CHANGING APPROACHES TO ADDRESS STUDENT ACADEMIC ACHIEVEMENT GAP: RECOMMENDATIONS FOR SCHOOL REFORMS AND REFORMERS

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ABSTRACT

The Trend in International Mathematics and Science Study reveals how the math and science achievement of students in participating countries compares with that of their international peers. Since 1995, the results have been surprising and disappointing for some countries. Astonished and disappointed by such outcomes, scholars and educational leaders are turning to top-achieving countries for approaches to close the achievement gap. To reverse the achievement gap, it is imperative to consider whether approaches used in top-achieving countries deserve primacy over approaches used within-country. Using TIMSS data, findings from this study show that every country in the sample has schools from which reformers could draw approaches to close the achievement gap. Additionally, this study revealed existence of schools serving disadvantaged students achieving at the top and schools serving advantaged students achieving at the bottom. Based on these findings, we highlight the importance of considering approaches used within-country by proposing a framework for education reformers as to where and how to initiate reform to close the achievement gap.

INTRODUCTION

The Trend in International Mathematics and Science Study ("TIMSS") is an international comparative study. TIMSS measures students' academic achievement in mathematics and science at the fourth- and eighth-grade levels. It is one of the studies of the International Association for the Evaluation of Educational Achievement (IEA). TIMSS assesses students' academic achievement in participating countries on a regular 4-year cycle since 1995.

Over the past 20 years, TIMSS has administrated five assessments (1995, 1999, 2003, 2007, and 2011). Each assessment shows student achievement in math and science in comparison to the achievement of international peers (Foy, Arora & Stanco, 2013). Some East Asian countries (e.g., Singapore, South Korea, Hong Kong, Chinese Taipei, and Japan) consistently take top positions. The average score in mathematics and science for eighth-graders in these countries is always among the highest since 1995 (IEA, 2015).

Achievement that falls below expectations is disappointing and generates concerns in countries that spend enormous amounts on education (i.e. Saudi Arabia and the United States). Certain questions commonly arise: Why do some East Asian countries regularly take the top positions? What are they doing right that we are missing? Why do we rank at this level despite the resources that we invest in our education system? If we fall behind in math and science, how can we compete in the global knowledge economy?

Following the release of the 2011 TIMSS assessment, the US Secretary of Education Arne Duncan issued a press release in which he called the results "unacceptable". He expressed "the need to close the large and persistent achievement gaps." He had made a similar statement earlier in response to the 2009 PISA results. According to the statement, the PISA results "show that American students are poorly prepared to compete in today's knowledge economy--Americans need to wake up to this educational reality" (Carnoy & Rothstein, 2013, p.7). Goodwin (2012) expressed similar concerns and stated that "there is a deep concern in the U.S. that the country is falling behind its peers across the globe, and that drastic reforms in education and in teaching are desperately needed to rectify this crisis" (p.186).

Concerns and disappointments are not unique to the US. The 2007 TIMSS results show that students in the Middle East and North Africa continue to lag behind students of other countries (Bouhlia, 2011). Studies documented concerns about student achievement in Australia, Chile, England, South Africa, Sweden, and Germany (Köller, Baumert, Clausen, & Hosenfeld, 1999; Masters, 2005; Prais, 1997; Raminez, 2006; Reddy, 2010; Rolfsman, Wiberg, & Laukaityte, 2013).

To respond to these alarms, scholars and educational leaders are focusing more on approaches used in top-achieving countries. This study, thus, examined one central question:

Do approaches used in top-achieving countries deserve primacy over approaches used within-countries? To answer this central question and provide a framework to close the achievement gap, we 1) examined the level of student achievement for each school within each country in the sample; 2) identified schools achieving in the top and bottom 25th percentiles; and 3) identified school composition in the top and bottom 25th percentiles according to student economic backgrounds.

LITERATURE REVIEW

In the last twenty years, many studies have examined how top-achieving countries deliver education (Bugas, et al., 2012; Carnoy & Rothstein, 2013; Darling-Hamond, Wei, & Andree, 2010; Goodwin, 2012, 2014; Hojo & Oshio; 2012; Masters, 2005; Mourshed, Chijioke, & Barer, 2011; Wang & Lin, 2005; Wobmann, 2005). Four main factors explaining the achievement gap between top and low-achieving countries emerge from these studies: Student characteristics and family backgrounds; curriculum and instruction; teaching and teacher quality; and education systems, policies and resources.

With regard to student characteristics and family backgrounds, Carnoy and Rothstein (2013) maintained that one of the main reasons for the low performance of US students is social class inequality. They suggest that the average US student scores is lower with respect to comparable countries due to the social class distribution of US. Using the production function technique, Hojo and Oshio (2012) determined that Japanese students' test scores are strongly associated with family background, particularly for variables affecting the household environment.

In another investigation using TIMSS data, Hojo and Oshio (2012) found that the key determinants of educational performance in top-achieving countries are associated with the individual students, family backgrounds, and peer effects. Considering the same five top-achieving TIMSS countries, Wobmann (2005) found that in South Korea and Singapore, family background is a strong factor predicting student performance.

Attempting to explain the causes of achievement differences in mathematics across countries, Jürges and Schneider (2004) support that social background factors (parents' formal education, language spoken at home, and resources at home) are the strongest predictors of student achievement.

With respect to curriculum and instruction, scholars argue that the curriculum in American schools lacks coherence, focus, and rigor. These arguments imply a fragmentation of the US education on math and science whereas other countries have a clear and consistent voice on expectations for pupils (Consortium for Policy Research in Education, 1998). The same policy briefing appears to suggest maintaining the decentralized system in the US while moving toward state standards as a promising way to reduce the dispersion of curriculum among localities, states, federal governments, and other less official actors.

Schmidt, Wang, and McKnight (2007) documented similar findings in their study, which investigated the coherence and rigor of content standards of the top five countries among the highest achievement relative to other TIMSS countries. The findings support that the organizational structures for mathematics and science topics in the best achieving countries contrast with the composite standards of 21 American states, suggesting that curriculum coherence is critical to learning.

Referring to the quality of teachers, teachers' education and training are essential for student achievement. Research findings show that students taught by a teacher with a master's degree with extra training outperform students taught by a teacher with only a secondary education (Jürges & Schneider, 2004). TIMSS videos of real classrooms also support that teachers in Germany and Japan are much more likely to develop concepts and procedures rather than simply stating them, as is the case in the US. Hence, pupils in Japan spend more time analyzing and proving ideas, whereas their peers in the US tend to engage in routine procedures (Consortium for Policy Research in Education, 1998).

Evidence from high-performing school systems reveal that three of the most important aspects of teacher quality are “getting the right people to become teachers; developing them into effective instructors, and ensuring that the system is able to deliver the best possible instruction for every child” (Darling-Hammond, Wei, & Andree, 2010, p.1). In search for models and approaches, two international summits on the teaching profession held in New York City in 2011 and 2012 to share the world’s best policies and practices for developing a high-quality profession (Goodwin, 2014).

With regard to education systems, policies, and resources, Lee (2014) argued that the extensive level of teachers’ participation in decision-making in significant areas of school curriculum and students’ learning is one of the main reasons for Hong Kong’s educational success. The policy briefing of the Consortium for Policy Research in Education (1998) recognized that curriculum and instruction involve a combination of both top-down and bottom-up actions. Accordingly, goals and contents are determined nationally and matters relating to instruction are determined locally. Examining how the world’s most improved school systems continue to improve, Mourshed, Chijioke, and Barber (2011) identified six policy strategies to enhance the quality of education:

> “Revising the curriculum and standards, ensuring an appropriate reward and remunerations structure for teachers and principals, building the technical skills of teachers and principals, assessing students, establishing data systems, and facilitating improvement through the introduction of policy documents and evaluation laws” (p.20)

Bugas, Kalbus, Rotman, Troute, and Vang (2012) argued that three general conditions distinguish top-achieving countries from low-achieving countries: The quality of education, institutional productivity, and equal opportunity for students. From a different perspective, Jürges and Schneider (2004) highlighted the importance of school autonomy. Students in schools that had the authority to hire their own teachers score on average four points higher than students in less autonomous schools.

From these studies, we understand the factors explaining the achievement differences between top-and low-achieving countries. However, the crucial question remains: Do approaches used in these top-achieving countries deserve primacy over approaches used within-country? Using TIMSS data, this study sought to answer this question and provide recommendations beneficial to education reforms and reformers.

DATA AND PROCEDURES

This study used TIMSS 2011 data for eighth-graders in math and science for five East Asian countries consistently achieving at the top in mathematics and science since 1995 (i.e., Singapore, South Korea, Chinese Taipei, Hong Kong, and Japan) and for two countries of interest (chosen based on researchers’ knowledge and experiences with the education systems of these two countries---the US and Saudi Arabia).

We downloaded the data from the TIMSS international database (IEA, 2015), which contains information on students’ achievement and economic backgrounds (Foy, Arora & Stanco, 2013).

For the analysis of the data, we utilized the IEA international database analyzer software, which allows users to merge and convert data into SPSS files for analysis. The data analysis involved three steps. The first step involved determining the level of student achievement for each school within each country using all five plausible values as recommended (Carstens & Hastedt, 2010; OECD, 2009; Wu, 2005). We used as dependent variables, the results of the aggregated statistical analyses for mathematics (BSMMAT01-05) and science (BSSSCI01-05) performed on each of the five plausible values. To display the analyzed data, we used a boxplot to show the achievement in math and science of schools within each country.

The second step aimed to identify each school within a country by showing its ranking and achievement score in the top or bottom 25th percentile. The rationale for including the bottom 25th

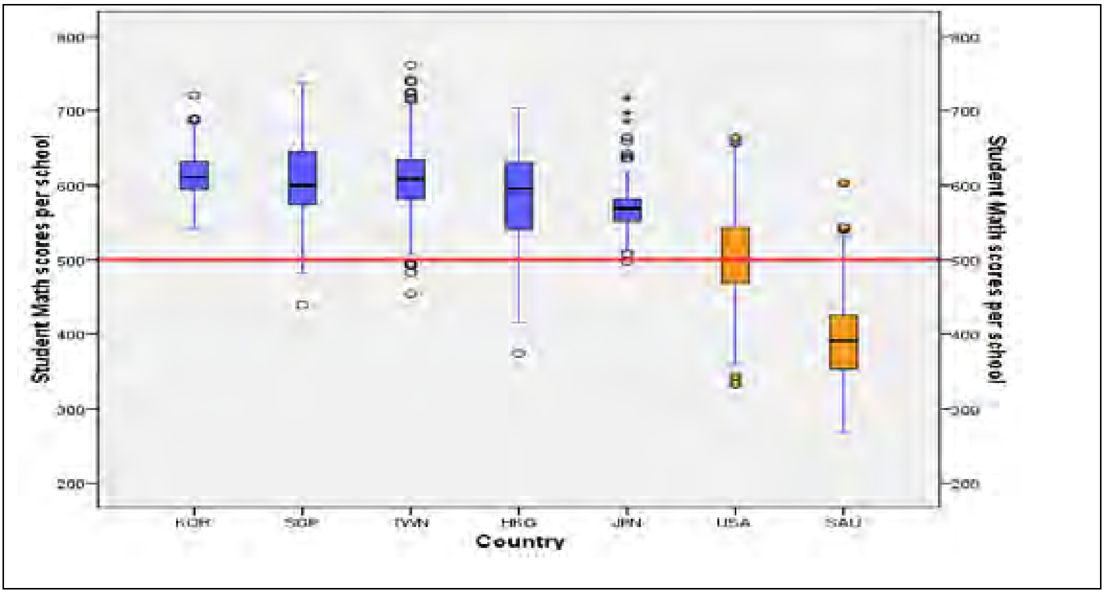
percentile is that school reformers need to know as well which schools are scoring at the bottom and what factors are responsible for their poor achievement scores.

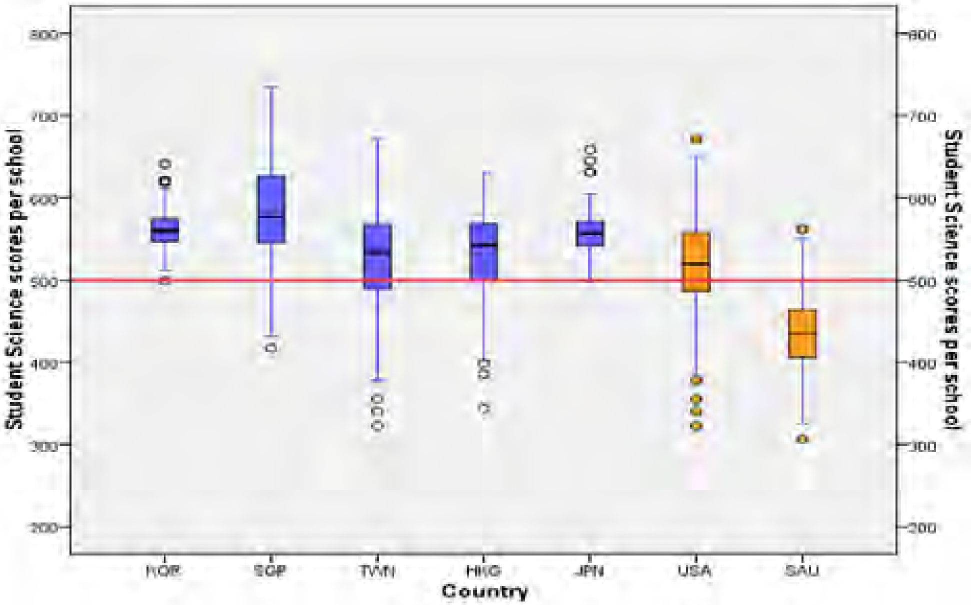
The third step of the analyses involved computing the top and bottom 25% of student achievement by school composition according to student economic backgrounds. In 2011, TIMSS and PIRLS (Progress in International Reading Literacy Study, IE) jointly collected information about school composition. TIMSS put schools in three economic background categories: More affluent; neither more affluent nor more disadvantaged; and more disadvantaged. This study used these three categories to identify student achievement in math and science by school composition in the top and bottom 25th percentiles. We displayed the results of this analysis in a table to help identify schools that can serve as models in their approaches within a country.

The rational for including both math and science achievement in this analysis is to make sure that a school achievement in the top or bottom 25th percentile did not happen by chance. In other words, for a school to be used in our arguments as model school, its student achievement in the top or bottom 25th percentile must be consistent in both math and science.

FINDINGS AND INTERPRETATON

***Student Achievement by School within Countries*:** For each of the countries in the sample, we analyzed and found students' academic achievement in each school as illustrated in Figure 1.





Note: *Bottom and top bubbles/stars are outlier/extreme scores, bottom and top wicks for each country represent approximately 25% of the scores, and the middle of the box represents 50% of the scores.*

Figure 1. *Students' academic achievement in math and science by school and by country*

The results (Figure 1) show that not all schools in top-achieving countries are achieving at the top and that not all schools in low-achieving countries are achieving at the bottom. For instance, in Singapore, Chinese Taipei, and Hong Kong, the achievement scores for some schools are below the international average score (mean=500) and well below the mean scores in their own countries. Even in South Korea and Japan, where all school scores are at or above the international mean score, some schools' student achievement is below the mean score in their own countries, which serves as a reference for comparison across countries.

We observe the opposite for countries that achieve below expectations, such as the US and Saudi Arabia. The results show that some US schools' student achievement scores are above the mean scores of the top-achieving countries. In Saudi Arabia, where the country's mean score is well below the international average (M=500), some schools' student achievement scores are above the country's international average and are comparable to the mean scores of top-achieving countries.

As shown in Figure 1, any schools within a country (any top bubble, star, or wick) whose scores are comparable to the mean scores of the top-achieving countries could serve as models in their approaches to close achievement differences. This information provides an important step for school reforms and reformers to consider. The second step of the analysis sought to identify schools representing these top bubbles, stars, and wicks as well as their rankings and specific scores. We, thus, analyzed all schools within each country. However, table 1 presents only schools whose student achievement falls in the top and bottom 25^{th} percentiles within their country, as our interest, is to identify schools that could serve as models to close the achievement gap.

Table 1. ***Student academic achievement by school and composition within each country***

Country	ID	TIMSS 2011 Eighth grade Mathematics					TIMSS 2011 Eighth grade Science				
		Sch ID	Sch .Rk	Sch Cp.	Variables PV1-5	Variables SD	Sch ID	Sch Rk	Sch Cp.	Variables PV1-5	Variables SD
Chinese Taipei	Top 25th	*290*	*1*	*2*	*760.6*	*58.0*	*290*	*1*	*2*	*672.2*	*48.3*
		278	*2*	*3*	*738.9*	*56.9*	*223*	*2*	*1*	*646.2*	*53.2*
		.	.	.	.	.	.	.	.	.	.
		183	*37*	*2*	*630.9*	*87.5*	*212*	*37*	*1*	*583.1*	*68.7*
	Bottom 25th	*260*	*107*	*3*	*580.7*	*108.7*	*299*	*107*	*2*	*545.0*	*79.0*
		237	*108*	*2*	*580.2*	*91.5*	*171*	*108*	*2*	*541.9*	*82.9*
		.	.	.	.	.	.	.	.	.	.
		261	*143*	*3*	*453.8*	*99.8*	*261*	*143*	*3*	*453.6*	*79.7*
Hong Kong SAR	Top 25th	*271*	*1*	*1*	*704.3*	*43.2*	*294*	*1*	*2*	*630.1*	*45.7*
		294	*2*	*2*	*694.6*	*51.8*	*271*	*2*	*1*	*629.0*	*38.5*
		.	.	.	.	.	.	.	.	.	.
		264	*26*	*2*	*637.6*	*50.8*	*297*	*26*	*2*	*572.4*	*42.3*
	Bottom 25th	*181*	*76*	*3*	*539.9*	*64.0*	*181*	*76*	*3*	*499.3*	*62.6*
		280	*77*	*2*	*538.7*	*54.2*	*189*	*77*	*3*	*498.6*	*53.5*
		.	.	.	.	.	.	.	.	.	.
		159	*101*	*2*	*373.7*	*110.6*	*159*	*101*	*2*	*343.6*	*99.8*
Japan	Top 25th	*291*	*1*	*1*	*717.3*	*45.2*	*297*	*1*	*1*	*658.5*	*57.4*
		297	*2*	*1*	*697.1*	*59.2*	*1,293*	*2*	*2*	*644.9*	*40.1*
		.	.	.	.	.	.	.	.	.	.
		211	*33*	*3*	*581.0*	*71.3*	*274*	*33*	*1*	*571.4*	*80.1*
	Bottom 25th	*212*	*97*	*1*	*552.4*	*80.6*	*258*	*97*	*2*	*545.4*	*74.1*
		170	*98*	*3*	*551.7*	*75.1*	*275*	*98*	*2*	*544.6*	*78.1*
		.	.	.	.	.	.	.	.	.	.
		215	*129*	*2*	*496.9*	*103.1*	*215*	*129*	*2*	*498.5*	*96.5*
South Korea	Top 25th	*164*	*1*	*1*	*720.6*	*57.5*	*164*	*1*	*1*	*641.2*	*55.4*
		191	*2*	*1*	*689.3*	*87.3*	*189*	*2*	*1*	*621.3*	*70.1*
		.	.	.	.	.	.	.	.	.	.
		277	*36*	*2*	*630.6*	*95.7*	*182*	*36*	*1*	*574.3*	*62.9*
	Bottom 25th	*264*	*104*	*2*	*595.1*	*99.5*	*289*	*104*	*2*	*547.2*	*60.5*
		218	*105*	*3*	*591.8*	*80.6*	*296*	*105*	*2*	*545.8*	*93.2*
		.	.	.	.	.	.	.	.	.	.
		168	*139*	*3*	*542.5*	*95.9*	*168*	*139*	*3*	*498.9*	*90.4*
Saudi Arabia	Top 25th	*287*	*1*	*1*	*602.6*	*40.5*	*278*	*1*	*1*	*561.9*	*50.7*
		327	*2*	*3*	*543.6*	*65.3*	*287*	*2*	*1*	*550.2*	*47.3*
		.	.	.	.	.	.	.	.	.	.
		308	*33*	*1*	*429.3*	*77.5*	*209*	*33*	*1*	*465.7*	*64.8*
	Bottom 25th	*256*	*98*	*1*	*352.8*	*64.5*	*221*	*98*	*2*	*400.7*	*64.9*
		253	*99*	*3*	*352.1*	*95.4*	*266*	*99*	*3*	*399.9*	*72.2*
		.	.	.	.	.	.	.	.	.	.
		259	*130*	*2*	*269.2*	*75.1*	*289*	*130*	*3*	*306.6*	*51.8*

Country ID		TIMSS 2011 Eighth grade Mathematics: Sch ID	Sch Rk	Sch Cp	Variables: PV1-5	SD	TIMSS 2011 Eighth grade Science: Sch ID	Sch Rk	Sch Cp	Variables: PV1-5	SD
Singapore	Top 25th	*329*	*1*	*1*	*736.9*	*38.1*	*329*	*1*	*1*	*734.7*	*48.7*
		174	*2*	*2*	*719.9*	*34.9*	*174*	*2*	*2*	*715.6*	*40.5*
		.	.	.	.	.	.	.	.	.	.
		263	*40*	*2*	*641.6*	*61.1*	*280*	*40*	*2*	*624.7*	*83.5*
	Bottom 25th	*310*	*117*	*2*	*574.5*	*55.6*	*319*	*117*	*2*	*545.6*	*62.2*
		298	*118*	*2*	*574.0*	*91.4*	*266*	*118*	*1*	*545.2*	*113.3*
		.	.	.	.	.	.	.	.	.	.
		246	*156*	*1*	*438.9*	*62.8*	*246*	*156*	*1*	*417.3*	*78.8*
United States	Top 25th	*881*	*1*	*2*	*663.6*	*42.1*	*881*	*1*	*2*	*671.2*	*53.2*
		590	*2*	*3*	*652.6*	*35.4*	*774*	*2*	*1*	*650.9*	*49.0*
		.	.	.	.	.	.	.	.	.	.
		820	*112*	*3*	*543.5*	*47.2*	*510*	*112*	*2*	*558.2*	*56.6*
	Bottom 25th	*650*	*326*	*3*	*470.2*	*51.8*	*932*	*326*	*3*	*487.7*	*70.8*
		799	*327*	*3*	*469.4*	*43.1*	*937*	*327*	*3*	*487.2*	*55.3*
		.	.	.	.	.	.	.	.	.	.
		636	*437*	*3*	*333.3*	*44.1*	*651*	*437*	*3*	*322.4*	*41.1*

Note: *PV01-05= plausible values of student academic achievement.*
School composition (sch cp.) 1=More affluent, 2= Neither more affluent nor more disadvantaged, and 3= More disadvantaged student economic backgrounds.
School Rank (sch Rk): 1, 2,3…, n.

The results in Table 1 show how many schools achieved in each of the brackets (the top and bottom 25th percentiles). We identified in the top and bottom 25th percentiles 36 schools in South Korea, 40 in Singapore, 26 in Hong Kong, 33 in Japan, 112 in USA, and 33 in Saudi Arabia.

As shown in Table 1, every country has at least 26 schools (names, rankings, and scores included) from which reformers could draw approaches to close the achievement gap. This information is valuable for informing reformers, but limiting the analysis at this stage would leave school reformers with ammunition to justify reform failures. Observers frequently assume that high-achieving schools have more students from affluent economic backgrounds than do low-achieving schools. Several studies support this argument (e.g., Carnoy & Rothstein, 2013; Hojo, 2012; Hojo & Oshio, 2012; Wobmann, 2005). Thus, it is necessary to analyze the schools in the top and bottom 25th percentiles to determine student achievement of schools serving students from different economic backgrounds.

Table 2a: *Student achievement in 8th- grade Math by school composition*

Country	Student Achiev. by school	School composition (students' economic bkgrds): Adv.	Neither Adv. Nor disadv.	Disadv.	Total schools within country (excl. missing values)
Chinese-Taipei	Top 25th	*16*	*20**	*1***	*37/143*
	Bottom 25th	*1*^{xx}	*26*^{x}	*10*	*37/143*
Hong Kong	Top 25th	*4*	*15**	*7***	*26/101*
	Bottom 25th	*0*	*5*^{x}	*21*	*26/101*
Japan	Top 25th	*20*	*12**	*1***	*33/129*
	Bottom 25th	*10*^{xx}	*16*^{x}	*7*	*33/129*
South Korea	Top 25th	*21*	*12**	*3***	*36/139*
	Bottom 25$^{t h}$	*0*	*14*^{x}	*22*	*36/139*
Saudi Arabia	Top 25th	*14*	*10**	*9***	*33/130*

	Bottom 25th	*8xx*	*11x*	*14*	*33/130*
Singapore	Top 25th	*23*	*17**	*0***	*40/156*
	Bottom 25th	*4xx*	*26x*	*10*	*40/156*
US	Top 25th	*36*	*34**	*42***	*112/336*
	Bottom 25th	*8xx*	*15x*	*89*	*112/336*

Table 2b: *Student achievement in 8th-grade Science by school composition*

Country	Student achiev. by school	School composition (students' economic bkgrds) Adv.	Neither Adv. Nor Disadv.	Disadv.	Total schools within country (excl. missing values)
Chinese-Taipei	Top 25th	*16*	*19**	*2***	*37/143*
	Bottom 25th	*1xx*	*29x*	*7*	*37/143*
Hong Kong	Top 25th	*4*	*16**	*6***	*26/101*
	Bottom 25th	*0*	*5x*	*21*	*26/101*
Japan	Top 25th	*22*	*11**	*0***	*33/129*
	Bottom 25th	*10xx*	*17x*	*6*	*33/129*
South Korea	Top 25th	*19*	*9**	*5*	*36/139*
	Bottom 25th	*0*	*15x*	*21*	*36/139*
Saudi Arabia	Top 25th	*12*	*11**	*10***	*33/130*
	Bottom 25th	*9xx*	*11x*	*13*	*33/130*
Singapore	Top 25th	*22*	*18**	*0*	*40/156*
	Bottom 25th	*5xx*	*25x*	*10*	*40/156*
US	Top 25th	*38*	*35**	*39***	*112/336*
	Bottom 25th	*4xx*	*16x*	*92*	*112/336*

Note
** School(s) with disadvantaged students achieving in the top 25th percentile
* School(s) with neither advantaged nor disadvantaged students achieving in the top 25th percentile
xx School(s) with more affluent students achieving at the bottom 25th percentile
x School(s) with neither more affluent nor more disadvantaged students achieving in the top 25th percentile

Table 2 shows that not all schools with students from more advantaged economic backgrounds were top-achieving schools. It also shows that all schools with students from more disadvantaged economic backgrounds were low-achieving schools. Within each country, some top-achieving schools in Math for instance (table 1a) are schools serving more disadvantaged or neither more affluent nor more disadvantaged economic backgrounds (15 in South Korea, 17 in Singapore, 21 in Chinese Taipei, 22 in Hong Kong, 13 in Japan, 76 in US, and 19 in Saudi Arabia).

Likewise, some low-achieving schools are schools serving more affluent or neither more affluent nor more disadvantaged economic background (14 in South Korea, 40 in Singapore, 27 in Chinese Taipei, 5 in Hong Kong, 26 in Japan, 23 in US, and 19 in Saudi Arabia).

Student achievement in science by school composition is analogous to that of mathematics. With a minor variation, schools ranked in the top or bottom percentile in math, maintained their rankings in science, which suggests that a school achievement is consistent in both math and science.

DISCUSSION

A cross-country comparison based solely on countries' mean scores clearly shows that the five top-achieving East Asian countries are the models in their approaches. However, as shown in figure 1, focusing on countries' mean scores in the quest for suitable approaches could mislead reformers. Some schools within-countries in search for approaches (i.e. US and Saudi Arabia) have achieved results comparable to those of top-achieving countries, but the mean score of their country shadow their achievements. As referenced in the literature review, studies and reformers tend to consider less within-country achievement and focus more on top-achieving countries for approaches although these countries' education systems, policies, and resources may not be realistic or easily adaptable for each country.

To benefit from within-country achievement, we need to analyze the achievement of each participating school within a country to identity the highest- and lowest- achieving schools. Additionally, reformers should examine the achievement of schools serving students from different economic backgrounds. In four of the five top-achieving East Asian countries (i.e., South Korea, Singapore, Chinese Taipei, and Japan), student economic background is a factor that predicts student academic achievement. This finding supports the arguments of previous studies (Hojo, 2012; Hojo & Oshio, 2012; Wobmann, 2005; Jürges & Schneider, 2004). Most of the schools in the top 25th percentile have many students from more affluent economic backgrounds, whereas all schools in the bottom 25th percentile include more students from disadvantaged economic backgrounds.

Interestingly, 61 schools (12 in South Korea, 17 in Singapore, 20 in Chinese Taipei, and 12 in Japan) classified as neither more affluent nor more disadvantaged succeeded in achieving in the top 25th percentile. In the other top-achieving East Asian countries (i.e., Hong Kong), 7 schools from more disadvantaged, 15 schools neither advantaged nor disadvantaged, and 4 schools more advantaged achieved in the top 25% percentile.

In countries achieving below expectations in this study (i.e., the US and Saudi Arabia), the picture is mixed. In the US, schools that achieved in the top 25th percentile, approximately 38% have students who come from more disadvantaged economic background (42), 32% from more affluent backgrounds (36), and 30% from neither affluent nor disadvantaged economic backgrounds (34). Of the 33 schools in Saudi Arabia that achieved in the top 25th percentile, approximately 27% are schools with students who come from more disadvantaged economic backgrounds (9), 42% from more affluent backgrounds (14), and 30% from neither more affluent nor more disadvantaged economic backgrounds (10).

These findings show that schools with students from disadvantaged economic backgrounds can be top-achievers too. Although, a disadvantaged economic background, generally a factor that negatively affects achievement, it should not be considered as an insurmountable barrier for not closing the achievement gap. These findings highlight the importance of paying attention to approaches of these high-achieving schools serving disadvantaged students. Their approaches should be regarded as the models for closing the achievement gap.

The second revelation in this study, which requires attention from school reformers, is the existence of schools serving students from more affluent or neither affluent nor disadvantaged achieving in the bottom 25th percentile (19 in Saudi Arabia, 23 in the US, 26 in Japan, 40 in Singapore, 27 in Chinese Taipei, 14 South Korea, and 5 in Hong Kong).

Based on this study's findings, we propose a framework for education reformers to use to close the achievement gap. This framework provides a road map for reformers with a step-by-step guide on where and how to start reform.

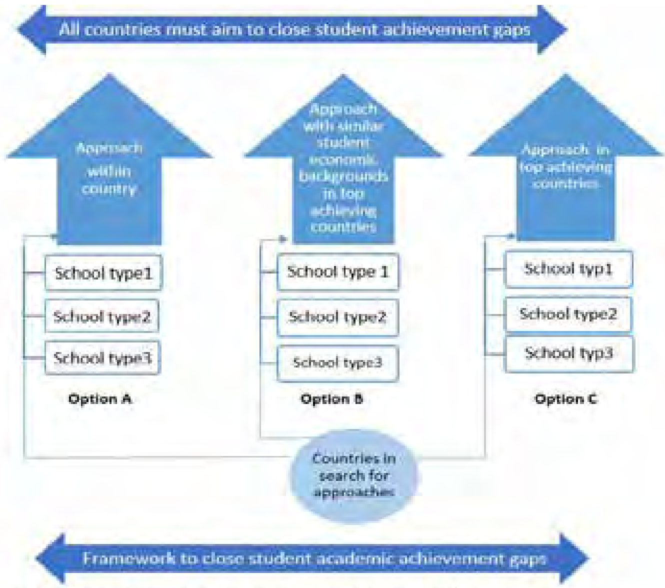


Figure 2: *Educational approaches to close student academic achievement gap*

The primary aim of this study was to answer the question whether approaches in top-achieving countries deserve primacy over approaches within-countries in order to close student achievement gap. Using the above framework (Figure 2), we first explain the framework and then provide some recommendations.

In this framework, we propose three options (A, B, and C) for countries in search of approaches to close the achievement gap. The first option (A) is the most preferred or the best of the three options. As shown in figure 1 and table 2, each country in the sample has at least 14 schools (among the schools achieving in the top 25th percentile) whose achievement scores are at or above the TIMSS mean score (M=500). Some of these schools' scores are even comparable to the mean scores of the five top-achieving countries. Because these schools, generally, have the same education system, policies, and contexts as the other schools within their country, their approaches may be easier for school reformers to adapt.

Within each option, we placed schools that achieve in the top 25th percentile in three categories (school type 1, school type 2, and school type 3). Schools Type 1 serve students from more disadvantaged economic backgrounds, schools type 2 serve students from neither affluent nor disadvantaged economic backgrounds, and schools type 3 serve students from affluent economic backgrounds.

Education reformers would agree that if the solution to a problem is at home, there is no need to seek it elsewhere. Real reform begins at home; therefore, it is important to start within country approaches before seeking solutions across countries. If the need to seek solutions across countries persists, then option B is the next suggestion.

Option B refers to countries (e.g. Hong Kong) among the five top-TIMSS achievers serving student economic backgrounds comparable to those in countries seeking new approaches (US and Saudi Arabia). In addition, it is advisable to focus on similar schools (school type 1, followed by type 2, and type 3) rather than the countries' mean scores.

Option C, which involves the other four top-TIMSS achievers in math and science (Chinese Taipei, South Korea, Japan, and Singapore) where school achievement is highly correlated with student economic backgrounds. As a result, schools in low-achieving countries with similar student economic backgrounds might consider approaches of schools in these four countries.

Based on our findings, we provide several suggestions for reformers to bridge student academic achievement gap.

1. Identify and analyze the highest- and the lowest-achieving schools within your country to determine the location of these schools (urban or rural, zones), the school types (public, private, and boys/girls), student characteristics and family backgrounds, teachers and school administrators' characteristics, curricula, and school policies and resources.
2. Determine whether the achievement scores of the top-achieving schools (models) are related to home factors, school factors or a combination of both home and school factors.
3. Help low-achieving schools benefit from the practices of top-achieving schools by working with all stakeholders at all levels (state, regional, and local).

CONCLUSION

The main question we examined in this study was to find out whether approaches used in top-achieving countries deserve primacy over approaches used within-countries. Findings from our study revealed that within each country, there are schools—particularly those serving disadvantaged students achieving in the top 25% percentile--- that can serve as models in their approaches to close the academic achievement gap. From the researchers' perspective, these schools are the "star" schools in terms of their approaches as far as closing student achievement gap is concerned. Disregarding these approaches at home and considering approaches in other countries (which may have different education systems, policies, and resources) might not bring the hoped outcomes.

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