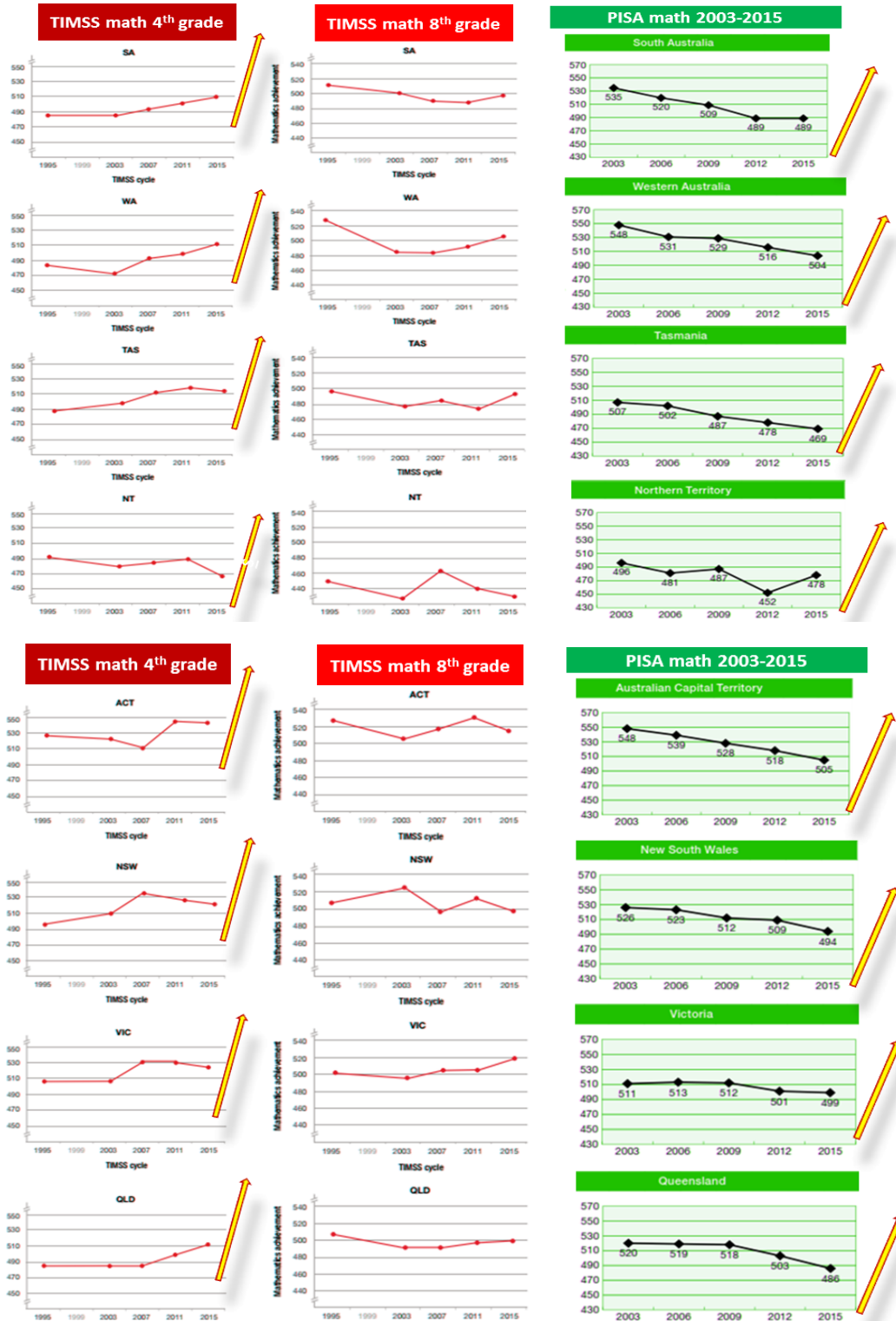
The timelines for the past 20 years (TIMSS math) or 12 years (PISA math) of the TIMSS math grade 4 vs. grade 8 vs. PISA math (15 year old students)

The persistent ethnic gaps in math achievement and how MMU1 can reverse the gap almost twice

TIMSS math 4th grade

TIMSS math 8th grade
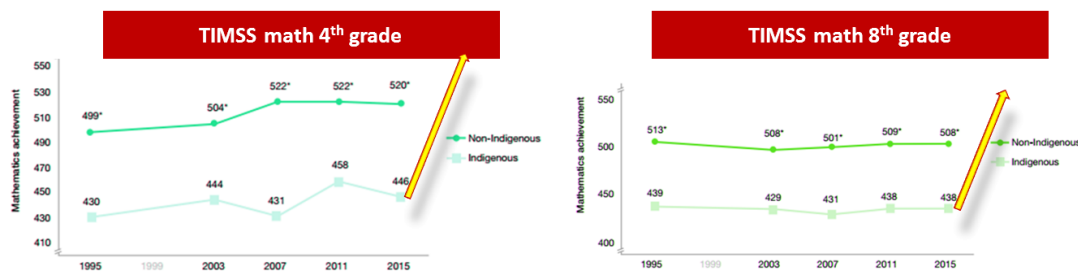
The math gaps between the non-indigenous vs. the indigenous haven't changed at all over the past 20 years of TIMMS math participations (1995-2015).

Source: Thomson, Sue, Nicole Wernert, Elizabeth O'Grady, and Sima Rodrigues. 2016. "TIMSS 2015 : A First Look at Australia's Results," TIMSS 2015, http://research.acer.edu.au/timss_2015/1

According to the TIMSS math history, the ethnic gaps in math in Australia between the non-indigenous vs. the indigenous are not narrowing in 20 years of reforms. This is similar to the results the author has observed in the ethnic gaps in New Zealand (between the White and the indigenous) and the USA (between the White and the Black vs. the White vs. the Hispanics according to the NAEP although in the USA, the narrowing the gaps have been more efficient that in Australia). Hypothetically, if only the indigenous populations in Australia embrace the MMU1, within 1 administration of 3-4 years, the math average of the indigenous population can far exceed to the extent of almost double or at least 150% more than the current gap between the non-indigenous vs. the indigenous math average.

Conclusion

We observed that the math stagnations or declines in all English-speaking countries, Australia nationally and across all of the 8 of the jurisdictions of Australia 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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Exhibit 1.1, Mullis, Martin, Foy, & Hooper, 2016

Thomson, Sue, Nicole Wernert, Elizabeth O'Grady, and Sima Rodrigues. 2016. "TIMSS 2015 : A First Look at Australia's Results," TIMSS 2015, http://research.acer.edu.au/timss_2015/1

TIMSS website (accessed December 2016)

PISA website (accessed December 28, 2016)

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