



# Performance on International Assessments and Learning Time: A Snapshot of How the U.S. Compares to Other Education Systems on an International Scale

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## INTRODUCTION

In the last three decades, United States researchers, policy makers, and educators alike have grown increasingly concerned that international assessments demonstrate that U.S. students are not among the top performing students (Hanushek, Peterson, & Woessmann, 2014; Duncan, 2013). One reason suggested for low performance is less time spent learning, but cross national studies linking academic outcomes to learning time show conflicting results (Baker, Fabrega, Galindo, & Mishook, 2004; Lavy, 2010). U.S. interest in learning time is not new.

## U.S. Policy Background

Under the direction of the U.S. Department of Education, the 1983 report: *A Nation at Risk*, recommended “more effective use of time, a longer school day, or a lengthened school year” in response to findings comparing the U.S. school day and school year structure with other industrialized countries such as England and Japan. In 2009, U.S. President Obama urged that we “rethink the school day to incorporate more time” as a means to improve student outcomes (The White House Office of the Press Secretary, 2009). That same year, the American Recovery and Reinvestment Act (ARRA) established new funding sources for state education agencies to improve student achievement, such as the insertion of extended learning time as

a strategy (ARRA, Pub. L. No. 111-5, 2009). Other policies were developed with the goal of looking at new ways to use instructional time to help U.S. students succeed. In 2015, under the reauthorization of the Elementary and Secondary Education Act (ESEA), known as the Every Student Succeeds Act (ESSA; Pub. L. No. 114-95, § 4204, 2015), eligibility criteria was increased for out-of-school time formula grants so that they now allow local education agencies requesting funds to offer 300 or more hours of extended learning time across an academic year. This increase can come from within or outside of a typical school day. In contrast, under the 2001 reauthorization of ESEA, deemed the No Child Left Behind Act (Pub. L. No. 107-110, § 4201, 2002), out-of-school time funds were restricted to grantees only offering out-of-school time academic enrichment activities not associated with the school day. The intent behind these federal policies was to improve academic outcomes of students, particularly ones who live in high poverty. Yet, current research does not necessarily support a relationship between learning time practices and academic performance (Kidron & Lindsay, 2014; Patall, Cooper, & Allen, 2010). Furthermore, Biddle (2012) and Carnoy, Garcia, & Khavenson (2016), among other researchers, have pointed out the numerous flaws in comparing international assessment results against the U.S. as a whole.



## Purpose

The purpose of this brief is to therefore provide a snapshot of how the U.S. compares to other education systems (countries, subnational units, cities, economies) with respect to academic performance on two international assessments and instructional-learning time made available to students. We address: (1) in overall performance on international assessments, how the U.S. differs from high-performing education systems, and (2) in the use and distribution of learning time, the discrepancies between the U.S. and other education systems.

Time spent learning can be measured in many ways (see Baker et al., 2004; Rocha, 2008). For the purposes of this study this variable depended upon metrics available on learning time allocated to students in and out-of-school, as well as within and across participating education systems. These metrics defined by the Organisation for Economic Co-operation and Development (OECD) and the International Association for the Evaluation of Educational Achievement (IEA), the administrators of the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Studies (TIMSS). These metrics include instructional days, hours, and minutes, as well as

out-of-school activities and shadow education. This analysis uses data from survey responses gathered from TIMSS and PISA. TIMSS and PISA scores also serve as academic outcome measures in this study. TIMSS average scale scores in math and science are pre-set to 500 with a standard deviation of 100 (Mullis, Martin, Foy & Arora, 2012). PISA mean math and science scores are dependent on the performance of OECD member countries; in PISA 2012, the OECD mean math score was 494 and the mean science score was 501. PISA average scores are reported on a 0 to 1000 range with a standard deviation of 100, though two-thirds of OECD participating countries reported mean scores of 400 to 600 points (Kena et al., 2015; OECD, 2013b). The final section of this brief offers policy recommendations based on our findings from TIMSS 2011 and PISA 2012 data.

## A Description of TIMSS 2011 and PISA 2012

TIMSS measures student achievement in math and science among nationally or regionally representative samples of students in grades four and eight. TIMSS also allows participating education systems to administer the fourth grade assessment to students in fifth or sixth grade and the eighth grade assessment to students in

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### Definitions Used in this Brief:

- The Organisation for Economic Cooperation and Development (OECD) is a group of 34 countries that work together to promote international economic growth and prosperity (OECD, n.d.).
- The IEA is a collaborative international group of research institutions and government agencies with nearly 70 member countries. The IEA administers International Large-Scale Assessments (ILSA), such as TIMSS to inform education policy worldwide (IEA, 2016).
- “Shadow education” is private afterschool tutoring that follows school curriculum (Bray, 2007).
- OECD and the IEA administer PISA and TIMSS every three and four years, respectively. TIMSS 2011 and PISA 2012 are the most current scores available. New scores for years TIMSS 2015 and PISA 2015 will be available in late November and early December of 2016.
- In this brief, education systems refers to countries, economies, cities, and subnational regions. Most TIMSS 2011 and PISA 2012 participants are considered countries, however some systems include: U.S. states, Canadian provinces, and regions, such as Northern Ireland – United Kingdom, and cities, such as Shanghai – China.
- Benchmark participants are subnational regions without IEA membership that participate in the TIMSS to compare their students’ academic performance and instructional practices to IEA member countries (Martin, et al., 2012; Mullis et al., 2012).

ninth grade. These education systems that choose to administer the test outside of the primary target groups are not included in this analysis. In 2011, 14 benchmark participants (comprised of nine U.S. states, three Canadian provinces, two emirates from the United Arab Emirates) and 63 additional subnational regions and countries, administered the TIMSS math and science assessment to fourth and eighth grade students. Florida and North Carolina participated in the grade four assessment and Alabama, California, Colorado, Connecticut, Florida, Indiana, Massachusetts, Minnesota, and North Carolina took part in the grade eight assessment. U.S. states that participated in TIMSS 2011 administered the test exclusively to fourth and eighth grade public school students (Martin, Mullis, Foy, & Stanco, 2012; Mullis et al., 2012). OECD administers PISA math, science, and reading literacy assessments to national or regional representative samples of 15-year-old students. In 2012, 34 OECD member countries and 31 non-OECD education systems administered the PISA. Of the 31 non-OECD education systems, U.S. public school students in Massachusetts, Connecticut, and Florida participated in PISA 2012 as well as other non-OECD education systems, such as the Russian Federation and Singapore (OECD, 2013b). For a comprehensive list of TIMSS 2011 and PISA 2012 participants, refer to the acknowledgements and technical notes section in the accompanying visualization by Sell and Saxena, 2016.

The central goal of TIMSS and PISA is to measure academic achievement among primary and secondary students, but the design and intent of the two assessments differ. PISA assesses the extent to which 15-year-old students are prepared to participate in a global society in math, science, and reading literacy, while TIMSS measures math and science knowledge held by students in grades four and eight (Kena et al., 2015). Refer to Table 1 for a side-by-side description of the PISA and TIMSS assessments.

## Background Information about the Relationship between Instructional Learning Time and PISA and TIMSS Scores

Student performance results from PISA 2012 and TIMSS 2011 suggest a large, persistent gap across grade levels and subjects between the U.S. and participating East Asian education systems (i.e. Singapore, The Republic of Korea, Hong Kong-China, Chinese Taipei, and Japan). Furthermore, our analysis of TIMSS 2011 and PISA 2012 data suggests that, at the country or subnational level, there is little to no clear evidence to support associations between academic performance and learning time. However, results are noticeably different when performing analyses at the school level. When initially analyzing PISA 2012 school-level data within 15 OECD education systems, OECD researchers found that the average learning time spent in math lessons during school hours, among other factors, positively related to a student's math performance (OECD, 2013b). Further, when comparing PISA 2006 scores for the same 10- and 13-year-old students in Israel across subjects, Lavy (2010) found instructional time to have a statistically significant relationship with student achievement (as cited in Mullis et al., 2012). Therefore, some evidence, in the presence of other factors, supports a link between time and learning at the school and student level. As comparisons are often made at the country or system-level, however, the analysis in this brief addresses national education systems as a whole, instead of the multitude of school or student-level factors influencing academic performance.

**TABLE 1. OVERVIEW OF PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT AND THE TRENDS IN INTERNATIONAL MATHEMATICS AND SCIENCE STUDY**

Description	PISA 2012	TIMSS 2011
Purpose	Assess the extent to which 15-year-olds have gained the knowledge and skills necessary to participate in the global economy	Collects information about learning contexts for math and science; view math and science curricula from an international perspective
Subject Areas	Reading, math, science, problem solving and financial literacy (as of 2012)	Math, science
Test Sponsor	Organisation for Economic Co-operation and Development (OECD)	International Association for the Evaluation of Educational Achievement (IEA)
Years Administered	Every 3 years since 2000	Every 4 years since 1995
Unit	Countries, economies	Countries, subnational entities
Age/Grade of Students Assessed	15-year-olds	Grades four and eight
Average Scores	PISA average scores are reported on a 0 to 1000 range with a standard deviation of 100; PISA mean assessment scores are based on OECD countries only	TIMSS average scale scores are set to 500 with a standard deviation of 100
Number of Participants	65 (34 OECD countries and economies and 31 partner participants)	Grade four: 52 countries and 7 benchmarking entities*; Grade eight: 45 countries and 14 benchmarking entities*

\* Three countries administered the 4th grade TIMSS 2011 assessment to 6th grade students and the 8th grade assessment to 9th grade students. These countries are excluded from analysis.  
Sources: OECD (2013), Kena et al., (2015); Mullis, et al., (2012); Martin, et al., (2012).

## LEARNING TIME PRACTICES AND ACADEMIC PERFORMANCE: A COMPARISON BETWEEN THE U.S. AND OTHER TIMSS 2011 AND PISA 2012 PARTICIPANTS

The following section describes academic performance and the allocation of learning time among participants of TIMSS 2011 and PISA 2012 assessments by various aspects of time, type, and subject matter.

### Learning Time Metric Collected by TIMSS 2011 and PISA 2012

In addition to measuring student achievement, TIMSS gathers information on a variety of topics from school principals and teachers, including the total number of annual instructional hours

in school, the number of annual instructional hours spent on math and science, and the number of instructional days in a calendar year. PISA collects data on the number of class periods spent in math and science, the total number of minutes spent in math and science, and out-of-school learning opportunities from principals and students.

### *Average Instructional Days per Year: Fourth Grade (TIMSS 2011)*

U.S. principals from schools participating in the TIMSS 2011 study reported that fourth grade students spent an average of 179 instructional days per year in school (NCES, 2011c). Fifty education systems (out of 57), including the benchmarking education systems, had at least one or more instructional days than the U.S.

average. For example, four education systems that consistently outperformed U.S. students in fourth grade math and science reported a greater number of instructional days—the Republic of Korea (206), Japan (200), Chinese Taipei (200), and Singapore (189) (NCES, 2011a, 2011b, 2011c). On average, these countries had at least 10 or more instructional days within their 2011 school year than the U.S., suggesting a relationship between the number of instructional days and fourth grade academic performance in both math and science.

### *Average Instructional Days per Year: Eighth Grade (TIMSS 2011)*

U.S. principals from schools participating in the eighth grade TIMSS 2011 study reported an average of 179 instructional days within the 2011 school year (NCES, 2011c). Students in eight education systems recorded higher levels of achievement than U.S. students on the eighth grade TIMSS 2011 math and science assessments. Of these education systems, only Minnesota (174), Massachusetts (180), and Hong Kong-China (183) held a comparable average number of instructional days within the 2011 school year. On average, the remaining five education systems—the Republic of Korea (206), Japan (201), Chinese Taipei (201), the Russian Federation (199), and Singapore (189)—had at least 10 or more instructional days within the school year than the U.S. (NCES, 2011a, 2011b, 2011c). Except for the Russian Federation and Hong Kong-China, high-performing education systems had approximately the same average number of instructional days in the eighth grade school year as the fourth grade school year. Notably, the TIMSS 2011 principal survey results indicate Minnesota implemented, on average, the fewest number of eighth grade instructional days annually (174), compared to nearly all other education systems, and Minnesota students scored higher than the U.S. average score on both the eighth grade math (545) and science (553) assessments.

### *Annual Instructional Hours: Fourth Grade (TIMSS 2011)*

A different picture is presented when looking at instructional time units as hours rather than days. The number of reported instructional hours spent by U.S. fourth grade students in the classroom per year (1,078) exceeded the international average (897) by 181 hours (NCES, 2016). Only Chile (1,228), Thailand (1,201), North Carolina (1,113), and Italy (1,085) recorded more instructional hours in grade four (with only North Carolina placing at or above the U.S. average score on both math and science). According to TIMSS 2011 data, fourth grade students in the U.S. spent approximately 289 more hours in the classroom than Korean students (789), yet Korean fourth grade students, on average, scored considerably higher in math (605) and science (587) than U.S. fourth graders (NCES, 2011a, 2016). The percentage of instructional time spent on fourth grade math per year in the U.S. (19 percent) was approximately the same as Singapore (21 percent), however, students in the U.S. scored lower (541) on the fourth grade TIMSS math assessment, than students in Singapore (606). Further, on the TIMSS fourth grade science assessment, students in high-performing education systems—the Republic of Korea (587) and Singapore (583)—spent an equivalent percentage of instructional time on science as students in the U.S.; U.S. fourth grade students scored considerably lower (544) in science than students in these countries (NCES, 2011a, 2016).

### *Annual Instructional Hours: Eighth Grade (TIMSS 2011)*

Results from the TIMSS 2011 assessment show eighth grade students in the U.S. spent a reported 1,114 instructional hours in school, whereas eighth grade students from other participating education systems spent 1,031 hours of instructional time in school (NCES, 2016). Across math and science subjects, Chinese Taipei was the only consistently high-performing education

system to implement more instructional hours (1,153) in 2011 than the U.S. average (1,114)—even when looking at Massachusetts (1,087) and Minnesota (1,043), the two U.S. states that performed better than the U.S. on both assessments. Eighth grade students in North Carolina (1,159), Colorado (1,148), and Indiana (1,133) performed better than the U.S. on one TIMSS subjects and reported more instructional hours than the U.S. average (NCES, 2011a, 2011b, 2016).

The percentage of total instructional time spent on both math (16 percent) and science (24 percent) in the Russian Federation was higher than the percentage of time spent in the U.S. on math (14 percent) and science (13 percent) instruction. Eighth grade students in Russia, on average, achieved higher scores in math (539) and science (542), than the U.S. eighth graders. A slight variation exists among education systems on the percent of annual instructional time spent in eighth grade math; however, a much larger discrepancy exists across education systems in eighth grade science, irrespective of performance on the TIMSS. For example, students in Slovenia, a high-performing country on the TIMSS 2011 eighth grade science assessment, spent 31 percent of instructional time on science, whereas students in Hong Kong-China, another high-achieving education system within eighth grade science, spent only 10 percent of instructional time in this subject area (NCES, 2011b, 2016).

### *Average Number of Minutes per week and the Total Number of Class Periods per Week (PISA 2012)*

PISA 2012 collected student-reported data on the average number of minutes per week and the total number of class periods per week. Across OECD member countries, the average time recorded by students per week was 217.8 minutes on math lessons and 200.2 minutes on science lessons (OECD, 2013a). The number of class

periods in math, science, and other subjects during a typical week of school varied from 14.2 to 45.6 periods. Students in Canada and the U.S. recorded approximately 19 class periods total per week. However, students in Canada spent an additional 59.7 minutes and 51.3 minutes per week on math and science instruction respectively, and scored significantly higher than the U.S. on math and science. Likewise, students in Singapore—who consistently scored higher than the U.S. national average on PISA 2012 math and science—recorded an additional 25.9 class periods per week and spent an additional 33.7 minutes on math and 47.3 minutes on science per week. Data compiled using OECD, 2013a, data show a variation in the number of class periods and time spent per week in learning during school hours. Notably, only students in Argentina and Indonesia had fewer periods per week than U.S. students. Among the highest performing education systems, the number of periods per week varied from 29.3 (Finland) to 45.6 (Singapore)—an indication that even the education systems that performed well on PISA 2012 had very different structures of the school day, school week, and school year (OECD, 2013; NCES, 2012a, 2012b).

### *Out-of-School Time Activities (PISA 2012)*

PISA 2012 also gathered information from students and principals regarding out-of-school time activities. Results show that 85.1 to 95.9 percent of principals in such high-performing systems as Hong Kong-China, Macao-China, the Republic of Korea, Singapore, and Chinese Taipei reported offering math lessons outside the typical school day. Only 63.6 percent of principals in the U.S. reported that school offered the same services (NCES, 2012a, 2012b; OECD, 2013a). The purpose for providing these out-of-school time lessons varied across education systems. Some principals reported that they offered after-school lessons to students needing remediation, while others reported that they provided these lessons

for enrichment purpose only. Another group of principals said that they provided these lessons for both remedial and enrichment purposes. Of the 63.6 percent of principals in the U.S. who reported offering math lessons outside of the typical school day, 36.1 percent of these principals reported providing supplemental math lessons for remediation purposes only. However, less than a quarter of principals in Hong Kong-China, Chinese Taipei, Singapore, the Republic of Korea, and Macao-China reported directing extra time solely for math remediation, even though 85.1 to 95.9 percent of them said the school offered additional math lessons outside of the typical school day. Regarding the amount of time spent on these activities, six percent of students in Hong Kong-China, 10.6 percent of students in Macao-China, 15.6 percent students in Shanghai-China, 18.0 percent of students in Singapore, and 26.3 percent of students in the Republic of Korea reported that they attended after-school math lessons for more than four hours per week, which is more than the amount of time than the U.S. spends on after-school activities (5.9 percent) (OECD, 2013a). Since U.S. students performed better than several countries with higher self-reported afterschool time hours (e.g., Qatar, Peru and Columbia), there is no clear trend to report across these variables.

In addition, the growth of shadow education has increased afterschool activity. For instance, although students in the Republic of Korea spent as much time as (412.7 minutes or 6.9 hours) OECD member systems (418.0 minutes or 7.0 hours) in math and science in school per week, they spent 3.6 hours per week on average in privately paid afterschool classes organized by a commercial company (OECD, 2013a). Afterschool classes are generally subsidized by the Korean government, which gives low-income students access to these additional educational services (OECD, 2013b).

## Limitations in Comparing TIMSS and PISA Findings across Participants

According to *TIMSS 2011 International Results in Math* (2012), numerous factors affect a student's ability to learn, including, but not limited to, school climate, access to early education, level of and access to certain school and home resources, classroom instructional approaches, teacher characteristics, student attitudes, and the student's mental and physical health. Additionally, the sample population of a test can influence the validity of the results. Unlike TIMSS, PISA assess students based on age, rather than grade level. The PISA sample population contains 15-year-old students enrolled in grades seven and above. Selecting students from such a wide range of grade levels presents problems, in terms of what students have learned, particularly in comparing results from one country or region to another (OECD, 2013b). When reviewing data at the country or education system-level, rather than at a regional or local level, it can be difficult, therefore, to tease out the factors that predict how well students within an education system perform academically.

In examining an education system's academic performance on international assessments, relative to other education systems, researchers should be sensitive to contextual economic factors. Traditionally, the IEA accepts a higher number of developing countries to participate in the TIMSS assessment compared to what the OECD allows with the PISA. Relatedly, the U.S. tends to rank higher and generally perform better on the TIMSS than the PISA (Provasnik, Gonzales, & Miller, 2009). To account for these differences, PISA calculates an average score from the results of OECD participants only, whereas TIMSS uses the midpoint of the assessment's reporting scale to derive a scale average. Another important aspect to consider when it comes to performance comparisons deals with curricula. The TIMSS member and benchmark

education systems cover TIMSS math and science content and concepts within the school day curriculum as students move from primary to secondary school. This curriculum is intentionally linked to the TIMSS assessments. In contrast, PISA measures the extent to which 15-year-old students have acquired the knowledge necessary to participate in a global economy and is not linked to curriculum (Martin et al., 2012; OECD, 2013b). TIMSS results inform stakeholders how well fourth and eighth grade students have mastered the assessed curriculum, whereas PISA results intend to answer questions such as: “Are schools adequately preparing young people for the challenges of adult life?” and “Are some kinds of teaching and schools more effective than others?” (OECD, n.d.). When comparing TIMSS and PISA math and science results, it is crucial to consider what the assessments intend to measure and how stakeholders plan to use the results.

## CONCLUSION

This brief compares U.S. performance on TIMSS 2011 and PISA 2012 math and science tests to other education systems and examines the relationship of assessment performance to learning and instructional time in the context of current U.S. education policy. Key findings derived from TIMSS 2011 and PISA 2012 data show:

- Countries and education systems that performed well on TIMSS 2011 math and science assessments were likely to perform well on PISA 2012 assessments (i.e., Hong Kong-China, Chinese Taipei, Singapore, Japan, and the Republic of Korea) (NCES, 2011a, 2011b, 2012a, 2012b).
- Learning time practices and academic performance have no clear relationship at the system-level.
  - TIMSS 2011: Education systems that statistically outperformed the U.S. on the fourth grade TIMSS math and/or science assessment also reported more

instructional days within the 2011 school year.

- PISA 2012: In contrast, some of the highest performing education systems recorded a wide variation in the number of class periods and time spent per week learning during after-school hours.

Despite the inclination of U.S. policy makers to link academic performance to increased learning/instructional time, our analysis of TIMSS 2011 and PISA 2012 system-level data indicates inconclusive results.

## RECOMMENDATIONS

Our results suggest a new direction for research on academic performance and the use and distribution of instructional/learning time. With the relationship between learning time and academic performance highly dependent on the quality of the curriculum and instruction within an education system, more data should be collected at the regional or local level to account for those other factors as noted in this brief that affect student learning.

### U.S. Researchers, policy makers, and educators should look inward for effective education policy strategies

Acknowledging the limitations of international large-scale assessments, we understand the comparison of countries can be problematic, but as Carnoy and colleagues (2015) mentioned, taking a closer look at state-level progress might offer a better picture on the performance of U.S. (particularly due to lack of federal control over state education systems). For example, Massachusetts, Connecticut, and Minnesota—performed as well or better than some high-performing systems on PISA 2012 and TIMSS 2011, depending on the target age and subject assessed (NCES, 2011a, 2011b, 2012a, 2012b). Based on these findings, U.S. researchers, policy



makers, and educators should examine the use of learning time and address academic performance from U.S. states that performed well on TIMSS and PISA and on other national assessments such as the National Assessment of Educational Progress (NAEP).

### The structure of the school day, week, and year and the amount of time spent in a given class period should be studied at the school and student-level

At the system-level, there appears to be no pattern between academic performance on TIMSS 2011 or PISA 2012 and the structure of the school day, week, or year. To inform policy decisions addressing improvements in student academic performance, researchers should turn their attention toward investigating the distribution and use of time at the regional, local, and student-level, rather than the system or country-level. A research design using data from school and student-levels, with a focus on longitudinal outcomes, would better inform policy. Finally, since PISA assesses students from a wide range of grade levels (grades seven and above), a student-level analysis is critical to interpret academic performance with regard to learning time and other influencing factors.

### TIMSS and PISA time metrics alone cannot predict system-level academic performance

Assuming other influencing factors are of equal quality and weight, the structure and use of time (i.e. school day, school week, school year) and expanded learning opportunities such as out-of-school time, significantly impact the holistic development of students across low- and high-performing education systems (Mullis et al., 2012). Therefore, additional research requires an exploration of the effects of the structure and implementation of learning time, on the school

and student-level, in order to forge a stronger empirical link between time and academic performance. With the upcoming release of PISA 2015 and TIMSS 2015 results, the authors plan to examine this empirical link in future research.

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