Chapter 4

Global Variation in Education Outcomes at Ages 5 to 19

Kin Bing Wu

INTRODUCTION

Education produces far-reaching benefits to populations by improving health, increasing individual productivity and earnings, enhancing civic engagement, and facilitating economic and social intergenerational mobility (Hannum and Xie 2016; Montenegro and Patrinos 2014; OECD 2013c; Schultz 1961). In the aggregate, it enhances economic growth by contributing to technological change and innovation (Becker 1964; Mankiw, Romer, and Weil 1992; Mincer 1974; Solow 1956; Pradham and others 2016, chapter 30 of this volume).

Education outcomes are affected by a number of factors. At the child or student level, nutrition, health, and interactions with parents and other adults affect brain development, emotional and psychological well-being, and the capacity to learn (Crookston and others 2013). At the school level, education quality is enhanced by school leadership, an orderly and safe environment, high expectations, positive reinforcement, regular assessment, constructive school-home relations, and opportunity to learn (OTL) (Sammons, Hillman, and Mortimore 1995). Education, health, and social policies can create an enabling environment and equalize opportunities for all students through resource allocation, monitoring and supervision, curriculum improvement, teacher management, policy toward the language of instruction, and interventions targeted to disadvantaged groups. Chudgar and Luschei's (2009) study of 25 participating systems in international studies found that although family background affects outcomes more, schools are an important source of variation in student achievement in poor countries and can bridge the achievement gap. Definitions of age groupings and age-specific terminology used in the volume can be found in chapter 1 (Bundy and others 2017).

INTERNATIONAL ASSESSMENT OF STUDENT ACHIEVEMENT

Cross-national studies confirm the positive relationship between educational attainment, as measured by average years of schooling, and economic growth (Barro 1991, 1997). However, student achievement can vary widely across countries, even across countries with the same average years of schooling. Education quality is the most critical component because the capability to use technology and to innovate is contingent on the improvement of cognitive skills. Hanushek and Woessmann (2015) found a strong positive relationship between student achievement and gross domestic product (GDP) per capita growth between 1964 and 2003; they also found that cognitive skills explained differences in growth rates between regions. For example, 10 East Asia and Pacific countries in their sample experienced growth that was at least 2.5 percentage points per year faster than the typical country in the world, attributable to their knowledge capital. Although other qualities, such as resilience, collaboration, and entrepreneurship, are very important, cognitive skills lend themselves more easily to international comparison.

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The International Association for the Evaluation of Educational Achievement (IEA) and the Organisation for Economic Co-operation and Development's (OECD's) Programme for International Student Assessment (PISA) conducted 21 cross-country studies of student achievement in mathematics, science, and reading between 1964 and 2015 (see annex 4A and table 4.1 for the history of international student assessments).

The IEA organized the first, second, and third mathematics, science, and reading tests from the 1960s to the 1990s, about once every decade, to study the differences between education systems and outcomes. The IEA subsequently conducted the Trends in International Mathematics and Science Study (TIMSS) once every four years and the Progress in International Reading Literacy Study (PIRLS) once every five years. Participating

Table 4.1 History of International Assessments of Student Achievement and Adult Skills

Studies conducted by the International Association for the Evaluation of Educational Achievement	Year	Age (years) and grade	Participating education systems
FIMS	1964	13 and final year	11
FISS	1970–71	10, 14, and final year	14, 16, 16
FIRS	1970–72	13	12
SIMS	1980–82	13 and final year	17, 12
SISS	1983–84	10, 13, and final year	15, 17, 13
SIRS	1990–91	9, 13	26, 30
TIMSS	1994–95	9 (grade 3 or 4), 13 (grade 7 or 8), final year	29, 46, 21
TIMSS-R	1999	13 (grade 8)	38
PIRLS	2001	9 (grade 4)	36
TIMSS	2003	9 (grade 4), 13 (grade 8)	26, 47
PIRLS	2006	9.5 (grade 4)	45
TIMSS	2007	9.5 (grade 4), 13.5 (grade 8)	37, 50
PIRLS	2011	9 (grade 4)	57
TIMSS	2011	9 (grade 4), 13 (grade 8)	50, 42
TIMSS	2015	9 (grade 4), 13 (grade 8)	48, 40
PISA, conducted by the OECD	**Year**	**Age (years)**	**Participating education systems**
PISA	2000, 2002	15	31, 10
PISA	2003	15	40
PISA	2006	15	57
PISA	2009	15	65
PISA	2012	15	65
PISA (to be published in late 2016)	2015	15	74
PIAAC, conducted by the OECD	**Year**	**Age (years)**	**Countries**
PIAAC	2011	16–65	24
PIAAC	2014	16–65	33

Sources: Hanushek and Woessmann 2015; NCES (National Center for Education Statistics) Trends in International Mathematics and Science Study (TIMSS), http://www.nces.ed.gov/TIMSS//countries.asp; NCES Progress in International Reading Literacy Study (PIRLS), http://www.nces.ed.gov/surveys/pirls/countries.asp; NCES Programme for International Student Assessment (PISA), http://www.nces.ed.gov/surveys/pisa/countries.asp.

Note: FIMS = First International Mathematics Study; FIRS = First International Reading Study; FISS = First International Science Study; OECD = Organisation for Economic Co-operation and Development; PIAAC = Programme for the International Assessment of Adult Competencies; PIRLS = Progress in International Reading Literacy Study; PISA = Programme for International Student Assessment; SIMS = Second International Mathematics Study; SIRS = Second International Reading Study; SISS = Second International Science Study; TIMSS = Trends in International Mathematics and Science Study; TIMMS-R = Trends in International Mathematics and Science Study-Repeat.

educational systems increased from the original 11 in 1964 to more than 50 in recent years; they include systems from Europe, East Asia, the Middle East and North Africa, Latin America and the Caribbean, South Asia, and Sub-Saharan Africa.

The IEA has historically assessed three student populations: upper primary (third or fourth grade), lower secondary (seventh or eighth grade), and the final year of upper secondary school. Participating educational systems agree on the content to ensure that the test covers topics in their curricula. The IEA enforces strict sampling rules and protocols to ensure that an educational system under study is representative, whether of a country or of a region of a country. A properly drawn sample of several hundred schools and several thousand students could yield results representative of an education system.

In 2000, PISA began testing the mathematics, science, and reading competency of 15-year-olds every three years, irrespective of the grade of enrollment. PISA assesses students' acquisition of the knowledge and skills that are essential for full participation in modern societies, with the goal of identifying ways in which students can learn better, teachers can teach better, and schools can operate more effectively (OECD 2010).

Both IEA and PISA provide training to participating education systems in sampling, test administration, and data cleaning and analysis. They also validate the results to ensure comparability across countries. The IEA and PISA scores are highly correlated at the national level (Hanushek and Woessmann 2015). Over 100 countries or regions of a country have participated in at least one of the IEA or OECD tests (annex 4A).[1] Financial constraints and consideration of the results' political impact often are the main deterrents to participation.

LESSONS FROM INTERNATIONAL ASSESSMENTS

Education system performance varies tremendously, and country rankings in the international league table often generate headlines. However, in addition to the previously mentioned student-level and school-level factors, student achievement at the system level is affected by size of the rural population, diversity of terrain, adult literacy rates, income distribution, ethnicity and languages, attitudes toward gender equality, and history of conflict. It is important to put the results in a broader context when interpreting them.

Changes in Student Performance and Adult Skills

Education system performance can improve or decline over time. For example, in TIMSS 1995, six education systems scored at the top of the international league table in eighth-grade mathematics: Singapore; Japan; the Republic of Korea; Hong Kong SAR, China; Belgium (Flemish); and the Czech Republic. In TIMSS 2011, the Republic of Korea's score increased by 32 points, rising to the top spot; Hong Kong SAR, China, increased by 17 points; and Singapore increased by 2 points. Over this period, Japan's score decreased by 11 points, Belgium's (Flemish) by 13 points, and the Czech Republic's by 42 points (Loveless 2013). Between PISA 2000 and PISA 2012, Peru made the greatest gains among all participating systems (increasing by 76 points in mathematics), albeit from a very low base, while Brazil and Chile were among the top 10 countries with the greatest gains during this period (Patrinos 2013). In PISA 2009 and 2012, Shanghai, China, overtook Finland as the top performer (annex 4B). Vietnam, a lower-middle-income economy, scored higher than the OECD average (OECD 2013a). These changes in performance demonstrate that cognitive skills are not fixed but can be developed. The relationship between education quality and economic development is not linear; relatively low income countries can make great strides, thereby changing the trajectory of their development.

The reasons for changes in student achievement are complex and country specific, and they may be attributable to a combination of interventions at the student, school, and policy levels and broader social trends. Where girls' performance in mathematics and science lagged behind boys', programs to improve girls' proficiency in these subjects increased the overall national average, as in the Republic of Korea (Chiu, personal communication 2016).[2] Countries that had previously divided their educational systems into general and vocational education saw improved academic achievement by postponing tracking and exposing more students to general education, as in Poland (OECD 2011). Germany increased its scores and ranking from 2003 to 2012 after it adopted a national educational standard in all federal states and put significant effort into teacher training and assessment (Chiu, personal communication 2016). Teaching math through strong visual presentation and improving student engagement improved test scores, as in Singapore (Cavendish 2015). Curriculum change that unintentionally reduced coherence led to a decline in test scores, as in Taiwan, China (Chiu, personal communication 2016). Linking strong schools with weak schools raised teachers' competency in weaker schools, as in Shanghai (Liang, Kidwai, and Zhang 2016). Using international assessment to guide educational interventions has substantially improved student outcomes, as in Germany and Peru (Anderson, Chiu, and Yore 2010; Patrinos 2013). The opening up, particularly to women, of more nonteaching professions with better remuneration and expanded migration opportunities with open borders made it harder for the education sector to retain capable teachers and recruit new talent, thereby affecting education quality (Chui, personal communication, 2016).

Findings from the OECD's first survey of adult skills, the Programme for the International Assessment of Adult Competencies (PIAAC), launched in 2011, confirmed that educational systems could shape people's skill profiles (OECD 2013b). The Republic of Korea was among the three lowest-performing countries when comparing the performance of adults ages 55–65 years with other countries, but it followed Japan in skill proficiency among the younger generation of workers ages 16–24 years. The United Kingdom was among the three highest-performing countries in literacy proficiency among adults ages 55–65 years, but it was among the bottom three in literacy proficiency among those ages 16–24 years. High school–educated adults ages 25–34 years in Japan and the Netherlands outperformed Italian and Spanish university graduates of the same age (annex 4C).

The PIAAC found that skills have a major impact on each person's life chances. The median hourly wage of workers scoring at the highest two levels in literacy (levels 4 and 5) is more than 60 percent higher than that for workers scoring at or below level 1. Those with lower skills also tend to report poorer health and lower civic engagement, and they are less likely to be employed (OECD 2013b). Countries would benefit from using mixed-method case studies to examine how decadal changes in education policy affect generational changes in skill profiles.

Characteristics of High-Performing Systems

Examining the distribution of student achievement at different levels of proficiency is important for assessing the depth of skills. For example, PISA has five levels of proficiency in ascending order, from level 1 to level 5. In PISA 2012, 55 percent of students in Shanghai, 40 percent in Singapore, and 37 percent in Taiwan, China, scored at level 5 in mathematics, compared with 13 percent of OECD students. Only 4 percent of students in Shanghai, 8 percent in Singapore, and 13 percent in Taiwan, China, performed below level 2, compared with 23 percent in OECD countries (annex 4B; OECD 2013a).

High-performing education systems tend to have standards-based external examinations and allocate resources more equitably across all types of schools. Systems that create more competitive environments in which schools vie for students do not systematically perform better. High teacher salaries relative to national income are associated with better student performance. School autonomy has a positive relationship with student performance when public accountability measures are in place, when school principals and teachers collaborate in school management, or when both occur. Schools with better disciplinary climates, more collaboration among teachers, and more positive teacher-student relationships tend to perform better. Stratification in school systems into general and vocational streams and grade repetition are negatively related to equity and student achievement. School systems with higher percentages of students having attended preprimary education tend to produce better results (OECD 2010, 2013b).

Variance in Achievement between Schools and between Students

International comparisons of the percentage of variance in achievement attributable to between-school differences and between-student (within-school) differences can provide direction for policy intervention. Variance in achievement attributable to between-school differences results from education policies, school resources, teacher characteristics, and instructional strategies. The smaller the between-school variance, the more equitable the school system. In Finland, less than 10 percent of the variance in PISA 2009 was attributable to between-school differences, suggesting that student achievement was less likely to be affected by which school they attended. In Hong Kong SAR, China; the Republic of Korea; Shanghai; and Taiwan, China, the variance in between-school achievement ranged from 30 percent to 35 percent, indicating relatively inequitable schools. In low-performing countries, such as Argentina and Trinidad and Tobago, the variance in student achievement between schools in PISA 2009 was 90 percent and more (OECD 2010). Where between-school variance is large, policy interventions could be directed to improving school-related factors to equalize the OTL.

Variance in achievement attributable to differences between students (within-school) results from students' family characteristics, innate ability, nutrition and health status, early childhood education, and learning strategies. PISA found that students whose parents read to them in their early years and who had attended preprimary school performed better than those without these types of support. Policy interventions directed at students and families could improve achievement. However, international student assessments focus on collecting the characteristics of education systems, schools, teachers, and students; they do not collect data on nutrition and health, which could be very important determinants of education outcomes, particularly in low-income countries and disadvantaged communities.

STUDENT ACHIEVEMENT IN POOR REGIONS OF INDIA AND CHINA

The high-performing education systems in TIMSS, PIRLS, PISA, and PIAAC are relatively small in size and population. Managing an educational system well is much more challenging in countries with more than a billion people and with highly variable geography and income. For example, top-performing Shanghai is a municipality of 23 million people and has the highest per capita income in China. The key question is how students in the poor regions of populous countries fare, relative to the more advanced regions of the same country and to international averages. This section addresses this question by reporting the findings of two surveys conducted in poor regions of India and China, using selected TIMSS mathematics items.

The India survey was part of the World Bank's study on secondary education in India. It was conducted in 2005, involving 3,418 students in 114 schools in Rajasthan (in the west) and 2,856 students in 109 schools in Orissa (in the east) (Wu, Sankar, and Azam 2006). These states have a significantly lower per capita GDP than the national average. The eighth grade was part of elementary education in Rajasthan but was part of secondary education in Orissa. The differences in the education structure in these two states led to selection of the ninth grade for testing because it was part of secondary education in both states. Thirty-six test items designed for the eighth grade internationally were selected from published items from the TIMSS 1999 (TIMSS-R) and administered to the sampled ninth-graders in both states (annex 4D). The survey also administered questionnaires to the sampled students, teachers, and schools to assess factors affecting student performance (annex 4E).

The China survey was part of a 2006 World Bank study on compulsory education (Wu, Boscardin, and Goldschmidt 2011). The same test items from TIMSS-R used in India were used to test a sample of 4,103 eighth-graders in 138 schools in Gansu province in China. Located in arid northwest China, Gansu is the second poorest province in the country. As in India, the survey administered questionnaires to the sampled students, teachers, and schools to assess factors affecting student performance, but a question on breakfast and measurement of weight and height were added to the student questionnaire (annex 4F).

Major differences existed between the two countries. India's per capita GDP was less than one-fourth of China's. Infrastrastructure and the telecommunication systems were relatively well developed, even in China's poor western regions, but much less so in India in 2006. India lagged far behind China in health indicators (WHO 2010). India did not have a national curriculum; each state determined its own education structure, curriculum, and language of instruction. China has a national curriculum that applies to all public schools irrespective of location. Chinese schools were far better resourced than Indian schools. In both countries, local educational authorities were consulted on the appropriateness of applying the test to their students. Stratified random sampling was used in both countries, but the sampling frames were different (and they were different from that of TIMSS-R). As such, the findings are only suggestive, not representative or definitive, of student achievement in the hinterland of these two large countries and its potential link with TIMSS performance. The results should be treated as a test case for further investigation.

Gansu's eighth-graders' average of 72 percent correct of the 36 items was above the international average of 52 percent; Rajasthan's and Orissa's ninth-graders scored 34 percent and 37 percent correct on average, respectively. Item by item, the Gansu students scored above the international average on 34 of 36 items, while Orissa students had lower scores on 35 of 36 items, and Rajasthan students performed below on all items. Given that students in Rajasthan and Orissa had the benefit of an additional year of education, their low scores should be a concern for policy makers. Figure 4.1 illustrates the differences in percentage correct for each item. These results to some extent foreshadow the relatively weak performance of two of the better-performing Indian states (Tamil Nadu and Himachal Pradesh) on PISA 2009 and the stellar performance of Shanghai, China, on the same test. Yet, a significant achievement gap between Gansu and Shanghai could be inferred given the latter's top position in PISA 2009 and 2012.

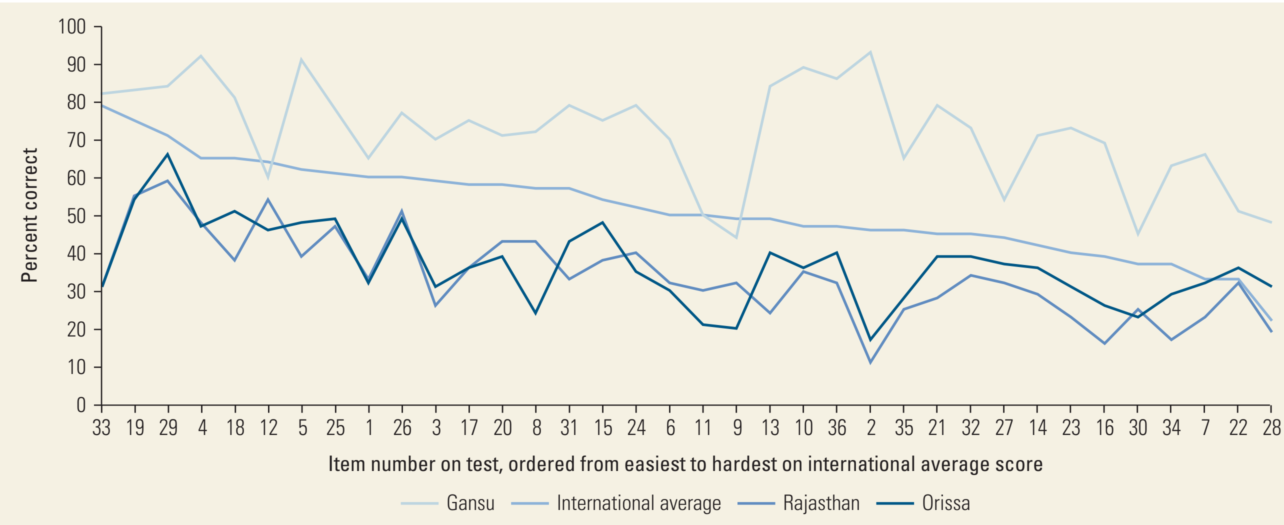
A multilevel analysis was performed to explore the determinants of achievement in Rajasthan, Orissa, and Gansu (Wu, Boscardin, and Goldschmidt 2011; Wu, Sankar, and Azam 2006). The unconditional analytical models found that school quality was highly variable in the poor regions of both large countries—46 percent of the variance in achievement in Rajasthan and 50 percent of the variance in Orissa was attributable to differences between schools; in Gansu, 55 percent of the variance was attributable to between-school differences (annex 4E). The paragraphs that follow and annexes 4F and 4G report only those variables with statistical significance and could inform policy.

India

Student Level

At the student level in Rajasthan and Orissa, the analysis found a statistically significant association between good

Figure 4.1 Average Percentage Correct by Item in Gansu, China, and Rajasthan and Orissa, India, Compared with International Average



Source: Wu, Boscardin, and Goldschmidt 2011.

performance on the one hand, and being male, higher education levels of mothers, higher parental expectations, advanced resources at home, and OTL on the other hand. Boys outperformed girls, on average, in both states. In Rajasthan, students who belonged to Scheduled Tribes[3] performed below nontribal students. In Orissa, Scheduled Caste students performed lower than the general students, on average. The OTL through homework and examination had positive effects on student achievement (annex 4F).

School Level

When students' family resources were aggregated at the school level, a significant effect on student achievement in both states was found. School types made a difference in Rajasthan: students enrolled in government-aided schools and unaided (private) schools performed better than government schools (annex 4F).

In the full model, student-level variables explained only 8 percent of the variance in achievement and school-level variables explained 33 percent in Rajasthan. Student-level variables explained only 4 percent of the variance in achievement between students, and school-level variables explained 19 percent in Orissa (annex 4E).

China

Student Level

In Gansu, significant factors at the student level were as follows: gender, age, students' prior achievement, parental expectations, and having had breakfast. On average, girls performed lower than boys. Increase in age and grade repetition were associated with lower performance. Students with parents who expected them to complete tertiary education performed better. Students who rarely had breakfast before school performed lower than students who had breakfast. The last variable is particularly important because 43 percent of students rarely had breakfast. However, there was insufficient variation in weight and height at the ninth-grade level to link those measures with student performance (annex 4G).

School Level

At the school level, teacher qualification, teacher preparation, and teaching strategy were positively associated with student achievement. Students with teachers who had higher levels of education performed much higher. An increase of an additional hour of lesson preparation by the teacher was associated with a small but significant increase in student performance. Additional teacher time spent during class time discussing questioning strategies was positively associated with student performance. Schools with more resources and facilities, ranging from drinking water and electricity to computers, student dormitories, and televisions, were positively associated with student performance. Schools with a high percentage of minority students were negatively associated with student performance, although at the individual student level, minority status was not associated with student outcome (annex 4G).

In the full model, the student-level variables only explained 7 percent of the variance in achievement between students, and the school-level variables only explained 12 percent of variance between schools (annex 4E).

Discussion

In both the India and China studies, the collected data explained a much smaller portion of the variance in achievement between students than the variance between schools. This outcome suggests that a singular focus on education policy without simultaneous interventions at the student level is unlikely to improve achievement on a large and sustained scale. Although it is difficult to change family characteristics, socioeconomic backgrounds, and innate abilities, it is entirely possible to improve students' nutrition and health, and to provide opportunity for early child development.

Longitudinal studies in a number of countries have found significant long-term impacts of nutrition and health on educational outcome (Crookston and others 2013; Hannum, Liu, and Frongillo 2014; Lundeen and others 2014). Several randomized controlled trials in elementary schools in western China that took blood samples from elementary students to use as independent variables to predict their test scores confirmed that giving the treatment group multivitamins, including iron, raised hemoglobin and increased mathematics test scores by 0.2–0.4 standard deviation compared with those of a control group (Kleiman-Weiner and others 2013; Luo and others 2012). These studies suggest that directly measuring nutrition and health through blood tests can help target interventions at the student level to increase their educational outcomes.

CONCLUSIONS

The evidence from international student assessments supports the overall relationship between knowledge capital and economic growth, although it is not linear. The PIAAC findings on adult skills suggest that countries with low skill levels are at a competitive disadvantage in the global knowledge economy. Yet TIMSS and PISA have shown that education systems can improve student achievement on a large scale. Future international assessments could consider including a more detailed questionnaire on nutrition and health and collection of biomarkers through blood tests, at least in a subsample. Availability of such integrated information on education, nutrition, and health on an international scale could explain in greater depth the differences in achievement across countries and between students, help countries prioritize their interventions, and enable international donors to target their resources more effectively.

ANNEXES

The annexes to this chapter are as follows. They are available at http://www.dcp-3.org/CAHD.

- Annex 4A. Participating Educational Systems in International Assessment of Student Achievement, 1995–2015
- Annex 4B. Performance of 15-Year-Old Students in 10 Top-Performing Educational Systems in PISA, 2012
- Annex 4C. Comparison of Skill Proficiency among Adults, 2011
- Annex 4D. Average Percentage Correct, by Item, in Gansu, China, and Rajasthan and Orissa, India, Compared with International Average
- Annex 4E. Percentage of Variance in Achievement Explained by Differences between Schools and between Students in Rajasthan, Orissa, and Gansu
- Annex 4F. Factors Associated with Student Achievement in Grade 9 in Rajasthan and Orissa, India
- Annex 4G. Factors Associated with Student Achievement in Grade 8 in Gansu

NOTES

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  a) lower-middle-income = US$1,046 to US$4,125
  b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

1. Other regional student assessment programs focus on Latin America and the Caribbean, as well as on English-speaking and French-speaking countries in Sub-Saharan Africa. However, this chapter only focuses on the IEA and PISA assessments because of their international scope and long history.
2. M. H. Chiu was interviewed by the author in Taiwan, China, on June 23, 2016. Dr. Chiu is Professor at the Graduate Institute of Science Education, National Taiwan Normal University and President, National Association for Research in Science Teaching (NARST), United States.
3. Scheduled Tribes are indigenous peoples and Scheduled Castes are the most disadvantaged social groups in India. They are recognized in India's constitution as eligible for support.

REFERENCES

Anderson, J. O., M. H. Chiu, and L. D. Yore. 2010. "First Cycle of Pisa (2000–2006)—International Perspectives on Successes and Challenges: Research and Policy Directions." *International Journal of Science and Mathematics Education* 8 (3): 373–88.

Barro, R. J. 1991. "Economic Growth in a Cross Section of Countries." *Quarterly Journal of Economics* 106 (2): 407–43.

———. 1997. *Determinants of Economic Growth: A Cross-Country Empirical Study.* Cambridge, MA: MIT Press.

Becker, G. S. 1964. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education.* Cambridge, MA: National Bureau of Economic Research.

Bundy, D. A. P., N. de Silva, S. Horton, G. C. Patton, L. Schultz, and D. T. Jamison. 2017. "Child and Adolescent Health and Development: Realizing Neglected Potential." In *Disease Control Priorities* (third edition): Volume 8, *Child and Adolescent Health and Development*, edited by Bundy, D. A. P., N. de Silva, S. Horton, D. T. Jamison, and G. C. Patton. Washington, DC: World Bank.

Chudgar, A., and T. F. Luschei. 2009. "National Income, Income Inequality, and the Importance of Schools: A Hierarchical Cross-National Comparison." *American Educational Research Journal* 46 (3): 626–58.

Crookston, B., W. Schott, S. Cueto, K. A. Dearden, P. L. Eagle, and others. 2013. "Post-Infancy Growth, Schooling, and Cognitive Achievement: Young Lives." *American Journal of Clinical Nutrition* 98 (6): 1555–63.

Hannum, E., J. Liu, and A. Frongillo. 2014. "Poverty, Food Insecurity, and Nutritional Deprivation in Rural China: Implication for Children's Literacy Achievement." *International Journal of Educational Development* 34: 90–97.

Hannum, E., and Y. Xie. 2016. "Education." In *The Oxford Handbook of the Social Science of Poverty*, edited by D. Brady and L. Burton, chapter 20. New York: Oxford University Press.

Hanushek, E. A., and L. Woessmann. 2015. *The Knowledge Capital of Nations: Education and the Economics of Growth.* Cambridge, MA: MIT Press.

Kleiman-Weiner, M., R. Luo, L. Zhang, Y. Shi, A. Medina, and S. Rozelle. 2013. "Eggs versus Chewable Vitamins: Which Intervention Can Increase Nutrition and Test Scores in Rural China?" *China Economic Review* 24: 165–76.

Liang, X., H. Kidwai, and M. Zhang. 2016. *How Shanghai Does It: Insights and Lessons from the Highest Ranking Education System in the World*. Directions in Development. Washington, DC: World Bank.

Loveless, T. 2013. "The Latest TIMSS and PIRLS Scores." Brown Center Report on American Education, Part I. Brookings Institution, Washington, DC.

Lundeen E. A., J. R. Behrman, B. T. Crookston, K. A. Dearden, P. Engle, and others. 2014. "Growth Faltering and Recovery in Children Aged 1–8 Years in Four Low- and Middle-Income Countries: Young Lives." *Public Health Nutrition* 9: 2131–37.

Luo, R., Y. Shi, L. Zhang, C. Liu, S. Rozelle, and others. 2012. "Nutrition and Educational Performance in Rural China's Elementary Schools: Results of a Randomized Control Trial in Shaanxi Province." *Economic Development and Cultural Change* 60 (4): 735–72.

Mankiw, G., D. Romer, and D. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics* 107 (2): 407–37.

Marshall Cavendish. 2015. *Math in Focus: Singapore Math.* Singapore: Marshall Cavendish Education, distributed by Houghton Mifflin Harcourt.

Mincer, J. 1974. *Schooling, Experience, and Earnings*. New York: National Bureau of Economic Research.

Montenegro, C. E. and H. A. Patrinos. 2014. "Comparable Estimates of Return to Schooling around the World." Policy Research Working Paper WP57020, World Bank, Washington, DC.

NCES (National Center for Education Statistics). Various years a. "Trends in International Mathematics and Science Study (TIMSS)." NCES, US Department of Education. http://www.nces.ed.gov/TIMSS//countries.asp.

———. Various years b. "Progress in International Reading Literacy Study (PIRLS)." NCES, US Department of Education. http://www.nces.ed.gov/surveys/pirls/countries.asp.

———. Various years c. "Programme for International Student Assessment (PISA)." NCES, US Department of Education. http://www.nces.ed.gov/surveys/pisa/countries.asp.

OECD (Organisation for Economic Co-operation and Development). 2010. *PISA 2009 Results: What Makes a School Successful? Resources, Policies and Practices.* Vol. IV. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264091559-en.

———. 2011. "The Impact of the 1999 Education Reform in Poland." OECD Education Working Paper No. 49, OECD Publishing, Paris. http://dx.doi.org/10.1787/5kmbjgkm1m9x-en.

———. 2013a. *PISA 2012 Results in Focus: What 15-Year-Olds Know and What They Can Do with What They Know*. Paris: OECD. http://www.oecd.org/pisa/keyfindings/pisa-2012-resultsoverview.pdf.

———. 2013b. *PISA 2012 Results: What Makes a School Successful? Resources, Policies and Practices*. Vol. IV. Paris: OECD Publishing. http://dx.doi.org/10.1787/9789264201156-en.

———. 2013c. *OECD Skills Outlook 2013: First Results from the Survey of Adult Skills*. OECD Publishing. http://dx.doi.org/10.1787/9789264204256-en.

Patrinos, H. 2013. "PISA Results: Which Countries Improved Most?" Education for Global Development: A blog about the power of investing in people. http://blogs.worldbank.org/education/pisa-results-which-countries-improve-most.

Sammons, P., J. Hillman, and P. Mortimore. 1995. *Key Characteristics of Effective Schools: A Review of School Effectiveness Research*. London: International School Effectiveness and Improvement Center, Institute of Education, University of London for the Office of Standards in Education.

Schultz, T. W. 1961. "Investment in Human Capital." *American Economic Review* 51 (1): 1–17.

Solow, R. M. 1956. "A Contribution to the Theory of Economic Growth." *Quarterly Journal of Economics* 70 (1): 65–94.

WHO (World Health Organization). 2010. *World Health Statistics 2010*. Geneva: WHO. http://www.who.int/whosis/whostat/2010/en.

Wu, K. B., D. Sankar, and M. Azam. 2006. "Secondary Education in India." Technical Notes. Unpublished. World Bank, Washington, DC.

Wu, K. B., C. K. Boscardin, and P. Goldschmidt. 2011. "A Retrospective on Educational Outcomes in China: From Shanghai's 2009 PISA Results to Factors that Affected Student Performance in Gansu in 2007." Unpublished. Background paper for *China 2030: Building a Modern, Harmonious, and Creative Society*. 2013. Washington, DC: World Bank and Development Research Center of the State Council, the People's Republic of China.