Sex Roles, Vol. 47, Nos. 3/4, August 2002 (© 2002)

Gender Differences in Interest and Knowledge Acquisition: The United States, Taiwan, and Japan[1]

E. Margaret Evans,[2,4] Heidi Schweingruber,[3] and Harold W. Stevenson[2]

The relationship between interest and knowledge was investigated in a representative sample of 11th grade students from cultures that differ in the strength of their gender-role stereotypes and their endorsement of effort-based versus interest-based learning. Among 11th graders from the United States ($N = 1052$), Taiwan ($N = 1475$), and Japan ($N = 1119$), boys preferred science, math, and sports, whereas girls preferred language arts, music, and art. General information scores were comparable across the three locations; however, boys consistently outscored girls. Gender and interest in science independently predicted general information scores, whereas gender and interest in math independently predicted mathematics scores. Cultural variations in the strength of the relationship between gender, interest, and scores indicate that specific socialization practices can minimize or exaggerate these gender differences.

KEY WORDS: culture differences; effort; gender differences; general information; interest; mathematics.

From G. Stanley Hall's early investigations of the "contents of children's minds" (Hall, 1921) to more recent work on functional literacy (e.g., Hirsch, 1988; Ravitch & Finn, 1988), parents and educators have been urged to foster children's acquisition of the knowledge commonly held by members of their culture. The most frequent reference to such knowledge has been to its role as an indicator of the level of intelligence of children and adults. Indeed, a test of general information is included as a component of intelligence tests such as the Weschler scales for children and adults.

The findings reported in this paper arose from a study of the general information possessed by high school students in three diverse cultures, and of two factors, interest and gender, that are likely to influence the acquisition of such knowledge. To provide a contrast to general information, which is knowledge acquired through everyday experiences as well as at school (see Hirsch, 1988), we also considered students' scores on a test of formal mathematics. Unlike general information, formal mathematics, at least beyond simple arithmetic, is an academic subject that requires extensive direct instruction that is less readily available in out-of-school contexts.

General information test items are typically drawn from a broad range of knowledge domains from history to technology and science, but the questions do not usually require specialized knowledge that would be conveyed only in school (see Wechsler, 1981). This "functional literacy" is the kind of background information that news reporters, politicians, and others concerned with mass communication must presume in their readers and listeners (Hirsch, 1988). On the basis of these criteria, we constructed a test of general information that consists of questions deemed by members of three diverse industrialized societies to be relevant and fair for evaluating the general knowledge of students in those cultures. Given that experts

[1]Portions of this research were presented at the meetings of the Society for Research in Adolescence, in Washington, DC, 1992, and the Society for Research in Child Development in New Orleans, 1993.

[2]Center for Human Growth and Development, University of Michigan, Ann Arbor, Michigan.

[3]OERI, U.S. Department of Education, Washington, DC.

[4]To whom correspondence should be addressed at Center for Human Growth and Development, University of Michigan, 300 N. Ingalls Building, Ann Arbor, Michigan 48109-0406; e-mail: evansem@umich.edu.

from all three cultures valued a particular item of information and believed that this information was disseminated in the culture, the goal of this study was to determine the extent to which male and female students in these three diverse cultures actually acquired this information.

We chose the United States, Taiwan, and Japan for comparison because these cultures differ both in their schooling and in the out-of-school experiences available to children (e.g., Stevenson & Stigler, 1992). Moreover, in comparison with the United States, East Asian cultures are more likely to emphasize effort-based learning, which has been hypothesized to be an important factor in the superior mathematics performance of East Asian students (Chen & Stevenson, 1995; Hess & Azuma, 1991; Stevenson & Lee, 1997; Stevenson & Stigler, 1992). Historically, Western education has placed a greater value on interest-based than on effort-based learning (Schiefele, 1991), whereas the Confucian traditions of East Asian cultures, such as those of Japan and Taiwan, have emphasized effort-based learning regardless of the individual's interest in the task (Hess & Azuma, 1991).

One question explored in this study is whether cultural and gender differences found in earlier studies of more formal school subjects, such as mathematics (e.g., Beller & Gafni, 1996; Stedman, 1997; Stevenson & Lee, 1997), would also be obtained on a test of general information. Reports of gender differences on general information in favor of males have been found in the United States (Feingold, 1993; Lubinski & Humphreys, 1990), but the reasons for this finding have been unclear. A cross-cultural evaluation of the scores of both males and females on a similar test would indicate whether such a result is confined to U.S. students or is more broadly characteristic of students in other industrialized cultures.

In addition to culture and gender, a critical variable of concern was whether students' interests in various subjects in the high school curriculum would have differential influences on general information and mathematics scores. One way of identifying personal interest is to assess an individual's preference for one topic or activity over another (Schiefele, Krapp, & Winteler, 1992). Because individuals are more likely to attend to and retain information that is particularly appealing to them (Stanovich & Cunningham, 1993), students' personal interests should be accompanied by greater knowledge in the relevant domains. In Western cultures, high levels of interest are positively related to achievement on the related tasks (e.g., Pintrich, 1989; Schiefele, 1991; Schiefele et al., 1992).

Relations between interest and test performance have not been systematically investigated in Asian cultural settings, nor have gender differences in patterns of interest. In the United States, students' interests do play a role in the relationships among gender, test scores, and eventual career choice (e.g., Eccles, 1994; Lubinski & Benbow, 1992). For instance, when comparing the selection of academic subjects by American boys and girls in the top 2% of mathematical ability, Lubinski and Benbow (1992) found that boys were more likely to consider science-related careers and to enroll in science and math courses rather than courses in the humanities. Equally talented girls were less likely than boys to select math or science courses because they perceived them to be incompatible with their interests in humanistic issues (Lubinski & Benbow, 1992).

Comparable patterns of relationships between gender and interest are likely to be present in East Asian countries as well, as similar pancultural gender stereotypes have been found among university students from many culturally and geographically diverse countries, including the United States and Japan (Williams, Satterwhite, & Best, 1999). Such stereotypes have been linked to gender differences in patterns of interest and achievement (e.g., Eccles, 1994). Furthermore, international assessments indicate that gender effects for science achievement in favor of males are pervasive, and, in general, they are larger than those for mathematics and increase with age (Beller & Gafni, 1996).

Even so, Chinese and Japanese cultures still appear to offer more traditional gender role models than the more egalitarian roles seen in the United States, though the situation is changing rapidly. Thus, if we assume both that there would be a greater difference in the interests of males and females in Chinese and Japanese cultures than in the United States and that interest is related to scores, gender should be more predictive of scores in these East Asian countries than in the United States. Alternatively, Hofstede (1996) has claimed that in Japan as well as in the United States social gender roles are more clearly distinguished than they are in Taiwan. Cultures with more distinct gender roles have more pronounced gender stereotypes, with, for example, stereotypically masculine traits such as ambitiousness more likely to be considered typical of males (Hofstede, 1996). From the latter findings, one might predict that differences between the interests of males and females would be greater in the United States and Japan than in Taiwan, and that the relationships among gender, interest, and scores would be correspondingly more pronounced in the United States and Japan than in Taiwan.

However, an argument can be made that the acquisition of knowledge by East Asian students might be less influenced by gender. As described earlier, East Asian cultures with Confucian traditions tend to emphasize effort-based over interest-based learning. Consequently, the personal interests of East Asian students, boys or girls, might be less likely to be related to test scores regardless of the prevailing gender stereotypes. Thus, the overall question we address is whether the relationship between interest and knowledge is as extensive in two East Asian cultures as it is in the West and to what extent these relationships are influenced by gender.

Specifically, we hypothesized that for mathematics, a subject largely acquired in school settings, the effort-based orientation of East Asian schools should result in higher scores for East Asian male and female students, in comparison to U.S. students, regardless of student interest in the subject. In other words, culture should contribute more to differences in mathematics scores than would gender or student interest. In contrast, for general information, which is more likely to be acquired in less formal everyday settings, we hypothesized that student interest would contribute more to differences in general information scores than would gender or cultural location.

METHOD

Participants

This study was part of a larger sequence of longitudinal and cross-sectional studies conducted by Stevenson and his colleagues in three comparable metropolitan areas: Minneapolis, U.S., Taipei, Taiwan, and Sendai, Japan (Stevenson, Chen, & Lee, 1993; Stevenson & Stigler, 1992). These data were collected in 1990 and 1991. The 11th graders were selected to constitute samples of students attending a representative group of high schools in each city (see Stevenson et al., 1993, for further details). The sample in Taipei consisted of 617 boys and 852 girls, in Sendai, 639 boys and 480 girls, and in Minneapolis, 476 boys and 527 girls.

Measures

Students responded to the materials during study periods or nonmathematics classes. In Minneapolis, consent to participate was obtained directly from the students and their parents. In Taiwan and Japan, consent was vested in the school authorities by the students' parents.

General Information Test

The general information test was constructed by members of a research team that included bilingual male and female native speakers of Chinese, Japanese, and English. In constructing the test, we first reviewed items contained in other tests of general information and added new items generated by members of the research team. Over 100 items were constructed and submitted for evaluation to undergraduate and graduate students from each of the three cultures who were attending the University of Michigan. Many items were rejected at this stage because they were not deemed to be culturally fair in that they represented knowledge not readily available in one or more of the cultures. We then submitted the remaining items to colleagues, both educators and academics, who lived in each of the three cultures for their evaluation. The items that constituted the pool from which the test was constructed were those that were selected most consistently as being culturally appropriate, fair, and devoid of bias in favor of any one of the three cultural groups to be included in the study. To ensure cultural appropriateness the test of general information was developed in the three languages simultaneously. This method avoids many of the problems associated with the translation of materials that are initially constructed in only one language, such as expressions that cannot be easily translated into the other two languages.

It immediately became clear that the items included in the test did not sample certain content areas. For example, items that dealt with the arts, music, literature, or psychology were likely to have an East Asian or Western bias and were much more difficult to construct than were items that tapped everyday scientific knowledge or historic and economic issues of global import. Because one question that motivated this research was whether the relationship between interest and test scores would be similar in the three cultures, it seemed important that we have a test that was, like mathematics, as potentially culturally unbiased as possible, thus such domains were excluded.

However, we were aware that, in the United States at least, boys would be more likely than girls to express an interest in school-based science and math, though such findings have not been investigated in other cultural settings. To counteract this potential gender bias we included items from the selected content areas that, we thought, would elicit girls' as well as boys' interest. For example, for history, we included questions on social/political history (e.g., Gandhi) rather than military history; for world affairs and for science we included questions with lifestyle implications, such as on Chernobyl and everyday science (e.g., sweat, blankets). Moreover, our coding of the responses was gender-fair (see Willingham & Cole, 1997), in that we gave equal weight to people-oriented and object-oriented responses, where appropriate, such as the human and environmental consequences of the Chernobyl disaster.

The final version of the test consisted of 12 items from two broad domains (based on face validity): (a) six from history, geography, politics, economics, and current issues, which we refer to as global cultural literacy, and (b) six from the natural sciences, which we refer to as (everyday) science literacy (see Table I). Two items (Chernobyl, greenhouse effect) from the "global cultural" group could reasonably have been placed in the "science" group, but because of their global lifestyle implications we included them in the former grouping. The questions were open-ended, a format that, if anything, favors girls (Stumpf & Stanley, 1999; but see Beller & Gafni, 2000, for a more nuanced view), and were presented in a random order; students were allowed 12 min to write their answers.

A formal coding scheme was developed with input from members of the research team from all three cultures. One point was given for partially correct answers, 2 points for correct answers that included only one key concept relevant to the question, and 3 points for comprehensive answers that mentioned at least two key concepts (see Appendix for examples of three of the questions). On the question concerning Ethiopia, the highest possible score was 2 (no partial credit was given for this question). Responses were coded directly in the respondent's language by trained male and female native-speakers from each of the three cultures. Coders did not know the sex of the respondents. To ensure reliability of coding, all responses were coded twice, and any differences between coders in scoring were resolved at meetings attended by all members of the coding teams. In other words, all questions achieved 100% interrater agreement. Total possible scores ranged from 0 to 35; the science-related subscores ranged from 0 to 18, and the global cultural subscores ranged from 0 to 17.

Mathematics Test

Students were given 40 min to complete a 46-item mathematics test, which covered concepts and operations common to all three locations, based on an analysis of the textbooks used in the high schools in each location. The test covered arithmetic, algebra,

Table I. Mean Scores on Individual Items From the General Information Test by Culture and Gender

	U.S.		Taiwan		Japan	
	Boys	Girls	Boys	Girls	Boys	Girls
Global cultural literacy	8.77	7.21	9.56	7.77	9.56	6.95
In which continent is Ethiopia?[a]	1.87	1.74	1.96	1.92	1.68	1.43
Why did the Egyptians build the pyramids?	1.46	1.25	1.75	1.61	1.54	1.46
What happened in Chernobyl several years ago?	1.61	1.10	1.65	0.98	2.01	1.63
What do we mean by inflation when we talk about a country's economy?	1.62	1.55	1.61	1.50	1.65	1.11
Gandhi was assassinated over 30 years ago. Why is this man still famous?	1.00	0.79	1.31	1.10	1.15	0.49
What is the Greenhouse Effect?	1.22	0.77	1.28	0.66	1.53	0.81
Science literacy	7.46	6.10	8.68	6.62	7.28	5.27
Why do blankets keep us warm?	1.72	1.54	1.69	1.44	1.50	1.33
Why do our bodies sweat when we are hot?	1.62	1.31	1.53	1.32	1.39	1.24
Why has it become possible to make smaller computers in recent years?	0.99	0.67	1.12	0.62	1.00	0.32
Why does the sky look blue?	0.63	0.43	0.69	0.35	0.40	0.20
What are the differences between rocks and fossils?	1.26	1.18	1.78	1.51	1.51	1.28
What causes an eclipse of the sun?	1.25	0.96	1.87	1.38	1.47	0.89

Note. Scores ranged from 0 to 3.
[a]Scores were either 0 or 2.

geometry, trigonometry, and advanced mathematics, and the items ranged in difficulty from those comparable to a fifth-grade level to some that appeared in textbooks for high-school advanced placement classes. Students were awarded 1 point for each correct answer, and the mathematics score was the total number of correct answers (see Stevenson et al., 1993, for further details).

Preferences and Interests

Students also completed a questionnaire on school-related issues. In order to reduce the time requirements two forms of the questionnaire were developed with half of the sample in each culture completing each form. We report the results from the form that included students' preferences for school subjects. We measured students' preferences by asking them to rank order their liking for six school subjects common to curricula in all participating schools (mathematics, science, language arts, music, art, and physical education). In contrast to rating measures, this type of measurement provides unambiguous data on student preferences, a particularly important point when carrying out cross-cultural comparisons. The rank the students assigned to each school subject was used to generate a 6-point preference measure, with a range from 1 (*most highly ranked*) to 6 (*least highly ranked*). The use of a ranking measure meant, however, that individual measures were not independent, and therefore we did not enter them into a single analysis to assess their relation to performance. Rather, we created grouping variables, with preferences ranked as first or second designated as "high interest" and other rankings designated as "low interest," which were subsequently used in the analyses comparing the effects of the major variables on test scores.

RESULTS

We first describe male and female 11th graders' scores on the general information and mathematics tests and report their school subject preferences. Following this, we evaluate the relation between gender and interest in specific school subjects to scores on the two tests. Analyses of variance were used to analyze the relationships among culture (U.S., Taiwan, Japan), gender (boys, girls), and interest (high, low), and general information and mathematics scores. Multiple classification analysis (see Nagpaul, 2001) was then used to determine the standardized regression coefficients (β) associated with the independent effects of these variables on performance (SPSS v. 6.1.1 [Computer software], 1994).

The reliabilities on both tests were high in all cultures: Cronbach alphas ranged from 0.91 to 0.95 for the mathematics test in the three cultures and were 0.82 (U.S.), 0.80 (Taiwan), and 0.67 (Japan) for the general information test (Stevenson et al., 1993).

General Information Test

Differences between the general information scores of the three cultural groups were small (see Fig. 1), though there was a significant effect for culture, $F(2, 3531) = 31$, $p < .01$; students from Japan ($M = 14.9$, $SD = 5.7$) and the U.S. ($M = 14.7$, $SD = 6.5$) obtained equivalent scores and both were lower than those of students from Taiwan ($M = 16.0$, $SD = 6.8$) (Scheffes: *p*s < .05). The gender differences were greater. Boys received higher scores than girls on all 12 questions, in each of the three cultures, $F(2, 3531) = 344.3$, $p < .001$ (see Table I). The less pronounced effect for gender in the U.S. (boys: $M = 16.2$, $SD = 6.2$; girls: $M = 13.3$, $SD = 6.5$) than in Taiwan (boys: $M = 18.2$, $SD = 6.1$; girls: $M = 14.4$, $SD = 6.8$) and Japan (boys: $M = 16.8$, $SD = 5.6$; girls: $M = 12.2$, $SD = 4.8$) resulted in a significant interaction between culture and gender, $F(2, 3531) = 4.9$, $p < .01$.

The standardized regression coefficients (β) associated with the independent effects of these variables on general information performance were calculated. These effects can be interpreted as small, .10, moderate, .30, or large, .50 (Rosenthal & Rosnow, 1991). Gender differences explained more of the overall variation in scores ($\beta = .30$) than did cultural differences ($\beta = .13$). However, it should be noted that on eight questions there were significant interactions between culture and gender (see Table II). Although the difference in scores among the three locations did not consistently favor any one culture, on all but three questions (Ethiopia, pyramids, rocks, and fossils), the effect for gender was either greater than that for culture, or the same (eclipse, Gandhi); questions on the greenhouse effect and computers elicited the largest effects for gender (see Table II).

Given the similarity of the results for the science literacy and global cultural literacy subscores to the statistical effects found for the overall test, and to conserve space, these results are not reported in detail.

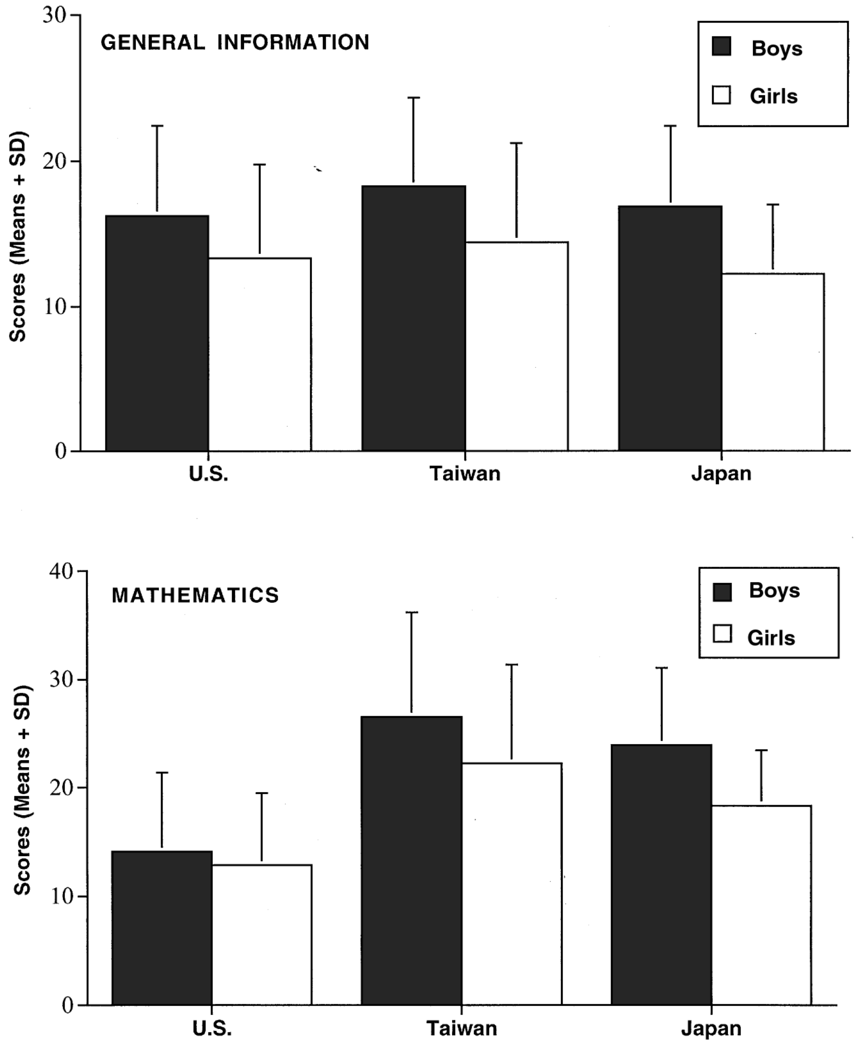

Fig. 1. Mean scores (standard deviations) of male and female 11th graders on the general information test (range: 0–35) and mathematics test (range: 0–46), by location and gender.

Mathematics Test

In contrast with the students' scores on the general information test, there were large differences in mathematics scores between the three cultures, $F(2, 3585) = 572.1$, $p < .001$; Students from Taiwan ($M = 24.0$, $SD = 9.6$) and Japan ($M = 21.5$, $SD = 6.9$) received much higher scores than did U.S. students, $M = 13.4$, $SD = 7.0$ (see Fig. 1). Gender differences on the mathematics test, $F(2, 3585) = 209.3$, $p = .001$, however, were significantly larger in Taiwan (boys: $M = 26.5$, $SD = 9.6$; girls: $M = 22.2$, $SD = 9.1$) and Japan (boys: $M = 23.9$, $SD = 7.1$; girls: $M = 18.3$, $SD = 5.1$) than in the U.S. (boys: $M = 14.1$, $SD = 7.2$; girls: $M = 12.8$, $SD = 6.6$), as seen in the interaction between culture and gender, $F(2, 3585) = 20.7$, $p = .01$. Even so, East Asian girls received higher scores than U.S. boys did (Scheffes: ps $< .05$). In the case of mathematics, culture ($\beta = .48$) explained more of the overall variation in scores than did gender ($\beta = .21$).

Preferences and Interests

In each of the three cultures, boys were more likely to prefer mathematics, science, and physical education (called "sports"), and girls were more likely to prefer language arts, music, and art (see Table III). An exception was the lack of gender differences in

Table II. General Information Items by Culture and Gender (Analyses of Variance and βs)

	F^a			β	
	Culture	Gender	Interaction	Culture	Gender
Global cultural literacy					
Ethiopia	130.1***	42.3***	8.3***	.26	.11
Pyramids	47.9***	26.3***	1.6	.16	.09
Chernobyl	94.9***	260.6***	7.0***	.22	.26
Inflation	9.8***	40.1***	15.6***	.07	.11
Gandhi	47.7***	98.5***	17.5***	.16	.16
Greenhouse effect	12.1***	253.0***	3.7*	.08	.26
Science literacy					
Blankets	14.9***	42.3***	0.6	.09	.11
Sweat	6.7***	40.4***	1.6	.06	.11
Computers	14.5***	246.7***	9.4***	.09	.26
Blue Sky	32.1***	99.1***	3.6*	.13	.17
Rocks and Fossils	50.6***	36.2***	2.9	.17	.10
Eclipse	83.8***	163.2***	4.7**	.21	.21

[a] *df*s (3531–3533).
*$p < .05$. **$p < .01$. ***$p < .001$.

Japanese students' preferences related to art. There were significant interactions between culture and gender for science, sports, music, and art (see Table III). In general, though, the strength of the relation between gender (βs from .14 to .30) and preference for school subject was larger than that for culture and preference for school subject (βs from .05 to .21).

For the three subjects preferred by boys paired comparisons revealed several significant findings (see Table III). Sports was preferred over both math and science by boys in the U.S., *t*s from 3.23 to 3.54 (all *p*s $< .001$), and in Japan, *t*s from 5.33 to 6.12 (all *p*s $< .001$). Boys in Taiwan liked math the least; they preferred both science and sports, *t*s from 2.06 to 2.79 (all *p*s $< .05$). Similar analyses of the three subjects preferred by girls (see Table III) indicated that girls in the U.S. preferred language arts over both music and art, *t*s from 5.85 to 4.23 (all *p*s $< .001$). Girls in Taiwan, on the other hand, preferred music the most and art the least, *t*s from 3.30 to 7.81 (all *p*s $< .001$). Japanese girls also showed a preference for music over both art and language arts, *t*s from 3.11 to 4.06 (all *p*s $< .01$).

The percentage of boys and girls within each location who designated each subject as "high interest" (operationalized as school subjects ranked as first or second) is seen in Fig. 2. Gender differences in high interest in a specific subject across all cultures were consistent with the results for the preference scores; an exception was the lack of an effect for gender on high interest in mathematics in the United States.

School–Subject Preferences and Performance on the General Information and Mathematics Tests

Correlations between school–subject preferences, gender, and general information and mathematics

Table III. School–Subject Preference by Culture and Gender (Mean Scores and Analyses of Variance)

	U.S.		Taiwan		Japan		F^a		
	Boys	Girls	Boys	Girls	Boys	Girls	Culture	Gender	Interaction
Boys' preferred subjects									
Math	3.2	3.6	3.3	3.9	3.5	4.0	5.3**	36.7***	*ns*
Science	3.2	3.6	2.9	4.2	3.7	4.3	17.5***	121.9***	13.4***
Sports	2.7	3.9	3.0	3.7	2.7	3.4	5.1**	126.9***	3.2*
Girls' preferred subjects									
Music	4.3	3.7	3.8	2.6	3.8	2.7	44.1***	183.9***	5.3**
Art	3.8	3.4	4.4	3.5	3.5	3.4	14.2***	34.0***	6.4**
Language Arts	3.8	2.8	3.6	3.0	3.8	3.2	*ns*	84.5***	*ns*

Notes. Scores ranged from 1 (*most preferred subject*) to 6 (*least preferred*), *SD*s 1.6–1.8.
[a] *df*s (479–736).
*$p < .05$. **$p < .01$. ***$p < .001$.

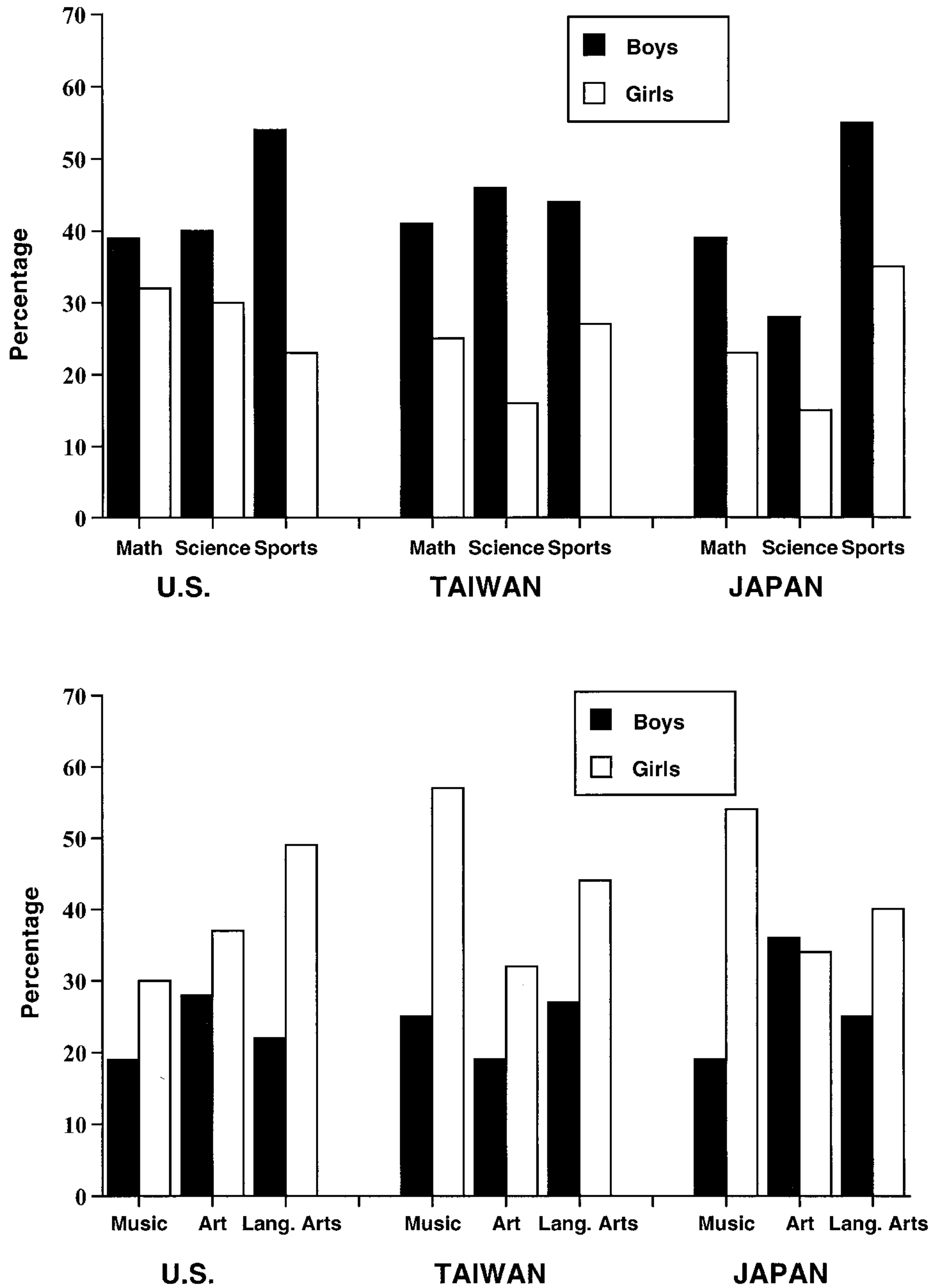

Fig. 2. Percentage of male and female 11th graders who indicated high interest (rank-ordered as first or second) in six school subjects, by location.

scores within each cultural location (see Table IV) indicated that the overall pattern of the relationships was similar in each location. As demonstrated with the previous analyses: girls were less likely than boys to score well on both the general information and mathematics tests and less likely to value mathematics, science, and sports; girls were, however, more likely to value music, art, and language arts. However, the strength of the relationships varied between cultural locations; with few exceptions they appeared to be stronger in both East Asian locations. This pattern supports the hypothesis

Table IV. Within-Culture, Zero-Order Correlations Between Gender, General Information and Mathematics Scores, and School–Subject Preferences[a]

	Gender[b]	General information	Mathematics
United States			
General information score	−.23***	—	—
Mathematics score	−.09**	.58***	—
Mathematics preference	−.12**	.03	.26***
Science preference	−.12**	.25***	.17***
Sports preference	−.34***	−.11*	−.13**
Music preference	.19***	−.09	−.07
Art preference	.10*	−.05	−.14**
Language arts preference	.30***	−.01	−.08
Taiwan			
General information score	−.28***	—	—
Mathematics score	−.22***	.71***	—
Mathematics preference	−.18***	.18***	.38***
Science preference	−.38***	.35***	.28***
Sports preference	−.23***	.02	−.01
Music preference	.36***	−.26***	−.25***
Art preference	.23***	−.15***	−.20***
Language arts preference	.18***	−.14***	−.20***
Japan			
General information score	−.40***	—	—
Mathematics score	−.40***	.48***	—
Mathematics preference	−.12**	−.02	.33***
Science preference	−.19***	.31***	.26***
Sports preference	−.22***	−.11*	.01
Music preference	.35***	−.20***	−.29***
Art preference	.03	.02	−.11*
Language arts preference	.18***	.00	−.23***

Note. All significance levels are two-tailed. *N*s (455–737).
[a]Reverse-scored: 1 = least-preferred subject to 6 = most-preferred subject.
[b]1 = male; 2 = female.
*$p < .05$. **$p < .01$. ***$p < .001$.

of greater gender differentiation in the East Asian locations.

There were some interesting consistencies in the overall relationship between subject-specific preference and performance on the two tests (see Table IV). In all locations science preference, a subject preferred by boys, was positively related to general information scores, and, to a lesser extent, to mathematics scores. In the case of mathematics scores, mathematics preference, another subject preferred by boys, and, to a lesser extent, science preference were positively related to these scores. However, the three subjects preferred by girls, art, music, and language arts, were either negatively related or unrelated to mathematics and general information scores in all three locations. Some cultural variations were also apparent. Sports preference was negatively related to general information and mathematics performance in the United States and in Japan. Only in Taiwan was a preference for mathematics positively related to general information scores.

Culture, Gender, Interest, and Knowledge Acquisition

We assumed that high interest in a specific school subject (see Fig. 2) would motivate students to obtain a greater amount of information in that subject. As the previous and following analyses demonstrate, this proved to be the case for mathematics and science, both subjects preferred by boys. However, given that gender is also related to test scores, it seemed important to determine the extent to which the effects of gender and interest were independent and whether this relationship varied between cultures. In the next analyses, following the overall ANOVAS, we assessed the independent contribution of each variable to the general information and mathematics scores, in turn,

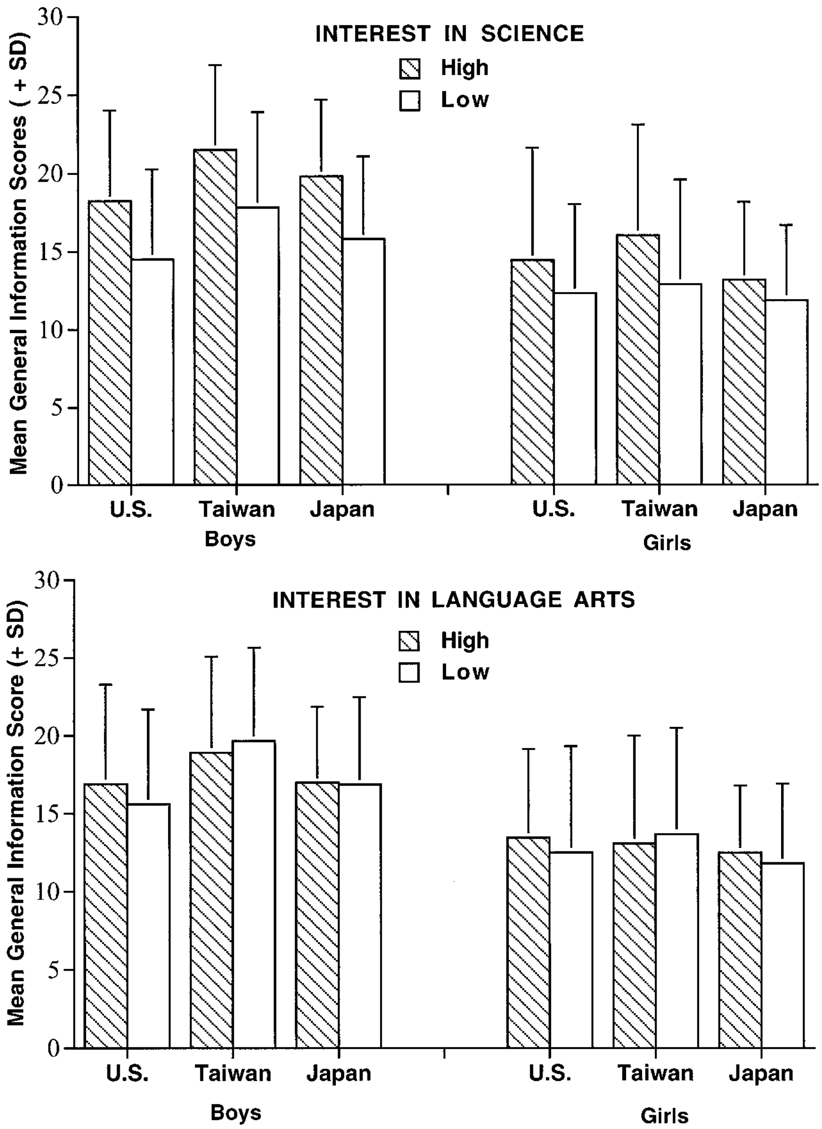

Fig. 3. General information scores of male and female 11th graders who indicated high or low interest in science and language arts, by location.

partialing out the effects of the other variables. We focused on two of the subjects preferred by boys, science and mathematics, and, for comparison, one academic subject preferred by girls, language arts.

Interest and General Information Scores

For the general information test there was a positive relationship between interest in science and both boys' and girls' scores on the test (*F*s from 26.9 to 40.4; *p*s $< .001$; see Fig. 3). Interest in language arts bore no relation to general information scores (see Fig. 3). The strength of the relation between degree of interest in science and general information scores, independent of the effect for gender, demonstrated a small-to-moderate effect in all cultures (βs $= .22$). However, the strength of the relationship between gender, independent of high interest in science, and scores on the general information test differed between cultures, with a small-to-moderate relation in the United States ($\beta = .22$) and a moderate relation in the other two cultures (βs from .35 to .39).

Interest in science predicted scores on the science literacy and global cultural literacy components of the test equally well. To conserve space and given the similarity to the statistical effects found for the overall test,

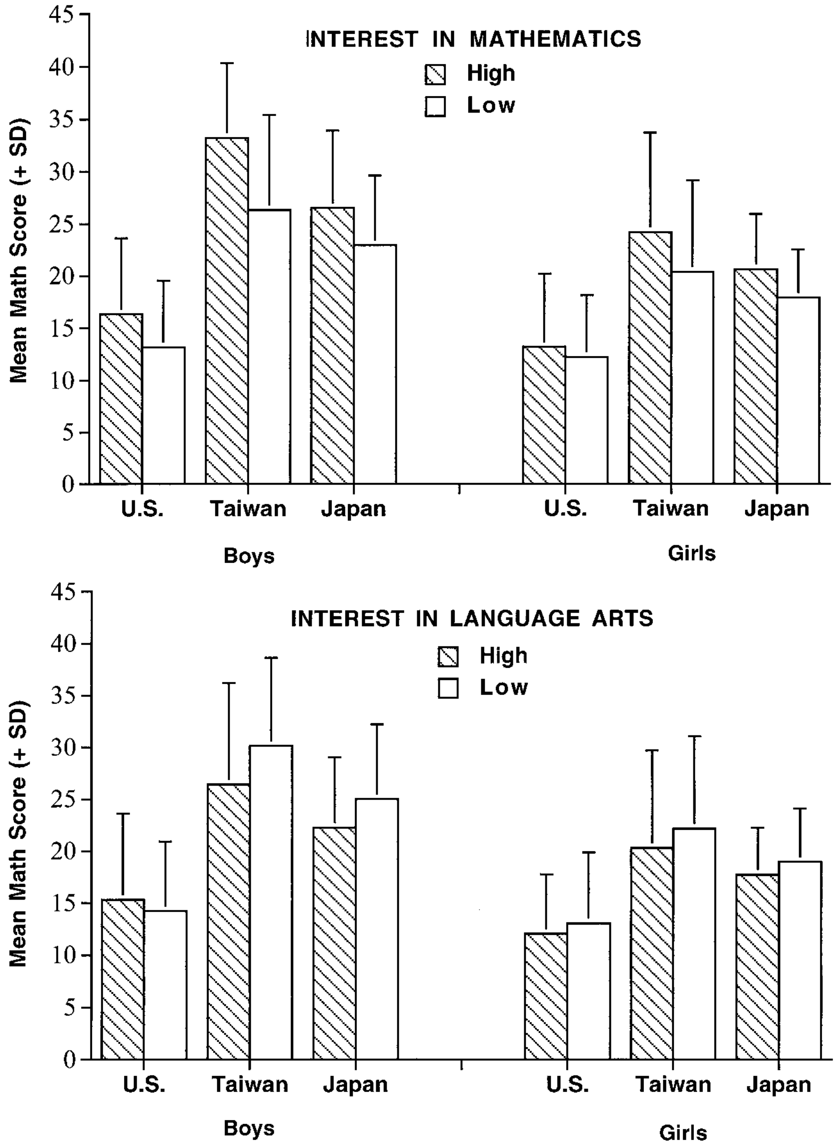

Fig. 4. Mathematics scores of male and female 11th graders who indicated high or low interest in mathematics and language arts, by location.

the results for the science literacy and global cultural literacy components will not be reported in detail.

Interest and Mathematics Scores

In line with our assumptions, in all three cultures, for both boys and girls, a significant relationship was found between interest in mathematics and students' mathematics scores (*F*s from 10.14 to 58.80; $ps < .01$; see Fig. 4). To a much lesser extent, this positive relationship was also found for interest in science (*F*s from 6.73 to 20.28; $ps < .01$). (Only the results for mathematics and language arts are presented in Fig. 4). Interest in language arts was significantly negatively related to mathematics scores in both East Asian cultures (*F*s from 9.7 to 13.8; $ps < .01$), though not in the United States (see Fig. 4).

The relationship between high interest in mathematics and mathematics scores, independent of gender, was similar in all cultures; it was small-to-moderate in the two East Asian cultures (βs from .22 to .25) and small in the United States ($\beta = .15$). However, gender, independent of interest in mathematics, and scores on the mathematics tests again differed between cultures: There was a small effect in the United States ($\beta = .13$) and a moderate effect in the other two cultures (βs from .35 to 39).

DISCUSSION

In contrast to the gloomy picture often painted in reports of American students' knowledge (e.g., Mullis et al., 1998; Ravitch & Finn, 1988), the present findings demonstrate that the interests and general knowledge of 11th graders from the United States were remarkably similar to those of 11th graders in two East Asian countries that are known for their outstanding levels of academic achievement. Given the different means of accessing sources of general information in the three cultures, we think it is remarkable that there was so little difference in these scores. However, girls' scores were lower than those of boys on every general information item in each of the three cultures, regardless of whether the questions tapped everyday scientific knowledge or information of a more global cultural nature. This finding adds a new dimension to earlier work (Feingold, 1993; Lubinski & Humphreys, 1990) on gender differences on general information measures in the United States.

The findings with mathematics provide an informative contrast. There were striking differences between the three cultures in scores on the mathematics test, with students from the two Asian cultures performing at much higher levels than students in the United States. But in this case, gender differences in mathematics scores were barely significant in the United States, even with the very large samples of 11th graders included in the study. Although gender differences in mathematics were much larger in Taiwan and Japan, the East Asian students, both boys and girls, outscored their counterparts from the United States.

Assessing the Role of Interest

We investigated whether in all three cultures high levels of interest in a particular subject would result in a deeper understanding of topics related to that specific domain of knowledge than would lower levels of interest. Of the interests we assessed we found that, overall, boys were more likely to be interested in mathematics, science, and sports, whereas girls were more likely than boys to declare an interest in language arts, music, and art. We found a positive relationship between interest in science and scores on both the science and global cultural components of the general information test. Either a negative relationship or none at all appeared between interest in other subjects and scores on the general information test; however, a different pattern appeared for mathematics. Degree of interest in mathematics predicted scores on the mathematics test, and, to a much lesser extent, so did degree of interest in science. A negative relationship or none at all was found between all other measures of subject-specific interest and mathematics scores.

The negative relationships between specific interests and performance on the general information and mathematics tests indicate that the more interested students are in certain topics (e.g., sports, music) not assessed by the general information and mathematics tests, the less likely they are to do well on these tests. Such findings provide additional evidence that students' interests and abilities are linked, and, further, they suggest that student's personal interests take up time that might otherwise have been dedicated to the material on the tests. For example, students are more likely to pay attention to information available in the media that is relevant to a specific interest (Stanovich & Cunningham, 1993), such as sports or music, and ignore information that is not, such as that assessed on the general information test. Moreover, the pattern of positive and negative correlations also suggests that there are distinct clusters of interests, an issue that will be addressed in more detail later.

Across the three cultures, male and female students' interests in specific subjects, independent of the effects for gender, bore a similar and differential relationship to the students' scores. This was true both for tests of general information and of mathematics. Personal interest appears to play a similar role in the acquisition of knowledge in cultural settings where interest-based learning is emphasized, such as in the United States, and in settings where effort-based learning is stressed, such as in the two East Asian cultures (Hess & Azuma, 1991; Schiefele, 1991). A cultural emphasis on effort, however, coupled with specific schooling practices, is hypothesized to be an important contributor to the higher mathematics scores of male and female East Asian students (e.g., Stedman, 1997; Stevenson & Stigler, 1992).

General Information Tests and Gender Differences in Interests

As described earlier, the construction of the general information test raised intriguing issues concerning the kinds of knowledge that are most effectively transmitted across cultural barriers. In addition to knowledge of everyday science, our questions dealt with global issues such as political history or power relations, (e.g., Gandhi, pyramids), economics (e.g., inflation), and environmental issues that have implications for lifestyles (e.g., Chernobyl, the greenhouse effect). Areas that appear to have equal salience for the three diverse industrialized cultures, however, do not necessarily have equal salience for the two genders. The discrepant scores of boys and girls on the test of general information occurred, we argue, because our questions tended to tap boys' rather than girls' interests, despite our efforts to create a measure that seemed gender neutral.

The interests subscribed to most often by representative samples of young men from these diverse cultures placed the humanities in a secondary position and appeared to converge in three distinct clusters: (1) the natural sciences, politics, and economics; (2) mathematics; and (3) sports (see also Eccles, 1994; Halpern, 1997; Willingham & Cole, 1997). Sports, science, and mathematics interest diverged to the extent that they differentially predicted general information (which included everyday science, politics, and economics) and mathematics scores. Of the boys' interests, only interest in science positively predicted scores on general information in all three cultural locations.

During the development of our measure of general information, our informants and colleagues convinced us that in order to achieve an unbiased, relevant set of culturally fair questions, we should exclude several areas of knowledge: psychological or interpersonal issues, art, music, foreign languages, and literature. In fact, these are precisely the topics that are more likely to be preferred by girls (Eccles, 1994; Lubinski & Humphreys, 1990; Willingham & Cole, 1997). Given the overall, if small-to-moderate, relationship between high interest in a particular topic and scores in a test of knowledge of this topic, it is reasonable to infer that if asked questions about these topics, girls would obtain superior scores. In fact, such a finding has been demonstrated for English literature and composition among a random selection of U.S. 11th graders (Ravitch & Finn, 1988) and on the more selective U.S. College Board Advanced Placement Tests in Art, Art History, and English Literature (Stanley, 1993; Stumpf & Stanley, 1999). Unfortunately, questions from these content areas for one culture might not be relevant for another culture, hence we avoided them.

The reasons for these gender differences are unclear, but the present results raise questions about the use of general information as a measure of overall intelligence. An examination of the items that test general information on the Weschler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981), for instance, indicate that, like the items in our measure, most of them tap everyday scientific, geographical, and political knowledge. Clearly, these are important domains; however, as the analysis of our general information test demonstrates, they concern areas of knowledge that are more likely to be preferred by men than by women. Only 5 of the 29 WAIS-R Information subtest items deal with areas of knowledge that might conceivably be favored by women.

Given the relationship between interest and scores demonstrated in our cross-cultural samples, it is hardly a surprise that men tend to do better on the WAIS-R Information test (Feingold, 1993; Lubinski & Humphrey, 1990). As part of a broader analysis of gender differences in cognitive abilities, Feingold (1993) found moderate-to-large gender differences in both adolescents and adults on the Wechsler Information subtest in the U.S. samples. The present study provides evidence that such differences are likely to continue as long as the content of such tests taps the interests of men rather than those of women. Such findings have far-reaching implications for the study of gender differences.

CONCLUSION

These results pose a challenge: Is it possible to create a test of general information that is unbiased in terms of both culture and gender? It is difficult to escape the conclusion that the creation of a general information test that is culturally fair may inevitably result in a gender-biased test. The reason, we argue, is that females tend to be more interested in areas of knowledge such as art, music, and literature, that traditionally define a culture, rather than in content areas such as science and math, that are more neutral and cross cultural barriers with relative ease. The converse is true for males. The strength of such interests is associated with differential scores by men and women in those domains.

However, it is important to note that gender, independent of interest, was more strongly related to scores of the East Asian students than to scores of the U.S. students. This result, found for both general information and mathematics, supports the hypothesis of greater gender differentiation in the two East Asian cultures than in the United States. Clearly, other factors associated with gender, such as differential access to sources of knowledge, also play a role in the dissemination of such information. In addition, there were interactions between culture and gender on more than half of the general information questions and on the majority of the assessed interests. Furthermore, specific cultural practices, such as an emphasis on effort-based learning, apparently raise the absolute level of girls' scores, as seen in the higher mathematics scores of East Asian girls relative to U.S. boys, despite the girls' less marked interest in the subject.

Overall, these findings lead us to conclude that cultural variations in socialization and schooling practices can minimize or exaggerate gender differences in interests and achievement scores (see also, Beller & Gafni, 1996; Eagly, 1999; Geary, 1996; Linn & Hyde, 1989). The construction of tests that are unbiased in terms of both culture and gender requires both a recognition of these gender-related differences in interests and their cultural variants, as well as an assessment of their probable effects on performance (Willingham & Cole, 1997).

APPENDIX: GENERAL INFORMATION TEST: SAMPLE CODING SYSTEM FOR THREE QUESTIONS

The full coding scheme included examples of correct, partially correct, and incorrect responses.

Pyramids: Why did the Egyptians build the pyramids?

3 = Both—the pyramids were built to honor and protect the body of the Egyptian king (funerary edifices for Egyptian rulers), and—the Egyptians thought that a person's body had to be preserved and protected so the soul could live forever (afterlife)
2 = Either—funerary edifices for Egyptian rulers, or—the afterlife
1 = Partially correct
0 = Incorrect or Don't Know

Chernobyl: What happened in Chernobyl several years ago?

3 = Both—an explosion (accident, leak) in a nuclear (atomic) power plant, and—a description of the effects or details of the accident
2 = Either—an explosion or accident in a nuclear power plant, or—the effects of the explosion
1 = Partially correct
0 = Incorrect or Don't Know

Blankets: Why do blankets keep us warm?

3 = Both—blankets insulate us from the cold (keep the cold out), and—they preserve our body heat (keep the heat in)
2 = Either—blankets insulate us from the cold, or—they preserve body heat
1 = Partially correct
0 = Incorrect or Don't Know

ACKNOWLEDGMENTS

This research was funded by grants from the National Science Foundation (Grant MDR 89564683) to the third author. The writing was supported, in part, by a Spencer postdoctoral fellowship from the National Academy of Education to the first author. This paper was written by the authors in their private capacities. No official support or endorsement by the U.S. Department of Education is intended or should be inferred. We are grateful to all members of the research group who participated in this study, especially Shin-ying Lee.

REFERENCES

Beller, M., & Gafni, N. (1996). The 1991 International Assessment of Educational Progress in Mathematics and Sciences: The gender differences perspective. *Journal of Educational Psychology*, *88,* 365–377.

Beller, M., & Gafni, N. (2000). Can item format (multiple choice vs. open-ended) account for gender differences in mathematics achievement? *Sex Roles*, *42,* 1–21.

Chen, C., & Stevenson, H. W. (1995). Motivation and mathematics achievement: A comparative study of Asian-American, Caucasian-American, and East Asian high school students. *Child Development*, *66,* 1215–1234.

Eagly, A. H. (1999). The origins of sex differences in human behavior: Evolved dispositions versus social roles. *American Psychologist*, *54,* 408–421.

Eccles, J. S. (1994). Understanding women's educational and occupational choices. *Psychology of Women Quarterly*, *18,* 585–609.

Feingold, A. (1993). Cognitive gender differences: A developmental perspective. *Sex Roles*, *29,* 91–124.

Geary, D. (1996). Sexual selection and sex differences in mathematical abilities. *Behavioral and Brain Sciences*, *19,* 229–284.

Hall, G. S. (1921). *Aspects of child life and education*. New York: Appleton.

Halpern, D. F. (1997). Sex differences in intelligence: Implications for education. *American Psychologist*, *52,* 1091–1102.

Hess, R. D., & Azuma, H. (1991). Cultural support for schooling: Contrasts between Japan and the United States. *Educational Researcher*, *20*(9), 2–8.

Hirsch, E. D. (1988). *Cultural literacy: What every American needs to know*. New York: Random House.

Hofstede, G. (1996). Gender stereotypes and partner preference of Asian women in masculine and feminine cultures. *Journal of Cross-Cultural Psychology*, *27,* 533–5446.

Linn, M. C., & Hyde, J. S. (1989). Gender, mathematics, and science. *Educational Researcher*, *18,* 17–19.

Lubinski, D., & Benbow, C. P. (1992). Gender differences in abilities and preferences among the gifted: Implications for the math-science pipeline. *Current Directions in Psychological Science*, *1,* 61–65.

Lubinski, D., & Humphreys, L. G. (1990). A broadly based analysis of mathematical giftedness. *Intelligence*, *14,* 327–355.

Mullis, V. S., Martin, M. O., Beaton, A. E., Gonzalez, E. J., Kelly, D. L., et al. (1998). *Mathematics and science achievement in the final year of secondary school: IEA's Third International Mathematics and Science Study* (TIMSS). Boston, MA: Boston College.

Nagpaul, P. S. (2001). Guide to advanced data analysis using IDAMS software [on-line]. Retrieved from www.unesco.org/webworld/idams/advguide/TOC.htm.

Pintrich, P. (1989). The dynamic interplay of student motivation and cognition in the college classroom. In C. Ames & M. L. Maehr (Eds.), *Advances in motivation and achievement: Motivation enhancing environments* (Vol. 6, pp. 117–160). Greenwich, CT: JAI Press.

Ravitch, D., & Finn, C. E. (1988). *What do our 17-year-olds know?* New York: Harper and Row.

Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis* (2nd ed.). New York: McGraw-Hill.

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, *26,* 299–323.

Schiefele, U., Krapp, A., & Winteler, A. (1992). Interest as a predictor of academic achievement: A meta-analysis of research. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The role of interest in learning and development* (pp. 183–212). Hillsdale, NJ: Erlbaum.

Stanley, J. C. (1993). Males and females who reason well mathematically. In G. R. Bock & K. Ackrill (Eds.), *The origins and development of high ability* (pp. 119–134). New York: Wiley.

Stanovich, K. E., & Cunningham, A. E. (1993). Where does knowledge come from? Specific associations between print exposure and information acquisition. *Journal of Educational Psychology*, *85,* 211–229.

Stedman, L. C. (1997). International achievement differences: An assessment of a new perspective. *Educational Researcher*, *26,* 4–15.

Stevenson, H. W., Chen, C., & Lee, S.-Y. (1993). Mathematics achievement of Chinese, Japanese, and American children: Ten years later. *Science*, *259,* 53–58.

Stevenson, H. W., & Lee, S.-Y. (1997). An examination of American student achievement from an international perspective. In D. Ravitch (Eds.), *The state of student scores in American schools* (pp. 7–52). Washington, DC: Brookings Institute.

Stevenson, H. W., & Stigler, J. W. (1992). *The learning gap: Why our schools are failing and what we can learn from Japanese and Chinese education*. New York: Summit Books.

Stumpf, H., & Stanley, J. C. (1999). Stability and change in gender-related differences on the College Board Advanced Placement and achievement tests. *Current Directions in Psychological Science*, *7,* 192–197.

Wechsler, D. (1981). *Manual for the Wechsler Adult Intelligence Scale-Revised*. New York: Psychological Corporation.

Williams, J. E., Satterwhite, R. C., & Best, D. L. (1999). Pancultural gender stereotypes revisited: The five factor model. *Sex Roles*, *40,* 513–525.

Willingham, W. W., & Cole, N. S. (1997). *Gender and fair assessment*. Mahwah, NJ: Erlbaum.