TIMSS

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Policy Brief

Advanced Academic Performance: Exploring Country-Level Differences in the Pursuit of Educational Excellence

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Summary

Every country strives for its students to have advanced achievement in some way, shape, or form. But too often, competence is a higher policy priority than excellence, and shrinking minimum competency gaps is a higher priority than closing excellence gaps. In this brief, educational excellence is defined as the percent of students who meet or exceed the advanced benchmark on the Trends in International Mathematics and Science Study (TIMSS). The brief draws from multiple years of TIMSS data to examine country-level differences in excellence, including disparities in advanced achievement within countries among subgroups of students (also known as excellence gaps). The brief concludes with policy implications and recommendations for further research.

Introduction

Excellence across fields and domains—from art to science, journalism to cooking, childrearing to leisure, architecture to farming—promotes economic growth and quality of life. Many cultures around the world celebrate individuals and groups that accomplish feats which are well above normal standards for human performance. In fact, it is difficult to argue that a society can ever have too much excellence. Given the multitude and magnitude of the world's problems, having talented and highly skilled people to tackle those problems is obviously important. As a case in point, even during severe economic downturns, many jobs for talented, highly skilled workers still exist. For example, in the United States, 2.3 million jobs were available during the depths of the 2007 to 2009 recession, many requiring advanced skills (U.S. Bureau of Labor Statistics, 2010).

Decades of research provide clear evidence that highly talented people and groups receive a great deal of support as they develop their exceptional talents. Family often provides this support, but another important support is education. The latter is especially true for talented, disadvantaged students, as having access to educational interventions allows them to develop their advanced abilities and skills and can be a ticket to economic security for both them and their families.

Yet, in general, the degree to which the pursuit of educational excellence drives national education policy is highly inconsistent, with some countries making advanced performance a national priority and others focusing more tightly on raising average performance or getting as many students as possible to minimum competency (see, for example, Bourne, 2009; Mullis et al., 2011; Plucker, Hardesty, & Burroughs, 2013).[1] With this consideration in mind, my purpose in this brief is to examine country-level differences in advanced performance, including advanced-performance disparities within countries and across subgroups of students.[2]

Advanced Performance

The synonymous terms "educational excellence" and "advanced achievement" can be defined as the percent of students in each country estimated to score at or above the advanced benchmark on the Trends in International Mathematics and Science Study (TIMSS) assessments conducted by the International Association for Educational Achievement (IEA). The TIMSS scales run from 1 to 1,000, although scores typically fall in the 300 to 700 range.

The advanced performance level, representing a score of 625 or higher, is designed to be challenging for students to reach. For example, Grade 4 students reaching the advanced level in mathematics can solve multistep word problems, show an understanding of fractions and decimals, apply knowledge of geometry to a range of situations, and draw conclusions from a table of data. In the 2011 TIMSS Grade 4 mathematics assessment, the international median for scoring advanced was four percent, which meant that only half of the participating countries succeeded in getting even four percent of their students to score at the advanced level (Mullis, Martin, Foy, & Arora, 2012).

Given increasing global competition for talent, it is illustrative to examine how countries compare in producing high-achieving students. In the following sections, both cross-sectional and quasi-longitudinal data are presented for selected countries on the TIMSS Grade 4 and Grade 8 science and mathematics assessments of 2003, 2007, and 2011.

Trends in Excellence by Country

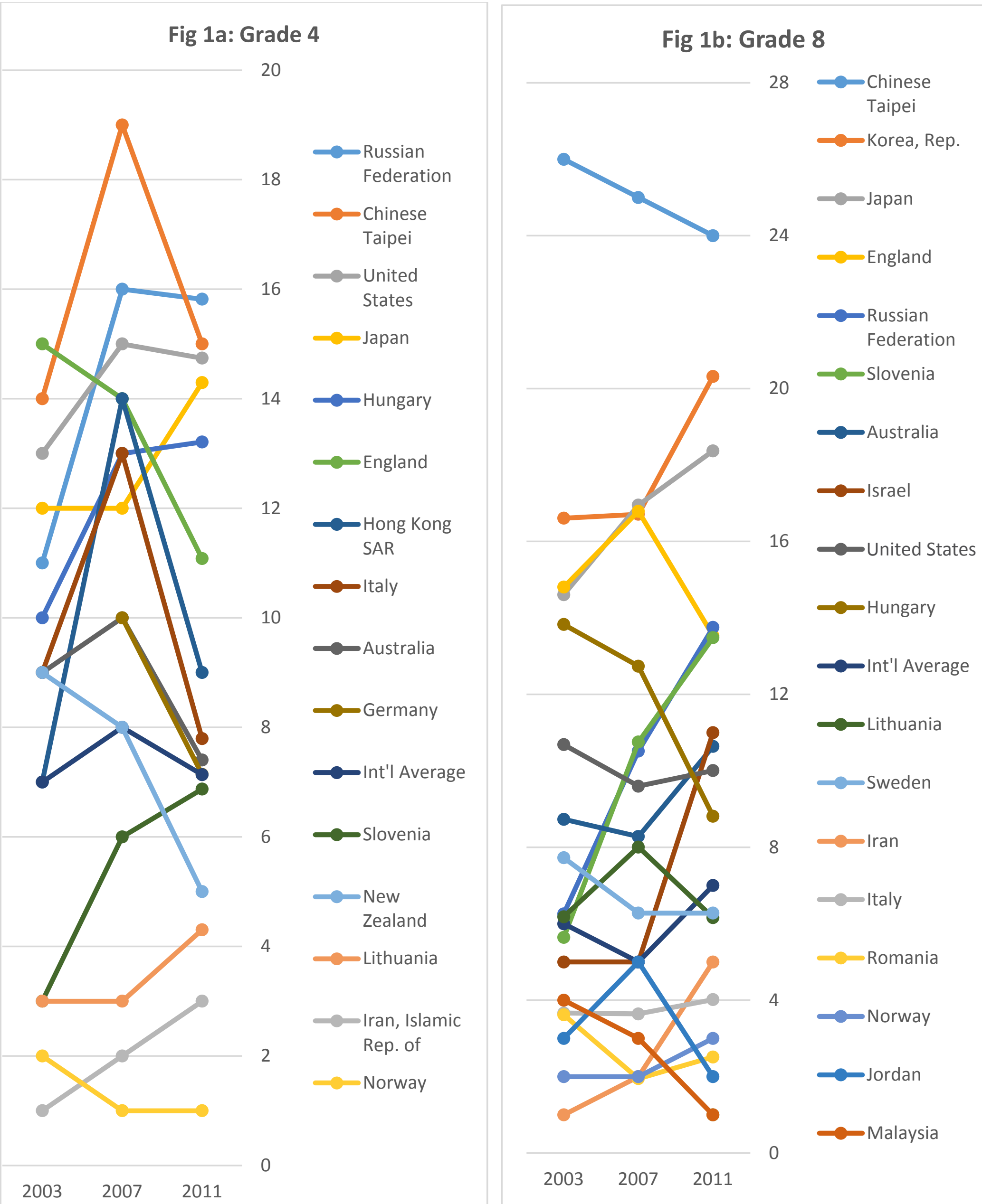
Figures 1a and b and 2a–c depict trends in the percent of students scoring at the TIMSS advanced level between 2003 and 2011.[3] Taking descriptive data with a grain of salt is always a good idea, which helps explain why assumptions about testing conditions across countries in large-scale international assessments are occasionally questioned (e.g., Loveless, 2014). The most notable caveat for the data in these figures is that not every country has been a consistent participant in the four TIMSS assessments since 2003. That said, several observations can be drawn from these descriptive data.

First, the range in performance among countries is considerable, extending from the low single digits for a handful of countries to the high teens and twenties for others. The range is much larger in mathematics (with nearly 50 percent of students reaching the advanced level in some countries) than in science with only 20 to 25% of students nearing this level in the top-performing countries).

Second, the relative rankings for countries vary based on subject and grade level, but the differences are not large. For example, in addition to the usual countries at the top of the table (Taiwan, Japan, South Korea, Singapore), Russia, England, and the United States perform relatively well in Grade 4 and Grade 8 science and Grade 4 mathematics. Russian students also perform at high levels in Grade 8 mathematics but American and English students less so.

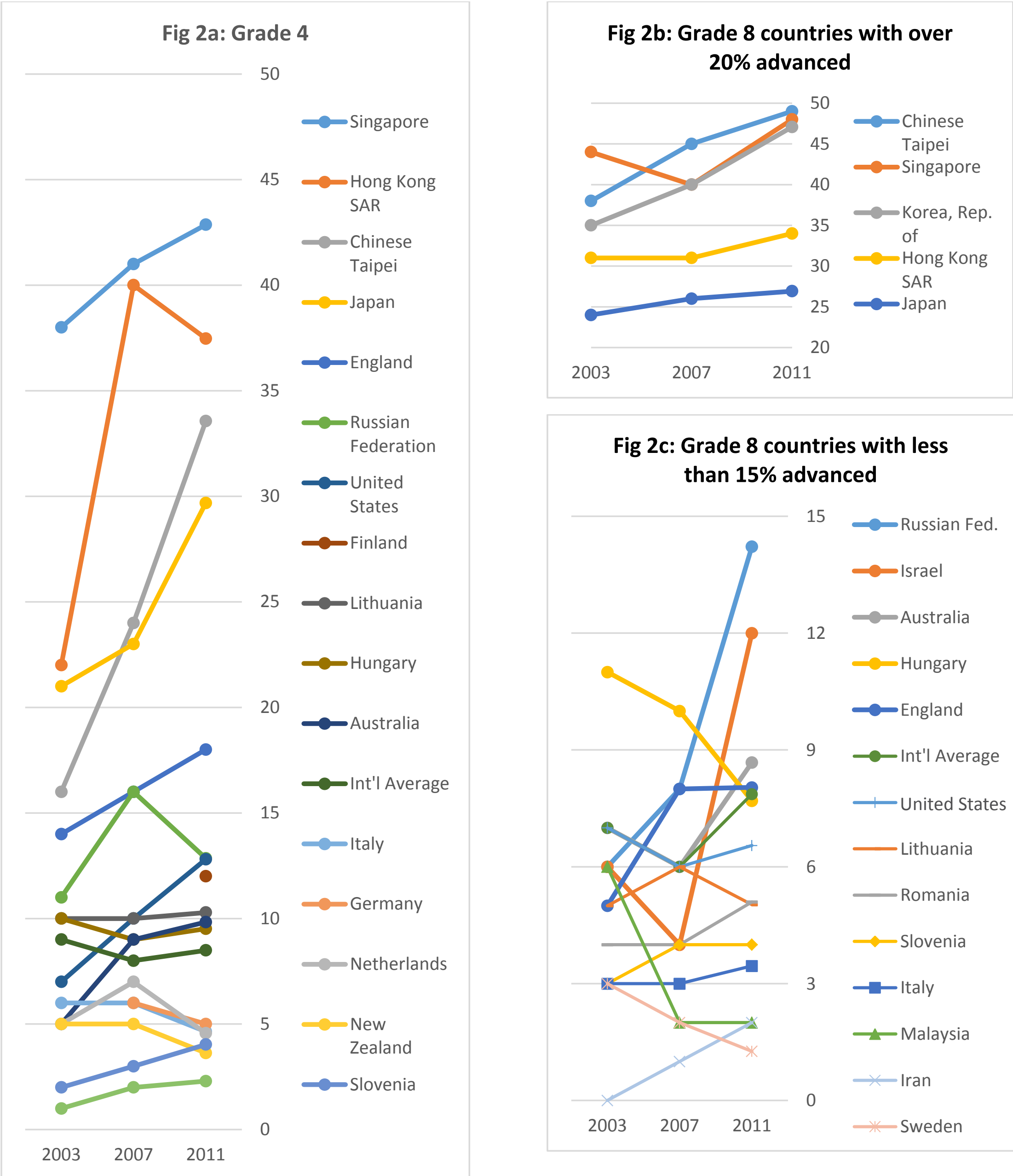
Third, although regression to the mean is often a complicating factor in studies of education excellence (cf. Lee, 2011; Xiang, Dahlin, Cronin, Theaker, & Durant, 2011), regression to the mean does not appear to be a major factor in these analyses, given roughly the same number of countries exhibit declining and increasing percentages of advanced students. Conducting a careful examination of countries with results moving in opposite directions may be a fruitful area of policy research: Did the country's education system do something differently from 2003 to 2011 that resulted in unexpected increases or decreases in the percentage of high performers? Those countries would include Japan and Norway in Grade 4 science, South Korea, Japan, Jordan, and Malaysia in Grade 8 science, most high-performing countries and a cluster of relatively low-performing European countries in Grade 4 mathematics, and most high-performing countries along with Sweden and Malaysia in Grade 8 mathematics.

Figures 1a and 1b: Grade 4 and Grade 8 science advanced achievement (percent scoring 625+) on TIMSS



Notes: Inclusion was limited to countries that participated in the past three TIMSS testing rounds. Countries that consistently participated but had very few students scoring at the advanced level (i.e., the percent advanced rounds to zero) are not included, as the intent is to illustrate trends and the variance in performance among countries, not to embarrass. *Note that the two grade levels are not on the same scale; doing so would make it difficult to differentiate between countries in the figures.*

Figures 2a, 2b, and 2c: Grade 4 and Grade 8 mathematics advanced achievement (percent scoring 625+) on TIMSS



Notes: Data limited to countries that participated in the past three TIMSS testing rounds, with a few exceptions for countries that are well regarded in education reform circles. Countries with very few students scoring at the advanced level (i.e., the percent advanced rounds to zero) are not included, as the intent is to illustrate trends and the variance in performance among countries, not to embarrass. *Note that the figures are not on the same scale; doing so would make it difficult to differentiate between countries in the figures.*

Cohort Trends in Excellence by Country

One aspect of the unique sampling framework for TIMSS (i.e., testing every four years in Grades 4 and 8) allows for another potentially useful analysis: How did the percent of advanced scorers change from Grade 4 in 2007 to Grade 8 in 2011? Or, more to the point, is there an “excellence value-added” from fourth to eighth grade in certain countries? Table 1 includes cohort comparison data for mathematics, Table 2 for science.

For math, three of the four highest scoring countries statistically significantly increased the percent of students scoring at the advanced level from Grade 4 to Grade 8, while some low-scoring countries declined further by Grade 8.

In science, three high-scoring countries increased from Grade 4 to Grade 8, but no country with below-average results in Grade 4 experienced a statistically significant decline over the ensuing four years. These results suggest that a handful of countries were able to add to already high levels of excellence. Specifically, Chinese Taipei, Singapore, and Japan should be the subject of further investigation, as the percentages of students reaching advanced level in these countries increased in both math and science.

Table 1: Advanced scorers (625+) on TIMSS mathematics: 2007 Grade 4 vs. 2011 Grade 8

Jurisdiction	2007 Grade 4		2011 Grade 8		Cohort Differences		
	Percent advanced	SE	Percent advanced	SE	Percent advanced	95% CI	
Chinese Taipei	24	(1.2)	49	(1.5)	+25	21.64	28.98
Singapore	41	(2.1)	48	(2.0)	+7	1.28	12.64
Japan	23	(1.2)	27	(1.3)	+4	0.71	7.49
Ukraine	2	(0.5)	5	(0.6)	+2	0.74	3.87
Iran, Islamic Rep. of	0	(0.1)	2	(0.5)	+2	0.74	2.88
Qatar	0	(0.0)	2	(0.3)	+2	1.56	2.80
Slovenia	3	(0.4)	4	(0.4)	+1	-0.48	1.90
Georgia	1	(0.4)	3	(0.3)	+1	0.33	2.27
Int’l Average	**11**	**(0.2)**	**11**	**(0.2)**	**0**	**-0.85**	**0.40**
Australia	9	(0.8)	9	(1.7)	0	-3.81	3.48
New Zealand	5	(0.5)	5	(0.8)	0	-2.08	1.65
Hungary	9	(0.8)	8	(0.7)	-1	-3.28	0.75
Norway	2	(0.3)	1	(0.2)	-1	-1.72	-0.41
Russian Federation	16	(1.8)	14	(1.2)	-2	-5.93	2.60
Italy	6	(0.7)	3	(0.5)	-2	-3.75	-0.44
United States	10	(0.8)	7	(0.8)	-3	-5.64	-1.27
Lithuania	10	(0.7)	5	(0.6)	-5	-6.45	-2.85
Armenia	8	(1.5)	3	(0.4)	-5	-8.25	-2.20
Hong Kong SAR	40	(2.2)	34	(2.0)	-6	-11.80	-0.25
England	16	(1.2)	8	(1.4)	-8	-11.75	-4.58
Kazakhstan	19	(2.1)	3	(0.7)	-16	-20.23	-11.59

Notes: Countries with estimates of 0% in both years are omitted. The cohort differences may appear incorrect due to rounding. SE: standard error, CI: confidence interval.

Table 2: Advanced scorers (625+) on TIMSS science: 2007 Grade 4 vs. 2011 Grade 8

Jurisdiction	2007 Grade 4		2011 Grade 8		Cohort Differences		
	Percent advanced	SE	Percent advanced	SE	Percent advanced	95% CI	
Slovenia	6	(0.6)	13	(0.8)	+7	4.98	9.01
Japan	12	(1.0)	18	(1.1)	+6	3.06	8.78
Chinese Taipei	19	(1.0)	24	(1.4)	+5	2.02	8.60
Singapore	36	(1.9)	40	(1.7)	+4	-0.91	9.17
Lithuania	3	(0.4)	6	(0.7)	+3	1.24	4.45
Ukraine	2	(0.3)	6	(0.8)	+3	1.69	5.24
Iran, Islamic Rep. of	2	(0.3)	5	(0.7)	+3	1.42	4.54
Qatar	0	(0.0)	3	(0.5)	+3	2.04	4.09
New Zealand	8	(0.5)	9	(1.0)	+1	-0.84	3.37
Norway	1	(0.4)	3	(0.4)	+1	0.33	2.53
Australia	10	(0.7)	11	(1.6)	0	-3.08	3.88
Int'l Average	**9**	**(0.2)**	**9**	**(0.2)**	**0**	**-0.81**	**0.33**
Georgia	1	(0.2)	0	(0.1)	0	-0.50	0.36
England	14	(1.2)	14	(1.5)	-1	-4.49	3.06
Russian Federation	16	(1.9)	14	(1.1)	-2	-6.38	2.31
United States	15	(0.9)	10	(0.7)	-5	-7.26	-2.70
Hong Kong SAR	14	(1.4)	9	(1.1)	-5	-8.55	-1.48
Hungary	13	(1.0)	9	(0.8)	-5	-7.15	-2.10
Kazakhstan	10	(1.3)	4	(0.6)	-6	-8.79	-3.02
Italy	13	(1.0)	4	(0.5)	-9	-11.07	-6.80
Armenia	12	(1.8)	1	(0.2)	-11	-14.13	-6.97

Notes: Countries with estimates of 0% in both years are omitted. The cohort differences may appear incorrect due to rounding. SE: standard error, CI: confidence interval.

Excellence Gaps

Every community has populations of students who academically underperform relative to other groups and to their own potential. These performance differences are generally called achievement gaps and are represented as differences in achievement between groups of students as defined by variables such as race, gender, and socioeconomic status. Over the past 15 years, education policy in many countries has focused on closing these achievement gaps (see, for example, Danhier & Martin, 2014; Goodman & Burton, 2012; Iannelli & Smyth, 2008; Leithwood, 2010). In most of this policy work, the principal focus has been on minimum competency, that is, closing achievement gaps by bringing a larger proportion of students in underperforming groups to a basic level of educational achievement.

A focus on minimum competency gaps has been justified—and is warranted—as a social justice issue and an economic imperative. However, basic proficiency represents only one level of achievement. Helping academically talented Grade 4 students achieve minimum competency may help close this type of achievement gap, but it does little for the students, their families and their communities if they never reach the high levels of achievement they have the potential to realize. As a result, closing gaps at advanced levels of achievement, commonly referred to as excellence gaps, must also be a priority. A sole focus on minimum competency is short-sighted and leaves far too many students insufficiently challenged.

Interestingly, there does not appear to be a link between efforts to shrink minimal competency gaps and a decrease in excellence gaps (Burroughs & Plucker, 2014; Plucker et al., 2013). A number of potential causes have been suggested for the existence and persistence of large excellence gaps. For example, Subotnik, Olszewski-Kubilius, and Worrell (2011) suggest that a lack of resources in schools serving predominantly lower-income and disadvantaged minority communities, paired with disparities in parents' awareness of and advocacy for resources supporting appropriate education for gifted students, plays a major role in the existence of gaps. Other potential factors include the pervasive effects of poverty, systemic bias in the design and implementation of programs for advanced students, inadequate training for educators who work with underperforming subgroups of students, and lack of attention to issues surrounding educational excellence in schools.

We have little recent research on international excellence gaps, with most such research occurring in the United States and United Kingdom (e.g., Dracup, 2014, 2105; Plucker et al., 2013). In the one available international comparative study, Rutkowski, Rutkowski, and Plucker (2012), using TIMSS data from 82 education systems, found evidence of shrinking gender excellence gaps and persistent but small immigration excellence gaps (e.g., academic performance of immigrant vs. nonimmigrant students). To date, little research appears to have been conducted on excellence gaps across countries based on student socioeconomic status.



Endnotes

1 In this brief, the terms "educational excellence" and "advanced achievement" are used synonymously.

2 Discussions of educational excellence and advanced performance often reveal confusion among policymakers and researchers about whether we are discussing gifted students or students exhibiting "gifted" levels of achievement. Research provides little evidence that advanced achievement is limited to gifted students, in part because definitions of giftedness and accompanying identification strategies vary so widely from country to country and even school to school. This brief operates under the assumption that an important goal of any national education system is to produce as many advanced students as possible.

3 Grade 8 mathematics data were split in the figures due to the considerable difference in performance between the cluster of very high-performing countries and all other countries.

Conclusions and Policy Implications

The analysis above leads to three conclusions and implications for policy research

1. The percent of students scoring at the advanced level at Grades 4 and 8 in mathematics and science ranges widely (some would say wildly), from several countries with essentially no students performing at advanced levels to a handful of countries that routinely have a quarter to a half of students scoring at advanced level. A few countries clearly benefit from having high proportions of high-achieving students (e.g., Singapore and Hong Kong SAR). Others have very low proportions, including some rather advanced economies (e.g., Norway, Sweden). Policymakers should focus on their countries' comprehensive national excellence policies for education and workforce development and determine the extent to which academic and intellectual talent is intentionally fostered.

Additionally, many of the highest-performing countries have limited natural resources, and their strong academic performance can be viewed as an investment in the nations' human capital. Policymakers in other countries can learn from these successful nations about how to develop high levels of student performance most effectively and efficiently. We also need to remember that countries with lower levels of excellence but abundant natural resources cannot count on those resources lasting forever.

An important policy issue that deserves more research is how economically developed countries with low levels of advanced academic performers (e.g., Norway in science, Sweden in math) are impacted differently from developing countries with similarly low levels of advanced scorers, such as Iran and Malaysia in math or Jordan in science. At a broader policy level, research should focus on the extent to which high-scoring countries have comprehensive national excellence policies for education and, eventually, workforce development. There have always been robust research programs on educational excellence around the world, but much rarer is research on country-level education policies for advanced achievement (see, for recent exceptions, Jung, Young, & Gross, 2015; Sarouphim, 2015).

2. Several countries routinely increase their percent of high-scoring students, which defies regression to the mean. At the same time, a smaller group of lower-performing countries has experienced consistent decreases in the percent of high-scoring students. Both groups should be the subject of additional research to determine the potential causes for the unexpected increases and decreases in advanced performance. These trends suggest that factors within those countries are influencing their education systems' ability to produce advanced performers. If not already known, these factors should be identified, and policymakers should determine whether such policies can be enhanced (where there is evidence of positive trends) or corrected (where there is evidence of negative trends).

More research is needed to determine the extent to which specific policy mechanisms promote advanced achievement at national levels. Although researchers have a growing, if limited, knowledge base of classroom and school-level interventions (e.g., Plucker & Callahan, 2014a, 2014b), our knowledge of the impact of country-level policies is very thin. Cases of particular interest are those countries whose trends appear to defy regression to the mean, and those with significantly different results in science and mathematics.

3. The limited research base with respect to excellence gaps suggests that even some relatively high-performing countries have significant gender, immigrant, or socioeconomic gaps they need to address. For example, research in the United States suggests that very high-performing systems, such as Massachusetts, have extremely large excellence gaps that depress improvements in advanced performance; it would be surprising if many (if not all) high-performing countries did not suffer from similar gaps. If a country does not, other countries could learn much from that education system. However, if most such countries do have large excellence gaps, these would signal an important policy intervention for those countries.

Countries should monitor the degree to which all subgroups of students achieve advanced performance and then include those data whenever assessment results are publicly released. During deliberation on new education policies, consideration should be given to the potential impact of these policies on academic excellence and excellence gaps. Finally, more research is needed to explore the effects of major national education initiatives, regardless of whether they focus on advanced achievement or on levels of excellence and excellence gaps.

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About the IEA

The International Association for the Evaluation of Educational Achievement, known as IEA, is an independent, international consortium of national research institutions and governmental agencies, with headquarters in Amsterdam. Its primary purpose is to conduct large-scale comparative studies of educational achievement with the aim of gaining more in-depth understanding of the effects of policies and practices within and across systems of education.

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