WP series of the Math Stagnation Nation series, for all English and most of the Latin American countries (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 paper, the author visually demonstrate the math stagnations of almost all English, German-speaking countries, most Latin American countries, and the top 5 math Eastern Asian countries (the most recent) 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) Virtually all other English-speaking developed countries – have been in deep math EDU growth stagnations or declining (and even declines) over the past 15 to 20+ years (according to PISA and TIMSS).
2) In almost all English and Spanish speaking countries, the reading gains are substantially more than the math gains according to PISA 2015.
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 Australia, which have failed to bring the concrete math EDU rise for the past 15-20 years at least.
4) MMU1 can raise the national math average boosts equivalent of what takes more than 1 century in most English-speaking developed countries.
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 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

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

Throughout the paper, 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 have been real and persistent according to PISA or TIMSS or at least the NAEP (the Nation's Report Card) 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 2-3 years for a district or city and 3-4 years for state or 4-5 years for a country, which is totally impossible otherwise by all means in the history of math education.

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

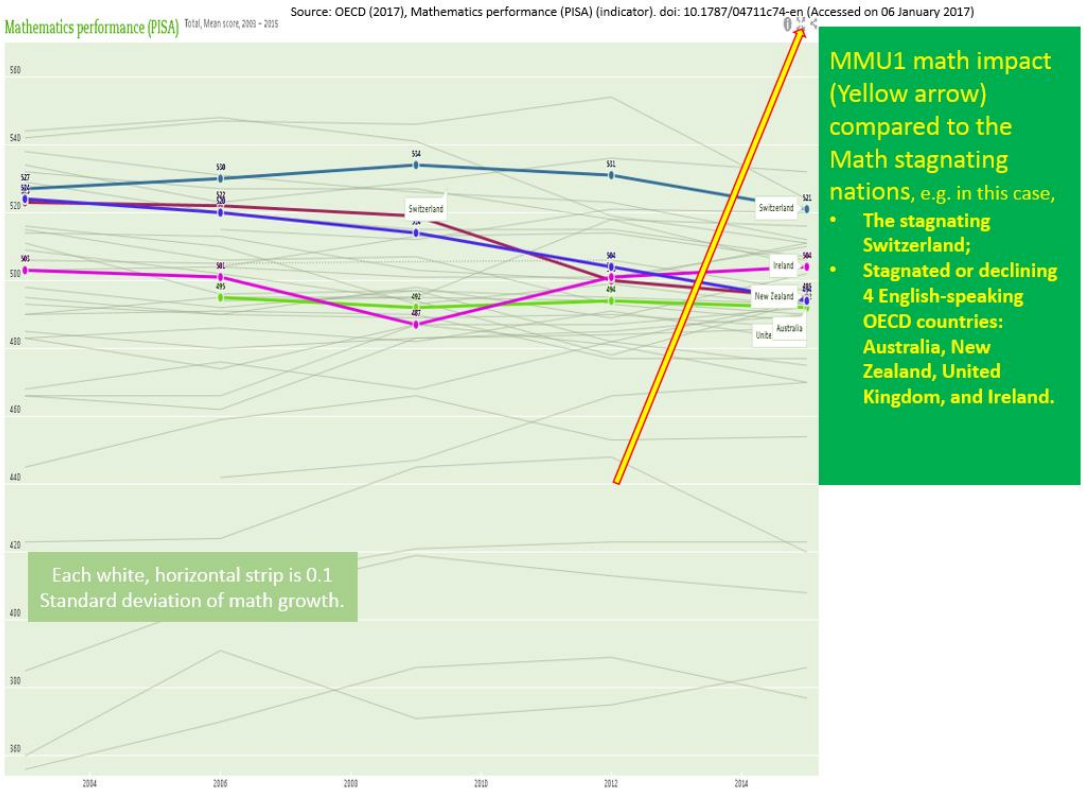
needed half or over a century) in just 2-4 years in each jurisdiction or for the entire Australia if there are committed supports and collaborations.

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.

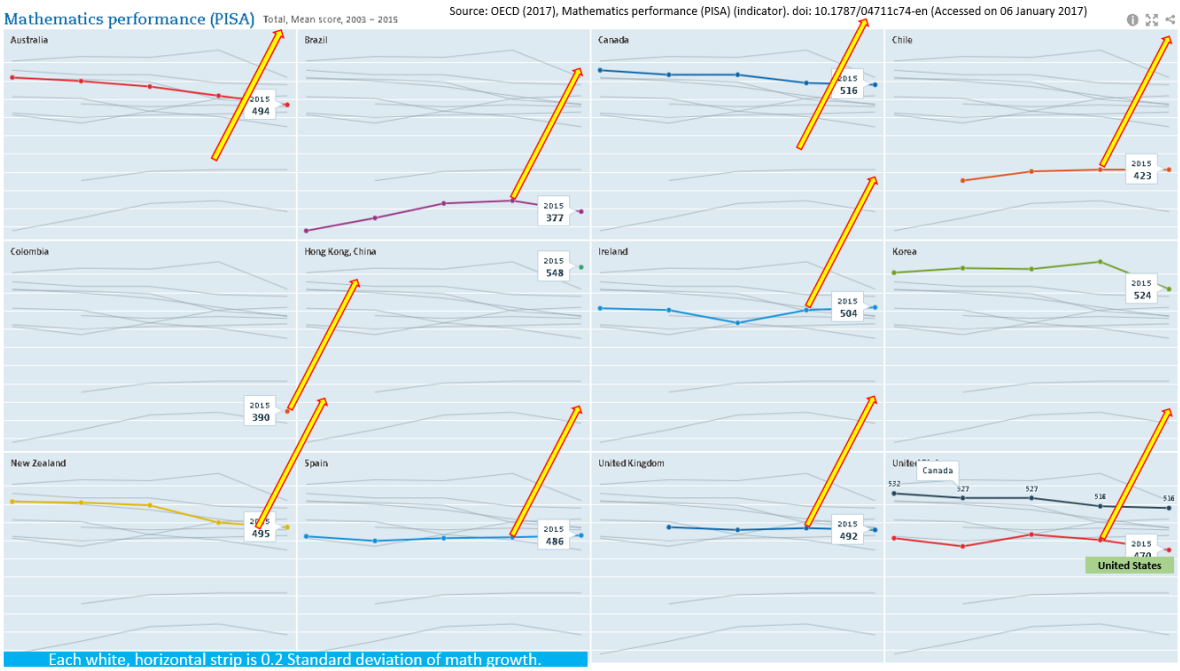
Math stagnations by PISA math average 2012-2015

The math stagnations from the English-speaking developed countries' points of views and the proofs

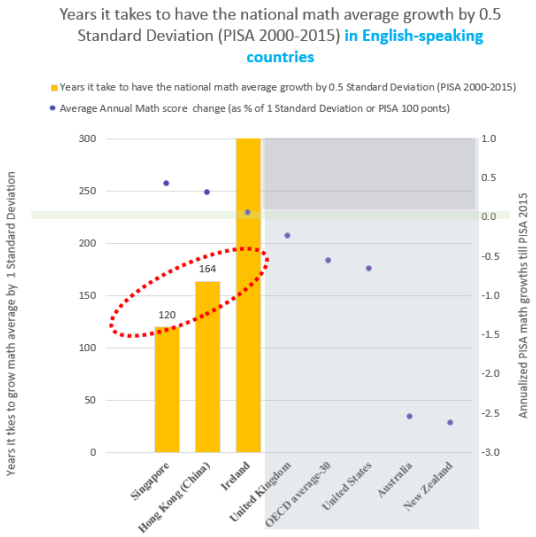
1) Math stagnations of PISA in 4 English-speaking, Latin American, and top math (Eastern Asian) countries



2) 12 sample countries of the PISA math stagnating English or Spanish speaking countries and top Math (Eastern Asian) countries



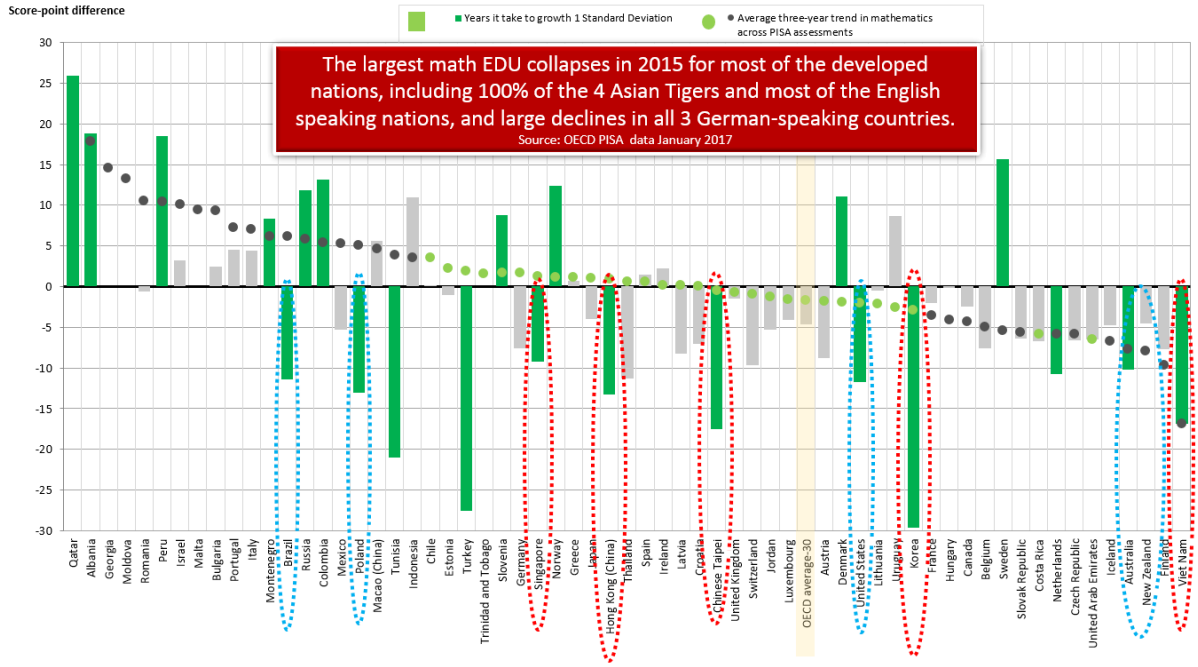
3) Math stagnations (TIMSS math grade 8) of all English-speaking OECD countries



PISA countries for math (for the average math growth trends 2000-2015)

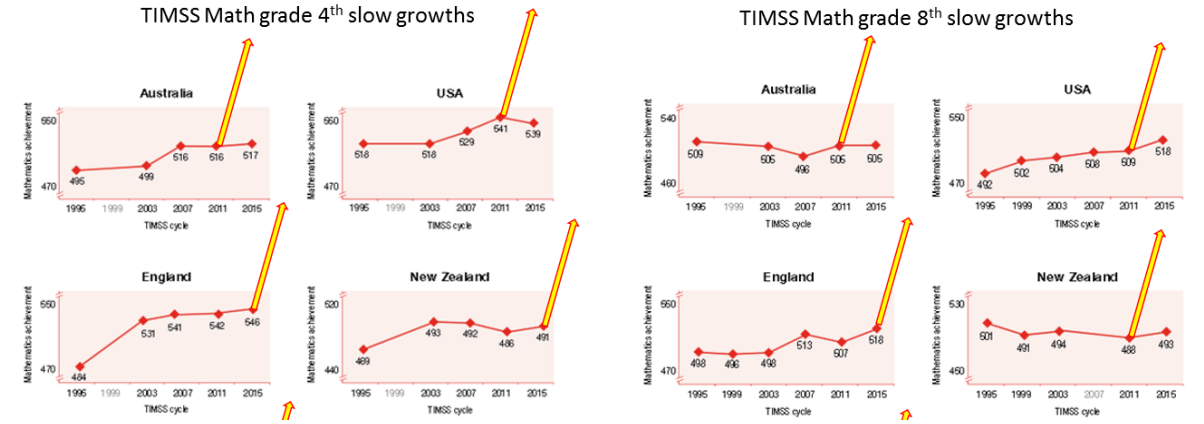
TIMMS Grade 4 math stagnations of 4 English-speaking OECD countries (for the average math growth trends 1995-2015)

4) The largest math declines in most of the developed countries in the history of PISA math: almost all English-speaking countries with the math stagnations; all 3 German-speaking countries big declines; the 4 Asian Tiger countries that have been basically on the top of the world math have all collapsed in PISA 2015 math (especially South Korea); and stagnations or the sudden declines of the math-leading Latin American countries (e.g. Brazil, Costa Rica, Mexico, etc.)

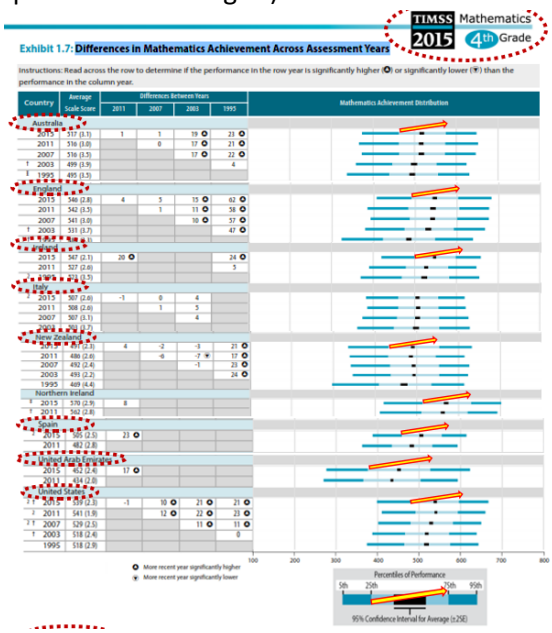


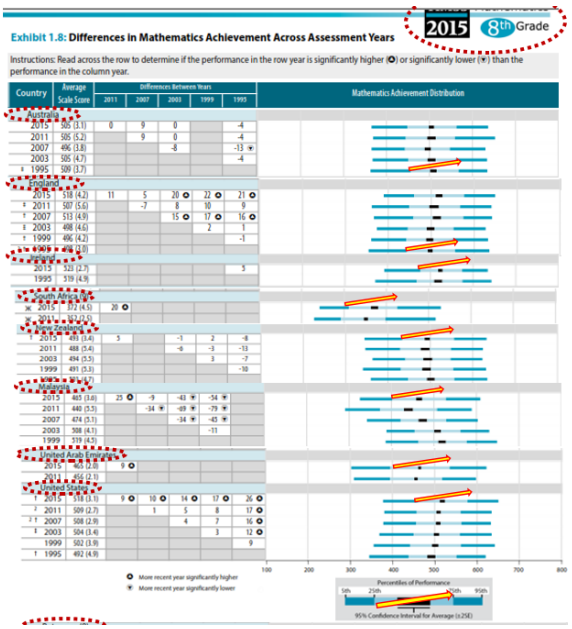
5) Very little math growths of the national math average, especially for the past 10 years for both 4th and 8th grades **NOT just for the USA, but for all of the English-speaking countries**.

Quasi-horizontal TIMSS math growths past 20 years and what MMU1 is equivalent to do if implemented **(Yellow Arrows)**

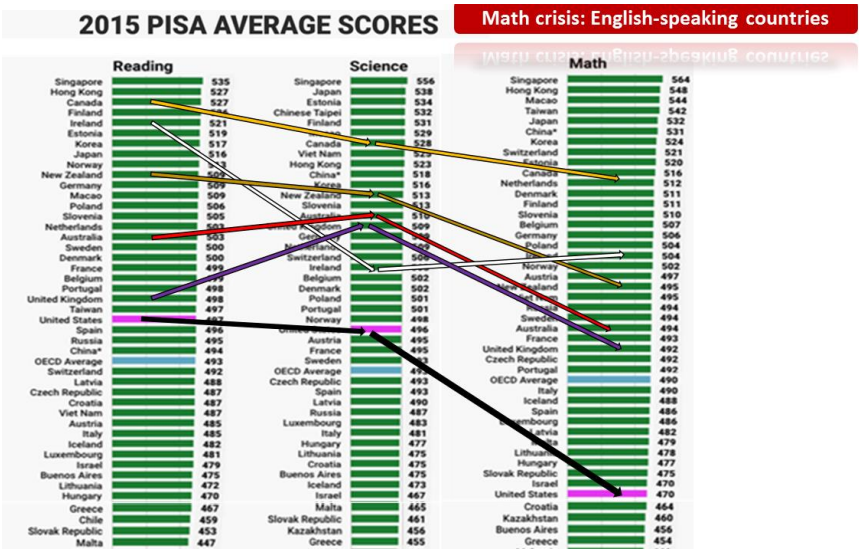


6) Math stagnations are here to stay and the tiny gains are illusions. Over the 2 decades (vertically), there are little changes as you can see in these percentile diagrams. The yellow arrows indicate the magnitude of math growths from the 25the percentile to the 75th percentile. Normally, this may take 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.)





7) 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.



8) 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

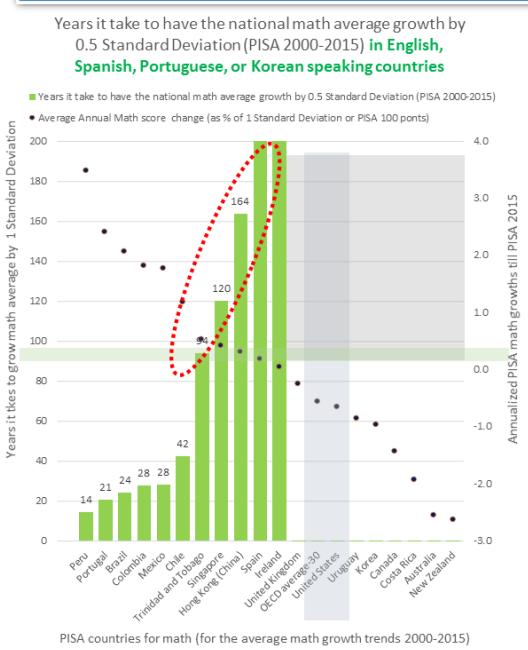
Mean score in PISA 2015	Math -Reading (PISA 2015)		Math - Science		Math - Science & reading average	
Chile		-36		-24		-30
Colombia		-35		-26		-31
Brazil		-30		-24		-27
Dominican Republic		-30		-4		-17
Costa Rica		-27		-19		-23
CABA (Argentina)		-19		-19		-19
Uruguay		-19		-17		-18
Mexico		-15		-8		-11
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

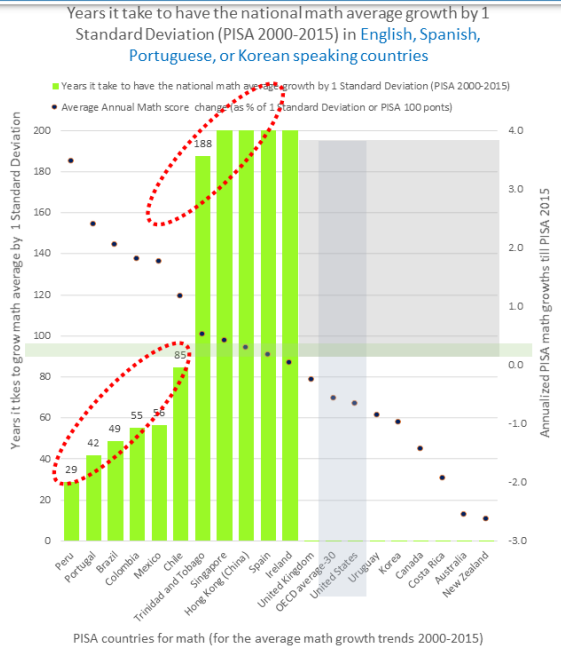
Source: OECD, PISA 2015 Database, Tables I.2.4a, I.2.6, I.2.7, I.4.4a and I.5.4a.

9) 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.





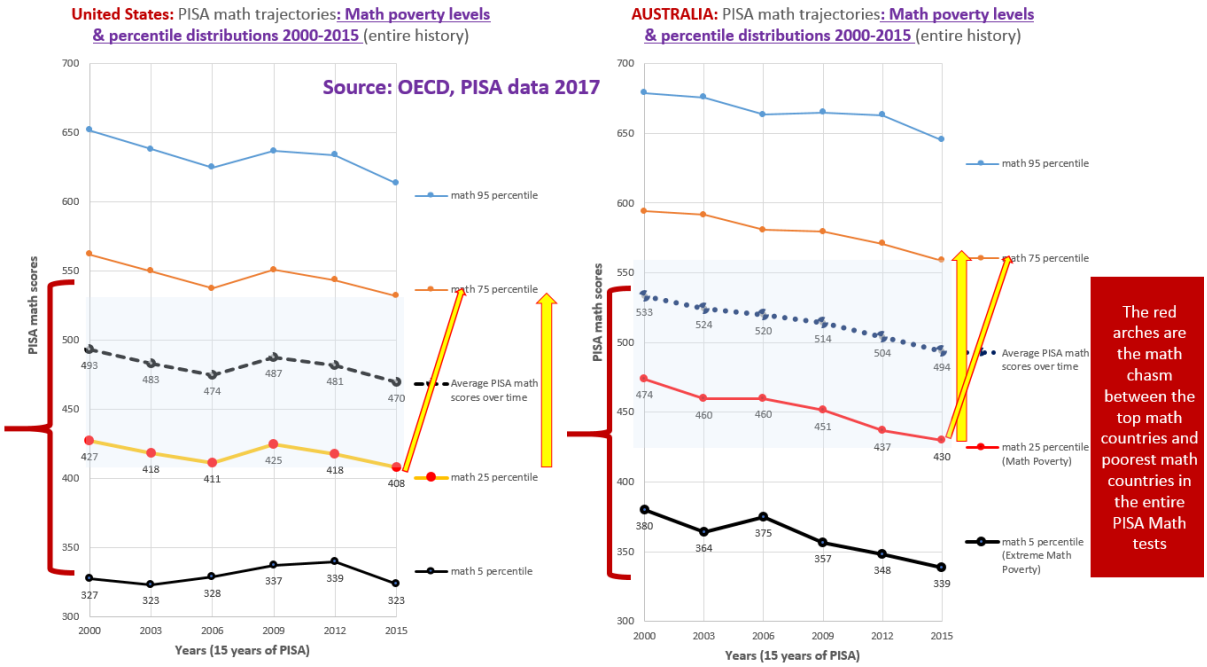
Math stagnations of all English-speaking OECD countries' math performance distributions. What the math boosts from the MMU1 math impacts (boosting from about the average of the worst half to the average of the best half in math) mean.

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)

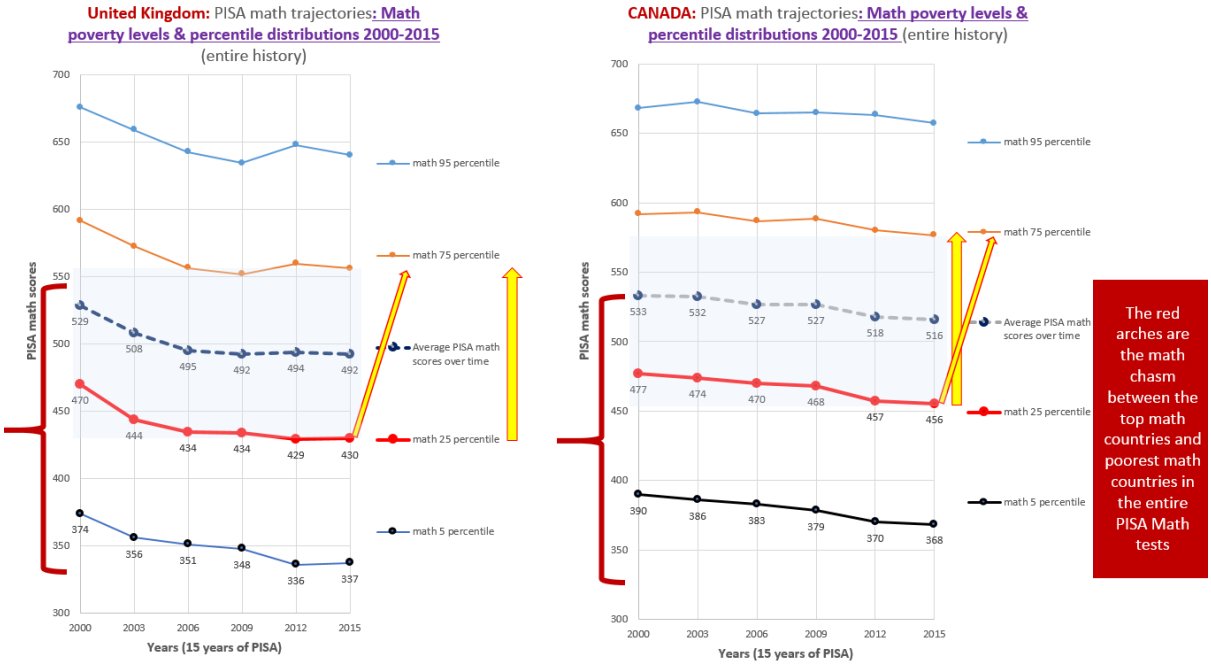
NOTE that the averages of the PISA math trend trajectories of the past 12 years almost exactly mimic the math 25 percentile (about average of the worst half).

USA (stagnating and zig-zag declining) and Australia (heavily declining)

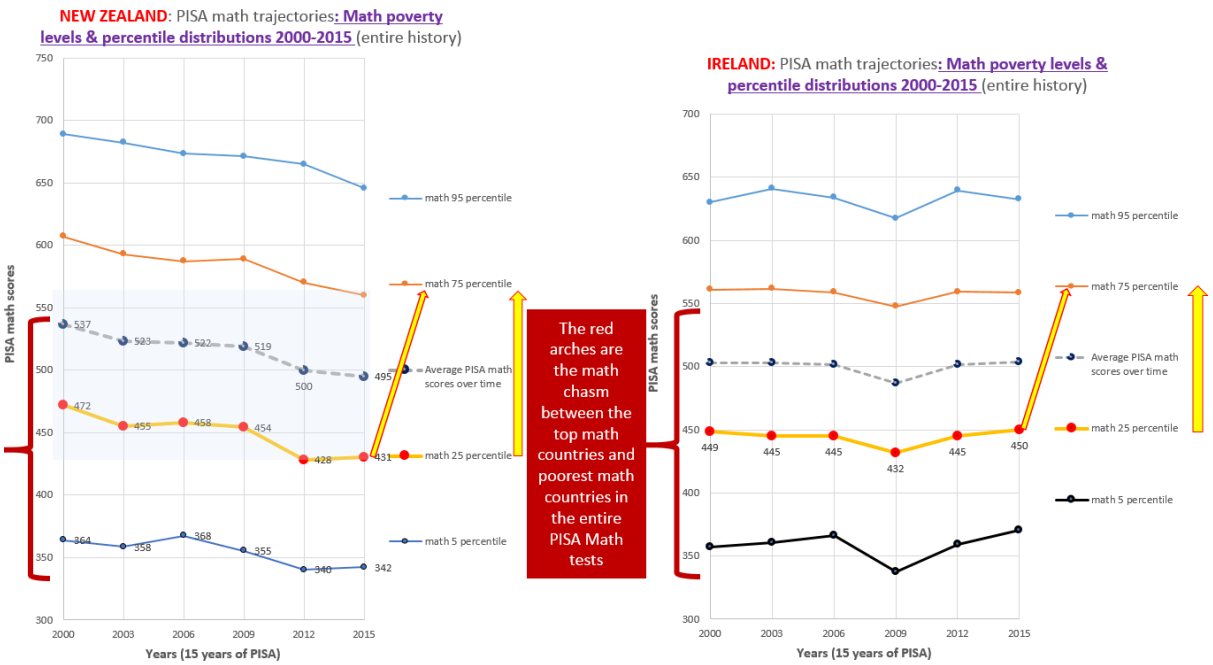
[1] For the entire English-speaking or Latin American countries' visual data, please refer to author's other paper.



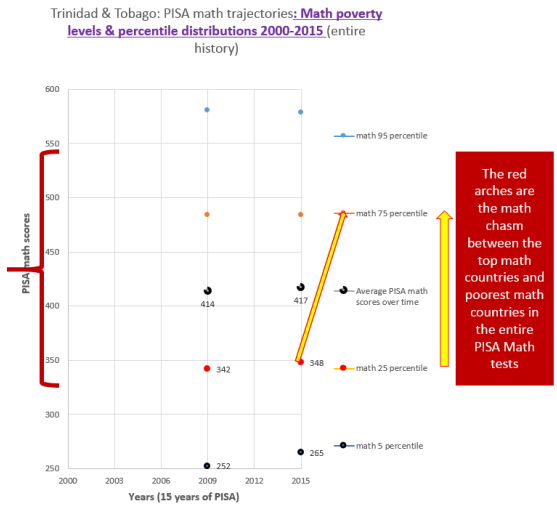
UK and Canada: math stagnations



New Zealand (heavily declining) and Ireland (stagnating, barely afloat)



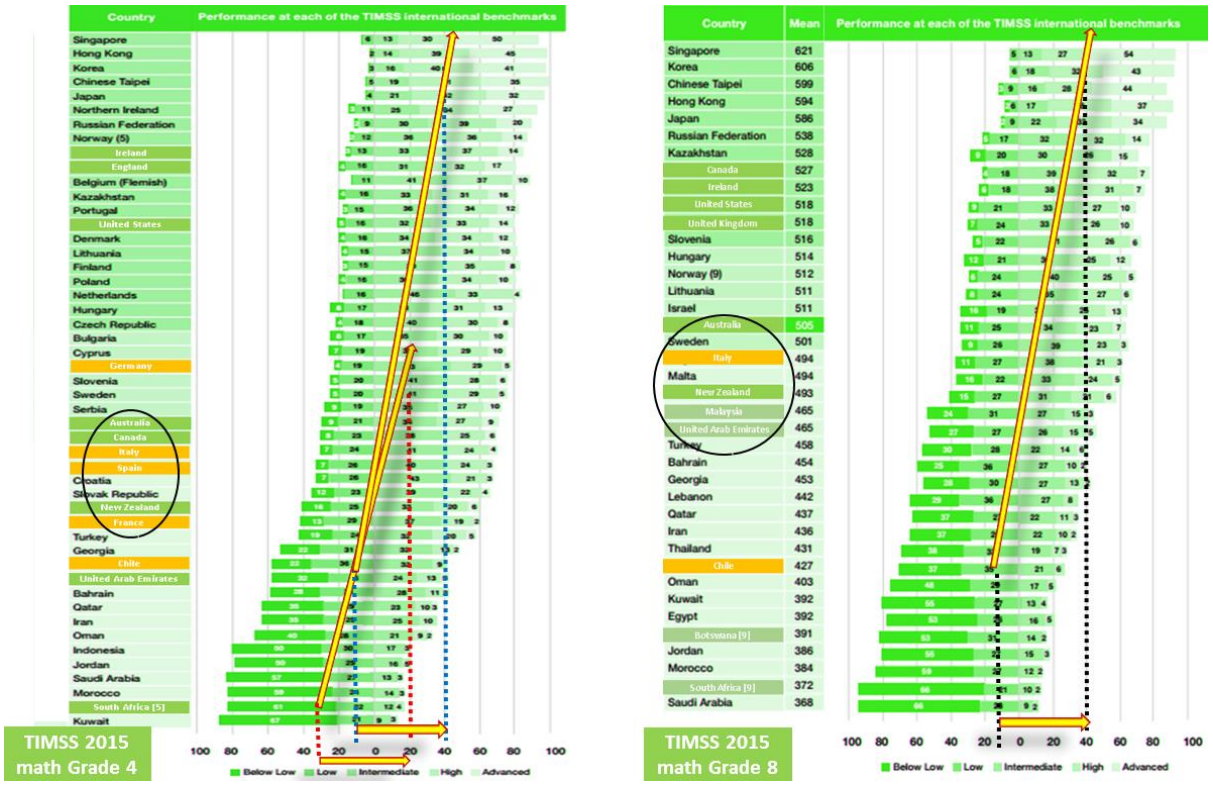
Trinidad and Tobago



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.

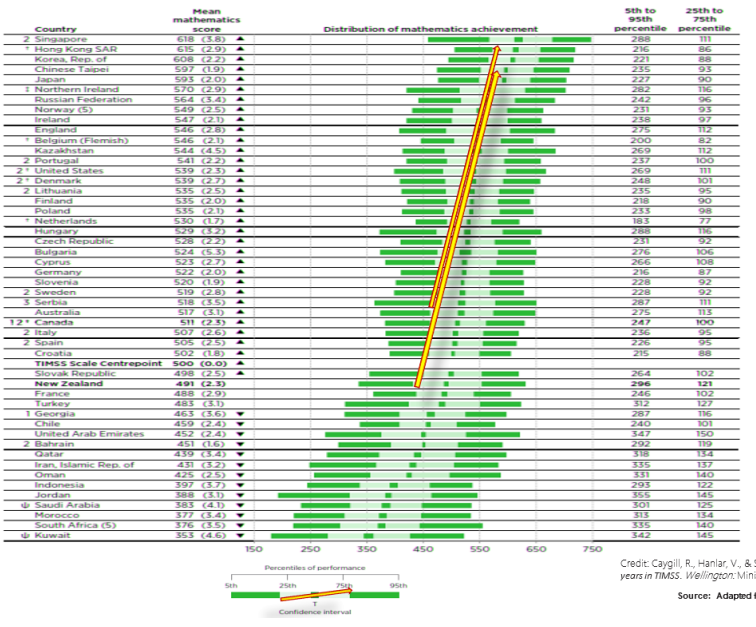
How MMU1 can impact the math grade 4 and 8 using the math performance distributions from TIMSS 2015



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 for instance 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.



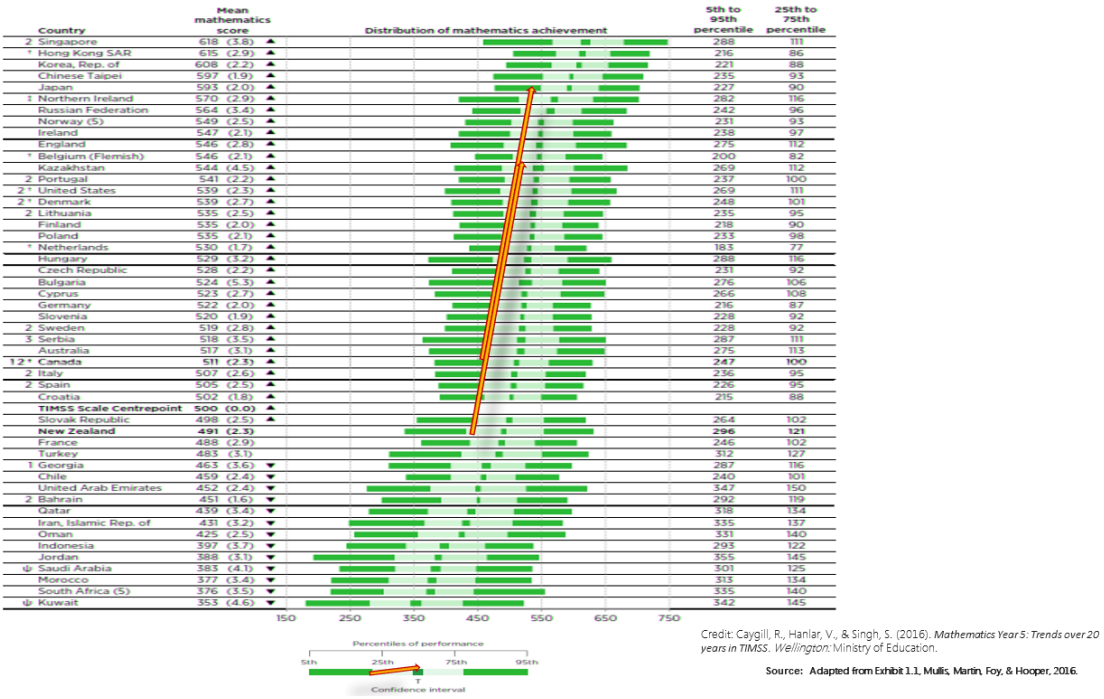
Credit: Caygill, R., Hanlar, V., & Singh, S. (2016). *Mathematics Year 5: Trends over 20 years in TIMSS*. *Wellington*: Ministry of Education.

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.



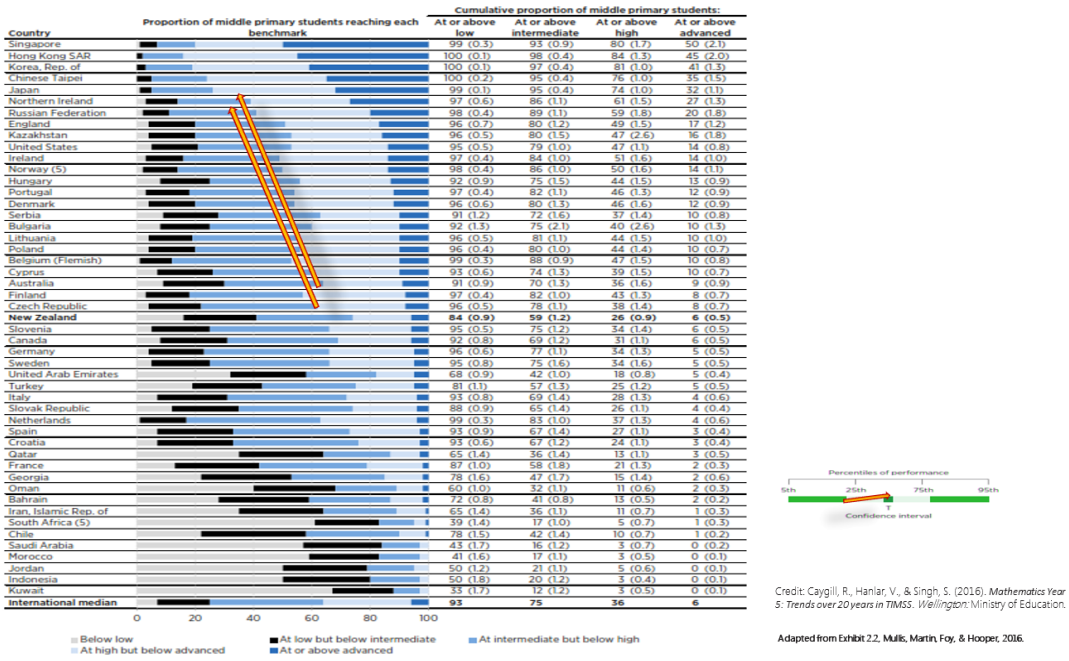
Country	Mean mathematics score	5th to 95th percentile	25th to 75th percentile
2 Singapore	618 (3.8)	288	111
* Hong Kong SAR	615 (2.9)	216	86
Korea, Rep. of	608 (2.2)	221	88
Chinese Taipei	597 (1.9)	235	93
Japan	593 (2.0)	227	90
1 Northern Ireland	570 (2.9)	282	116
Russian Federation	564 (3.4)	242	96
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
Ψ Saudi Arabia	383 (4.1)	301	125
Morocco	377 (3.4)	313	134
South Africa (5)	376 (3.5)	335	140
Ψ 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.

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.

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, 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.

APPENDIX

PISA math data 2015

PISA math data for the English-speaking countries

Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile (E
Australia	2000	679.00	594.00	533.00	474.00	380.00
Australia	2003	675.68	591.65	524.27	459.79	364.32
Australia	2006	663.46	580.72	519.91	459.99	374.85
Australia	2009	664.93	579.51	514.34	451.25	356.59
Australia	2012	663.13	570.88	504.15	436.84	348.02
Australia	2015	645.17	558.77	493.90	429.81	338.69
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
Canada	2000	668.00	592.00	533.00	477.00	390.00
Canada	2003	672.66	593.29	532.49	473.94	386.18
Canada	2006	664.19	586.70	527.01	470.28	382.72
Canada	2009	664.80	588.29	526.81	468.06	378.57
Canada	2012	663.40	580.07	518.07	457.38	370.28
Canada	2015	657.07	576.55	515.65	455.66	368.50
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
Ireland	2000	630.00	561.00	503.00	449.00	357.00
Ireland	2003	640.97	561.88	502.84	444.99	360.43
Ireland	2006	634.14	558.94	501.47	444.97	365.97
Ireland	2009	617.36	547.57	487.14	432.16	337.82
Ireland	2012	639.56	559.21	501.50	445.31	359.30
Ireland	2015	632.50	558.72	503.72	450.14	370.63
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
New Zealand	2000	689.00	607.00	537.00	472.00	364.00
New Zealand	2003	682.30	593.01	523.49	455.23	358.50
New Zealand	2006	673.51	587.25	521.99	458.02	367.51
New Zealand	2009	671.37	588.84	519.30	454.18	355.39
New Zealand	2012	664.88	570.05	499.75	428.14	340.31
New Zealand	2015	645.77	559.97	495.22	430.61	342.26
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
United Kingdo	2000	676.00	592.00	529.00	470.00	374.00
United Kingdo	2003	659.34	572.60	508.26	444.10	356.08
United Kingdo	2006	642.96	556.51	495.44	434.48	351.17
United Kingdo	2009	634.72	551.96	492.41	433.84	348.08
United Kingdo	2012	648.26	559.86	493.93	429.17	336.18
United Kingdo	2015	640.52	556.46	492.48	429.78	337.42
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
United States	2000	652.00	562.00	493.00	427.00	327.00
United States	2003	637.97	549.70	482.89	417.99	322.96
United States	2006	624.89	537.23	474.35	411.24	328.38
United States	2009	636.70	550.64	487.40	424.68	337.05
United States	2012	633.75	543.29	481.37	417.71	339.20
United States	2015	613.28	531.78	469.63	408.10	323.49
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
Trinidad and To	2009	580.33	484.09	414.04	342.07	252.34
Trinidad and To	2012					
Trinidad and To	2015	578.31	484.11	417.24	348.08	264.52
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
United Arab Er	2012	590.74	493.92	..	369.55	297.05
United Arab Er	2015	593.28	492.54	427.48	359.67	275.16
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
Singapore	2009	724.58	637.79	562.02	490.26	382.92
Singapore	2012	737.41	649.59	573.47	500.80	393.03
Singapore	2015	710.79	632.34	564.19	500.40	398.74
Country	Time	math 95 percentile	math 75 percentile	Average PISA math	math 25 percentile	math 5 percentile
Hong Kong SAR	2000	699.00	626.00	560.00	502.00	390.00
Hong Kong SAR	2003	699.52	621.84	550.38	484.80	373.83
Hong Kong SAR	2006	691.88	614.11	547.46	486.16	385.61
Hong Kong SAR	2009	702.97	621.58	554.53	492.50	389.80
Hong Kong SAR	2012	708.73	628.59	561.24	498.84	390.52
Hong Kong SAR	2015	686.87	610.67	547.93	490.41	389.26

Source: PISA 2015 math (OECD website)

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