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U.S. Student Achievement From A Global Perspective

Thomas Loveless
Brookings Mountain West

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Understanding International Assessments

Tom Loveless
UNLV
Las Vegas, Nevada
January 17, 2012

Outline of Talk

1. The First International Tests
2. Why International Test Scores Matter
3. Comparing PISA and TIMSS
4. Sample Items
5. Results from TIMSS and PISA
6. Some surprises

INTERNATIONAL PROJECT FOR THE EVALUATION
OF EDUCATIONAL ACHIEVEMENT (IEA)

Phase I

International Study of Achievement in Mathematics

A Comparison of Twelve Countries

VOLUME

II

EDITED BY

TORSTEN HUSÉN

Chairman of the IEA

ALMQVIST & WIKSELL
STOCKHOLM

JOHN WILEY & SONS
NEW YORK · LONDON · SIDNEY

1st International Mathematics Study, Population 1B

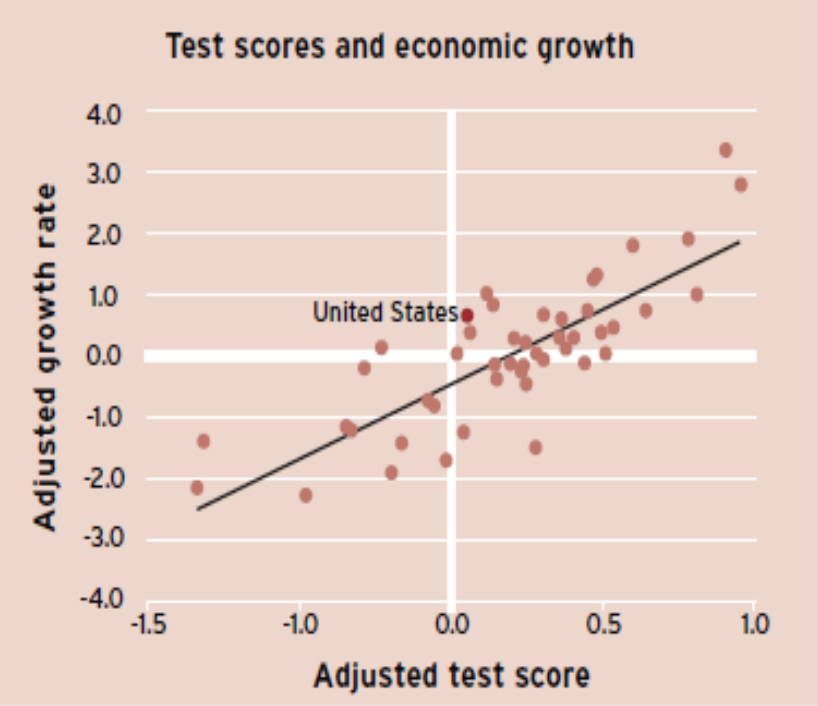
Country	Mean	SD
Israel	32.3	14.7
Japan	31.2	16.9
Belgium	30.4	13.7
Finland	26.4	9.6
Germany	25.4	11.7
England	23.8	18.5
International Avg.	23.0	15.0
Scotland	22.3	15.7
The Netherlands	21.4	12.1
France	21.0	13.2
Australia	18.9	12.3
United States	17.8	13.3
Sweden	15.3	10.8

International Project for the Evaluation of Educational Achievement, *International Study of Achievement in Mathematics: A Comparison of Twelve Countries*, edited by Torsten Husén (New York, John Wiley and Sons, 1967).

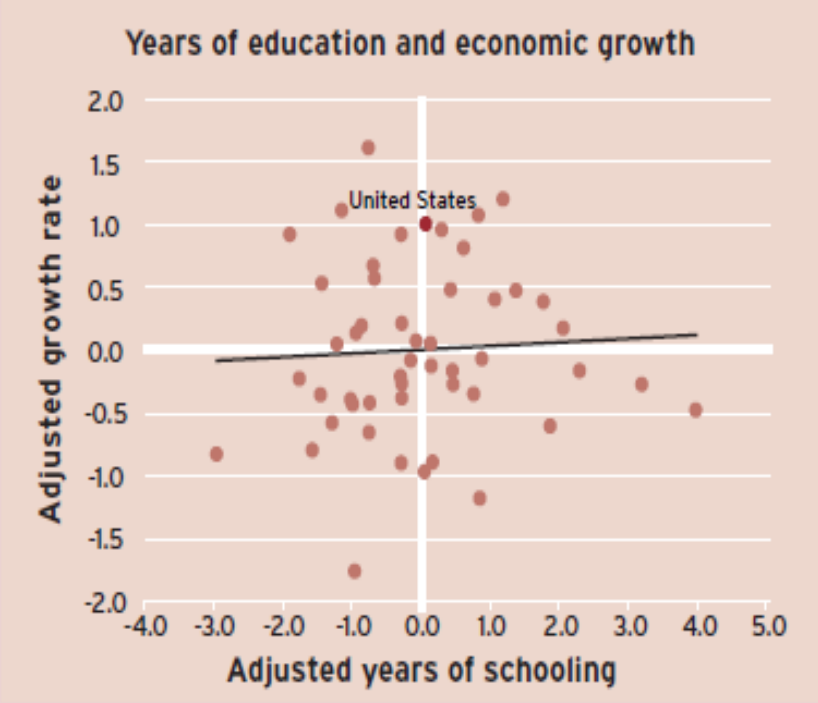
Economic Growth and Education, 1960-2000
Hanushek et al (2008)

Explaining Economic Growth (Figure 3)

How much students learn, not how long they stay in school, is the key to economic growth. The United States, however, has had a higher growth rate during this period than would be expected given its test scores and levels of school attainment.



Note: The y-axis indicates growth rates from 1960 and 2000, adjusted for GDP in 1960 and school attainment. The x-axis shows test scores adjusted for school attainment. The solid line plots the relationship between the two variables among the 50 countries with available test score information, each of which is represented by a dot.



The y-axis indicates growth rates from 1960 and 2000, adjusted for GDP in 1960 and test scores. The x-axis shows school attainment adjusted for test scores. The solid line plots the relationship between the two variables among the 50 countries with available test score information, each of which is represented by a dot.

Comparing PISA and TIMSS

Governance	
PISA	TIMSS
▪ Government representatives	▪ Researchers and Government Representatives

Sample	
PISA	TIMSS
▪ Age-based; 15-year-olds	▪ Grade-based; 4th and 8th grades

Comparing PISA and TIMSS (cont.)

Philosophy of Assessment	
PISA	TIMSS
• Measures the ability to apply what has been learned to real-world situations (socio-constructivist)	• Measures what has been learned in the school curriculum

Scope	
PISA	TIMSS
▪ Learning inside and outside of school, including attitudes, values, and beliefs	▪ Topics in school curriculum

Comparing PISA and TIMSS (cont.)

Content-Math	
PISA	TIMSS
▪ Mathematical literacy: Space and shape, change and relationships, quantity, uncertainty	▪ Grade 4 mathematics: Number, geometric shapes and measures, data display ▪ Grade 8 mathematics: Number, algebra, geometry, data and chance

Sample Item—TIMSS 4th Grade Math

Exhibit 2.8 **TIMSS 2007 High International Benchmark (550) of Mathematics Achievement – Example Item 3**

TIMSS2007 Mathematics 4th Grade

Content Domain: Number

Description: Determines the missing digit to give a specified difference in a three-digit subtraction problem.

$$\begin{array}{r} 942 \\ -5\blacksquare7 \\ \hline 415 \end{array}$$

Mano did the subtraction problem above for homework but spilled some of his drink on it. One digit could not be read. His answer of 415 was correct. What is the missing digit?

Answer: 2

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit
Chinese Taipei	88 (1.6)
Hong Kong SAR	85 (1.9)
Singapore	85 (1.4)
Russian Federation	84 (1.8)
! Kazakhstan	83 (3.1)
Japan	80 (1.8)
! Lithuania	71 (2.3)
! Latvia	71 (2.6)
Ukraine	68 (2.3)
Armenia	66 (3.0)
! Georgia	60 (2.7)
Hungary	51 (2.8)
Slovak Republic	50 (2.3)
Italy	49 (2.1)
International Avg.	42 (0.4)
Germany	41 (2.2)
Czech Republic	41 (2.6)
2 † United States	41 (1.8)
Austria	41 (2.4)
Slovenia	31 (2.0)
‡ Netherlands	31 (2.6)
Iran, Islamic Rep. of	29 (2.2)
† Denmark	28 (2.5)
England	28 (2.1)
Colombia	25 (2.1)
† Scotland	25 (2.2)
Australia	22 (2.6)
Sweden	18 (1.7)
New Zealand	18 (1.6)
Norway	18 (1.9)
Tunisia	18 (1.8)
Algeria	16 (1.9)
Morocco	14 (1.7)
El Salvador	13 (1.6)
↔ Kuwait	10 (1.4)
Yemen	7 (1.3)
Qatar	5 (0.8)
Benchmarking Participants	
2 Massachusetts, US	52 (3.8)
2 † Minnesota, US	45 (3.9)
2 Quebec, Canada	42 (2.9)
↔ ‡ Dubai, UAE	32 (2.9)
2 British Columbia, Canada	31 (2.2)
2 Alberta, Canada	26 (2.4)
2 Ontario, Canada	22 (2.8)

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Sample Items: PISA 2006 Mathematics Literacy

MATHEMATICS UNIT 48: ROCK CONCERT

QUESTION 48.1

For a rock concert a rectangular field of size 100 m by 50 m was reserved for the audience. The concert was completely sold out and the field was full with all the fans standing.

Which one of the following is likely to be the best estimate of the total number of people attending the concert?

A. 2 000

B. 5 000

C. 20 000

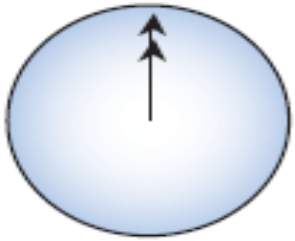
D. 50 000

E. 100 000

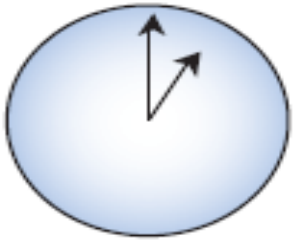
MATHEMATICS UNIT 11 : INTERNET RELAY CHAT

Mark (from Sydney, Australia) and Hans (from Berlin, Germany) often communicate with each other using "chat" on the Internet. They have to log on to the Internet at the same time to be able to chat.

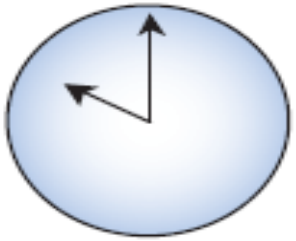
To find a suitable time to chat, Mark looked up a chart of world times and found the following:



Greenwich 12 Midnight



Berlin 1:00 AM



Sydney 10:00 AM

QUESTION 11.1

At 7:00 PM in Sydney, what time is it in Berlin?

Answer: .....

QUESTION 11.2

Mark and Hans are not able to chat between 9:00 AM and 4:30 PM their local time, as they have to go to school. Also, from 11:00 PM till 7:00 AM their local time they won't be able to chat because they will be sleeping.

When would be a good time for Mark and Hans to chat? Write the local times in the table.

Place	Time
Sydney	
Berlin	

TIMSS 2007 Math Scores (Grade 4)

Hong Kong SAR	607	Germany	525
Singapore	599	Denmark	523
Chinese Taipei	576	Australia	516
Japan	568	Hungary	510
Kazakhstan	549	Italy	507
Russian Federation	544	Austria	505
England	541	Sweden	503
Latvia	537	Slovenia	502
Netherlands	535	Armenia	500
Lithuania	530	Slovak Republic	496
United States	529		

Countries in blue are significantly above the international average scale score (M = 500, sd = 100).

Source: TIMSS & PIRLS International Study Center, *TIMSS 2007 International Mathematics Report: Findings from IES's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades* (2008).

TIMSS 2007 Math Scores (Grade 4)

Scotland	494
New Zealand	492
Czech Republic	486
Norway	473
Ukraine	469
Georgia	438
Iran, Islamic Rep. of	402
Algeria	378
Colombia	355
Morocco	341
El Salvador	330
Tunisia	327
Kuwait	316
Qatar	296

Countries in green are significantly below the international average scale score (M = 500, sd = 100).

Source: TIMSS & PIRLS International Study Center, *TIMSS 2007 International Mathematics Report: Findings from IES's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades* (2008).

TIMSS 2007 Math Scores (Grade 8)

Chinese Taipei	598
Korea, Rep. of	597
Singapore	593
Hong Kong SAR	572
Japan	570
Hungary	517
England	513
Russian	512
United States	508
Lithuania	506
Czech Republic	504
Slovenia	501
Armenia	499
Australia	496

Countries in blue are significantly above the international average scale score (M = 500, sd = 100).

Source: TIMSS & PIRLS International Study Center, *TIMSS 2007 International Mathematics Report: Findings from IES's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades* (2008).

TIMSS 2007 Math Scores (Grade 8)

Sweden	491	Tunisia	491
Malta	488	Georgia	488
Scotland	487	Iran	487
Serbia	486	Bahrain	486
Italy	480	Indonesia	480
Malaysia	474	Syrian Arab Republic	474
Norway	469	Egypt	469
Cyprus	465	Algeria	465
Bulgaria	464	Colombia	464
Israel	463	Oman	463
Ukraine	462	Palestine	462
Romania	461	Botswana	461
Bosnia	456	Kuwait	456
Lebanon	449	El Salvador	449
Thailand	441	Saudi Arabia	441
Turkey	432	Ghana	432
Jordan	427	Qatar	427

Countries in green are significantly below the international average scale score (M = 500, sd = 100).

Source: TIMSS & PIRLS International Study Center, *TIMSS 2007 International Mathematics Report: Findings from IES's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades* (2008).

Table 1-1 Top Ten and Bottom Ten Countries on PISA 2009

Reading		Math		Science	
Country	Scale Score	Country	Scale Score	Country	Scale Score
Shanghai-China	556	Shanghai-China	600	Shanghai-China	575
Korea	539	Singapore	562	Finland	554
Finland	536	Hong Kong-China	555	Hong Kong-China	549
Hong Kong-China	533	Korea	546	Singapore	542
Singapore	526	Chinese Taipei	543	Japan	539
Canada	524	Finland	541	Korea	538
New Zealand	521	Liechtenstein	536	New Zealand	532
Japan	520	Switzerland	534	Canada	529
Australia	515	Japan	529	Estonia	528
Netherlands	508	Canada	527	Australia	527
International Ave	493	International Ave	496	International Ave	501
United States	500	United States	487	United States	514
Tunisia	404	Jordan	387	Argentina	401
Indonesia	402	Brazil	386	Tunisia	401
Argentina	398	Colombia	381	Kazakhstan	400
Kazakhstan	390	Albania	377	Albania	391
Albania	385	Tunisia	371	Indonesia	383
Qatar	372	Indonesia	371	Qatar	379
Panama	371	Qatar	368	Panama	376
Peru	370	Peru	365	Azerbaijan	373
Azerbaijan	362	Panama	360	Peru	369
Kyrgyz Republic	314	Kyrgyz Republic	331	Kyrgyz Republic	330

What Can We Learn from International Tests?

- Trends in National Achievement
- Top Scoring Nations
- Some Surprises

Poor U.S. Math Showing Didn't Surprise Experts
By Gerald Grant Washington Post Staff Writer
The Washington Post, Times Herald (1959-1973); Mar 12, 1967;
ProQuest Historical Newspapers The Washington Post (1877 - 1994)
pg. A3

Poor U.S. Math Showing Didn't Surprise Experts

By Gerald Grant
Washington Post Staff Writer

The poor showing of American youngsters in the first major international comparison of mathematical ability did not surprise the experts.

Although the study, made public last week, did not attempt to plumb the reasons why such countries as Japan and England outscored the United States, mathematical scholars say they are not difficult to perceive.

The experts assert that teachers here are not as well trained, and that neither American students nor the society at large places as much value on mathematics achievement as do many countries abroad.

Table 1-3

	FIMS 1961-1965	Last TIMSS (1995-2007)*	PISA 2009
Israel	0.62	-0.51	-0.58
Japan	0.55	0.56	0.25
Belgium	0.49	0.23	0.11
Finland	0.23	0.06	0.37
Germany	0.16	-0.05	0.09
England	0.05	-0.01	-0.13
Scotland	-0.05	-0.27	-0.06
The Netherlands	-0.11	0.22	0.22
France	-0.13	0.24	-0.08
Australia	-0.27	-0.18	0.10
United States	-0.35	-0.06	-0.18
Sweden	-0.51	-0.23	-0.11
Means:			
All Countries	23	500	496
12 Listed Countries	23	514	505

*Year of last TIMSS participation. TIMSS 2007: Israel, Japan, England, Scotland, Australia, United States, and Sweden. TIMSS 2003: Belgium (Flemish) and Netherlands. TIMSS 1999: Finland. TIMSS 1995: Germany and France.

Note: z-score is computed using the twelve nation mean as 0.00 and SD of 1.00.

FIMS: First International Math Study

Trends in Mathematics Scores, 8th grade by country: 1995 to 2007

Country	Average score 1995	Average score 2007	Difference 2007-1995
Colombia	332	380	47 *
Lithuania	472	506	34 *
Korea, Rep. of	581	597	17 *
United States	**492**	**508**	**16 ***
England	498	513	16 *
Slovenia	494	501	7 *
Hong Kong SAR	569	572	4
Cyprus	468	465	-2
Scotland	493	487	-6
Hungary	527	517	-10 *
Japan	581	570	-11 *
Russian Federation	524	512	-12
Romania	474	461	-12 *
Australia	509	496	-13 *
Iran, Islamic Rep. of	418	403	-15 *
Singapore	609	593	-16 *
Norway	498	469	-29 *
Czech Republic	546	504	-42 *
Sweden	540	491	-48 *
Bulgaria	527	464	-63 *

* *p*<.05. Within-country difference between 1995 and 2007 average scores is significant.

- Country difference in scores between 1995 and 2007 is greater than U.S.
- Country difference in scores between 1995 and 2007 is not measurably different from U.S.
- Country difference in scores between 1995 and 2007 is less than U.S.

Table 1-2
U.S PISA Scores

	PISA 2000	PISA 2003	PISA 2006	PISA 2009
Reading	504	495	---	500
Mathematics	---	483	474	487
Science	---	---	489	502

From *Strong Performers and Successful Reformers in Education: Lessons From PISA For The United States*, P. 26

TIMSS 2007 Mathematics Grade 8

Country	Average score
TIMSS scale average	500
Chinese Taipei	598
Korea, Rep. of	597
Singapore	593
Hong Kong SAR	572
Japan	570
Hungary	517
England	513
Russian Federation	512
United States	**508**
Lithuania	506
Czech Republic	504
Slovenia	501
Armenia	499
Australia	496
Sweden	491
Malta	488
Scotland	487
Serbia	486
Italy	480
Malaysia	474
Norway	469
Cyprus	465
Bulgaria	464
Israel	463
Ukraine	462
Romania	461
Bosnia and Herzegovina	456
Lebanon	449
Thailand	441
Turkey	432
Jordan	427
Tunisia	420
Georgia	410
Iran, Islamic Rep. of	403
Bahrain	398
Indonesia	397
Syrian Arab Republic	395
Egypt	391
Algeria	387
Colombia	380
Oman	372
Palestinian Nat'l Auth.	367
Botswana	364
Kuwait	354
El Salvador	340
Saudi Arabia	329
Ghana	309
Qatar	307

Chinese Taipei	598
Korea, Rep. of	597
Singapore	593
Hong Kong SAR	572
Japan	570

- Average score is higher than U.S. average score
- Average is not measurably different from U.S. average
- Average score is lower than U.S. average score

- U.S. average score lower than average scores of 5 countries
- Top countries in Asia

Why Do Top Scoring Nations Do So Well? My Own Speculation

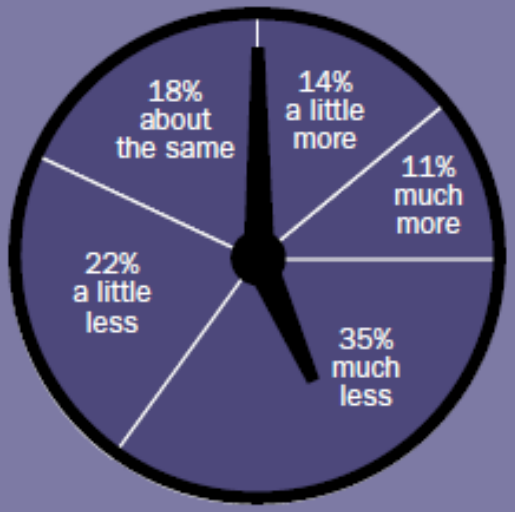
1. Culture—emphasis on academic achievement in childhood.
2. Time—longer day and year + time outside of school
3. Curriculum—lean, focused, sequential
4. Teachers—trained in academic disciplines rather than education schools

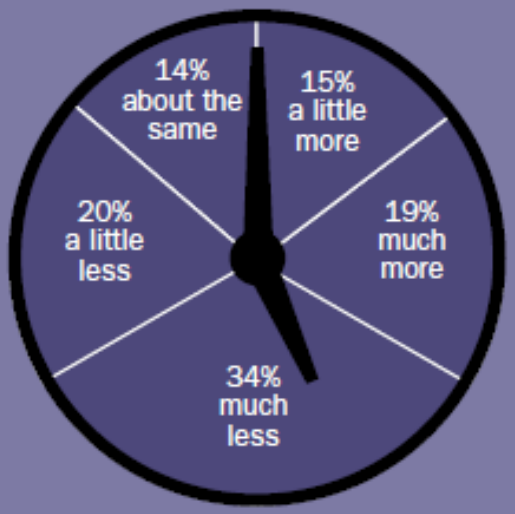
What Do Foreign Exchange Students Think?

- Brown Center Reports 2001, 2002.
- Sample of approximately 380 students from abroad (2001) and about the same from U.S (2002).
- Asked a series of questions comparing schools and peers in U.S. and abroad.

Both groups say that U.S. students spend less time on schoolwork.

International and U.S. students were asked:
Do you think U.S. students spend more, less, or about the same amount of time on schoolwork as students in other countries?



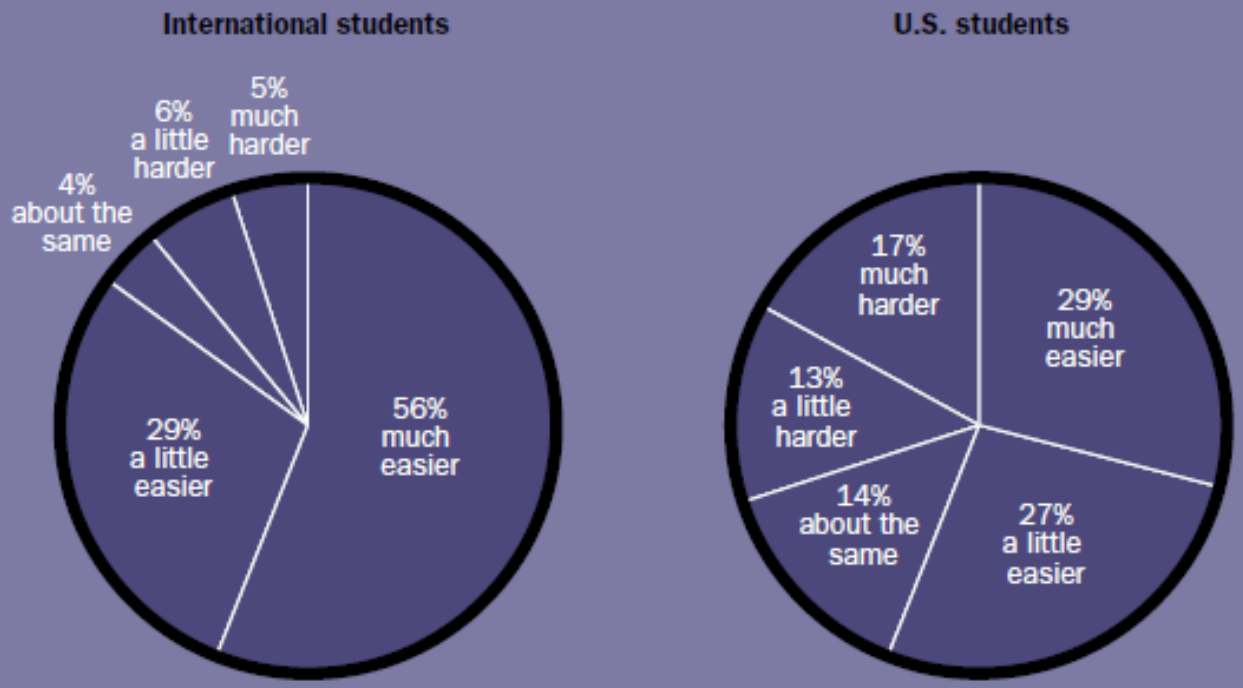


Margin of error: +/– 6%

Students from abroad say American classes are easier.

Fig 8

U.S. students agree, but less emphatically.

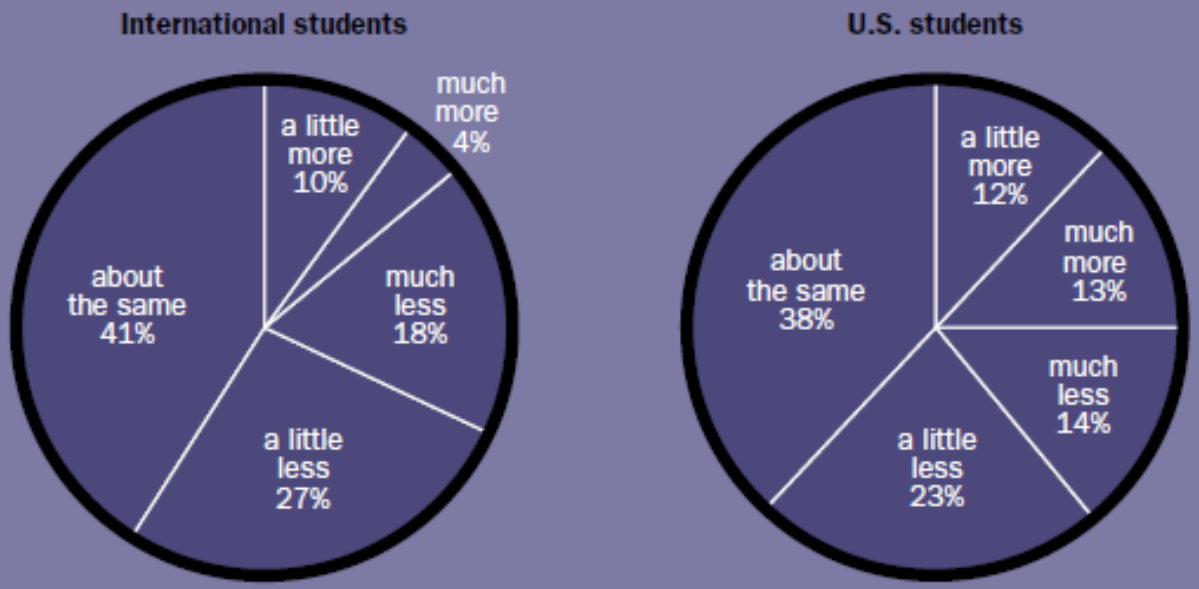


Margin of error: +/–6%

Both groups agree that math is valued less by U.S. students.

Fig 11

International and U.S. students were asked: Compared to students in other countries, how important is it to your American friends to do well in math?

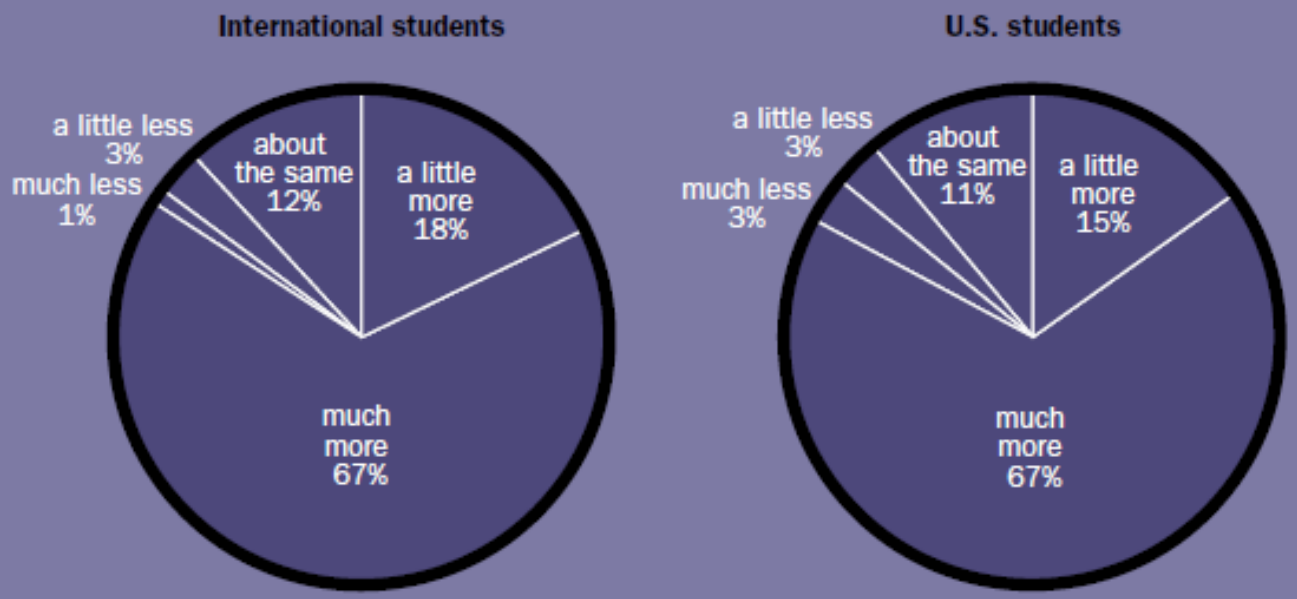


Margin of error: +/– 6%

Both groups resoundingly agree that the U.S. students highly value sports.

Fig 12

The survey asked: Compared to students in other counties, how important is it to your American friends to do well in sports?

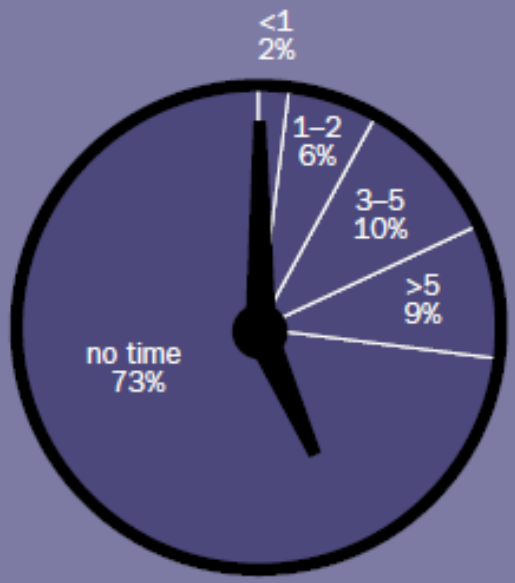


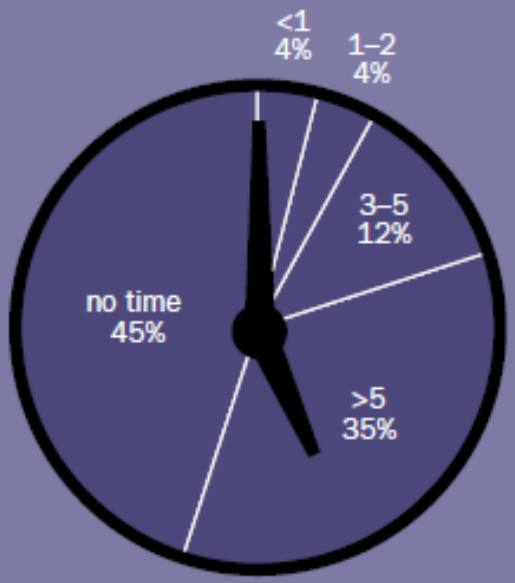
Margin of error: +/– 6%

U.S. students are more likely to work at part-time jobs during a typical school week.

Fig 10

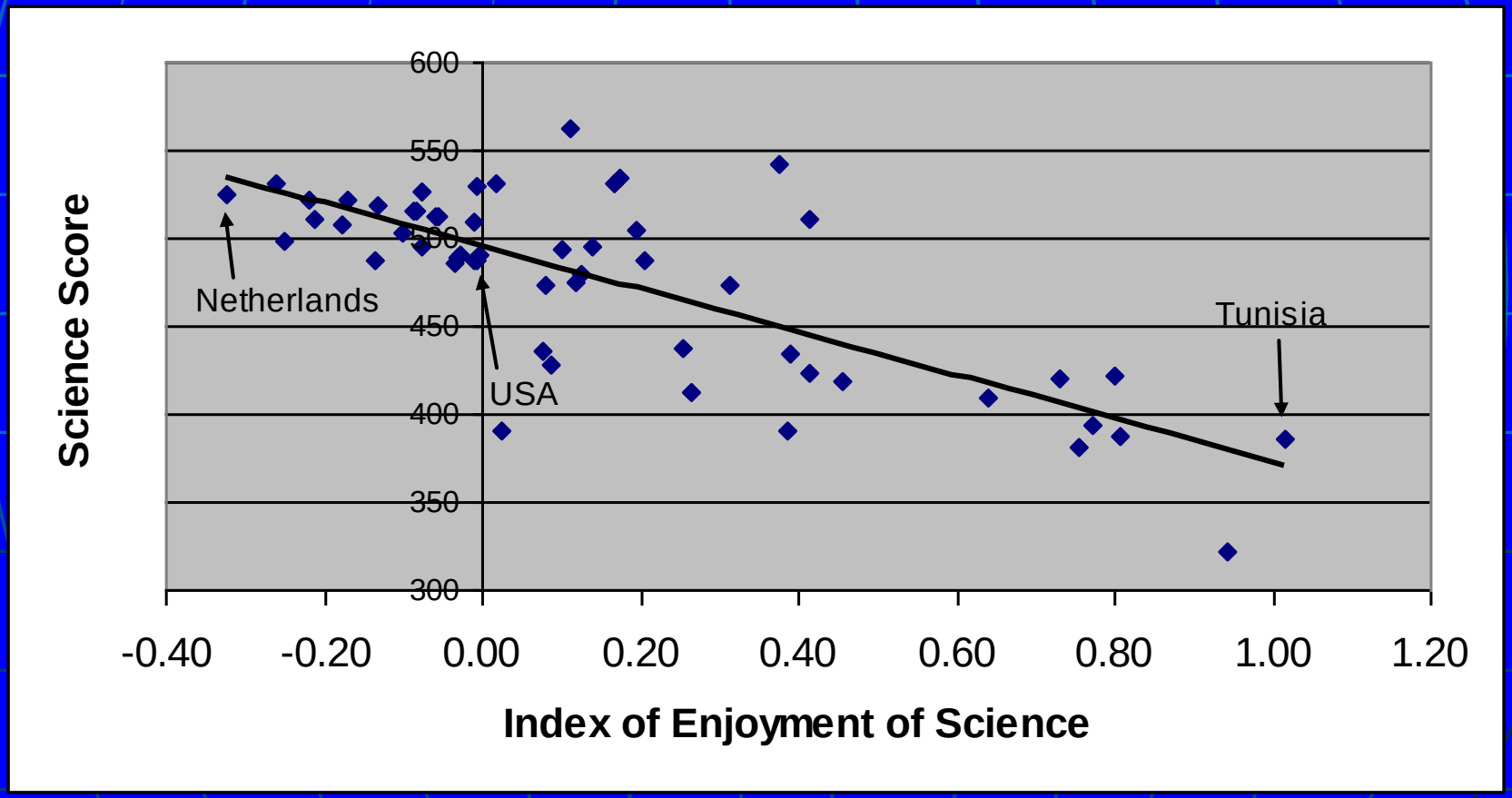
More than one-third of U.S. students work at least five hours per week, but only 9% of students abroad do so.





Margin of error: +/– 6%

A Surprise
Achievement and Enjoyment
Between Country Relationship, r = -0.76



Confidence: "I usually do well in mathematics" (8th grade)
(countries ranked by percent agree a lot)

Table 2-1

Country	Percent Students "Agree A Lot"	National Score
Jordan	48	424
Egypt	46	406
Israel	43	496 ✔
Ghana	41	276
Bahrain	40	401
Tunisia	39	410
Cyprus	39	459
Palestinian Authority	39	390
United States	39	504 ✔
South Africa	38	264
International Average	27	467
Romania	18	475 ✔
Singapore	18	605 ✔
Latvia	17	508 ✔
Moldova	17	460
Netherlands	16	536 ✔
Malaysia	13	508 ✔
Chinese Taipei	11	585 ✔
Hong Kong	10	586 ✔
Korea	6	589 ✔
Japan	4	570 ✔

(✔ – above international average)

Source: TIMSS 2003 Userguide (see almanacs, bsalm1_m3.pdf, pg.67): http://timss.bc.edu/timss2003i/userguide.html

Reported in the International Mathematics Report: this question is one of four questions constituting the student confidence index.

American students are much more confident about their math abilities than Singaporean students.

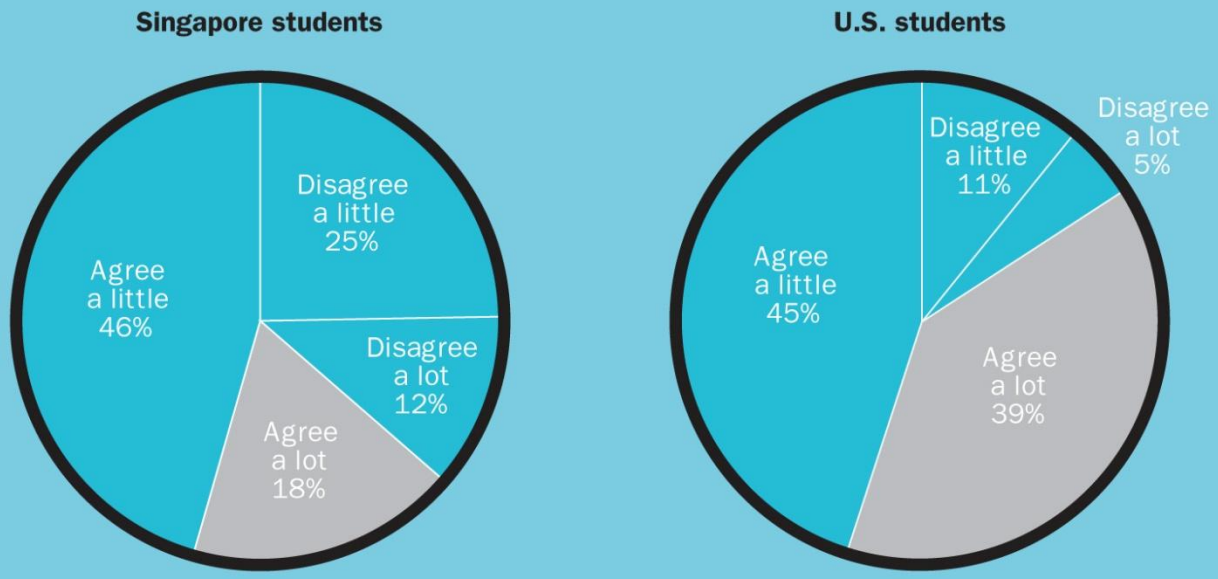
Fig 2-1

Students were asked whether they agreed with the statement, "I usually do well in mathematics."

39% of American students agreed a lot.

NOTE: Data refer only to 8th grade.

Source: TIMSS 2003 Userguide (see almanacs, bsalm1_m3.pdf, pg. 67): http://timss.bc.edu/timss2003i/userguide.html



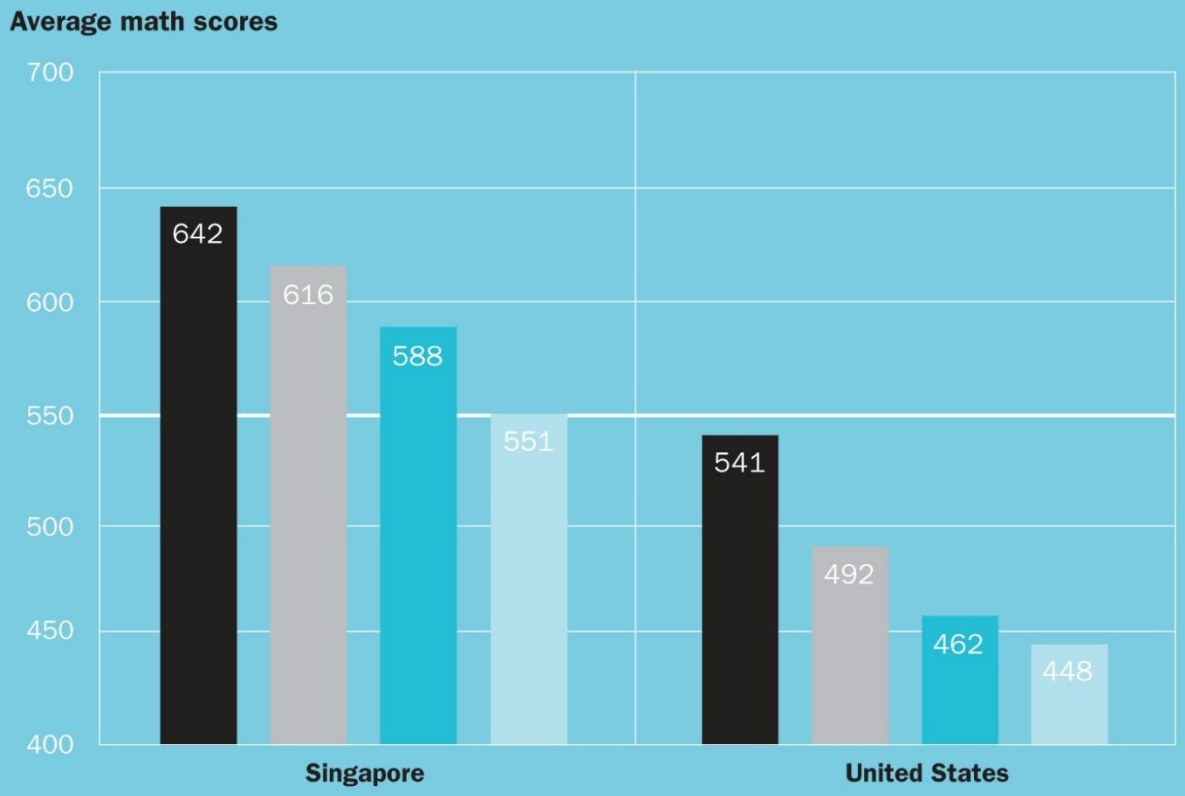
But even the least confident student in Singapore outscores the most confident American student!

Fig 2-2

Students were asked whether they agreed with the statement, "I usually do well in mathematics."

NOTE: Data refer only to 8th grade.

Source: TIMSS 2003 Userguide (see almanacs, bsalm1_m3.pdf, pg. 67): http://timss.bc.edu/timss2003i/userguide.html



How Does Clark County Stack Up?

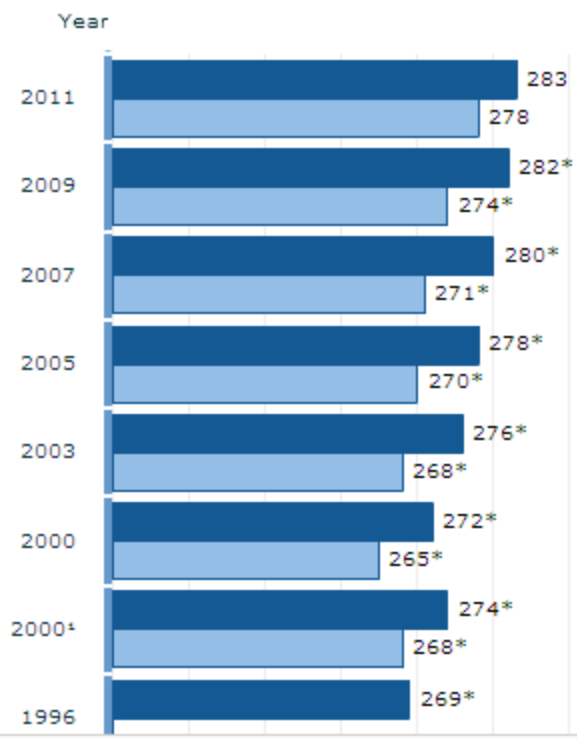
Finland in the U.S - Outl | Bush institute rates sch | School District Ranking | NAEP - Mathematics 20

nationsreportcard.gov/math_2011/gr8_state.asp

BofA Goog Mail AMTD Bet EdWk Vngrd Bee TCRF CNN CBS » Other bookmarks

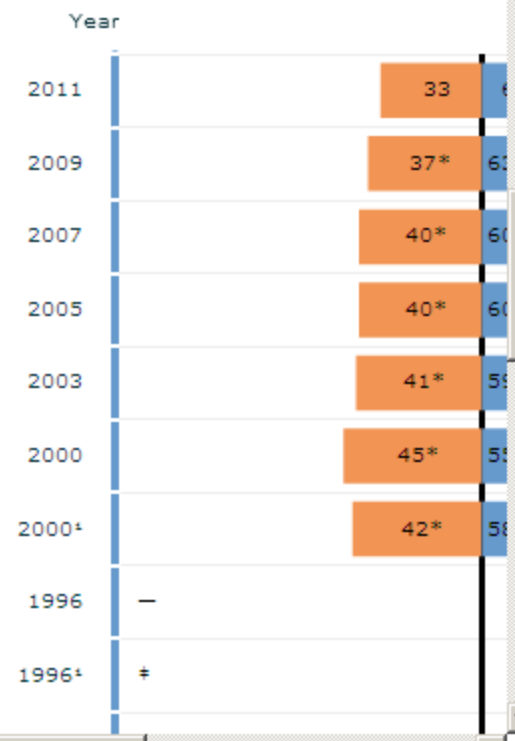
Average scale scores for mathematics, grade 8, by year and jurisdiction for All students [TOTAL]: 1990, 1992, 1996, 2000, 2003, 2005, 2007, 2009, and 2011

All students



Percentages at or above each achievement le
grade 8, by year for jurisdiction and All studer
2000, 2003, 2005, 2007, 2009, and 2011

Nevada, All students



Start | Schedule_Lovel... | NAEP - Mathe... | UNLV-01-12 | International Te... | unlv-new slides | 2:02 PM

Finland in the U.S - Outlook W | Bush institute rates school dist | School District Ranking | Educa

www.globalreportcard.org/map.html?state=NV&district=clark#

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HOW TO USE MAP

MINIMIZE MAP STATS

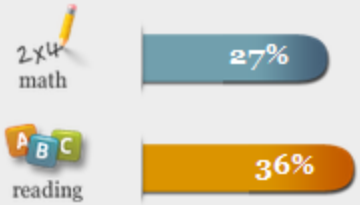
District vs. International | District vs. National | District vs. State

The GRC score indicates the level of math or reading achievement by the average student in a public school district compared to student achievement in a set of 25 developed countries. The score represents the percentage of students in the international group who would have a lower level of achievement. For example, a percentile of 60 means the average student in a school district would perform better than 60% of the students in the international group.

HISTORICAL VIEW
DISTRICT PERFORMANCE
2004 - 2007 RESULTS

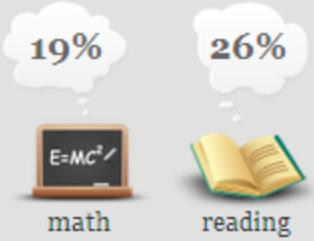
KEY: math, reading

Clark County



HERE'S HOW CLARK COUNTY WO STACK UP IF IT WAS DROPPED I THESE COUNTRIES...

Canada



Finland

Singapore

Switzerland

Shocked by your districts results?

Want to do something about it? We've provided a few questions that might help you start a conversation with education leaders.

MORE

The Bush Institute: | The Best & The Biggest

www.globalreportcard.org/map.html?state=NV&district=clark#

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Conclusion

- The two international tests, TIMSS and PISA, differ in content, sampling design, and age of students tested.

- The U.S. scores near the international average on mathematics tests. Mediocre but not awful.

- The U.S. has <u>never</u> scored at the top on international tests of math and science.

- The U.S. has improved (modestly) on international tests of math since 1995.

- National test scores in math are inversely correlated with national indicators of student confidence and enjoyment of subject.

Conclusion (cont.)

- Culture seems to matter a lot in promoting academic achievement.

- Extrapolations of state to national to international scores are fraught with error.

- That said, Clark County almost certainly would score significantly below average on a test of international achievement.