

What's behind Hong Kong's success in TIMSS?

- A look at how well Hong Kong does in TIMSS and what might explain their success

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Introduction

- How well Hong Kong does in TIMSS?
- And Why?
- Public interest in TIMSS usually focused only on ranking of countries in the league tables
- International studies such as TIMSS may provide answers to important questions in education, “using the world as a laboratory”
- The most important question: **In students’ learning and achievement, what matters?**
- Are there any system background variables which can be used to explain the results?

Countries participating in TIMSS 2007

Algeria	El Salvador	Kuwait	Russia
Armenia	England	Latvia	Saudi Arabia
Australia	Georgia	Lebanon	Scotland
Austria	Germany	Lithuania	Serbia
Bahrain	Ghana	Malaysia	Singapore
Bosnia and Herzegovina	Hong Kong SAR	Malta	Slovak Republic
Botswana	Hungary	Mongolia	Slovenia
Bulgaria	Indonesia	Morocco	Sweden
Chinese Taipei	Iran, Islamic Rep.	Netherlands	Syrian Arab Rep
Colombia	Israel	New Zealand	Thailand
Cyprus	Italy	Norway	Tunisia
Czech Republic	Japan	Oman	Turkey
Denmark	Jordan	Palestinian N A	Ukraine
Egypt	Kazakhstan	Qatar	United States
	Korea, Rep. of	Romania	Yemen

Background characteristics

- Hong Kong is relatively affluent, and schools are well resourced
- Parents are not highly educated
- Most teachers have a degree, as do those in most countries
- Student/teacher ratio is about the international average, but class size is large
- Time for maths instruction not particularly high

Student achievement cannot be accounted for totally by these background factors

Attitudes of Hong Kong students

- The high achievements do not seem to be accompanied by correspondingly positive attitudes towards study
- In TIMSS 2007,
 - the overall attitudes of Hong Kong students towards mathematics is below the international average
 - students do not value the subject much, and
 - **they lacked self-confidence in learning maths**

Classroom teaching in Hong Kong

- How do we explain the high achievement and low attitudes of Hong Kong students?
- Do Hong Kong students do well because their teachers teach well?

TIMSS 1999 Video Study (Mathematics)

- Describe and compare eighth-grade mathematics teaching across seven countries (Australia, Czech Republic, Hong Kong SAR, Japan, Netherlands, Switzerland, United States)
- Quantitative and qualitative analyses of the same dataset

Instructional practices in Hong Kong as portrayed by quantitative analysis

1. Classroom interaction:

Whole-class interaction dominated and teacher talked most of the time

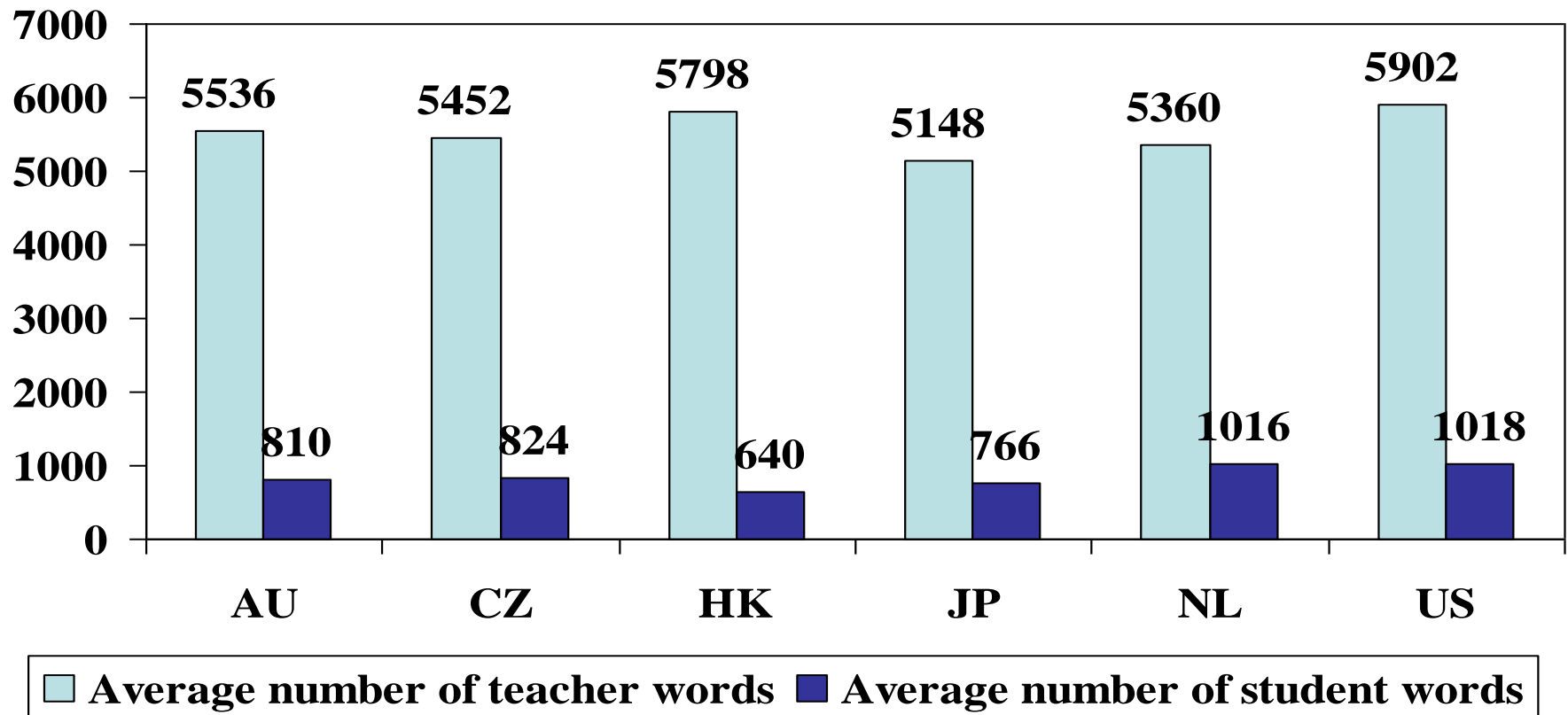
- Students' reticence: the large class size (37) in Hong Kong means a ratio of 16:1 is in effect a ratio of nearly 600:1 as far as an individual student is concerned



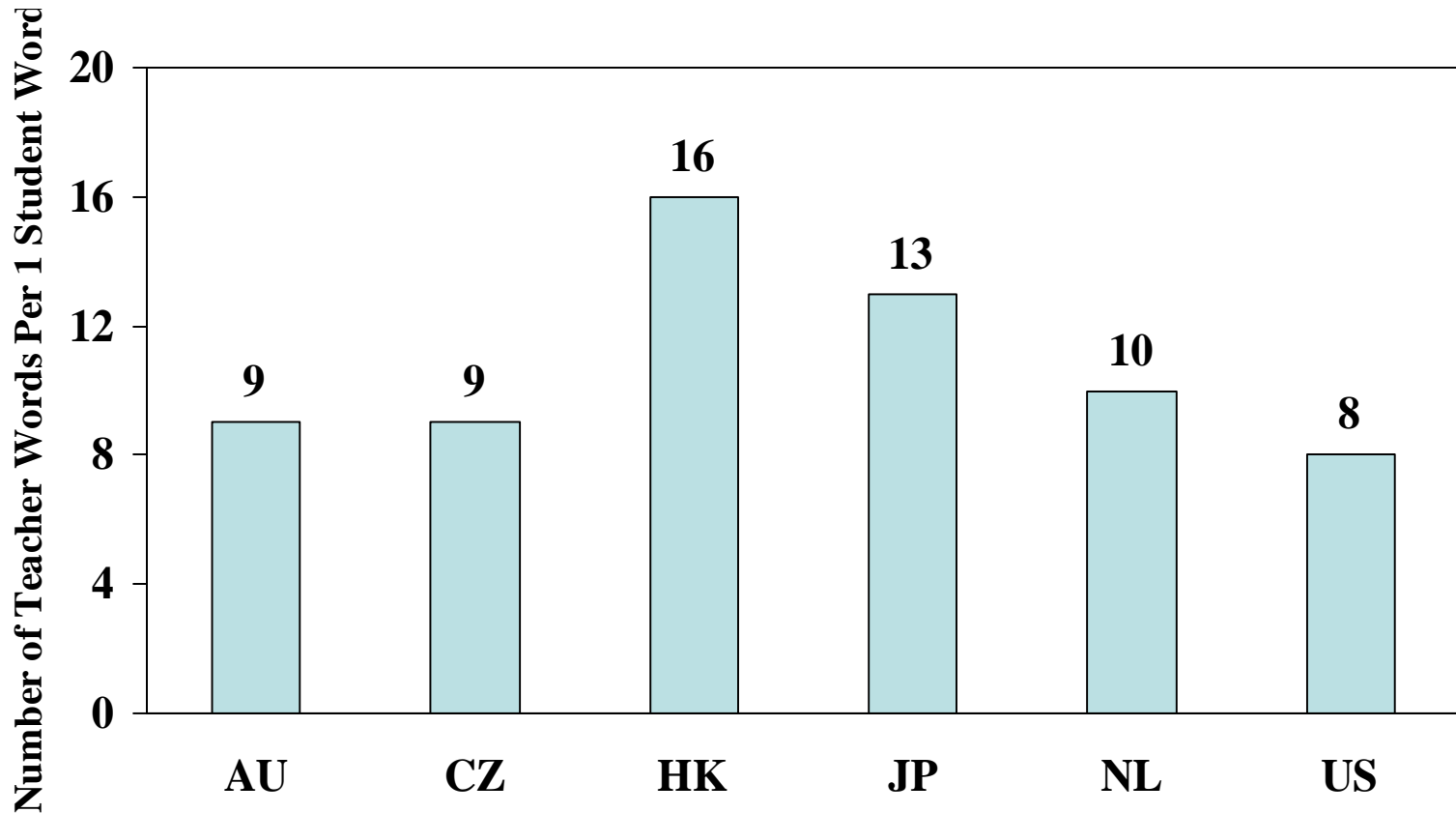
Average percentage of lesson time devoted to public and private interaction

Country	Public interaction	Private interaction	Others
Australia	52	48	0
Czech Republic	61	21	18
Hong Kong	75	20	5
Japan	63	34	3
Netherlands	44	55	1
Switzerland	54	44	1
United States	67	32	1

Average number of teacher and student words per lesson



Average number of teacher words to every one student word per lesson



2. Mathematics problems worked on in the classroom

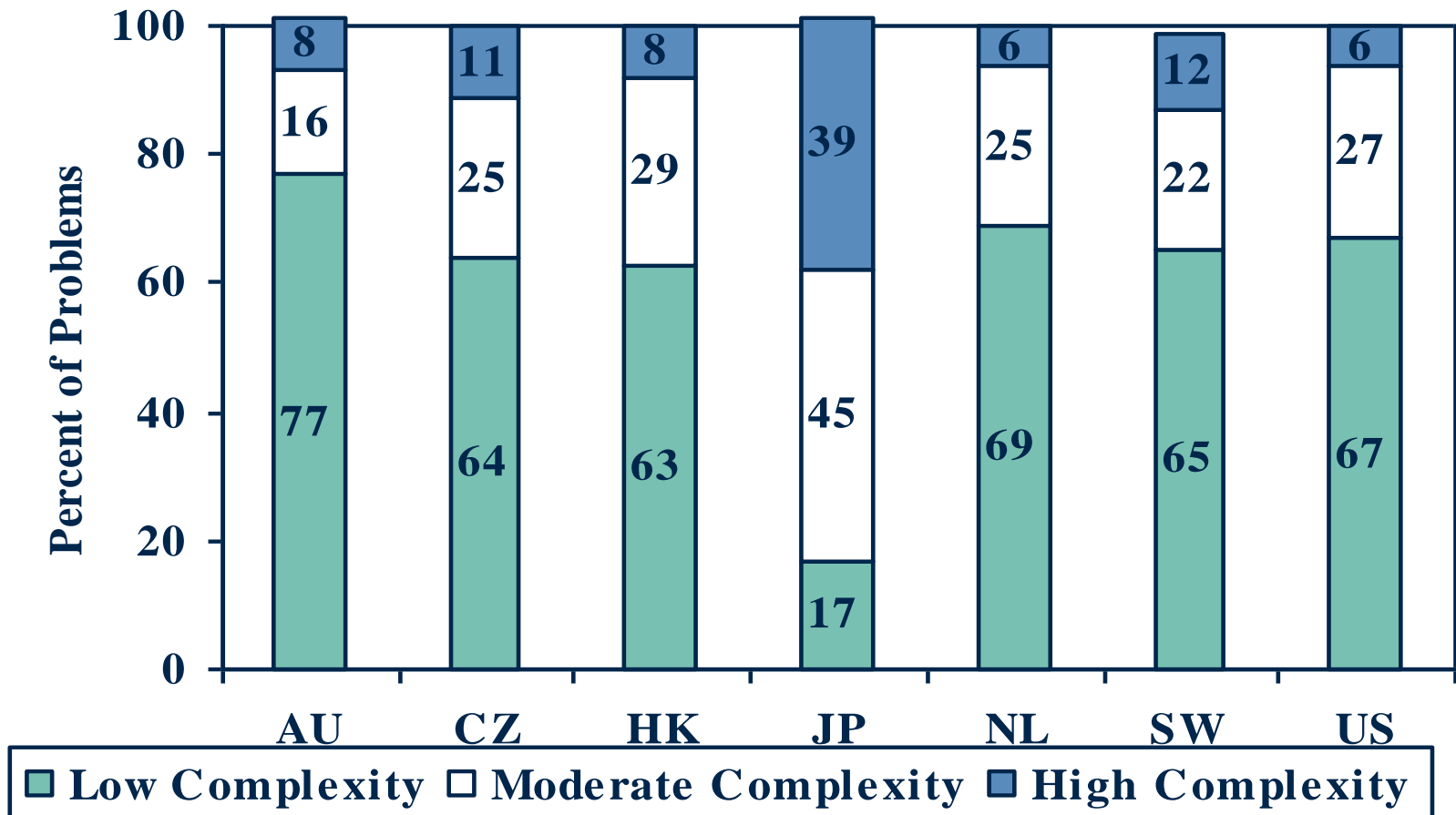
1. more complex
2. procedural rather than conceptual problems
3. unrelated to real-life
4. following prescribed methods

1. Complexity

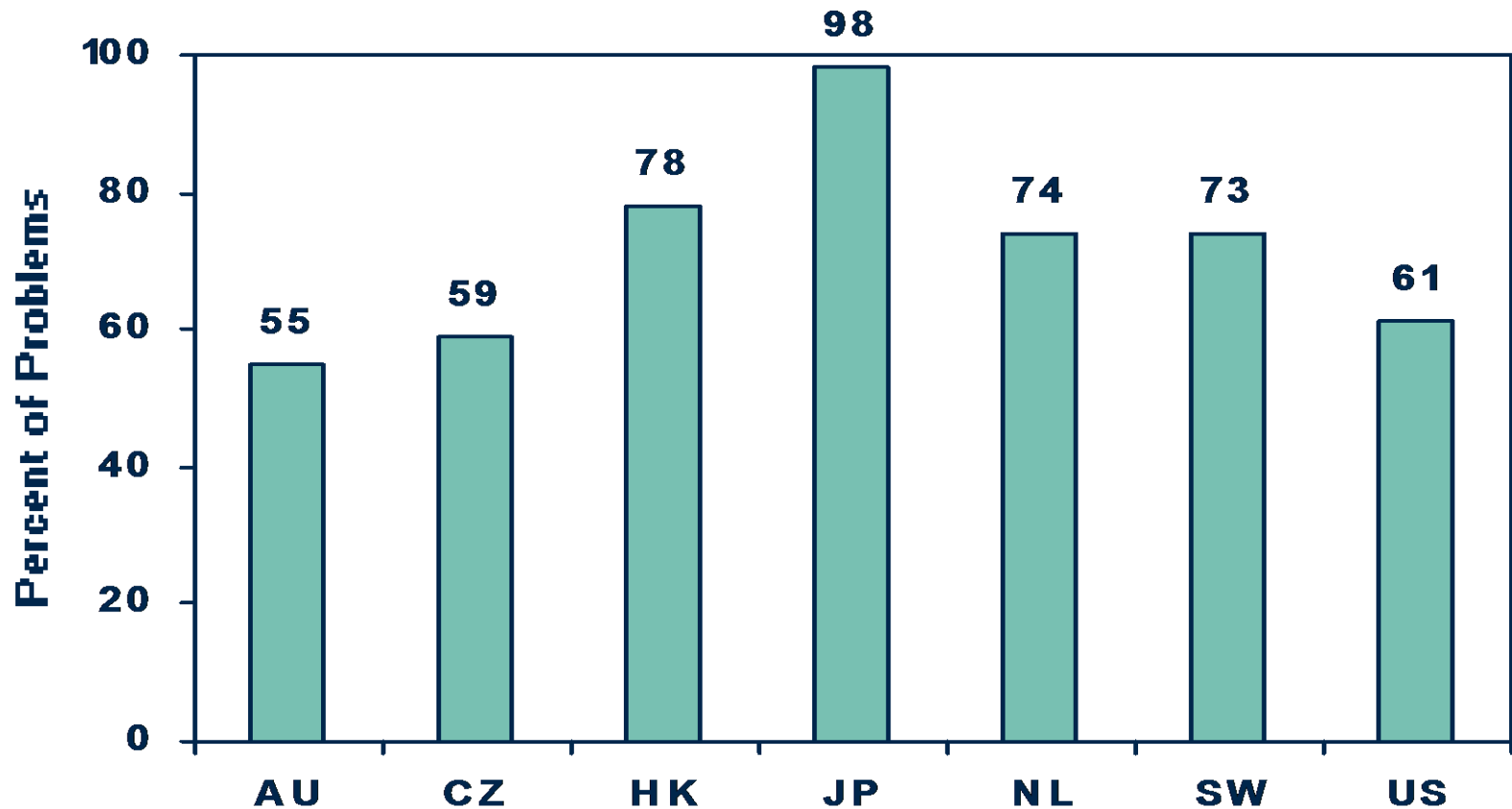
- “number of steps it takes to solve a problem using a common solution method” (p.70)
- time spent working on problem more than 45 s

East Asian students have more opportunities to work on procedurally more complex problems which required a longer duration to solve

Average percentage of problems at each level of procedural complexity



Average percentage of problems that were worked on longer more than 45 s



2. Nature of Problem Statements

The problem statement procedural rather than conceptual solution to the problems

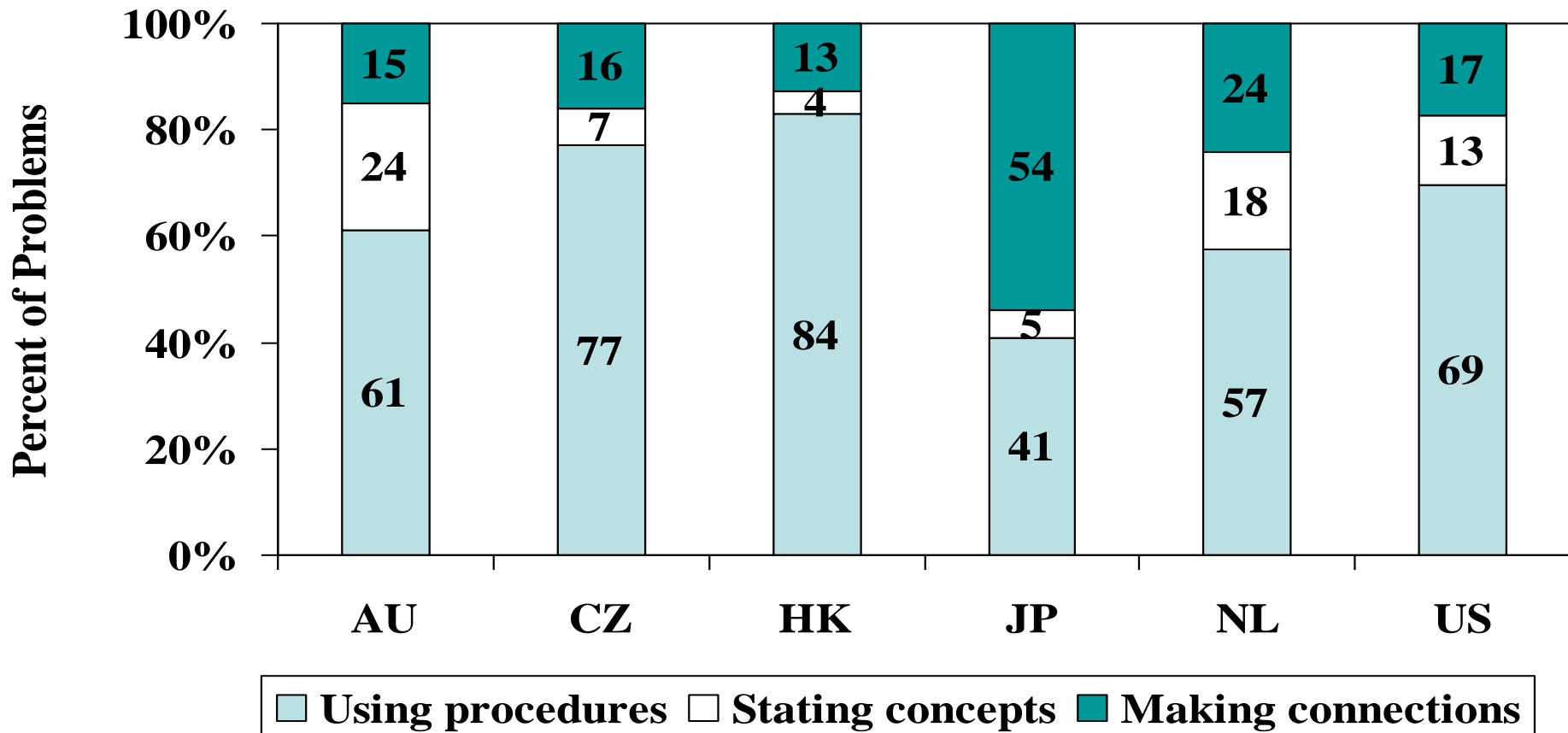
3. Contexts of the problems

Many mathematics educators argue that mathematics problems presented within real-life contexts make mathematics more meaningful and hence more interesting for students

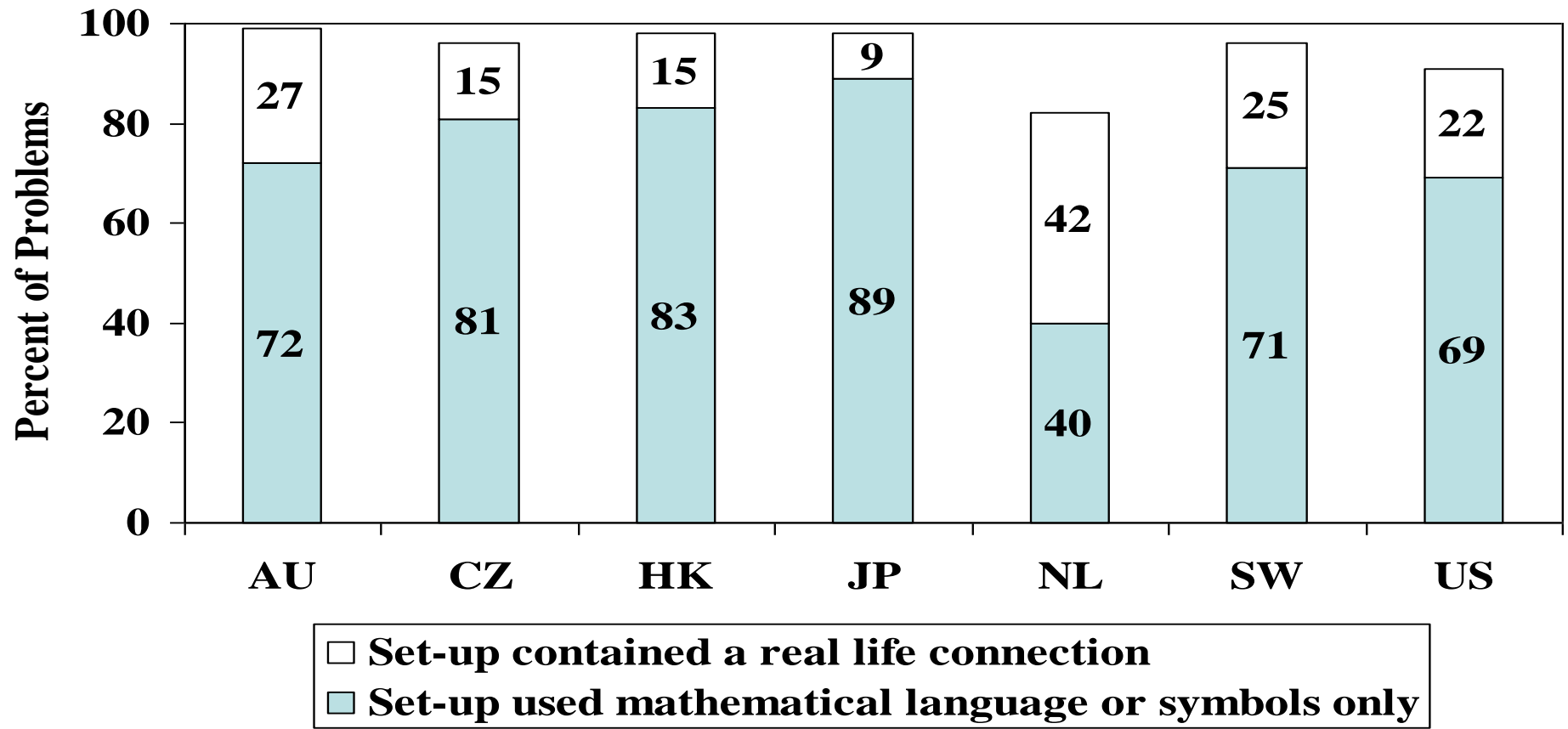
4. Choice of solution methods

Did not seem to be encouraged

Average percentage of problems per lesson of each problem statement type



Average percentage of problems per lesson set up with a real life connection or with mathematical language or symbols only



Average percentage of problems per lesson and percentage of lessons with at least one problem in which students had a choice of solution methods

Country	Average percent of problems with a choice of solution methods	Percent of lessons with at least one problem with a choice of solution methods
Australia	8	25
Czech Republic	4	20
Hong Kong	3	17
Japan	15	31
Switzerland	7	24
United States	9	45

Instructional practices as portrayed by the quantitative data analysis

- Lessons conducted in whole-class, public interaction setting
- Dominance of teacher talk
- Problems solved by students:
 - more complex and challenging
 - procedural problems
 - unrelated to real-life
 - following prescribed methods

Not conducive to quality teaching and learning!

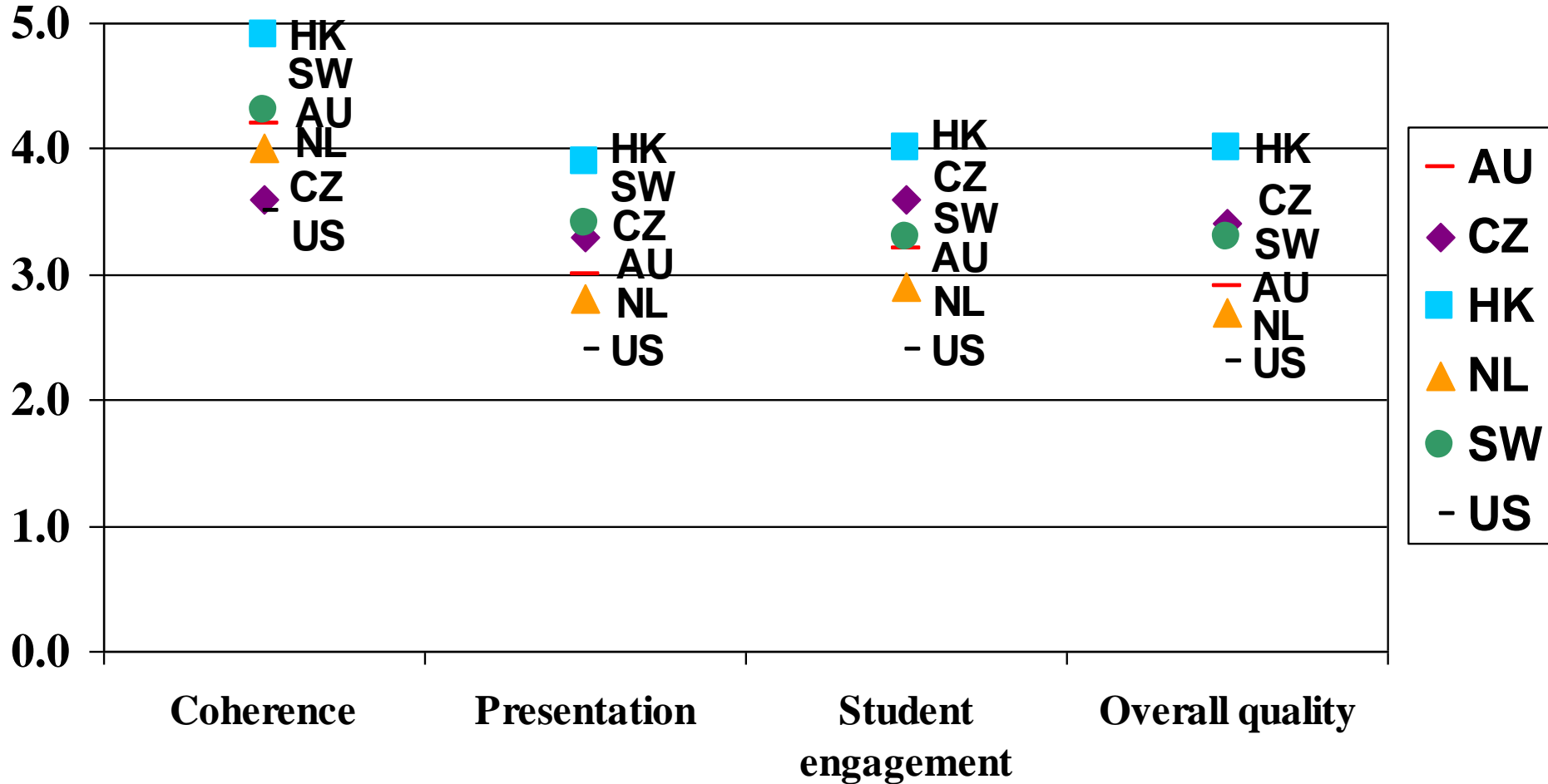
Qualitative Analysis

Judgement of an expert group on the same dataset portrayed a more positive picture:

- Relatively advanced content
- More deductive reasoning
- More coherent
- More fully developed presentation
- Students are more engaged, and
- Overall quality is high

Methodological issues concerning analysis of video data

General Ratings for Each Overall Dimension of Content Quality of Lessons



Picture consistent with findings in the literature

“Curricula (in East Asia) ... are content oriented and examination driven. Teaching is very traditional and old fashioned. Teachers in these countries seem to be ignorant about the latest methods of teaching, and think that mere competence in mathematics is sufficient for effective teaching of the subject. Classroom teaching is conducted in a whole class setting, and given the large class size involved, there are virtually no group work or activities. Instruction is teacher dominated, and student involvement is minimal. Memorization of mathematical facts is stressed and students learn mainly by rote. There is ample amount of practice of mathematical skills, mostly without thorough understanding. Students and teachers are subjected to excessive pressure from the highly competitive examinations, and the students do not seem to enjoy their study.” (Brimer and Griffin, 1985; Biggs, 1994; Leung, 1995, 2000; Wong and Cheung, 1997; Wong, 1998)

Discussion

- If classroom teaching in Hong Kong is indeed backward and traditional, how does this backward teaching produce students who perform so well in international studies?
- Why is the superior achievement not accompanied by a correspondingly positive attitude towards study?
- Background characteristics and classroom teaching are important factors for explaining student achievement, but they are not the only factors – and may not even be the most important factors
- They may explain variations in achievement within a country, but may not account for across country differences
- Cultural factors for student achievement - an important factor sometimes ignored in the discussion of achievement

Hong Kong: Confucian heritage culture (CHC)

Relevant CHC cultural values for explaining achievement

1. Strong emphasis on the importance of education and high expectation to achieve
2. Examination culture
3. The role of practice and memorization in learning
4. The Chinese language (skip)

1. Emphasis on the importance of education and expectation to achieve

- The Confucian culture: emphasizes importance of education
- Students are expected to hold a serious attitude towards study
- Higher expectations of students to achieve both in educational level and in the level of subject matter to be learned
- This may explain the more advanced content learned in the East Asian classroom

2. Examination culture (and selection)

China is the first country in the world where a national examination system was introduced - as early as the Sui Dynasty (A.D. 587), a national examination was instituted in the imperial court to select scholars to high offices in the government. From then on, “the examinations at different dynasties were invariably the means to select appointees to the officialdom. ... The examination was later developed into a stratified system where scholars competed in local examinations and became qualified for higher level examinations ... Local successful candidates were awarded lifelong titles of *scholars* who became local intellectuals with respectable social status. The champions in the examination held at the central imperial court were granted high positions in the government (as high as the prime minister) and often granted marriage to the royal family.” (Cheng, 1994)

Examination culture and performance in international studies

- So East Asian students are good in taking examinations – does that explain their superior performance in international studies?
- This has serious consequence for international studies, as it touches on the issue of the validity of these studies
- If tests such as those used in international studies are not the appropriate instrument for measuring achievement, what are the alternatives?
- International studies represent a common agreement among participating countries on how achievement can be measured

3. Practice makes perfect?

- How do East Asian students prepare for examination (and international studies??)?
- Stress in the East Asian culture on diligence and practice
- Attributes success to effort rather than innate ability
- In East Asia, “repetitive learning” is “continuous practice with increasing variation” (Marton, 1997), and practice and repetition is a “route to understanding” (Hess & Azuma, 1991)
- Equating memorization without full understanding to rote learning is too simplistic
- Practice and memorization are legitimate (and probably effective) means for understanding and learning
- Is constructivism always right? Learning is a complex and multi-faceted phenomenon. Constructivism provides a framework for looking into this process, but it is not the only framework - not that “more constructivistic, the better”

4. The Chinese Language


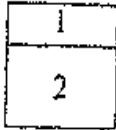
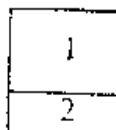
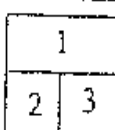
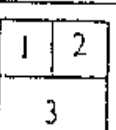
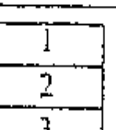
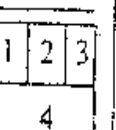
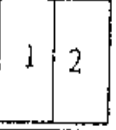

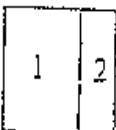
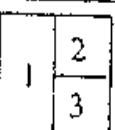
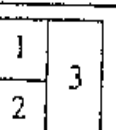
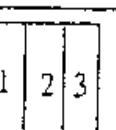
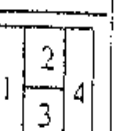
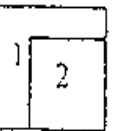
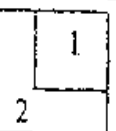
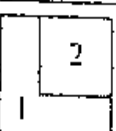
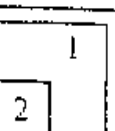
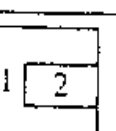
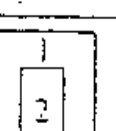
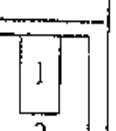
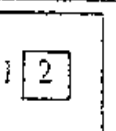
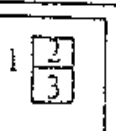

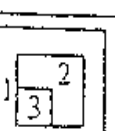
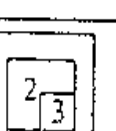
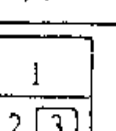
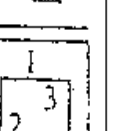
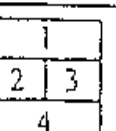
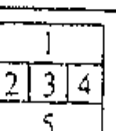
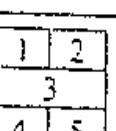
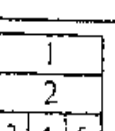
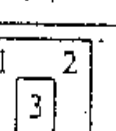
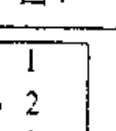
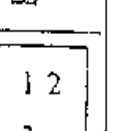
Written Chinese

- Logographic: Chinese words are represented by a large number of different visual symbols known as characters
- Characters are made up of components (radicals), and have an imaginary square as a basic writing unit

e.g., 梁貫成

- Chinese characters put emphasis on the spatial layout of strokes, and the orthography of Chinese is based on the spatial organization of the components of the characters
- Close relationship between learning to write Chinese characters and the visual-spatial properties of Chinese characters (Kao, 2000, 2002; Hoosain, 1991)

漢字組成結構表

結構		舉 例							
上下組合	部位								
	例字	崇	宗	烈	露	望	冀	樊	
左右組合	部位								
	例字	駿	個	劍	聰	部	街	繳	
內外組合	半包圍	部位							
		例字	痛	道	趙	旬	臣	月	凶
	全包圍	部位							
		例字	回	固	圖	囪	圍	晉	田
其他組合	部位								
	例字	藍	燕	器	羸	間	巨	占	

Chinese writing and mathematics learning

- Chinese characters: possess visual properties such as connectivity, closure, linearity and symmetry which are faster and easier to be captured by vision (Kao, Leong and Gao, 2002), and Chinese learners were found to have stronger visual-spatial abilities (Hoosain, 1991)
- Lai (2008) showed that Chinese children have
 - Higher visual perceptual and geometric skills
 - Higher visual-motor integration skills than motor-reduced visual perceptual skills
- Lai used both the motor control theory and the psychogeometric theory of Chinese-character writing to account for the surprising results

Spoken Chinese

1. Chinese is a monosyllabic language, where one syllable constitutes one morpheme (Sun, 1980; Li, 1993)
 2. In particular, the short pronunciation of the numbers zero to ten makes it easy to process
 3. Tonic nature of Cantonese – nine tones (times table Vs “Nine factor song”)
- (The regular number system - in contrast to the numbers between ten and nineteen in English)

Negative attitudes

Relevant CHC cultural values for explaining attitudes:

1. Examination culture and serious attitude towards studying
2. Motivation for learning, and high expectation for achievement
3. Virtue of modesty

1. Examination culture

- Examination culture: two-way sword
- The examination culture and the consequent competitive examination system may create “undue pressure upon students, resulting in all sorts of harmful effects such as loss of interest in (study) and behavioral problems”
- Also, learning/studying is considered a serious endeavour
- Students expected to put in hard work/perseverance and are not supposed to enjoy the study
- This may explain their negative attitude towards study as found in international studies

2. Intrinsic Vs extrinsic motivation

- The examination culture legitimizes performance in examinations as a source of motivation for study
 - this contrasts with the views of some Western educators who value intrinsic motivation to study and consider extrinsic motivations such as those derived from examination pressure as harmful to learning
- The East Asian value of high expectation to achieve
 - East Asian parents and teachers may communicate this expectation explicitly or implicitly to their children
 - high expectations and competitive examinations leave the majority of students classified as failures
 - repeated experiences of a sense of failure reinforced the lack of confidence

3. The virtue of modesty

- Modesty is a highly valued virtue in East Asia; children are taught from young that one should not be boastful
- Chinese saying: “Contentedness leads to loss; modesty (or humility) leads to gain”
- This may inhibit East Asian Culture students from rating themselves too highly in attitude questionnaires, and the scores may represent less than what students really think about themselves
- But if students are constantly taught to rate themselves low, they may internalize the idea and result in really low confidence
- **According to East Asian value, negative correlation between students’ confidence and achievement is expected: over-confidence lowers incentive to learn**

Implications

- No simple causal relation between culture and student achievement
- International studies are meant for countries to learn from each other
- Before we can learn from another culture, we should first understand and evaluate our cultural values
- Take our own cultural values as given and starting point, and design and improve our educational practice
- In learning from each other, we should not give up our tradition too easily

e.g., high expectation of students
Vs enjoyment of study

- Expectation of students to learn relatively advanced content may be a factor for explaining high achievement
- Repeatedly reducing content difficulty to make it more accessible to students is an endless retreat
- Teachers should try to make lessons enjoyable - purpose is to induce students' interest in the subject matter rather than in activities per se
- Positive attitude and enjoying learning not enough: if the price to pay is low achievement, should consider whether the price is too high

Learning from other countries

- Drastic changes should not be undertaken until cultural factors thoroughly examined
- **Simple transplant of policies and practices from high to low achieving countries won't work**
- One cannot transplant the practice without regard to the cultural differences
- Culture by definition evolves slowly and stably - no quick transformation of culture
- Through identifying commonality and differences of both educational practices and the underlying cultures, we may then determine how much can or cannot be borrowed from another culture

Concluding remarks

- Results of international studies provide impetus for educational changes, but sometimes, changes are made without careful consideration of the complex context within which achievement and classroom instructions are situated
- Results of international studies should serve as mirrors for us to better understand our system
- Education is complex - cannot expect international studies to produce answers for all national problems in education
- International studies provide rich dataset for countries to seek answers for their own issues
- **Need wisdom, not just data!**

*Thank you very much for your
attention!*

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TIMSS 1995

Table 1.1

Distributions of Mathematics Achievement - Upper Grade (Fourth Grade*)

Country	Mean	Years of Formal Schooling	Average Age	Mathematics Achievement Scale Score
Singapore	625 (5.3)	4	10.3	
Korea	611 (2.1)	4	10.3	
Japan	597 (2.1)	4	10.4	
Hong Kong	587 (4.3)	4	10.1	
Czech Republic	567 (3.3)	4	10.4	
Ireland	550 (3.4)	4	10.3	
United States	545 (3.0)	4	10.2	
Canada	532 (3.3)	4	10.0	
[†] Scotland	520 (3.9)	5	9.7	
^{†2} England	513 (3.2)	5	10.0	
Cyprus	502 (3.1)	4	9.8	
Norway	502 (3.0)	3	9.9	
New Zealand	499 (4.3)	4.5–5.5	10.0	
Greece	492 (4.4)	4	9.6	
Portugal	475 (3.5)	4	10.4	
Iceland	474 (2.7)	4	9.6	
Iran, Islamic Rep.	429 (4.0)	4	10.5	

Exhibit 1.1 Distribution of Mathematics Achievement

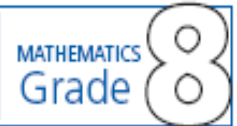
	Mathematics Achievement Scale Score					Average Scale Score	Years of Formal Schooling	Average Age
Singapore						▲ 604 (6.3)	8	14.4
Korea, Rep. of						▲ 587 (2.0)	8	14.4
Chinese Taipei						▲ 585 (4.0)	8	14.2
Hong Kong, SAR ¹						▲ 582 (4.3)	8	14.2
Japan						▲ 579 (1.7)	8	14.4
Belgium (Flemish) ¹						▲ 558 (3.3)	8	14.1
Netherlands ¹						▲ 540 (7.1)	8	14.2
Slovak Republic						▲ 534 (4.0)	8	14.3
Hungary						▲ 532 (3.7)	8	14.4
Canada						▲ 531 (2.5)	8	14.0
Slovenia						▲ 530 (2.8)	8	14.8
Russian Federation						▲ 526 (5.9)	7 or 8	14.1
Australia						▲ 525 (4.8)	8 or 9	14.3
Finland						▲ 520 (2.7)	7	13.8
Czech Republic						▲ 520 (4.2)	9	14.4
Malaysia						▲ 519 (4.4)	8	14.4
Bulgaria						▲ 511 (5.8)	8	14.8
Latvia (LSS) ¹						▲ 505 (3.4)	8	14.5
United States						▲ 502 (4.0)	8	14.2
England ¹						● 496 (4.1)	9	14.2
New Zealand						● 491 (5.2)	8.5 to 9.5	14.0

Exhibit 1.1: Distribution of Mathematics Achievement

 MATHEMATICS
 Grade 4

Countries	Years of Schooling*	Average Age	Mathematics Achievement Distribution	Average Scale Score	Human Development Index**
Singapore	4	10.3		594 (5.6)	0.884
† Hong Kong, SAR	4	10.2		575 (3.2)	0.889
Japan	4	10.4		565 (1.6)	0.932
Chinese Taipei	4	10.2		564 (1.8)	–
Belgium (Flemish)	4	10.0		551 (1.8)	0.937
† Netherlands	4	10.2		540 (2.1)	0.938
Latvia	4	11.1		536 (2.8)	0.811
† Lithuania	4	10.9		534 (2.8)	0.824
Russian Federation	3 or 4	10.6		532 (4.7)	0.779
† England	5	10.3		531 (3.7)	0.930
Hungary	4	10.5		529 (3.1)	0.837
† United States	4	10.2		518 (2.4)	0.937
Cyprus	4	9.9		510 (2.4)	0.891
Moldova, Rep. of	4	11.0		504 (4.9)	0.700
Italy	4	9.8		503 (3.7)	0.916
† Australia	4 or 5	9.9		499 (3.9)	0.939
International Avg.	4	10.3		495 (0.8)	–
New Zealand	4.5 - 5.5	10.0		493 (2.2)	0.917
† Scotland	5	9.7		490 (3.3)	0.930

Exhibit 1.1: Distribution of Mathematics Achievement



Countries	Years of Schooling*	Average Age	Mathematics Achievement Distribution	Average Scale Score	Human Development Index**
Singapore	8	14.3		605 (3.6) ○	0.884
† Korea, Rep. of	8	14.6		589 (2.2) ○	0.879
† Hong Kong, SAR	8	14.4		586 (3.3) ○	0.889
Chinese Taipei	8	14.2		585 (4.6) ○	–
Japan	8	14.4		570 (2.1) ○	0.932
Belgium (Flemish)	8	14.1		537 (2.8) ○	0.937
† Netherlands	8	14.3		536 (3.8) ○	0.938
Estonia	8	15.2		531 (3.0) ○	0.833
Hungary	8	14.5		529 (3.2) ○	0.837
Malaysia	8	14.3		508 (4.1) ○	0.790
Latvia	8	15.0		508 (3.2) ○	0.811
Russian Federation	7 or 8	14.2		508 (3.7) ○	0.779
Slovak Republic	8	14.3		508 (3.3) ○	0.836
Australia	8 or 9	13.9		505 (4.6) ○	0.939
‡ United States	8	14.2		504 (3.3) ○	0.937
¹ Lithuania	8	14.9		502 (2.5) ○	0.824
Sweden	8	14.9		499 (2.6) ○	0.941
† Scotland	9	13.7		498 (3.7) ○	0.930
² Israel	8	14.0		496 (3.4) ○	0.905
New Zealand	8.5 - 9.5	14.1		494 (5.3) ○	0.917
Slovenia	7 or 8	13.8		493 (2.2) ○	0.881
Italy	8	13.9		484 (3.2) ○	0.916
Armenia	8	14.9		478 (3.0) ○	0.729
¹ Serbia	8	14.9		477 (2.6) ○	–
Bulgaria	8	14.9		476 (4.3) ○	0.795
Romania	8	15.0		475 (4.8)	0.773
International Avg.	8	14.5		467 (0.5)	–

Exhibit 1.1 TIMSS 2007 Distribution of Mathematics Achievement

TIMSS2007
Mathematics 4th Grade

Country	Mathematics Achievement Distribution	Average Scale Score	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Hong Kong SAR		607 (3.6)	4	10.2	0.937
Singapore		599 (3.7)	4	10.4	0.922
Chinese Taipei		576 (1.7)	4	10.2	0.932
Japan		568 (2.1)	4	10.5	0.953
¹ Kazakhstan		549 (7.1)	4	10.6	0.794
Russian Federation		544 (4.9)	4	10.8	0.813
England		541 (2.9)	5	10.2	0.946
¹ Latvia		537 (2.3)	4	11.0	0.855
[‡] Netherlands		535 (2.1)	4	10.2	0.953
¹ Lithuania		530 (2.4)	4	10.8	0.862
² [†] United States		529 (2.4)	4	10.3	0.951
Germany		525 (2.3)	4	10.4	0.935
[†] Denmark		523 (2.4)	4	11.0	0.949
Australia		516 (3.5)	4	9.9	0.962
Hungary		510 (3.5)	4	10.7	0.874
Italy		507 (3.1)	4	9.8	0.941
Austria		505 (2.0)	4	10.3	0.948
Sweden		503 (2.5)	4	10.8	0.956
Slovenia		502 (1.8)	4	9.8	0.917
TIMSS Scale Avg.		500			
Armenia		500 (4.3)	4	10.6	0.775
Slovak Republic		496 (4.5)	4	10.4	0.863
[†] Scotland		494 (2.2)	5	9.8	0.946
New Zealand		492 (2.3)	4.5–5.5	10.0	0.943

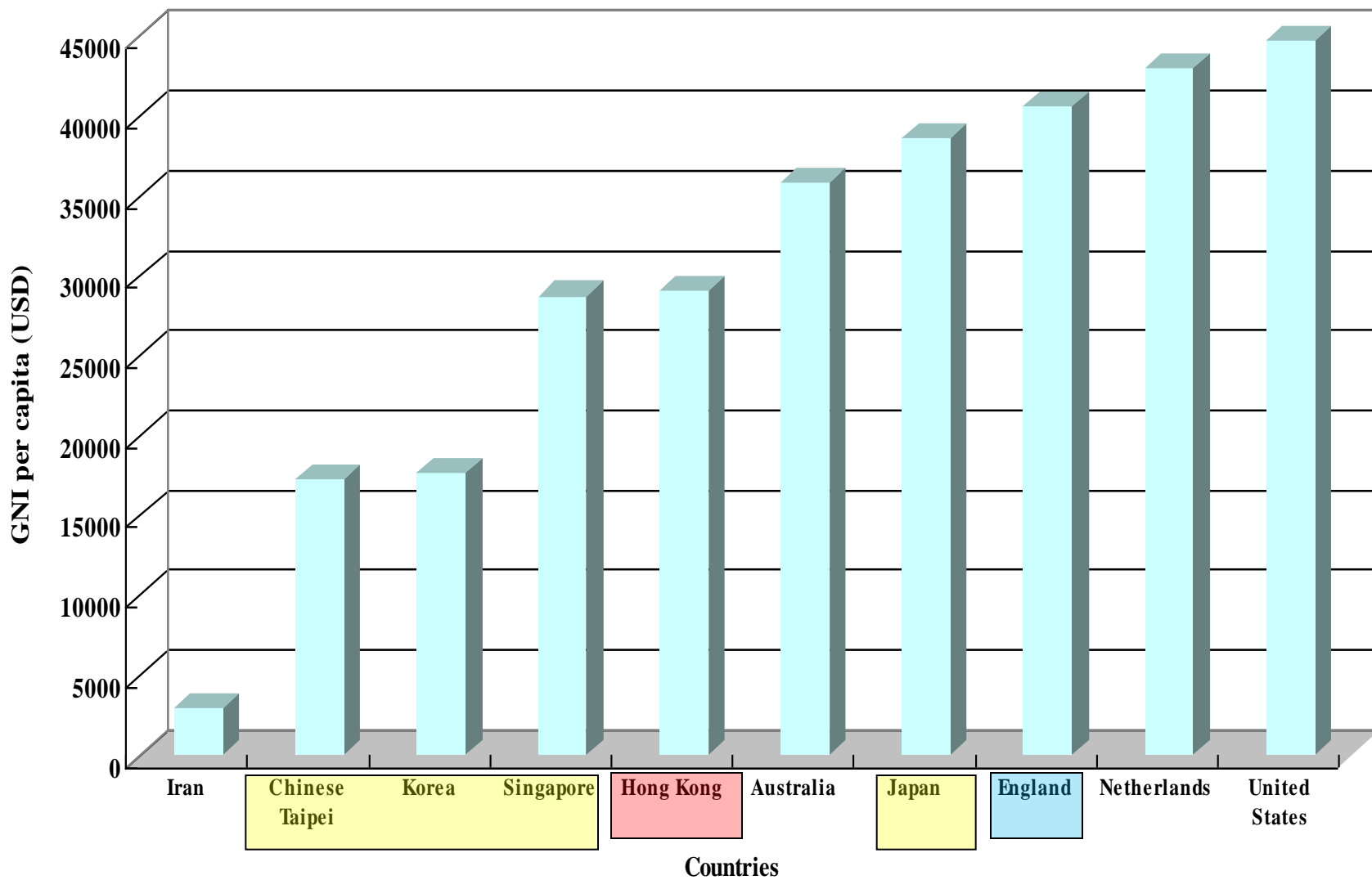
Exhibit 1.1 TIMSS 2007 Distribution of Mathematics Achievement (Continued)

TIMSS2007
Mathematics 8th Grade

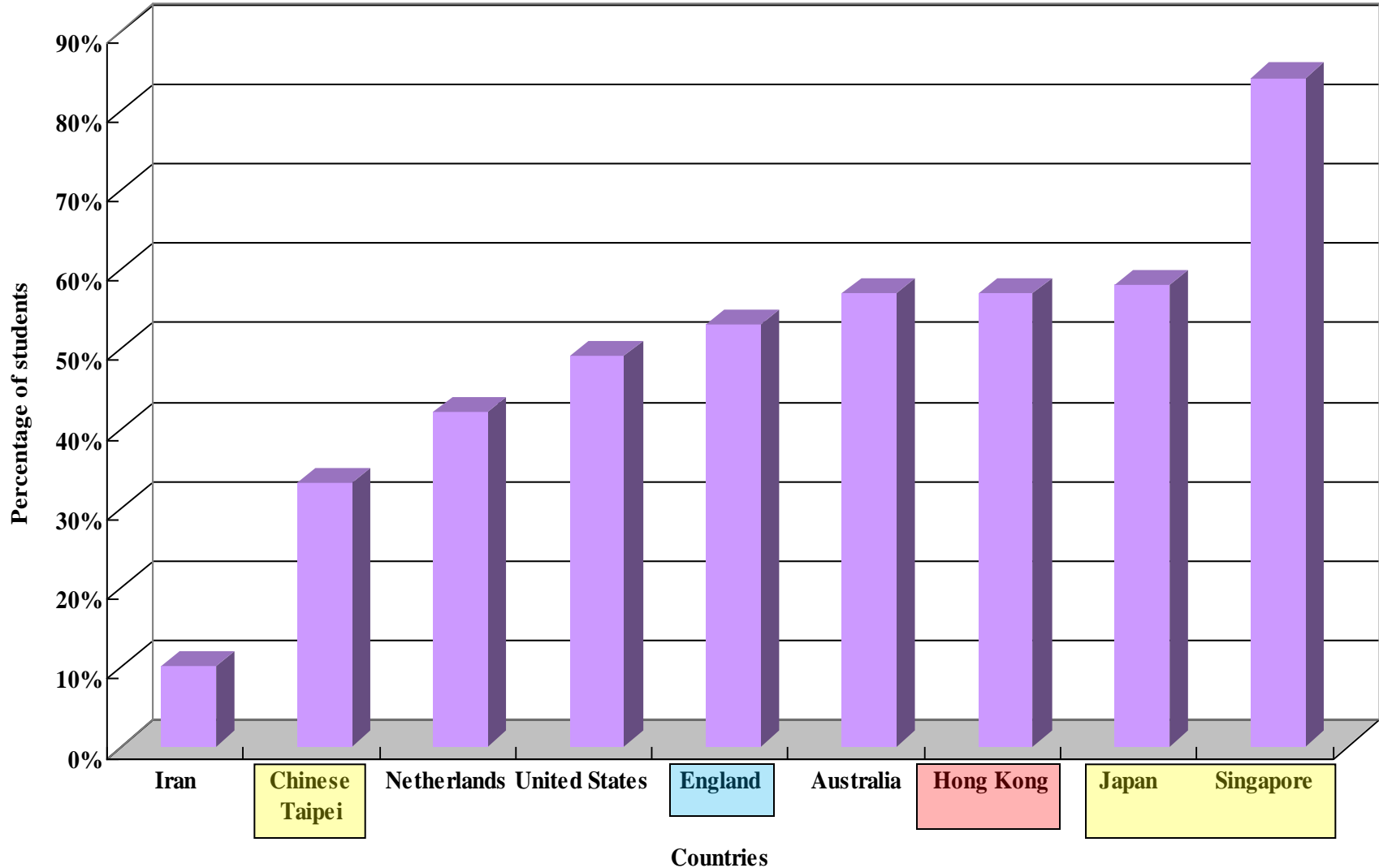
Country	Mathematics Achievement Distribution	Average Scale Score	Years of Formal Schooling*	Average Age at Time of Testing	Human Development Index**
Chinese Taipei		▲ 598 (4.5)	8	14.2	0.932
Korea, Rep. of		▲ 597 (2.7)	8	14.3	0.921
Singapore		▲ 593 (3.8)	8	14.4	0.922
† Hong Kong SAR		▲ 572 (5.8)	8	14.4	0.937
Japan		▲ 570 (2.4)	8	14.5	0.953
Hungary		▲ 517 (3.5)	8	14.6	0.874
† England		▲ 513 (4.8)	9	14.2	0.946
Russian Federation		▲ 512 (4.1)	7 or 8	14.6	0.802
² † United States		▲ 508 (2.8)	8	14.3	0.951
¹ Lithuania		▲ 506 (2.3)	8	14.9	0.862
Czech Republic		504 (2.4)	8	14.4	0.891
Slovenia		501 (2.1)	7 or 8	13.8	0.917
TIMSS Scale Avg.		500			
Armenia		499 (3.5)	8	14.9	0.775
Australia		496 (3.9)	8	13.9	0.962
Sweden		▼ 491 (2.3)	8	14.8	0.956
Malta		▼ 488 (1.2)	9	14.0	0.878
† Scotland		▼ 487 (3.7)	9	13.7	0.946
^{1 2} Serbia		▼ 486 (3.3)	8	14.9	0.810
Italy		▼ 480 (3.0)	8	13.9	0.941
Malaysia		▼ 474 (5.0)	8	14.3	0.811
Norway		▼ 469 (2.0)	8	13.8	0.968
Cyprus		▼ 465 (1.6)	8	13.8	0.903

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

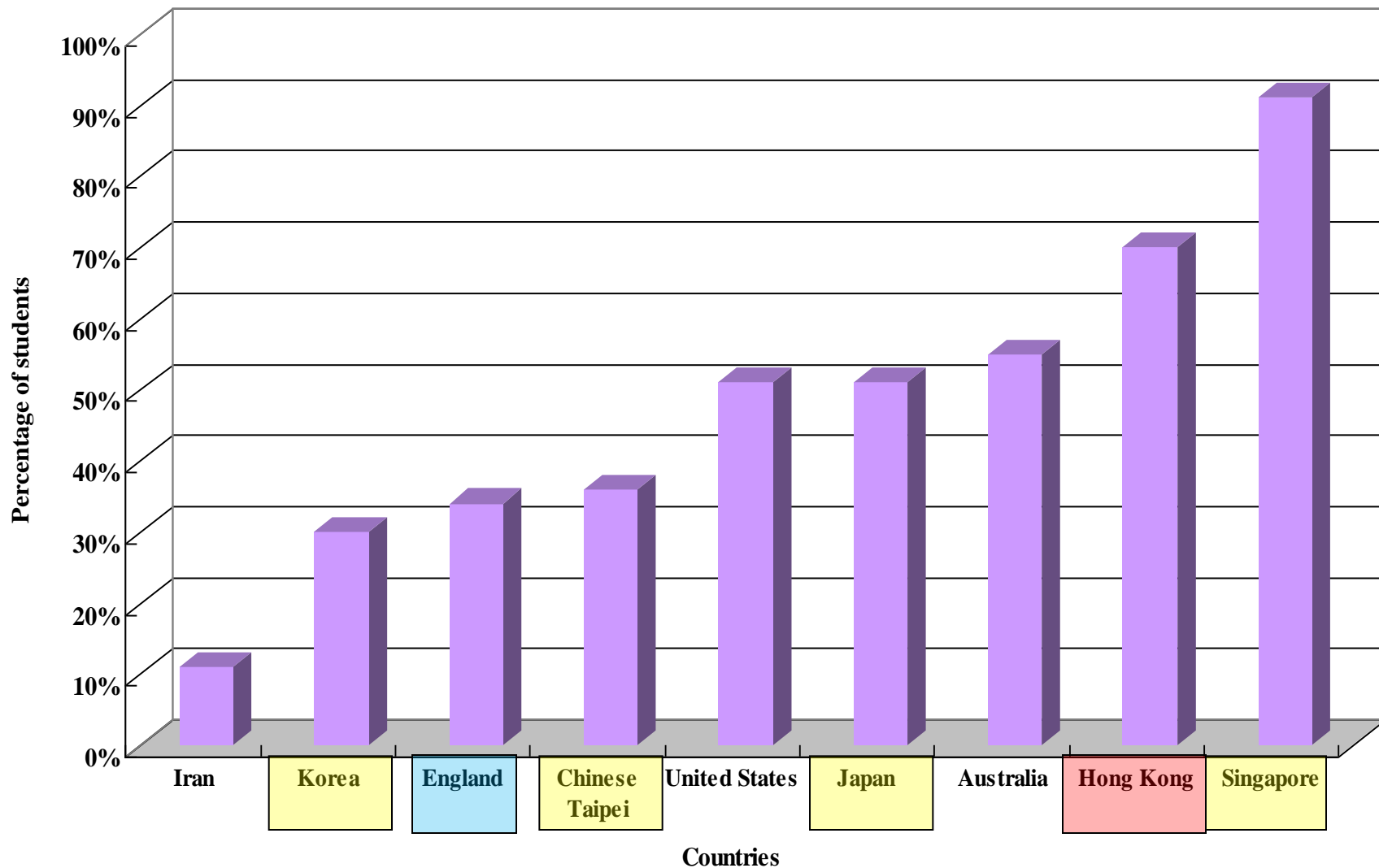
GNI per capita (Int'l Avg. = 15883)



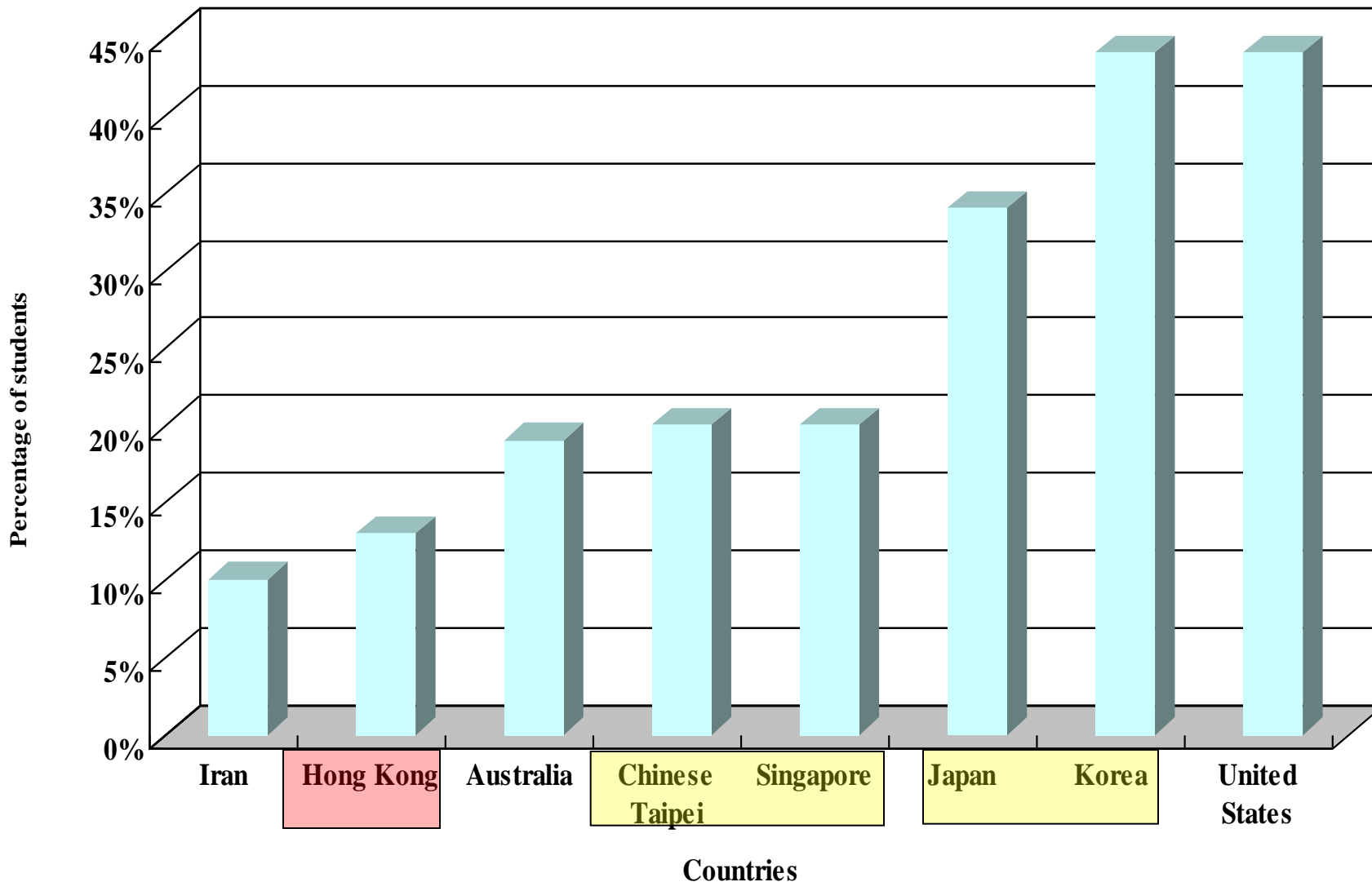
School Resources for Mathematics Instruction (G.4 Int'l Avg. = 43%)



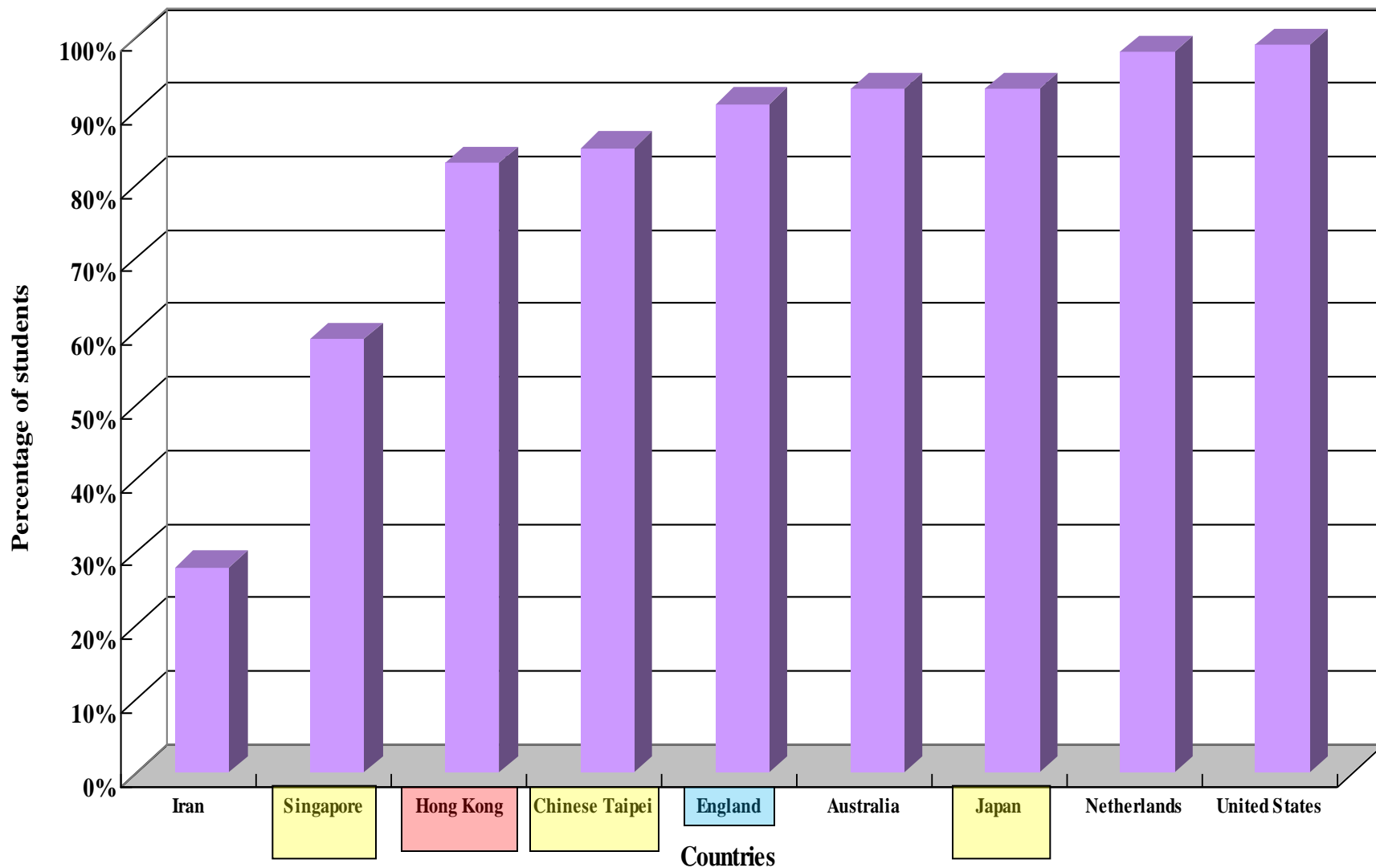
School Resources for Mathematics Instruction (G.8 Int'l Avg. = 32%)



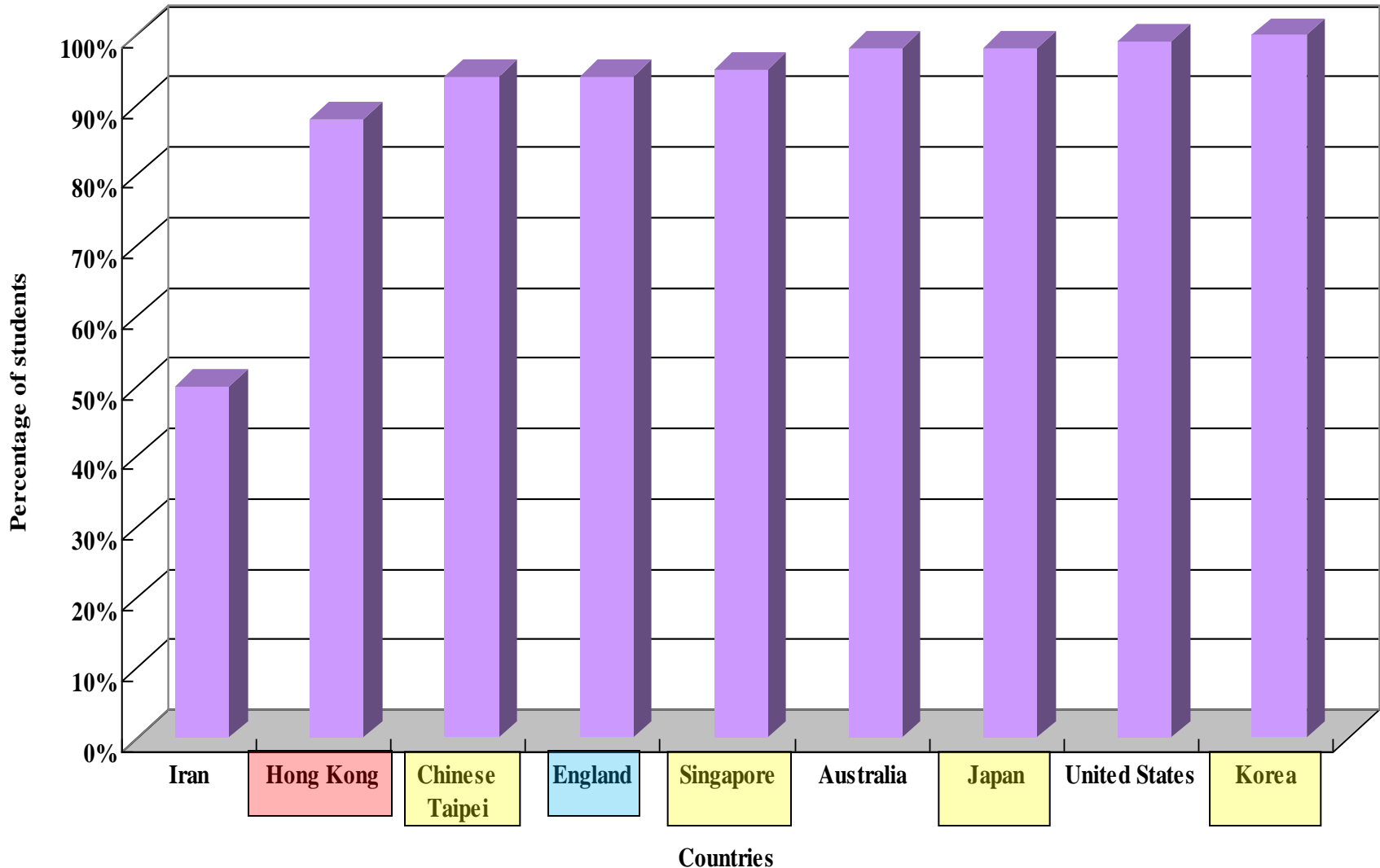
Parent with University Degree or Above (Int'l Avg. = 24%)



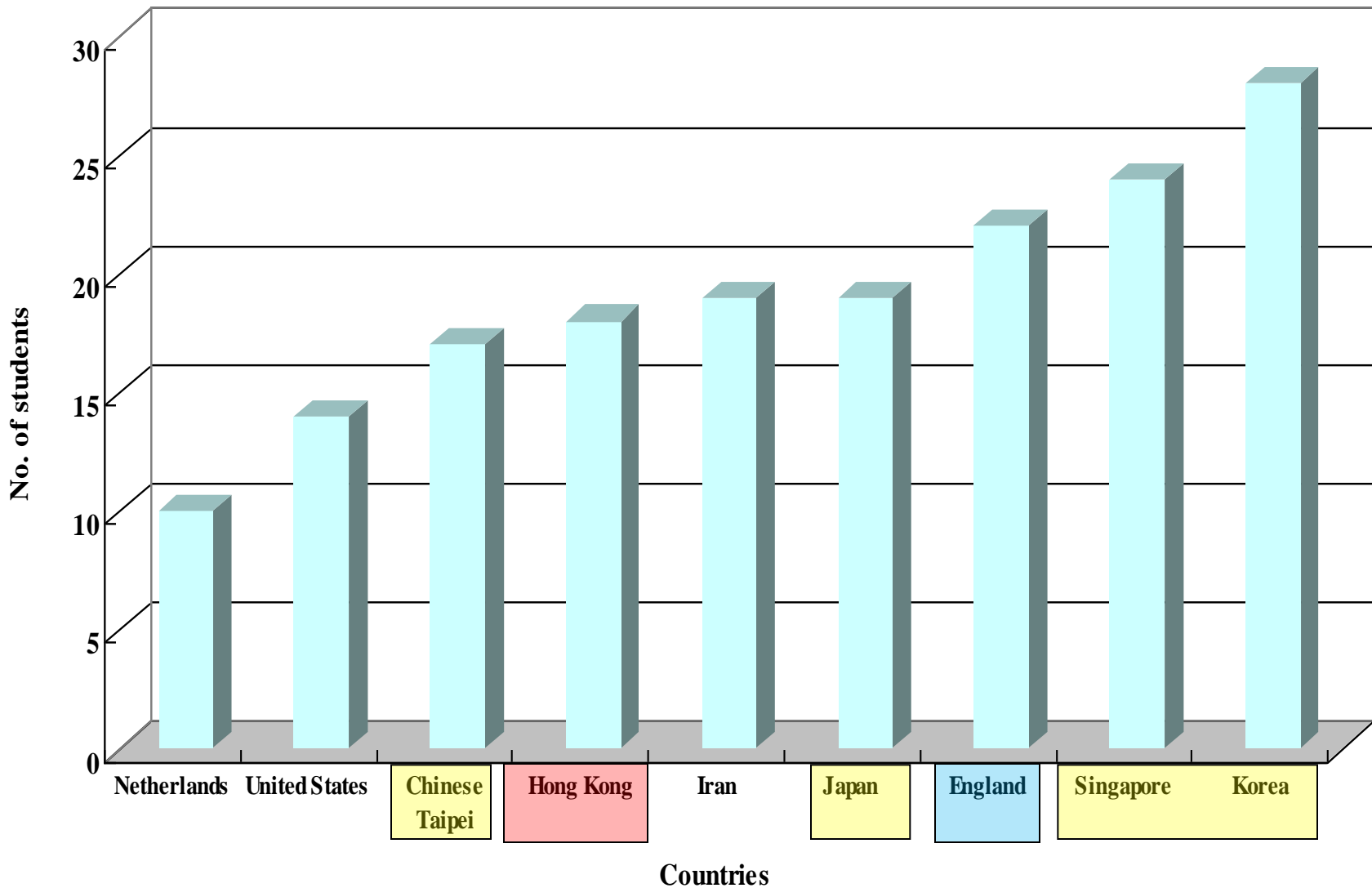
Mathematics Teacher with University Degree or Above (G.4 Int'l Avg. = 70%)



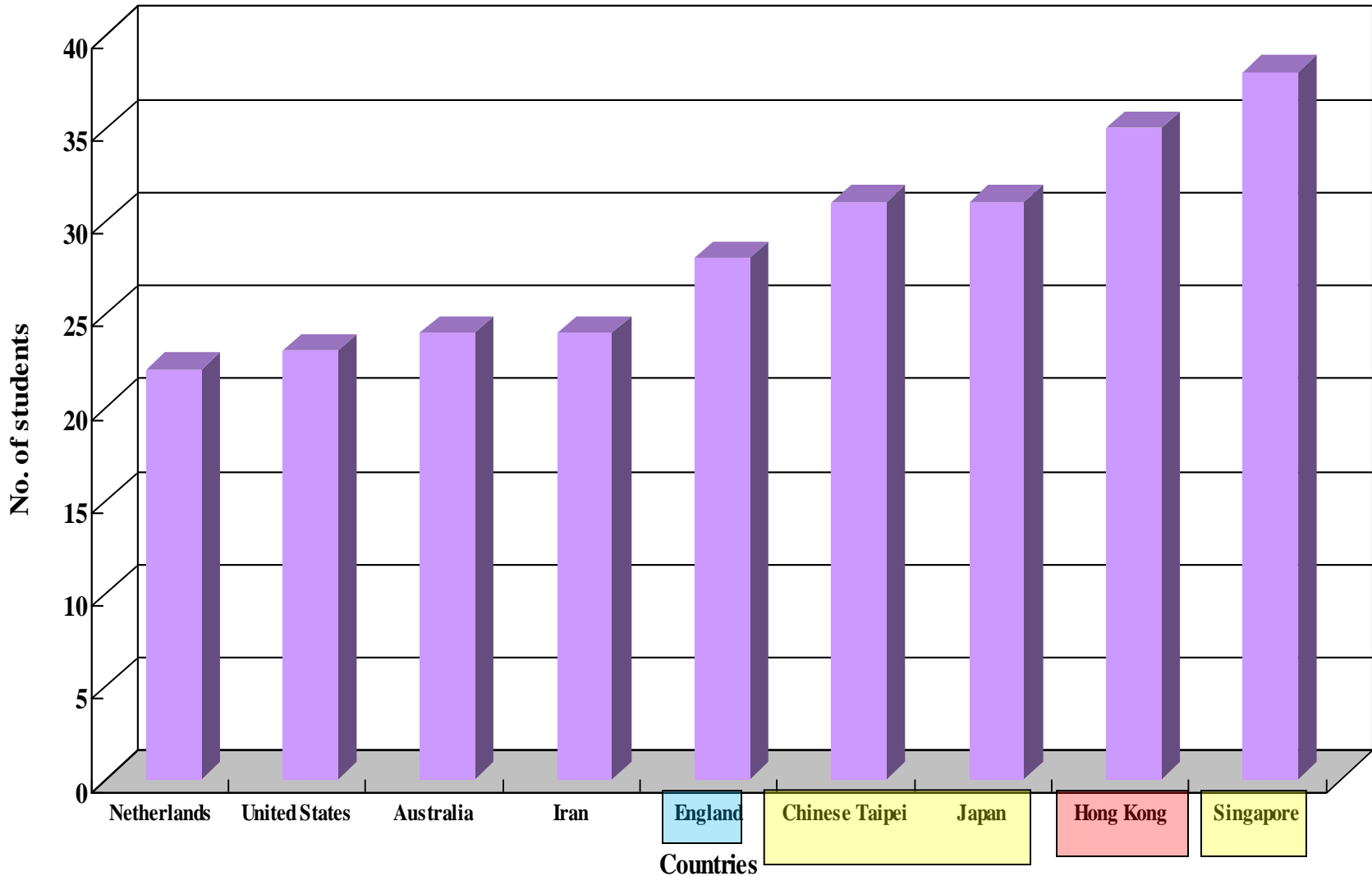
Mathematics Teacher with University Degree or Above (G.8 Int'l Avg. = 78%)



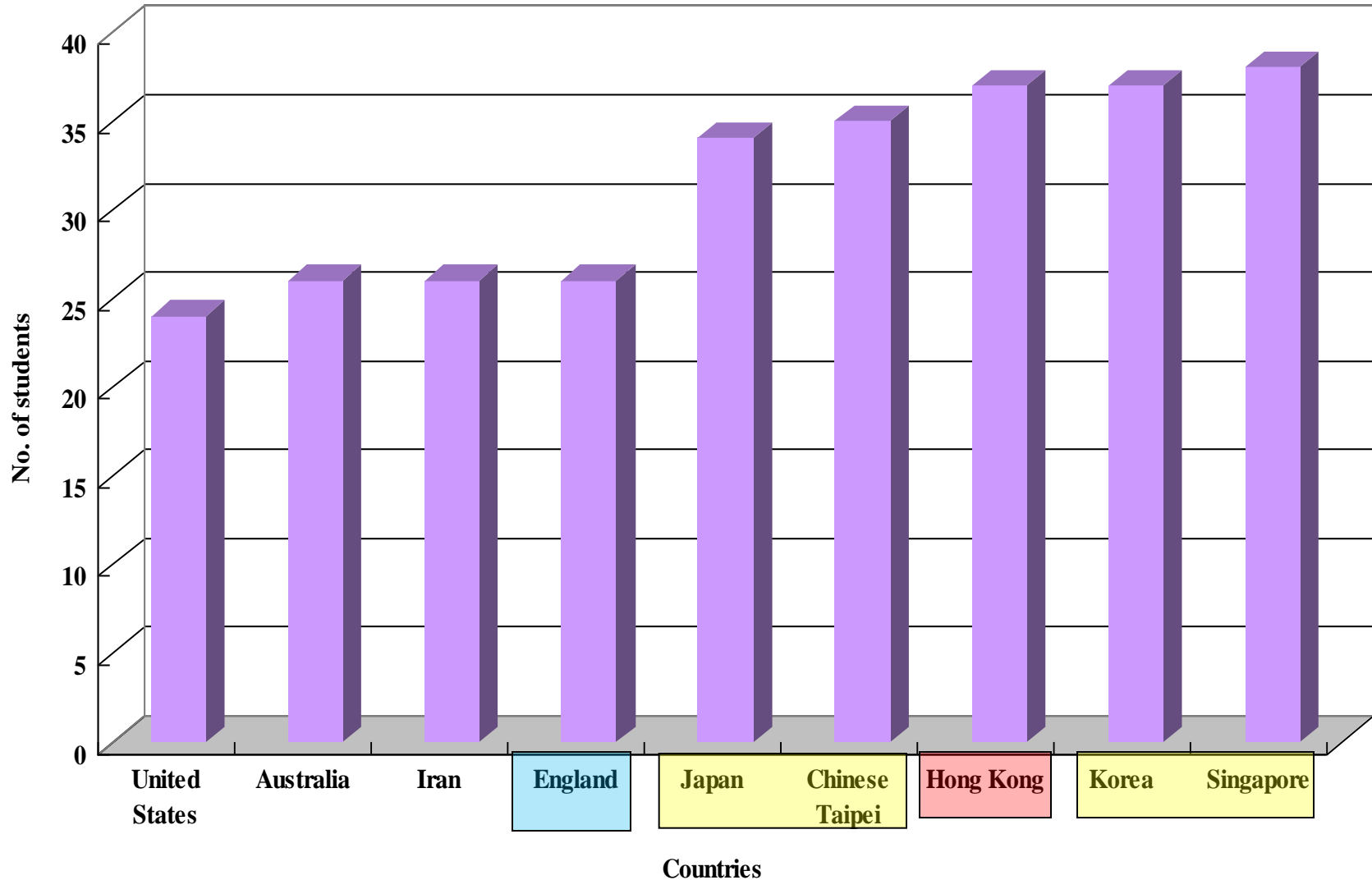
Primary Student-Teacher Ratio (Int'l Avg. = 18 students)



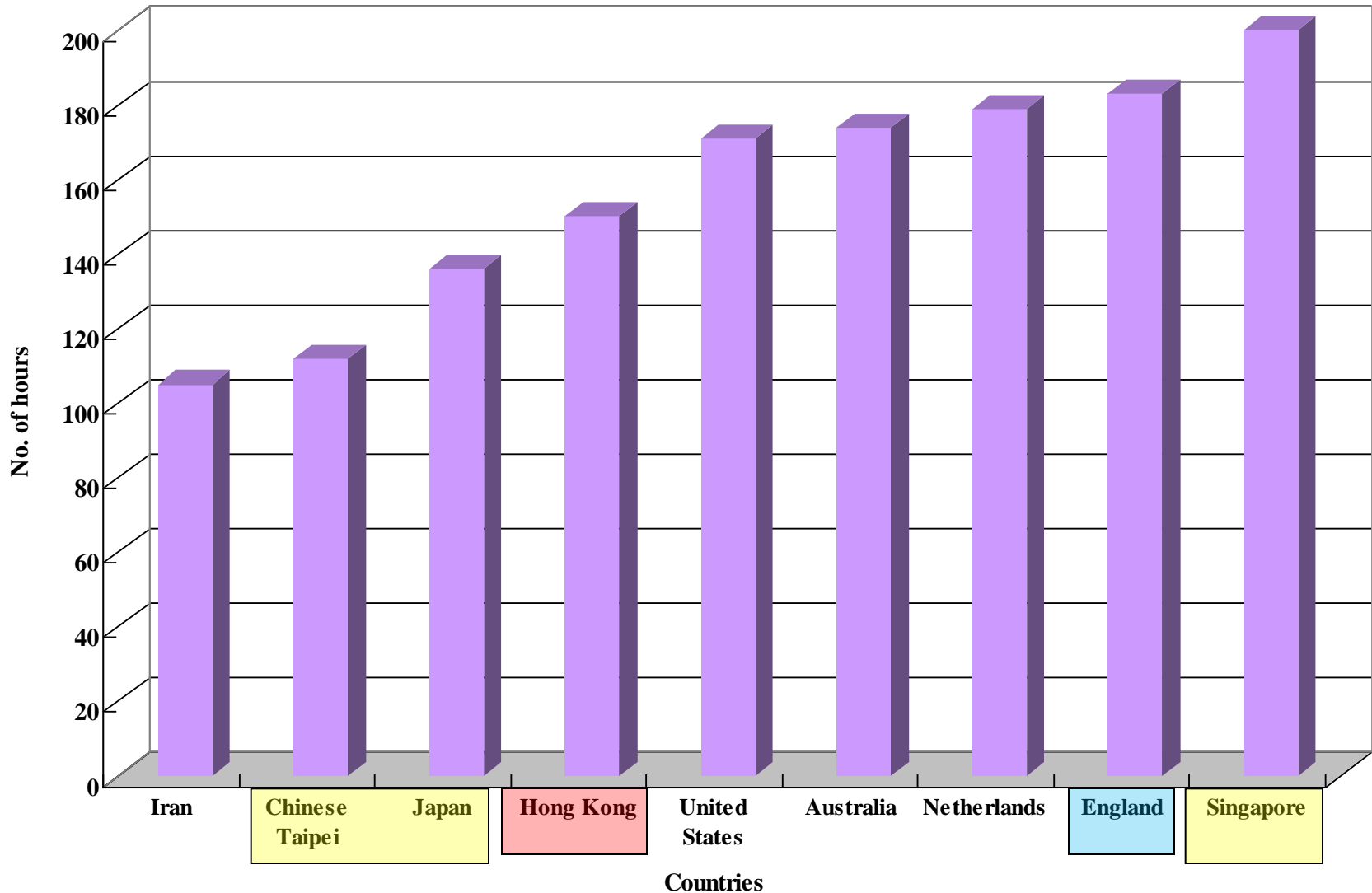
Class size for Mathematics Instruction (G.4 Int'l Avg. = 26 students)



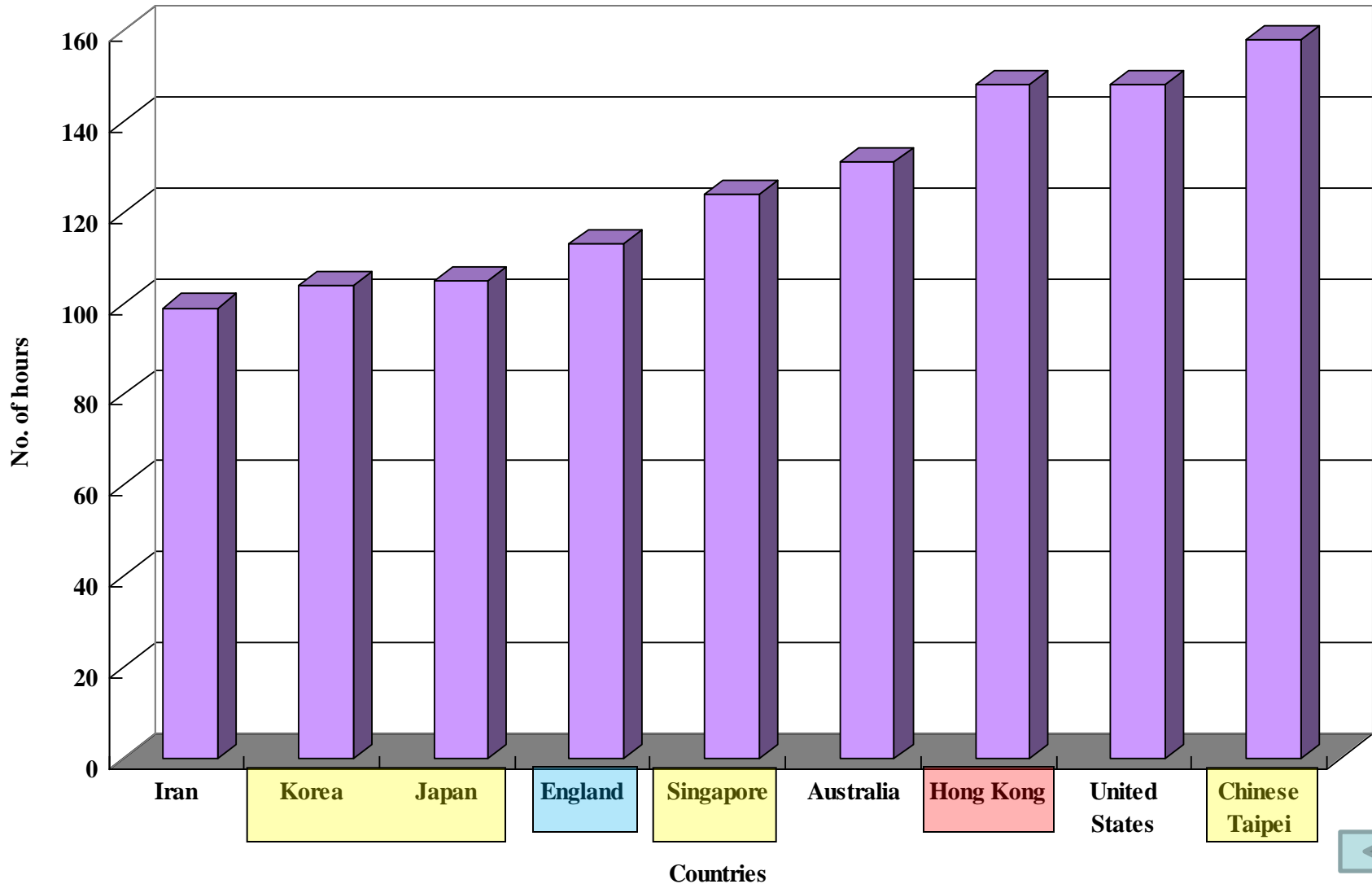
Class size for Mathematics Instruction (G.8 Int'l Avg. = 29 students)



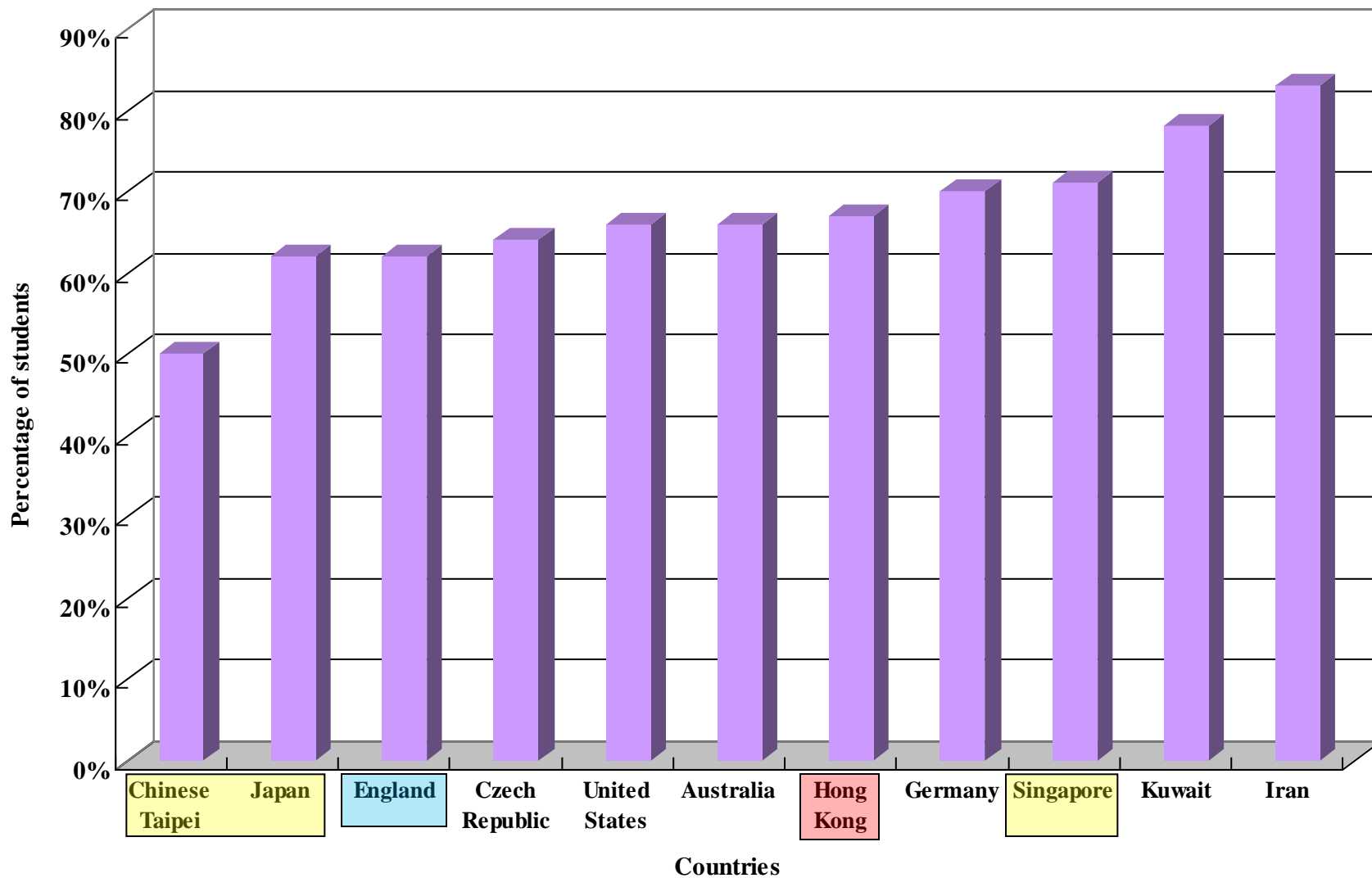
Mathematics Instructional Time (G.4 Int'l Avg. = 144 hours)



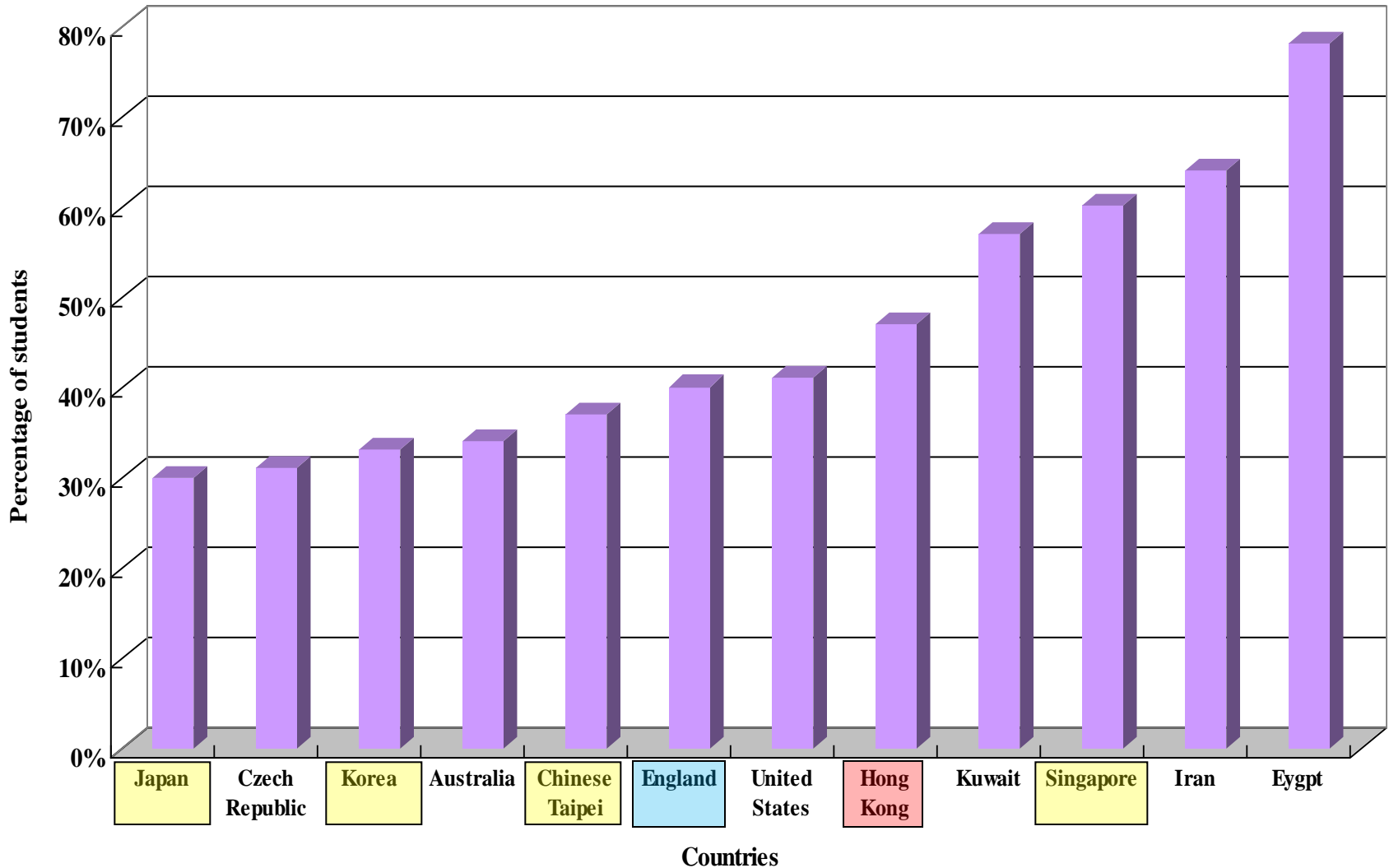
Mathematics Instructional Time (G.8 Int'l Avg. = 120 hours)



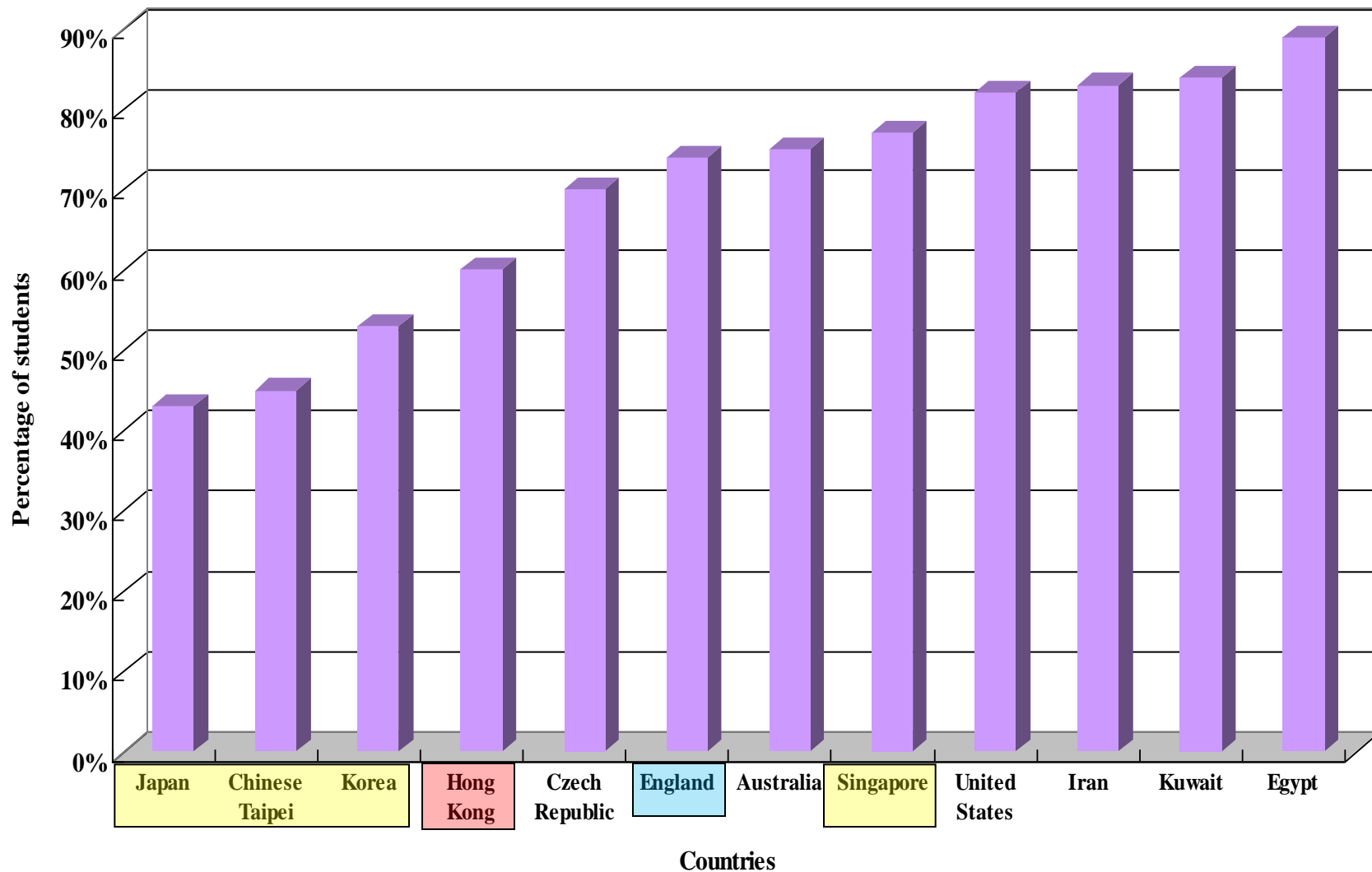
High Positive Affect Toward Mathematics (G.4 Int'l Avg. = 72%)



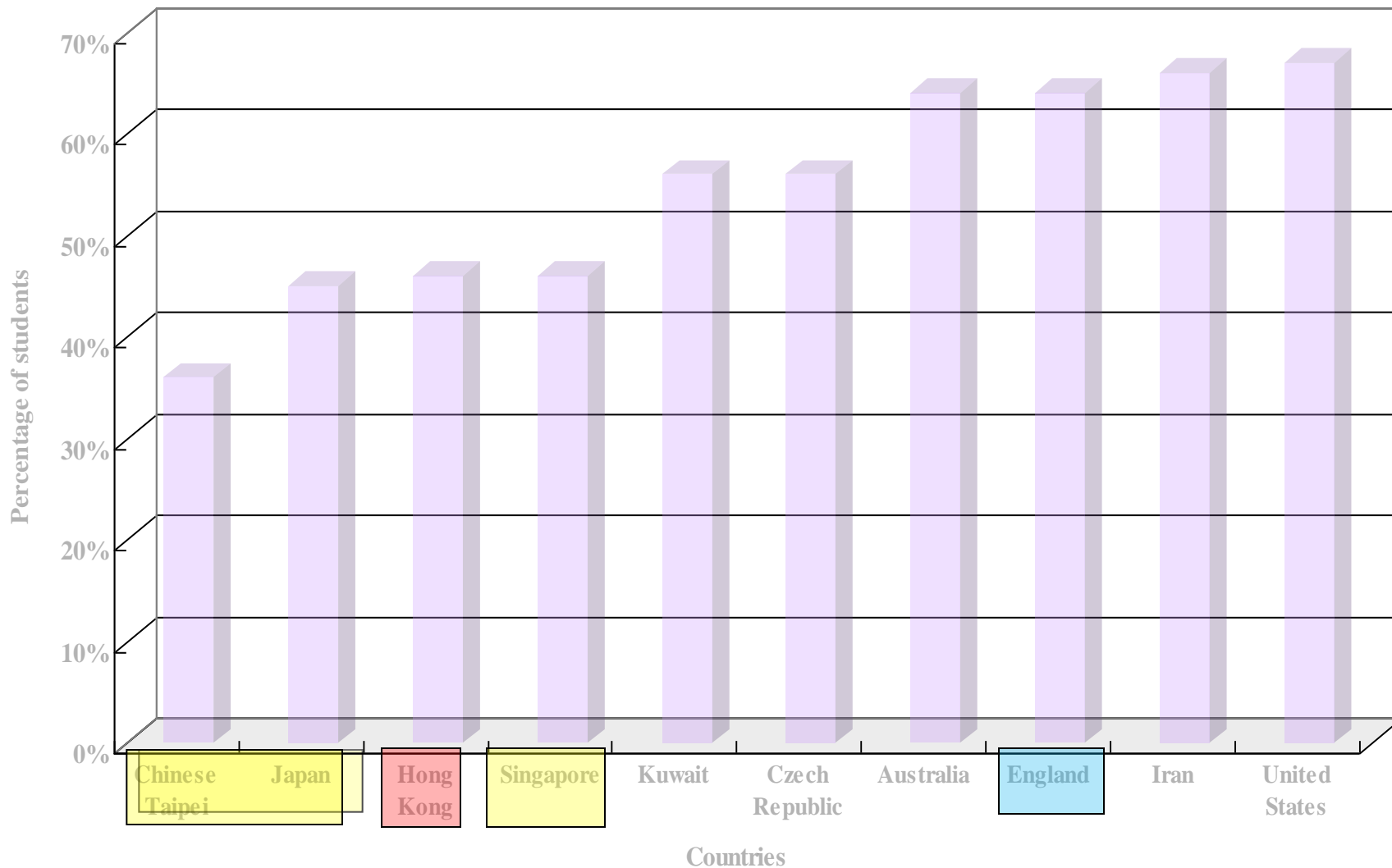
High Positive Affect Toward Mathematics (G.8 Int'l Avg. = 54%)



Students Valuing Mathematics Highly (G.8 Int'l Avg. = 78%)



High Self-Confidence in Learning Math. (G.4 Int'l Avg. = 57%)



High Self-Confidence in Learning Math. (G.8 Int'l Avg. = 43%)

