TAIWAN PISA 2009
Short Report

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OVERVIEW OF PISA

PISA 2009 - An Overview

Are students well prepared to meet the challenges of the future? Can they analyze, reason, and communicate their ideas effectively? Have they found the interests they can pursue throughout their lives as productive members of the economy and society? The OECD Programme for International Student Assessment (PISA) seeks to answer these questions through its triennial surveys of key competencies of 15-year-old students in OECD member countries and partner countries/economies. PISA assesses the extent to which students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in modern societies, with a focus on reading, mathematics, and science. PISA seeks to assess not only whether learners can reproduce knowledge, but also to examine how well they can extrapolate from what they have learned and apply their knowledge in unfamiliar settings, both in and outside of schools. PISA focuses on young people's ability to use their knowledge and skills to meet real-life challenges. This orientation reflects a change in the goals and objectives of curricula themselves, which are increasingly concerned with what students can do with what they learn at school and not merely with whether they have mastered specific curricular contents.

PISA has now completed its fourth round of surveys. In each round, the assessment focuses on a single subject, i.e., reading in 2000, mathematics in 2003, and science in 2006. The 2009 survey marks the beginning of a new round with a return to a focus on reading, but in ways that reflect the extent to which reading has changed since 2000, including the prevalence of digital texts. For the first time, the PISA 2009 survey also assessed 15-year-old students' ability to read, understand and apply digital texts. The Electronic Reading Assessment (ERA) is a text or texts with navigation tools and features that make possible and indeed even require non-sequential reading, a result of the trend towards popular network learning and communication. In 2012, Taiwan will take the ERA as a national option. PISA assesses not only students' knowledge in these areas, but also their ability to reflect on their knowledge and experience and to apply them to deal with real-world issues. The emphasis is on mastering processes, understanding concepts, and functioning in various situations within each assessment area. The definition of PISA literacy focuses on functional knowledge and technique application, which would facilitate individual's active participation in society. The meaning of participation is not only to complete tasks passively, but also to acquire the ability to make decisions.

PISA 2009 focuses on reading literacy including collecting information while engaged in reading. Prominent constructs in the empirical literature on individual reading

engagement include interest in reading, perceived autonomy, social interaction, and reading practices. Educational contexts for reading engagement refer to students' perceptions of support from the teachers, classrooms and schools for the motivational attributes and behavioral characteristics of their reading. Reading literacy covers both a wide range of reading and difficulty of reading. In PISA 2009, reading literacy is assessed in relation to texts, reading processes (aspects) and situations. Texts refer to the reading text types. Aspects are the mental strategies, approaches, or purposes that readers use to negotiate their way into, around, or between texts. Five aspects guide the development of the reading literacy assessment tasks: retrieving information, forming a broad understanding, developing an interpretation, reflecting on and evaluating the content of a text, and reflecting on and evaluating the form of a text. Four situations, i.e., personal, educational, occupational, and public, are defined by the use for which the text was constructed.

The PISA mathematical literacy is demonstrated in students' ability to analyze, reason, and communicate effectively as they pose, solve, or interpret mathematical problems that involve quantitative, spatial, probabilistic or other mathematical concepts. Citizens in every country are increasingly confronted with a myriad of tasks involving quantitative, spatial, probabilistic, or other mathematical concepts. For example, media outlets (newspapers, magazines, television, and the internet) are filled with information in the form of tables, charts, or graphs about subjects such as weather, economics, medicine, and sports. Last but not least, citizens meet with the need to read forms, pay bills, successfully carry out transactions involving money, determine the best buy at the market, and so forth. PISA mathematical literacy focuses on the capacity of 15-year-old students to use their mathematical knowledge and comprehension to help make sense of these issues and to carry out the relevant tasks. Scientific literacy for PISA 2009 focuses on the students' capacity to use scientific knowledge, to identify questions, and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity. These three subscales are fully reflected in the human resources demands commonly found in society.

There are 'standard' and 'easy' booklets available. Taiwan takes the 'standard' booklets. Each standard booklet is made of 4 clusters sampled from 13 clusters, i.e., 7 in reading, 3 in mathematics and 3 in science. Each cluster takes 30 minutes to complete resulting in 2 hours of total assessment time. There are 4 to 5 units in each reading cluster, 8 to 9 in mathematics, and 6 in science. The questions vary in different formats such as multiple choice, closed-constructed response, and open-constructed responses. Answers of the open-constructed responses are coded by an independent panel of centrally trained experts.

There are 65 participants in PISA 2009 as shown in table 1. Around 470,000 students spend two hours completing the pencil-and-paper based assessments. Test items are

organized in units with a written passage or graphic relevant to students' daily life. Students are also required to take around 30 minutes to fill out a questionnaire. The questionnaire aims to acquire a picture of their personal backgrounds, learning habits, attitudes towards reading, and engagement and motivation. School principals complete another questionnaire about school demographic characteristics and the quality of learning environments.

Table 1 Participating countries and economies in PISA 2009 (partner countries)

OECD Countries	Partner Countries (Non-OECD Countries / Regions)
Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Israel, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States	Albania, Argentina, Azerbaijan, Brazil, Bulgaria, Colombia, Croatia, Dubai, the Republic of Slovenia, Estonia, Hong Kong, Indonesia, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Macao, Monte Montenegro, Panama, Peru, Qatar, Romania, Russian Federation, Serbia, Shanghai, Singapore, Taiwan, Thailand, Tobago, Trinidad, Tunisia and Uruguay

Sampling Procedures for Taiwan PISA 2009

The main survey for PISA 2009 in Taiwan takes place from May 23rd to April 24th and the school sample size is 158. A two-stage stratified sampling design is used. In the first stage, schools are stratified based on the type of schools, school funding (public or private) and location (urban or rural). According to the PISA student population, schools are sampled systematically with probabilities proportional to a measure of size (PPS). PISA is an age-based survey, assessing 15-year-old students at the time of assessment, and covers students who are born between 1st of January 1995 and 31st of December 1995. Most of 15-year-old students in Taiwan are in the third grade of junior high school, the first grade of senior high school, vocational senior high schools, and 5-year colleges. Sampling units in the second stage are students within sampled schools, and they are sampled using the software KeyQuest. Each sampled school prepares a list of eligible students with 6 variables which serve as sampled students' identification. The variables are name, grade, gender, birth month, study program, and special education need (SEN). From each sampled school, 40 students are randomly sampled and double checked against eligibility. In total, there are 6,251 students sampled from 158 schools. The distribution of student numbers by grades is shown in table 2, and by school types in table 3. There are 5,831 students attending the assessment sessions and the assessment rate is 93.3%. If the predefined non-participation students are excluded from the denominator, the assessment rate is 96.7%.

Table 2 Distribution of assessed students by grades in Taiwan PISA 2009

Grade	Frequency	Percent
8	7	.1
9	1870	32.1
10	3953	67.8
11	1	.0
total	5831	100.0

Table 3 Proportions of assessed students by school types in Taiwan PISA 2009

School type		Assessed students in Taiwan	Percentage of assessed students in Taiwan(%)		Student Population	Percentage of number of students (%)	
general junior high school		1538	26.4		87927	26.8	
Senior high school	general senior high school	731	12.5	68.6	35005	10.7	69.5
	vocational senior high school	533	9.1		31812	9.7	
	mixed general and vocational	1391	23.9		84371	25.7	
	comprehensive high school	562	9.6		34951	10.7	
	complex high schools	787	13.5		41645	12.7	
Five-year Colleges		289	5.0		12293	3.7	
Total		5831	100		328004	100.0	

Taiwan PISA 2009: A Brief Report

In this brief report, we first describe Taiwanese students' performance in reading, mathematics, and science literacy in comparison to performances of students in countries or areas such as Finland, Korea, Japan, Singapore, Shanghai, Macao and Hong Kong. Then we discuss the relationship between school variables and reading literacy performances. Finally, we address Taiwan's educational indices. The proportion of reading literacy variance accounted by social economic status variables is a major focus on the equity issue.

The average score of Taiwan PISA 2009 is 495 on the overall reading scale, which is very close to the score of 496 in 2006. The PISA reading performance of Korea and Finland, the best performers on the PISA reading scale among the OECD countries, are 539 and 536, respectively. As a partner economy, Shanghai has an average performance of 556, and the result shows that Shanghai outperforms all the others on the overall reading scale by a significant margin. For mathematics literacy, the average score of Taiwan in PISA 2009 is 543, slightly lower than the score of 2006 by 6 points. Taiwan ranks in 5th place but is not significantly different from Korea in 4th place. For science literacy, the mean score of 2009 is 520, significantly lower than the score of 2006 by 12 points.

In addition to carrying out the well-established assessment routines, facing the digital era, PISA prepares to increase the applications of electronic tests. The content of the computer-based assessment would cover problem solving, mathematics and reading literacy. To prepare for the computer-based assessment, students not only need to posses

the navigation ability, but also have to equip themselves with the capacity for autonomous exploration and dynamic adjustment. These are the new factors which may potentially affect students' performances. Our research team has participated in the series of workshops and meetings of PISA2009 with the approximately 60 other countries. We are fully aware of the powerful and rapid revolution of educational assessment. We hope this brief report can invite educational researchers and classroom teachers to pay attention to the rationales and implications of PISA assessment. Detailed information for the design of PISA is available on the PISATW website (http://pisa.nutn.edu.tw). Paper-based and computer-based assessment sample items in appendix II are also available on the same website (http://pisa.nutn.edu.tw→news→PISA sample items).

After PISA 2000, several countries made educational reforms by taking into account the PISA results. Participating in PISA, we learn about the key competencies defined by OECD, and amass objective statistics about our students' relative performances on these dimensions. The detailed information about the relationship between the reading strategy, approach and engagement, and the reading performance is in the PISA 2009 National Report. Innovative and realistic design, standardized sampling and analysis and strict quality assurance make PISA results convincing and widely referenced, especially for cross-country comparison and trend analysis. Therefore, by participating in PISA2012, we expect to obtain some information concerning trends in our educational system. We hope this brief report helps our educators and policy makers to better understand PISA. Given these objective assessment results, we hope to reach to some consensus and come up with a workable plan to improve the quality of education by raising the key competences and the willingness for life-long learning for our kids.

A PROFILE OF TAIWANESE STUDENTS' PERFORMANCE IN READING

How are Reading Proficiency Levels Defined in PISA 2009

The metric for the overall reading scale is normalized with a grand mean for all OECD countries in PISA 2000 at 500 and with a standard deviation of 100. To interpret students' scores in substantive terms, the scale is divided into levels, based on statistical theory. Levels are associated with various tasks that require different skills and knowledge to successfully complete. For PISA 2009, the range of difficulty of tasks is associated with 7 levels of reading proficiency: Level 1b is the lowest level, then Level 1a, 2, 3, and so on up to 6 as described in table 4. Students proficient at Level 5 on the reading literacy scale can demonstrate precise understanding, deal with concepts that may be contrary to expectations, locate critical details, and make sophisticated inferences. Students proficient at Level 3 are expected to be able to complete daily tasks that demand moderate levels of reading literacy. It is the basic level defined by PISA of applying reading literacy for learning.

Taiwanese Students' Performance in PISA 2009 on the Reading Scale

The descriptive statistics of reading literacy and gender differences in Taiwan and top 10 countries/areas are presented in table 5. For PISA 2009 the OECD mean is 493, with a standard deviation of 93. The average performance of Taiwan in PISA 2009 is 495, with a standard deviation of 86 on the overall reading scale, which is less than, even though not significantly different from, the OECD average. In terms of PISA Chinese version, Taiwan, Hong Kong and Macao use the traditional Chinese version, while Shanghai has adopted the simplified Chinese version. The results show that Shanghai and Hong Kong outperform Taiwan and Macao by a significant margin. Among these 4 areas, Macao has the least dispersive distributions of ability while Taiwan has the most. In the PISA 2009 reading assessment, girls outperform boys in every participating country, by an average margin, across OECD countries, of 39, which is over half a proficiency level and roughly equivalent to the average progress in one school year (table 5). The gender difference in Taiwan is 37, which is not far from the OECD average gap. In other words, boys' reading proficiency is about one school year's behind girls' in Taiwan.

Table 4 Summary descriptions for the seven levels of proficiency in reading

Level (%[1]) Lower Score Limit	Characteristics of tasks
6 (0.8) 708	Tasks at this level typically require the reader to make multiple inferences, comparisons and contrasts that are both detailed and precise. They require demonstration of a full and detailed understanding of one or more texts and may involve integrating information from more than one text. Tasks may require the reader to deal with unfamiliar ideas, in the presence of prominent competing information, and to generate abstract categories for interpretations. Reflect and evaluate tasks may require the reader to hypothesize about or critically evaluate a complex text on an unfamiliar topic, taking into account multiple criteria or perspectives, and applying sophisticated understandings from beyond the text. A salient condition for access and retrieve tasks at this level is precision of analysis and fine attention to detail that is inconspicuous in the texts.
5 (7.6%) 626	Tasks at this level that involve retrieving information require the reader to locate and organise several pieces of deeply embedded information, inferring which information in the text is relevant. Reflective tasks require critical evaluation or hypothesis, drawing on specialised knowledge. Both interpretative and reflective tasks require a full and detailed understanding of a text whose content or form is unfamiliar. For all aspects of reading, tasks at this level typically involve dealing with concepts that are contrary to expectations.
4 (28.3%) 553	Tasks at this level that involve retrieving information require the reader to locate and organise several pieces of embedded information. Some tasks at this level require interpreting the meaning of nuances of language in a section of text by taking into account the text as a whole. Other interpretative tasks require understanding and applying categories in an unfamiliar context. Reflective tasks at this level require readers to use formal or public knowledge to hypothesise about or critically evaluate a text. Readers must demonstrate an accurate understanding of long or complex texts whose content or form may be unfamiliar.
3 (57.2%) 480	Tasks at this level require the reader to locate, and in some cases recognise the relationship between, several pieces of information that must meet multiple conditions. Interpretative tasks at this level require the reader to integrate several parts of a text in order to identify a main idea, understand a relationship or construe the meaning of a word or phrase. They need to take into account many features in comparing, contrasting or categorising. Often the required information is not prominent or there is much competing information; or there are other text obstacles, such as ideas that are contrary to expectation or negatively worded. Reflective tasks at this level may require connections, comparisons, and explanations, or they may require the reader to evaluate a feature of the text. Some reflective tasks require readers to demonstrate a fine understanding of the text in relation to familiar, everyday knowledge. Other tasks do not require detailed text comprehension but require the reader to draw on less common knowledge.
2 (81.2%) 407	Some tasks at this level require the reader to locate one or more pieces of information, which may need to be inferred and may need to meet several conditions. Others require recognising the main idea in a text, understanding relationships, or construing meaning within a limited part of the text when the information is not prominent and the reader must make low level inferences. Tasks at this level may involve comparisons or contrasts based on a single feature in the text. Typical reflective tasks at this level require readers to make a comparison or several connections between the text and outside knowledge, by drawing on personal experience and attitudes.
1a (94.3%) 335	Tasks at this level require the reader to locate one or more independent pieces of explicitly stated information; to recognise the main theme or author's purpose in a text about a familiar topic, or to make a simple connection between information in the text and common, everyday knowledge. Typically the required information in the text is prominent and there is little, if any, competing information. The reader is explicitly directed to consider relevant factors in the task and in the text.
1b (98.9%) 262	Tasks at this level require the reader to locate a single piece of explicitly stated information in a prominent position in a short, syntactically simple text with a familiar context and text type, such as a narrative or a simple list. The text typically provides support to the reader, such as repetition of information, pictures or familiar symbols. There is minimal competing information. In tasks requiring interpretation the reader may need to make simple connections between adjacent pieces of information.

1. Percentage of students able to perform tasks at this level or above

Table 5 Mean score, variation and gender differences in student performance on the reading scale

Country	Rank	Mean score	Standard deviation	Boys	Girls	Difference (B - G)
Taiwan	23	495	86	477	514	-37
Taiwan 2006	16	496	84	486	507	-21
Shanghai	1	556	80	536	576	-40
Korea	2	539	79	523	558	-35
Finland	3	536	86	508	563	-55
Hong Kong	4	533	84	518	550	-33
Singapore	5	526	97	511	542	-31
Canada	6	524	90	507	542	-34
New Zealand	7	521	103	499	544	-46
Japan	8	520	100	501	540	-39
Australia	9	515	99	496	533	-37
Netherlands	10	508	89	496	521	-24
Macao	28	487	76	470	504	-34
OECD AVG		493	93	474	513	-39

This brief report takes several countries/areas for comparison, including Asian countries and Finland; Shanghai and Singapore participated in the PISA survey for the first time, while Korea, Japan, Hong Kong and Macao have conducted the PISA survey since 2000.

Table 6 shows the ranks and mean scores for Taiwan and the selected reference countries on each subscale, i.e., access and retrieve, integrate and interpret, reflect and evaluate. The mean scores of Taiwanese students' performance on the three subscales are 496, 499, and 493, respectively. Taiwanese students perform poorer on the reflect-and-evaluate subscale and better on the integrate-and-interpret subscale. However, the difference is not significant. In common with the overall reading scale, girls perform much better than boys on every subscale. The mean differences of 3 subscales are 39, 32, and 41, respectively. It shows that the gender difference is greater on the reflect-and-evaluate, and the access-and-retrieve subscales in Taiwan. The gender difference and pattern in Taiwan are very similar to the performance of OECD countries.

Table 6 Rank and Mean score in student performance on the reading subscales access and retrieve, integrate and interpret, reflect and evaluate

Country	Access and Retrieve		Integrate and Interpret		Reflect and Evaluate	
	Rank	Mean	Rank	Mean	Rank	Mean
Taiwan	23	496	18	499	24	493
Shanghai	1	549	1	558	1	557
Korea	2	542	2	541	2	542
Finland	3	532	3	538	4	536
Hong Kong	4	530	4	530	3	540
Singapore	6	526	5	525	7	529
Japan	4	530	7	520	9	521
Macao	24	493	29	488	33	481
OECD AVG	-	495	-	493	-	494

Table 7 shows figures for the percentage of students at each proficiency level on the reading scale. Figure 1 compares the student percentages at each proficiency level on the reading scale between Taiwan and the OECD. Though the performance of Taiwan on the overall reading scale is similar to the average of OECD, only 5.2% of students are proficient at Levels 5 and 6, below the OECD average of 7.6%, and significantly below Shanghai's 19.4% and Hong Kong's 12.4%. For examples of PISA 2009 reading assessment at proficiency Level 6, please refer to question 3 of "Example 2: The Play's The Thing" of Appendix III. It is a long continuous text by PISA standards, and it seems that the depicted fictional world is remote from the experience of most 15-year-old students. The setting is exotic to many, and the situation is gradually revealed through the dialogue itself. Individual pieces of vocabulary in the text are not particularly difficult. The cognitive demand of this question is the aspect of integrate-and-interpret and is attributable to the high level of interpretation. Readers must define the meaning of the question's terms in relation to the text. Moreover, the reader needs to be alerted to the distinction between characters and actors. Also, the required information is in an unexpected location. Students with reading proficiency 767 have a 50% chance of answering it correctly. The correct rate in Taiwan is only 6%.

As it is often the case in the OECD countries, Level 3 is the most common level of performance in Taiwan. It means that students reaching Level 3 might be expected to be able to deal with the tasks commonly demanded in their daily lives. For examples of reading proficiency at Level 3, please refer to question 1 of "Example 1: Telecommuting" in Appendix III. The stimulus for the unit has two short texts that offer contrasting opinions on telecommuting. The purpose of each of the short texts in the stimulus is to persuade readers, and the stimulus is classified as "argumentation" in occupational situation. Because they are generated independently and juxtaposed for the purpose of the assessment, the text format classification in this part is multiple. This question requires students to recognize the relationship between the two short texts. To answer correctly, students must have an overview of each of the short texts, and then identify the relationship between them. The difficulty of this question is the level of interpretation required to identify the position that is expressed in each text. Students whose reading proficiency is 549 have a 50% chance to arrive at the correct answer. The correct rate in Taiwan is 52%. In Taiwan, over 15% students are not proficient at Level 2. As compared to other countries with higher performance on the reading scale, Taiwan has smaller and larger proportions of students on the high and low proficiency levels, respectively.

Table 7 Percentage of students at each proficiency level on the reading scale

Country	Proficiency Levels							
	Below 1b (less than 262.04)	1b (262.04 ~334.75)	1a (334.75~ 407.4)	2 (407.47~ 480.18)	3 (480.18~ 552.89)	4 (552.89 ~ 625.61)	5 (625.61~ 698.32)	6 (above 698.32)
Taiwan	0.7	3.5	11.4	24.6	33.5	21.0	4.8	0.4
Shanghai	0.1	0.6	3.4	13.3	28.5	34.7	17.0	2.4
Korea	0.2	0.9	4.7	15.4	33.0	32.9	11.9	1.0
Finland	0.2	1.5	6.4	16.7	30.1	30.6	12.9	1.6
Hong Kong	0.2	1.5	6.6	16.1	31.4	31.8	11.2	1.2
Singapore	0.4	2.7	9.3	18.5	27.6	25.7	13.1	2.6
Japan	1.3	3.4	8.9	18.0	28.0	27.0	11.5	1.9
Macao	0.3	2.6	12.0	30.6	34.8	16.9	2.8	0.1
OECD AVG	1.1	4.6	13.1	24.0	28.9	20.7	6.8	0.8

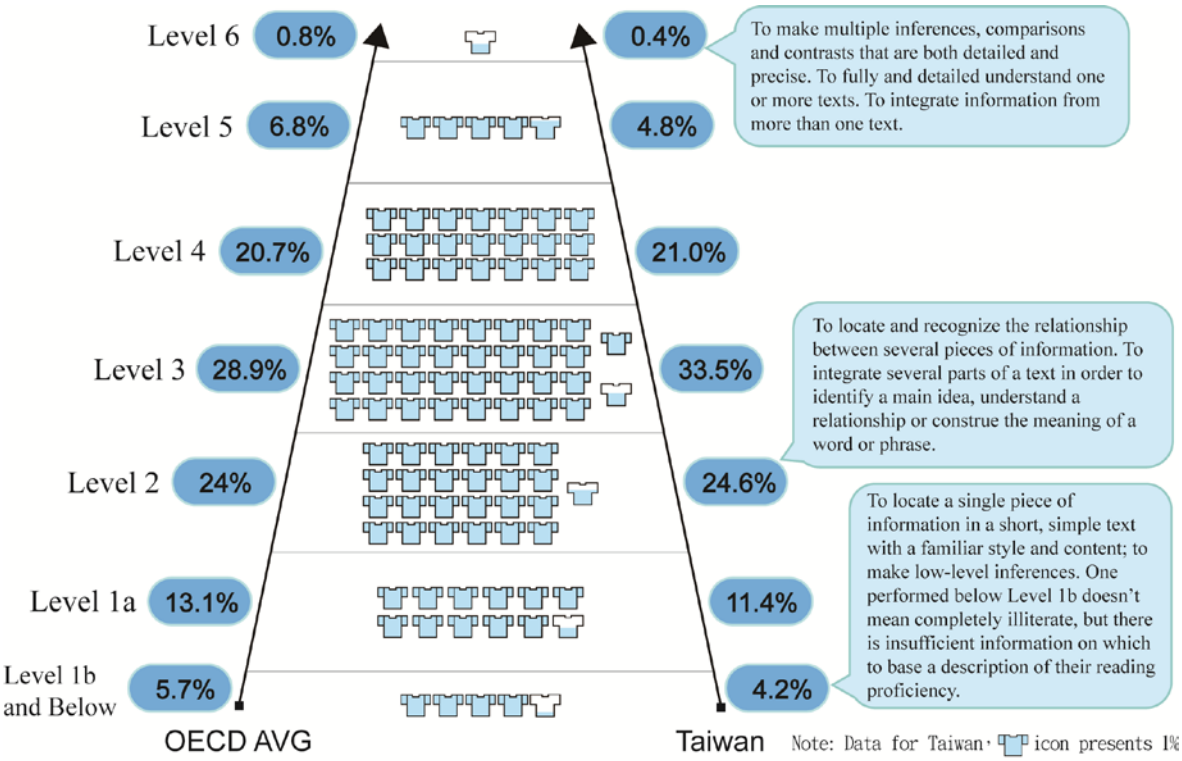

Figure 1 The percentages of student at each proficiency level between OECD average and Taiwan

Since continuous texts make up a large part of the PISA 2009 reading test, it is not surprising that the performance profile by reading level for the continuous scale is very similar to that for the overall reading scale, with a mean of 496 and standard deviation of 88. Mean performance in Taiwan is better on the non-continuous texts subscale than on the overall scale (500 vs. 495), but is slightly more dispersed (standard deviation of 93 vs. 88). From the perspective of gender difference, across the OECD countries, girls consistently outperform boys on the continuous subscale with the gap slightly larger than that on the overall scale (42 vs. 35). Compared to OECD countries, Taiwan has the same pattern of gender gap in that girls generally outperform boys on both subscales by a margin of 39 and 36, respectively.

The 2009 PISA further categorizes performance below Level 2 in 2 sub-levels, i.e., Level 1a and 1b. Some low-performing students show the ability to find and process simple information at proficiency Level 1a. Among those unable even to do these tasks, the majority nevertheless still demonstrate technical reading skills, by solving easier tasks at the lower Level 1b, which only require students to retrieve very simple and explicit information from texts. In all but 6 countries in PISA 2009, over 90% of students can at least get to this level. This shows that if a country attempts to compete in the world economy, it needs to reduce the number of students failing to reach Level 2. The policy challenge is to improve their proficiency by raising their ability to find, interpret, and reflect on information in various texts.

Taiwanese Students' Reading and Learning Habits

Students who read for enjoyment are more proficient readers than students who do not read for enjoyment in all PISA participating countries. On average across OECD countries, over one third (37.4%) of students claim, acknowledge, or say that they do not read for enjoyment, while their mean performance on the reading proficiency scale is 459.5 as shown in table 8. In contrast, 17.3% of students reporting that they do not read for enjoyment in Taiwan, is lower than the average of OECD countries, also lower than most reference countries on table 8 except for Shanghai. However, the mean performance on reading proficiency scale is 437.3, much lower than the mean performance of OECD countries. In Shanghai, one of the best performers, only 8% of students claim that they do not read for enjoyment and the mean performance is 497 which is even higher than the overall performance in Taiwan by a margin of 2. In terms of time spent on reading, about one third of students across the OECD countries report reading for 30 minutes or less per day, with a performance level of 504. Also, 30.9% of students report reading for 30 minutes or less per day in Taiwan, with an average performance of 492, very close to the overall performance.

In general, the performance of Taiwanese students in reading literacy increases in proportion to the time spent on reading for enjoyment. In our findings when students read for between half an hour and one hour per day, their performance is about 513. If students spend more time on reading, say between one and two hours per day, their average score rises to 522. Nevertheless, assiduous readers, who read for enjoyment for more than two hours daily, score 518, not better than students who read for one to two hours per day. This is also true for OECD countries. The gaps in performance between students who read for enjoyment for 30 minutes or less per day and students who do not read for enjoyment are 55, 44, and 63 points in Taiwan, across OECD countries, and in Shanghai, respectively. However, in no country is the performance gap greater than 20 between students who read for enjoyment between one and two hours per day and students who read between half an

hour and one hour per day. In Taiwan and across OECD countries, the average gap is 9 and 5, respectively. Regardless of the amount of time spent on reading for enjoyment, the performance gap between students who read for enjoyment and students who do not read for enjoyment is 57 across OECD countries. In Taiwan, the performance gap is 70.9, almost equal to the amount of progress in two academic years. The performance gap on the reading proficiency scale for Shanghai is 63.8. These results indicate that reading for enjoyment has more impact on 15-year-old students' reading literacy performance than the amount of time spent in reading for enjoyment. This is particularly true for Taiwanese students' reading literacy performance.

Table 8 Percentage of students and reading performance, by time spent reading for enjoyment

Countries	Percentage of students, by time spent on reading for enjoyment									
	I do not read for enjoyment		30 minutes or less a day		More than 30 minutes to less than 60 minutes a day		1 to 2 hours a day		More than 2 hours a day	
	%	Mean	%	Mean	%	Mean	%	Mean	%	Mean
Taiwan	17.3	437.3	30.9	492.3	21.4	513.2	18.8	522.4	11.6	518.0
Shanghai	8.0	497.3	35.9	560.3	36.5	563.4	13.2	563.7	6.4	547.7
Korea	38.5	517.8	29.8	550.0	19.1	557.6	8.4	559.8	4.2	534.8
Finland	33.0	491.7	32.4	545.3	18.6	569.0	12.7	571.6	3.2	568.0
Hong Kong	19.5	497.8	35.9	532.1	23.5	554.0	13.8	552.2	7.3	532.2
Singapore	22.5	482.6	29.0	524.4	23.6	544.1	16.1	547.8	8.8	558.0
Japan	44.2	492.4	25.4	536.2	16.4	550.0	9.6	551.8	4.4	537.4
Macao	19.8	456.7	35.8	484.2	23.3	501.1	13.1	506.4	8.0	502.1
OECD AVG	37.4	459.5	30.3	503.9	17.2	526.9	10.6	532.4	4.5	526.9

A PROFILE OF TAIWANESE STUDENTS' PERFORMANCE IN MATHEMATICS AND SCIENCE

What Can Students Do in Mathematics and Science?

PISA defines mathematical literacy as an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. This includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. In PISA, mathematical literacy is demonstrated in students' ability to analyze, reason, and communicate effectively as they pose, solve and interpret mathematical problems involving quantitative, spatial, probabilistic or other mathematical concepts. PISA defines science literacy as an individual's scientific knowledge, and use of that knowledge, to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues. It emphasizes their understanding of the characteristic features of science as a form of human knowledge and enquiry, their awareness of how science and technology shape our material, intellectual and cultural environments, and their willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen.

Taiwanese Students' Performance in Mathematics and Science

Reading is the focus of the PISA 2009 survey while mathematics and science are given a smaller amount of assessment time. We can only make an update on overall performance rather than an in-depth analysis of knowledge and skills. The PISA 2009 survey shows the eastern countries and economies are the top performers in mathematics and science. The top 5 in mathematics are Shanghai, Singapore, Hong Kong, Korea and Taiwan. The top 5 in science are Shanghai, Hong Kong, Singapore, Japan and Korea. The mean score of PISA 2003 is the benchmark to which mathematics performances in PISA 2006 and PISA 2009 are compared. Taiwan, with a country mean score of 549 in mathematics in PISA 2006 is the highest performing country, but Taiwan, Finland, Hong Kong and Korea cannot be significantly distinguished. The number of participating countries increases from 56 to 65 in PISA 2009. The mean score of Taiwan is 543 which dropped by 6 points from PISA 2006. The performance of Taiwan, the 5th on the list, cannot be significantly distinguished from Korea. In both PISA 2006 and 2009, Taiwan is among the 5 countries with the highest performance in mathematics, but has the largest standard deviation. Science is the focus of the PISA 2006 survey. Taiwan ranks 4th on the PISA 2006 science scale, not distinguishable significantly from Canada which is in the 3rd place. In Taiwan the mean score of PISA 2009 is 520, which dropped by 2 points from 2006, the 12th in country ranking, but not distinguishable significantly from Australia and Netherlands which are in

the 10th and 11th places, respectively.

There are 6 proficiency levels used in mathematics and science in the PISA 2009. According to these levels, we can describe the performance of students' mathematics and science abilities specifically. Table 10 shows the percentage of students at each proficiency level on the mathematics and science scale in Taiwan and reference countries plus Taiwan in PISA 2006. In mathematics, the percentage of top performance is 28.5% in Taiwan, 50.4% in Shanghai, 35.6% in Singapore, and 30.7% in Hong Kong. The percentage of lower performance for Taiwan is the highest. In science, Taiwan has only 8.8% of its students above Level 5, revealing a contrast to Shanghai (24.3%), Singapore (19.9%), Finland (19.7%), Japan (17%), Hong Kong (16.2%), and Korea (11.6%). It is this proportion of higher level attainment where further improvements need to be made. The proportion of students below Level 1 in Taiwan is 11.1%, only less than Singapore's 11.5% among those reference countries.

Figures 2 and 3 show the percentages of students at each proficiency level on the mathematics and science scale in Taiwan 2006 and 2009, respectively. The performance of Taiwanese students in 2009 is slightly lower than that in 2006. According to the percentages of each proficiency level, the proportion at Level 6 is almost the same, but the proportion at Level 5 decreases by about 3%. The number of middle to low achieving students seems to have increased slightly. In science, the percentage in the top performance category in Taiwan is 8.8%, having decreased by 6% from 2006. The percentages at Level 2 and 3 increased, and those at Level 1 and below Level 1 remain stable.

Table 9 Rank of countries on the mathematics and science scale in PISA 2006 and 2009 (the top eighteen)

Ranking	Mathematics						Science					
	2006			2009			2006			2009		
	Country	Mean Score	(SD)	Country	Mean Score	(SD)	Country	Mean Score	(SD)	Country	Mean Score	(SD)
1	Taiwan	549	(103)	Shanghai	600	(103)	Finland	563	(86)	Shanghai	575	(82)
2	Finland	548	(81)	Singapore	562	(104)	Hong Kong	542	(92)	Finland	554	(89)
3	Hong Kong	547	(93)	Hong Kong	555	(95)	Canada	534	(94)	Hong Kong	549	(87)
4	Korea	547	(93)	Korea	546	(89)	Taiwan	532	(94)	Singapore	542	(104)
5	Netherlands	531	(89)	Taiwan	543	(105)	Estonia	531	(84)	Japan	539	(100)
6	Switzerland	530	(97)	Finland	541	(82)	Japan	531	(100)	Korea	538	(82)
7	Canada	527	(86)	Liechtenstein	536	(88)	New Zealand	530	(107)	New Zealand	532	(87)
8	Liechtenstein	525	(84)	Switzerland	534	(99)	Australia	527	(100)	Canada	529	(90)
9	Macao	525	(93)	Japan	529	(94)	Netherlands	525	(96)	Estonia	528	(84)
10	Japan	523	(91)	Canada	527	(88)	Liechtenstein	522	(97)	Australia	527	(101)
11	Australia	522	(88)	Australia	526	(89)	Korea	522	(90)	Netherlands	522	(96)
12	New Zealand	522	(93)	Macao	525	(85)	Slovenia	519	(93)	Taiwan	520	(87)
13	Belgium	520	(106)	New Zealand	519	(96)	Germany	516	(100)	Germany	520	(101)
14	Estonia	515	(80)	Belgium	515	(104)	United Kingdom	515	(107)	Liechtenstein	520	(87)
15	Denmark	513	(85)	Australia	514	(94)	Czech Republic	513	(98)	Switzerland	517	(96)
16	Czech Republic	510	(103)	Germany	513	(98)	Switzerland	512	(99)	United Kingdom	514	(99)
17	Iceland	506	(88)	Estonia	512	(81)	Austria	511	(98)	Slovenia	512	(94)
18	Austria	505	(98)	Iceland	507	(91)	Macao	511	(78)	Macao	511	(76)
	OECD Average	498	(92)	OECD Average	496	(92)	OECD Average	500	(95)	OECD Average	501	(94)

Table 10 Percentage of students at the different levels of mathematics proficiency

Country	six levels of proficiency in Mathematics							six levels of proficiency in Science						
	Below Level 1 (Below 357.8)	Level 1 (357.8~ 420.1)	Level 2 (420.1~ 482.4)	Level 3 (482.4~ 544.7)	Level 4 (544.7~ 607)	Level 5 (607~ 669.3)	Level 6 (Above 669.3)	Below Level 1 (Below 334.94)	Level 1 (334.94~ 409.54)	Level 2 (409.54~ 484.14)	Level 3 (484.14~ 558.73)	Level 4 (558.73~ 633.33)	Level 5 (633.73~ 707.93)	Level 6 (Above 707.93)
Taiwan	4.2	8.6	15.5	20.9	22.2	17.2	11.3	2.2	8.9	21.1	33.3	25.8	8.0	0.8
Taiwan2006	3.6	8.3	14.3	19.4	22.4	20.1	11.8	1.9	9.7	18.6	27.3	27.9	12.9	1.7
Finland	1.4	3.4	8.7	15.2	20.8	23.8	26.6	0.4	2.8	10.5	26.0	36.1	20.4	3.9
Korea	1.9	6.2	15.6	24.4	26.3	17.7	7.8	1.1	5.2	18.5	33.1	30.4	10.5	1.1
Shanghai	1.7	6.1	15.6	27.1	27.8	16.7	4.9	1.1	4.9	15.3	28.8	31.2	15.4	3.3
Hong Kong	2.6	6.2	13.2	21.9	25.4	19.9	10.8	1.4	5.2	15.1	29.4	32.7	14.2	2.0
Macao	3.0	6.8	13.1	18.7	22.8	20.0	15.6	2.8	8.7	17.5	25.4	25.7	15.3	4.6
Singapore	4.0	8.5	17.4	25.7	23.5	14.7	6.2	3.2	7.5	16.3	26.6	29.5	14.4	2.6
Japan	2.8	8.2	19.6	27.8	24.5	12.8	4.3	1.5	8.1	25.2	37.8	22.7	4.5	0.2
OECD Total	9.3	15.5	22.7	23.5	17.3	8.9	2.8	5.4	14.6	24.8	27.1	19.6	7.3	1.1
OECD Average	8.0	14.0	22.0	24.3	18.9	9.6	3.1	5.0	13.0	24.4	28.6	20.6	7.4	1.1

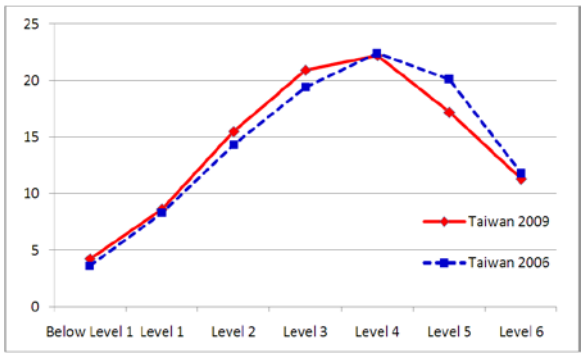

Figure 2 Percentage of Taiwanese students at each proficiency level on the mathematics scale in PISA 2006 and 2009

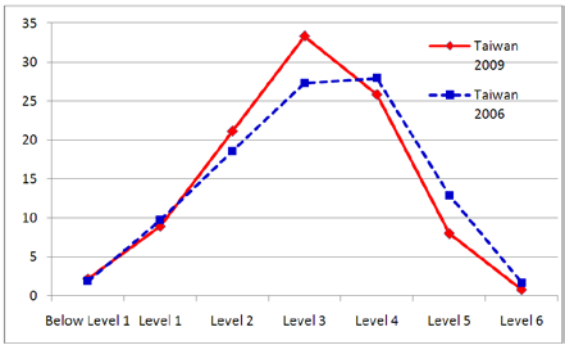

Figure 3 Percentage of Taiwanese students at each proficiency level on the science scale in PISA 2006 and 2009

FEATURES SHARED BY SUCCESSFUL SCHOOL SYSTEMS

The analyses here focus on reading; however, the patterns observed for mathematics and science are not so different at all.

The Characteristics of the School System Relate to Student Performance

Since school is where most learning occurs, what happens in school has a direct impact on learning. In turn, what happens in school is influenced by the resources, policies and practices approved at higher administrative levels in a country's educational system. Researches from PISA show that the organizational features of a school system, which relate to student performance, exhibit vertical differentiation and horizontal differentiation at the system level. Horizontal differentiation in the educational system refers to providing parents and students with a chance to choose schools (school choice), the extent to decide school organization policies (school autonomy), the policies of using assessment and achievement data, resources invested in education such as class and school size, the quality of materials, the availability of equipment, the quality of teachers, and learning environments.

PISA defines successful school systems as those that perform above average (e.g. 493 in Reading, 496 in Math, and 501 in Science) and keep socio-economic inequalities below average providing all students with equal opportunities to learn, regardless of their socio-economic backgrounds. Systems that show high performance and an equitable distribution of learning outcomes tend to be comprehensive, requiring teachers and schools to embrace diverse student populations through personalized educational pathways. In contrast, school systems assuming students to continue to different destinations, have different expectations on students, and consequently place students in certain schools, classes and grades; consequently, they often show less equitable outcomes without an overall performance advantage. Table 11 shows a comparison of Taiwan and the reference countries on the resulting classifications for the selected characteristics of successful school systems.

Table 11 Selected characteristics of school systems – Taiwan and reference countries

Country	Reading performance	Percent variance explained by students' socio-economic background.	Selecting and grouping students			Governance of schools		Assessment and accountability policies			Resources invested in education	
			Vertical difference	Horizontal differentiation at the system level	Horizontal differentiation at the school level	School autonomy for curriculum and assessment	School competition	use of assessment	use of achievement data for decision making	use of achievement data for benchmarking and information purposes	cumulative expenditure on education	Class size/teachers' salaries
Taiwan	495	11.8	low	medium	high	high	high	frequent	infrequent	frequent	low	large/ high
Shanghai*	556	12.3	low	medium	low	high	low	frequent	frequent	frequent	low	large/ high
Korea*	539	11.0	low	medium	low	high	high	frequent	frequent	frequent	high	large/ high
Finland**	536	7.8	low	low	low	high	low	frequent	infrequent	infrequent	high	small/ low
Hong Kong**	533	4.5	low	medium	low	high	high	frequent	frequent	frequent	low	large/ high
Singapore*	526	15.3	low	high	low	high	low	frequent	frequent	frequent	low	large/ high
Japan**	520	8.6	low	medium	low	high	low	frequent	infrequent	frequent	high	large/ high
Macao	487	1.8	high	medium	high	high	high	frequent	infrequent	frequent	low	large/ high
OECD average	493	14.0										

*Performance higher than the OECD average in reading
**Performance higher than the OECD average in reading and where the relationship between students' socio-economic background and reading performance is weaker than the OECD average

The Relationship between Resources, Policies and Practices, and Student Performance

We take socio-economic differences among students and schools into consideration when examining the relationship between student performance and resources, policies and practices. Results show that school systems that track students at early ages tend to show a stronger impact of socio-economic background on learning outcomes, signaling larger socio-economic inequalities. School systems with higher grade repetition and student transfer rates tend to show lower student performance and a stronger impact of socio-economic background on learning outcomes. Grouping students by academic performance within schools tends to be associated with lower performance levels, both among schools systems and among individual schools. Schools with high test score standard for admission perform at higher levels than schools with lower standard, but a system as a whole does not benefit from having high selective schools.

Finland, Hong Kong, Shanghai, Singapore and Korea, whose performance are better than Taiwan in reading and science, have low horizontal differentiation at the school level,

low vertical differentiation, low grade repetition, and fewer schools that transfer students due to poor academic achievement, behavioral problems or special educational needs. The characteristics of the school system in Taiwan are the same as in these countries except for the transfer rate. In contrast, the performance in reading and science in Macao is lower than that in Taiwan. Note that all these characteristics in Macao go in the opposite direction.

Most successful school systems grant greater autonomy to individual schools to design curricula and establish assessment policies, but these school systems do not necessarily offer parents a choice of schools for their children. In countries where schools have greater autonomy over what is taught and how students are assessed, students tend to perform better. Taiwan, Finland, Hong Kong, Shanghai, Singapore, Korea, Japan and Macao are classified as having greater autonomy in curriculum and assessment, but Taiwan, Korea, Hong Kong and Macao provide lower levels of school choice for parents and students.

In countries that use standards-based external examinations, students tend to do better overall, but there is no clear relationship between performance and the use of standardized tests or the public posting of results at the school level. However, differences between schools with students of different social backgrounds are on average lower in countries that use standardized tests. Although Taiwan, Finland, Hong Kong, Shanghai, Singapore, Korea, Japan and Macao are classified as frequently using assessment and achievement data, Taiwan, Japan and Macao all have a lower extent of using assessment and achievement data to “provide information for parents,” “compare with other schools,” “monitor progress over time,” ”post achievement data publicly” and ”have their progress tracked by administrative authorities.”

The Relationship between Learning Environment and Student Performance

Research into what makes schools effective finds that learning requires an orderly and co-operative environment, both in and outside the classroom (Jennings and Greenberg, 2009). In effective schools, academic activities and student academic performance are valued by both students and teachers (Scheerens and Bosker, 1997; Sammons, 1999; Taylor, Pressley and Pearson, 2002). Results from PISA suggest that schools and countries where students work in a climate characterized by high performance expectations and the readiness to invest effort, good teacher-student relations, and high teacher morale tend to achieve better results. Even after accounting for socio-economic background and other aspects of the learning environment measured by PISA, the results showed that student performance is positively related to a better teacher-student relationship, a better disciplinary climate and teacher-related factors affecting school climate.

PISA shows that the socio-economic background of students and schools and the

learning environment are closely interrelated and that both factors are linked to performance in important ways, perhaps because students with socio-economically advantaged backgrounds bring with them a higher level of discipline and more positive perceptions of school values, or perhaps because parental expectations of good classroom discipline and strong teacher commitment are higher in schools with advantaged socio-economic intake. Conversely, disadvantaged schools may experience less parental pressure to reinforce effective disciplinary practices or ensure that unqualified or unmotivated teachers are replaced. In summary, students perform better in schools with a stronger school climate, partly because such schools tend to have more students from advantaged backgrounds who generally perform well, partly because the favorable socio-economic characteristics of students reinforce a favorable climate and partly for reasons unrelated to socio-economic variables. What these findings tell policy makers is that, while it is possible to work on improving features of schools such as school discipline separately from tackling socio-economic issues, if these two issues are worked on together they could have a much bigger impact.

EQUITY IN LEARNING OPPORTUNITIES IN TAIWAN

Equality in Reading Learning Outcomes in Taiwan

Analyzing the distribution of student performance in a school system provides valuable policy insights for stakeholders interested in educational equity. The percentage of students who fall behind is an important measure of the differences in achievement, which indicates the proportion of students who have not obtained the fundamental knowledge or mastered the basic skills that will enable them to progress further in education and beyond. A large proportion of students at low levels of proficiency tell us that the school system is failing to provide all students with equal and proper levels of knowledge and skills. Accordingly, how to narrow the gap in performance differences within countries by raising performance at the bottom end of the achievement distribution is an important educational policy goal for all countries.

PISA assesses reading performance along six levels of proficiency, of which Level 2 is regarded as the baseline level. The percentage of students who fall behind is defined as the proportion of the students failing to reach a baseline level of proficiency in PISA. On average across OECD countries, 18.8% of students are not proficient at Level 2. Compared to the OECD average, the percentage of students who fall behind is smaller in Shanghai-China (4.1%), Korea (5.8%), Finland (8.1%), Hong Kong-China (8.3%), Singapore (12.5%), Japan (13.6%), Macao-China (14.9%), and Taiwan (15.6%). Among the countries and economies whose testing language is Chinese, Taiwan has the greatest percentage of students who fall behind whereas Shanghai-China has the smallest.

The Socio-Economic Gradient: An Approach to Equity in PISA

The socio-economic gradient refers to the relationship between student performance and the PISA index of economic, social, and cultural status. The distribution of educational opportunities can be analyzed through understanding this relationship. From a school-policy perspective, the relationship also signals how equitably the schooling benefits students. Students at higher socio-economic status levels generally perform better.

The strength of the gradient measures the relationship between performance and background. In other words, it measures the percentage of the variation in student performance accounted for by socio-economic background. The greater percentage of variance is explained by socio-economic background, the better the socio-economic and cultural backgrounds of students, the easier it is to predict their achievement. On average across OECD countries, 14% of the variation in student reading performance within each country is related to the PISA index of economic, social and cultural status.

Compared to the OECD average, the strength of the gradient is higher in Singapore

whereas it is weaker in Finland, Japan, Korea, Taiwan, Macao-China, Hong Kong-China, and Shanghai-China. Among the countries and economies whose testing language is Chinese, Shanghai-China has the highest gradient strength (12.3%), Macao-China has the weakest (1.8%), and Taiwan (11.8%) has a slightly lower gradient strength than Shanghai-China.

The slope of the gradient indicates the extent of inequality in reading performance resulting from socio-economic status. The slope reveals how much students' performance changes, on average, with a change of one unit on the index of socio-economic status. Steeper gradients indicate a greater impact of economic, social and cultural status on student performance (i.e. more inequality), whereas gentler gradients imply a smaller impact of socio-economic background on student performance (i.e. more equity). On average across OECD countries, the slope of the gradient is 38 score points. That is, on average in OECD countries, students' scores on the reading scale are 38 score points greater for one unit increase on the PISA index of economic, social and cultural status.

Compared to the OECD average, the slope of the gradient is relatively gentle in Finland, Korea, Taiwan, Macao-China, Hong Kong-China, and Shanghai-China; the slope of the gradient is relatively steep in Singapore (47) and Japan (40). Among the countries and economies whose testing language is Chinese, the steepest gradient is found in Taiwan (36) while the gentlest is found in Macao-China (12); Shanghai-China has the slope of the gradient in between. The challenges are greatest in the countries where the slope of the gradient is steep and the gradient is strong because this combination indicates that students and schools are unlikely to "escape" the close association between socio-economic background and learning outcomes.

The linearity of the gradient measures the extent to which the performance associated with an advantaged background remains constant over levels of socio-economic status. A positive index signals that the socio-economic gradient becomes steeper for more advantaged socio-economic students. That is, when socio-economic background increases, an increase appears in the extent to which inequalities in socio-economic status translate into performance differences. A negative value signals the flattening off of the gradient at higher levels of socio-economic background, which indicates that as socio-economic background becomes more advantaged, a decline shows in the extent to which inequalities in socio-economic background translate into performance differences.

In Japan (-4.9) and Finland (-3.6), however, the gradients are steep at low levels of economic, social and cultural status, and level off at higher status levels, indicating that above a particular level of socio-economic background, there is progressively less related advantage appeared in student performance. However, in Taiwan (3.2), Hong Kong-China (2.7), Shanghai-China (2.7), and Singapore (1.4), the gradients are relatively gentle at lower levels of socio-economic status and become steeper at higher levels. In these

countries, students with more advantaged socio-economic status show better performance than would be predicted by a linear relationship. That is, in these countries, the greater the socio-economic advantage, the greater the marginal increase shown in student performance, and among students with lower levels of socio-economic status, there are small differences in performance.

CONCLUSIONS AND SUGGESTIONS

Reading Literacy

The reading literacy of PISA emphasizes student's ability to process learning materials, to communicate, and to solve problems. As Taiwanese students' reading performance is close to the OECD average, the overall quality of our human resources should be relatively fine. Nevertheless, from a more competitive perspective, only 5.2% of Taiwanese students reach level five. In other words, the top 10% of students in Taiwan may run into difficulties in competing with the top 10% of students in Shanghai or Hong Kong, if reading literacy is crucial for job positions. In contrast, the percentage of Taiwanese students who are below level two is about 15.6%. Therefore, for Taiwan, a country in which human resources is the most precious factor, reading education needs some systematic and urgent improvements. PISA focuses the functional reading and emphasizes evidence-based arguments. So, content reading and reasoning activities on math, science or social studies will also be helpful to students' reading performance. Promoting learning literacy by elevating the top students and supporting the disadvantaged students are the tasks about which our educational bureau should make an effort. Reading literacy is an important foundation for lifelong learning. In 2006, the results presented in PIRLS (Progress in International Reading and Literacy Study) and PISA (Programme for International Student Assessment), had a great impact over the practices of reading education in Taiwan. The Ministry of Education and some private business worked together with an attempt to apply some human and financial resources to the promotion of students' reading habits and interests on campuses.

Indeed, results presented in PISA 2009 reveal an effective and systematic reading intervention program in junior high school students' reading literacy because the improvement of elevating literacy could not be achieved by partial or shallow modifications. It is still an issue whether the reading literacy program of PISA is a plausible criterion for Taiwanese reading education. However, in a global competitive market, through the comparison with other countries, we can observe our educational system more objectively. Does instruction in reading strategies need to be adjusted? Could the assessment of reading comprehension and reasoning be included in our national large-scale examinations? The educational communities should have a clear policy for our reading education goals and the practices of reading instruction and assessment. If the Base Competency Test of junior high school deeply influences the teaching and learning in schools, maybe the framework and item types of language assessment should also be included as an important aspect of reform.

Mathematics and Science Literacy

About 12% of Taiwanese students have not progressed beyond a very basic level of understanding at Level 1. This means that they can only perform mathematical tasks in very familiar contexts and can only show understanding of science at a very basic level in a limited range of situations. Such students will have difficulty thinking mathematically and scientifically in a world that demands this of them in their working lives and even as everyday citizens. Taiwan still needs to work hard to enable the students who are below Level 2 to understand a world in which scientific issues play such an important part.

At the other end of the proficiency scale, the number of students reaching Level 5 and Level 6 in mathematics and science will be particularly important for countries wishing to create a pool of workers able to advance the frontiers of scientific and technological knowledge in the future, helping countries to compete in the global economy. 28% of students reach this high level of mathematics proficiency. Taiwan is clearly advantaged by having twice the proportion of students highly proficient in mathematics than the average for the OECD, while other East Asian countries and economies show that this is by no means an upper limit. Around one in three students in Hong Kong and Singapore, and half of those in Shanghai are at Level 5 or Level 6 in mathematics. In the case of science, 9% students reach this high level of science proficiency, compared to Shanghai's 24% of students at Levels 5 or 6, 20% in Singapore, 19% in Finland, 17% in Japan, 16% in Hong Kong, and 12% in Korea. This constitutes a challenge for Taiwan, showing that it is possible to develop a population where high mathematical and scientific proficiency becomes the norm, allowing broadly-based participation at the high end of the knowledge economy.

Trends in performance in mathematics and science are derived by comparing results of PISA 2009 with those of the 2006 assessments. Taiwan showed a slight decline in mathematics performance but was still among the top-performing countries in PISA. Taiwan decreased in the mathematics and science scores by 6 and 12 points, respectively. Particularly, Taiwan showed the largest reduction in the percentage of top performers in science: six percentage points, from 15 to 9%. This finding raises a warning. Taiwanese students' excellent performances in mathematics and sciences are meant to be the competitive power of Taiwan in essence. Facing the decline, the communities which conduct the mathematics and science education need to find some ways to help improve our students' performances in mathematics and sciences.

Quality and Equity in Learning Opportunity

PISA highly values the issue of educational equity and attempts to provide different reference indices for each participating country. In general, the status of educational equity

in Taiwan is slightly superior to the OECD average; however, compared to the most equitable country, Finland, there is much room for improvement. The comparison across countries can facilitate the substantial reflection of education policy. The performance differences between schools can be attributed not only to urban-rural differences but also to the Entrance Examination of senior high /vocational schools. The Ministry of Education is currently promoting the 12-year National Education and also the Quality Regional High Schools project; thus it will help to minimize the proportion of variance in student performance between schools.

Implications for Educational Reflection

PISA defines literacy as key competencies for students' learning and career potential in the future. The literacy approach assessment design especially focuses on task authenticity. The interesting and meaningful testing scenario invites students to solve problems more attentively. Generally speaking, for most students, taking PISA will be a new and challenging experience. In Taiwan, our students fall behind in evidence-based arguments. To help our students comprehend the intention of task design and the logic of a sufficient response is also a very valuable learning experience. Understanding the assessment design of PISA, and applying the new elements into our education system appropriately will be the most important impacts from PISA.

Facing the challenge of PISA 2012 digital assessment, Taiwan's educational system is forced to speed up preparations for the digital learning and assessment era. Internet navigation, information evaluation, active attempts to explore ill-defined situations, and the disposition for problem solving have formally become the focus of international assessment. In order to catch up with this fast progress, many PISA participant countries or economies, Taiwan included, are dedicated to keeping pace with the others,. Based upon the PISA results and the forthcoming challenges, the educational communities in Taiwan might need to form a higher degree of consensus for a feasible and sustainable action plan to elevate the distinguished students and to support the disadvantaged students.

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