CHAPTER III: STUDENT ACHIEVEMENT

STUDENT ACHIEVEMENT

Keeping Illinois globally competitive requires all citizens to have strong mathematics and science skills. To determine the status of STEM performance in Illinois, Chapter III compares the performance of

- U.S. students to their international peers
- Illinois students to their international peers
- Illinois students to their national peers
- Subgroups of students within Illinois to each other

A recurring theme in this chapter is the average, or at times below average, performance of the U.S. in international comparisons, and the average performance of Illinois students compared to the aggregated U.S. performance. However, the Illinois average represents some high-scoring subgroups and some extremely low-scoring subgroups. Keeping Illinois competitive will require strategically addressing three gaps: 1) the extreme differences in performance of U.S. students when compared to the highest-scoring Asian countries; 2) the gap in the performance of Illinois low-income students, black students, and Hispanic students compared to Asian and white students; and 3) the decreasing percentages of students meeting or exceeding state goals as they move from fifth grade to middle school and then to high school, especially the male low-income students.

Keeping Illinois competitive will require addressing the low performance of Illinois low-income students and the decreasing percentages of students who meet state goals as they move from grade school through high school.

International Comparisons - United States

Over the past ten years, major international studies have assessed student academic achievement in nearly 50 countries. Testing protocols and standardized procedures have increasingly become stricter to help ensure that representative samples of all students in each country are used so that the scores from the various participating nations can be compared.

Two major international studies provide information about U.S. student academic achievement in STEM subjects:

- *Trends in International Mathematics and Science Study* (TIMSS) assessed student mastery of curriculum-based knowledge and skills in mathematics and science at the equivalent of 4th grade and 8th grade in 46 countries.
- *Programme for International Student Assessment* (PISA) focused on how 15-year olds in 40 countries used mathematics, science, and problem-solving skills to solve real-life problem; most participants were Organisation for Economic Co-operation and Development (OECD) countries.

CHAPTER III

Trends in International Mathematics and Science Study (TIMSS)

In 2003, the International Association for the Evaluation of Educational Achievement (IEA) conducted the TIMSS project. The mathematics and science tests reflect the curricula frameworks that the test developers view as appropriate for the given grade level, and the tests measure the degree to which students have learned these concepts.

TIMSS - Mathematics

On the 2003 TIMSS mathematics test, the average U.S. score for 4th grade and 8th grade students was statistically equivalent to the international average. However, the U.S. scored much lower than many of the other industrialized nations, including several Asian countries—especially Singapore, Korea, Hong Kong, Chinese Taipei, and Japan—and the Netherlands and Belgium.

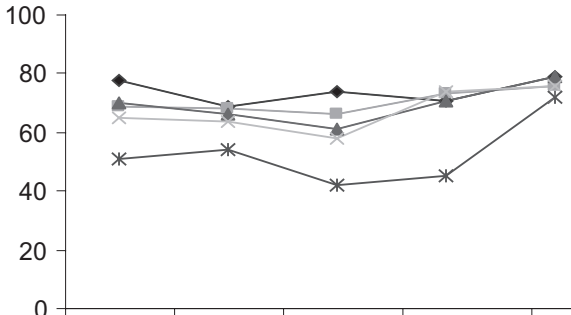
Table 1 Scores on TIMSS 2003 Mathematics Test for Selected Countries[63]

Mathematics – 4th Grade		**Mathematics - 8th Grade**	
Country	Score	Country	Score
Singapore	*594*	Singapore	605
Hong Kong SAR	*575*	Korea	*589*
Japan	*565*	Hong Kong SAR	*586*
Chinese Taipei	*564*	Chinese Taipei	*585*
Belgium-Flemish	*551*	Japan	*570*
Netherlands	*540*	Belgium-Flemish	*537*
Latvia	*536*	Netherlands	*536*
Lithuania	*534*	Hungary	*529*
Russian Federation	*532*	*Russian Federation*	*508*
Hungary	*529*	*Australia*	*505*
U.S.	***518***	*Latvia*	*505*
Cyprus	*510*	***U.S.***	*504*
Italy	*503*	*Lithuania*	*502*
Australia	*499*	*Sweden*	*499*
New Zealand	*493*	*Scotland*	*498*
Scotland	*490*	*New Zealand*	*494*
Norway	451	*Italy*	*484*
Shading and italics indicate statistically similar to the U.S.		Norway	461
		Cyprus	459

STUDENT ACHIEVEMENT

The following figure compares the performance of 8th grade U.S. students to the performance of selected Asian countries on the content area tests in mathematics. The U.S. students scored much lower, especially on the geometry and measurement content. They scored the closest to their Asian peers on the data content.

Figure 8 Percentages of Correct Answers in 8th Grade Mathematics Test by Content Area in 2003[64]



	Number	Algebra	Measure-ment	Geometry	Data
Singapore	78	69	74	71	79
Hong Kong	69	68	66	73	76
Chinese Taipei	70	66	61	71	79
Japan	65	64	58	74	76
US	51	54	42	45	72

CHAPTER III

TIMSS - Science

Table 2 Scores on TIMSS 2003 Science Test for Selected Countries[65]

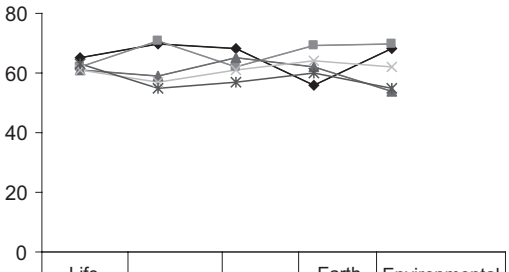
Science – 4th Grade		Science - 8th Grade	
Country	Score	Country	Score
Singapore	565	Singapore	578
Chinese Taipei	551	Chinese Taipei	571
Japan	*543*	Korea	558
Hong Kong SAR	*542*	Hong Kong SAR	556
U.S.	***536***	Japan	552
Latvia	*532*	Hungary	543
Hungary	*530*	*Netherlands*	*536*
Russian Federation	*526*	*Australia*	*527*
Netherlands	525	***U.S.***	*527*
Australia	521	*New Zealand*	*520*
New Zealand	520	Lithuania	519
Belgium-Flemish	518	Belgium-Flemish	516
Italy	516	Russian Federation	514
Lithuania	512	Latvia	513
Scotland	502	Scotland	512
Cyprus	480	Norway	494

Shading and italics indicate statistically similar to the U.S.

The U.S. students in 4th and 8th grade achieved scores statistically similar to the international average on the 2003 TIMSS science test. In both grades, however, students from Singapore, Chinese Taipei, and Japan performed consistently higher than the U.S. students.

In 4th grade science, U.S. students scored similarly to those in Hong Kong, but in 8th grade science, the U.S. slipped further down the rankings.

Figure 9
Percentages of Correct Answers in 8th Grade Science Test by Content Area in 2003[66]



	Life Science	Chemistry	Physics	Earth Science	Environmental Science
Singapore	65	70	68	56	68
Chinese Taipei	62	71	62	69	70
Japan	61	59	65	62	54
Hong Kong	61	57	61	64	62
U.S.	63	55	57	60	55

The science test is divided into content areas as shown in the figure at left. The U.S. 8th grade students performed significantly lower in chemistry than did the top performers. This is an especially critical gap because chemistry is a prerequisite in STEM fields such as engineering.

STUDENT ACHIEVEMENT

Programme International Student Assessment (PISA), 2003

PISA assesses the mathematics, science, and problem-solving skills of 15-year olds through questions that require students to apply knowledge and skills to new situations. The U.S. mathematics and science scores were statistically similar to the respective international average scores, but problem-solving scores were lower.

Table 3 Comparison of Mean Performance on PISA Mathematics and Science Tests in 2003 in Selected Countries[67]

PISA Mathematics 2003		PISA Science 2003	
Country	Score	Country	Score
Hong-Kong, China	550	Finland	548
Finland	544	Japan	548
South Korea	542	Hong-Kong, China	540
Netherlands	538	South Korea	538
Japan	534	Macao-China	525
Canada	532	Australia	525
Belgium	529	Netherlands	524
Macao-China	527	Canada	519
Switzerland	527	Switzerland	513
Australia	524	France	511
New Zealand	523	Belgium	509
Iceland	515	Sweden	506
Denmark	514	Ireland	505
France	511	Hungary	503
Sweden	509	Germany	502
Austria	506	Poland	498
Ireland	503	Iceland	495
Germany	503	Austria	491
Norway	495	**UNITED STATES**	491
Luxenbourg	493	Latvia	489
Hungary	490	Russian Federation	489
Poland	490	Spain	487
Spain	485	Italy	487
UNITED STATES	483	Norway	484
Russian Federation	468	Luxenbourg	483
Italy	466	Greece	481
Portugal	466	Denmark	475
Greece	445	Portugal	468
Turkey	423	Uruguay	438
Uruguay	422	Turkey	434
Indonesia	360	Indonesia	395
Tunisia	359	Tunisia	385

Shading and italics indicate statistically similar to the U.S.

The U.S. students scored lower on the PISA mathematics and science tests than many of the industrialized nations and emerging nations. Students in Hong Kong-China, Finland, South Korea, and the Netherlands were the top performers in mathematics. Finland, Japan, Hong Kong-China, and South Korea were the top performers in science. Some of the other countries outperforming the U.S. on these tests are Canada, Switzerland, Australia, France, Sweden, and Germany.

CHAPTER III

When students were required to use their knowledge and skills to solve authentic problems, the U.S. scored lower than 22 countries, the same as 8 countries, and higher than 9 countries. The top-scoring countries on problem-solving included Korea, Hong Kong-China, Finland, and Japan. The nine countries scoring lower than the U.S. were Greece, Thailand, Serbia, Uruguay, Turkey, Mexico, Brazil, Indonesia, and Tunisia.

Summary of International Comparisons - United States

Statistically, the U.S. students performed at approximately the international average on TIMSS and PISA mathematics and science exams. These statistics, however, can be deceiving because the scaled scores for the U.S. students were predominately lower than the scores of other industrialized nations on all of these tests. Also, U.S. students outscored only 9 countries on the PISA problem-solving tests.

To remain competitive with the top-scoring countries—Hong Kong-China, Singapore, Chinese-Taipei, Korea, Japan, and the Netherlands—the U.S. needs to improve the mathematics, science, and problem-solving skills of all students. These skills lay the foundation for innovation, increased productivity, and the development and implementation of new technologies. A starting point is to look at the curricula and instructional strategies, which are discussed in Chapter VI.

International Comparisons - Illinois

In 1997 and 1999, TIMSS allowed subgroups within a state to participate in the international studies. Illinois was represented in 1997 by the First in the World Consortium, a group of 17 Chicago suburban districts and the Illinois Math and Science Academy (IMSA). These districts and IMSA were determined to learn how their students were doing in a global competition and to make the necessary changes to become "first in the world."[68] These school districts were already among the highest performing in Illinois and the nation. The students in the consortium were predominantly white (78%), only 7% were low income, and 6% had limited English proficiency. With considerably more fiscal resources than most schools, the districts' per-pupil expenditures were 55% higher than the national average. The teachers within the consortium had higher levels of education and more years of teaching experience than the national and state averages.

Compared to their global competitors, the First in the World students did extremely well in 1997. In 4th and 8th grade mathematics, only students in Singapore performed better. No nation outperformed the consortium in 4th and 8th grade science.

At the 12th grade level, students were assessed for general achievement in mathematics and science knowledge and in a separate test for advanced topics. In the general test, First in the World students performed similarly with the top seven countries; however, the consortium students scored around the average in the advanced tests. A bright spot on the advanced tests was a subgroup of consortium students taking Advanced Placement courses; they were