Analysis on TIMSS 2003 in Seven Countries: The Correlations of 4th Graders' Backgrounds, Family Environments, Interests in Science, and Self Confidence with their Science Achievement

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Abstract

The study based on TIMSS 2003 data is to investigate the relationships of the 4th graders' in Taiwan, Singapore, Japan, the United States, the Netherlands, Italy, and Australia among personal backgrounds, family environments, interest in science, self confidence and science achievement. T-test, Pearson's Product-moment Correlations and One-way ANOVA are applied to compare the correlations of science achievement and variables in different countries. The results are as follow:

1. The students' background factors, such as "gender" and "how often to speak TIMSS survey language at home" are influential on the 4th graders' interest, self confidence, and performance in science.

2. Among the students in seven countries, in general, the more books one's family has, the more interested and confident in science with better science achievement than those whose family with fewer books. However, students going to cramming schools have more interests in science; students not going to cramming schools have more confidence in science and better science achievement.

3. The interest, self confidence, and science performance are positive correlated. The self-confidence is more correlated than the interest.

4. The 4th graders in Asian countries have lower interests and self confidence in science than those in western countries. However the former have better scientific performances than the latter.

Keywords: *international comparison, background, interest in science; self confidence, family environments*

Study Purposes

Every country with its own culture and race formed its values and educational expectations. Socialized languages have effects on students to create various learning experiences, and students' learning performances (Lee, 1989; Chen, 2001; Chen, 1996). Researches indicate that students with different cultural backgrounds and parents' beliefs would influence on their learning progress (Krugly-Smolska, 1995; Zellman, 1998). Even the various political environments would cause different educational beliefs and targets (Hsu, 2002). TIMSS is cross-county study, which locates the influential elements upon more complicated contexts. By analyzing the abundant database of TIMSS 2003, we could understand more about the variations among countries as a reference for improving educational environments and learning performances.

The main purposes are as below:

1. To understand about the differences of 4th graders with personal variables and interest in science, confidence in science, and science achievement in seven countries.
2. To understand about the differences of 4th graders with family environmental variables and interest in science, confidence in science, and science achievement in seven countries.
3. To investigate if there is a significance in the 4th graders with different interest and confidence in science and their science achievement in these seven countries.
4. To investigate if different interest and confidence and science achievement have a correlation with one another in these seven countries.
5. To understand about the differences between the students in Asian and western countries upon the interest, confidence, and science achievement.

Methodology and Data Sources

1. Research Design

The correlation of students' performance in science learning with personal background, family environment is examined deeper and clearer from TIMSS 2003 database. The research framework is as Figure 1.

[Take in Fig.1 about here]

2. Subject and Data Sources

Based on the GNP ppp (General National Product: Purchasing Power Parity) of Taiwanese citizens, the research subjects were picked out from the TIMSS 2003 participants whose country's GNI ppp (General National Income: Purchasing Power Parity) are close to one another, to make sure the living standards reach the similarity and lessen the variation. The subjects were TIMSS 2003 participants, who are the 4th graders from seven countries mentioned before.

TIMSS 2003 International Science Reports, International Technical Reports, questionnaire, and Science performance data are from the attached the CD-ROM "TIMSS 2003 International Database" of the TIMSS 2003 User Guide for the International Database (Martin, 2005). Students' questionnaire in Chinese version is downloaded from the website of the Science Education Center, National Taiwan Normal University.

3. Statistic Methods

For this study, T-test and One-way ANOVA, and Pearson's Product-moment Correlations were used to examine the difference and correlations among countries and students. The dependent measure used in this study was each student's science score, and the average of the five science plausible values generated for each student in TIMSS 2003 was to be each student's science score. The five plausible values for each student were generated to estimate student proficiency (Gonzalez, Galia, & Li, 2004). To assess the relative contribution of "students use the survey language" and "the number of books one's home has", "how often having extra lessons or tutoring in science" "interest in science", and "confidence in science" variables may be toward the explanation of science scores.

Finding and Discussion

1. The Results of Interest, Confidence, and Science Achievement by Different Background Variables.

A. Background Variables on Interest in Science

(a) The results of interest in science by genders are shown on the Table 1. The regions of Taiwan, Singapore, and Japan reached the significance, while boys are superior to girls, but Italy is contrary. Take seven countries as a whole, 4th graders of boys are superior to girls and reached significant difference. There is a phenomenon in Asian countries that males prefer better science than females.

[Take in Table 1 about here]

(b) The results of interest in science by different frequency of using survey language are shown on the Table 2. Only Singapore and the U. S. reached the significance, where shows the tendency of more interest by higher frequency of using survey language. The seven countries result reached the significance difference, which means the more students use their national languages, the more interest they have in science.

[Take in Table 2 about here]

B. Background Variables on Confidence in Science

(a) The results of confidence in science by genders are shown on the Table 3. Five regions of Taiwan, Singapore, Japan, the U. S., and Italy reached the significance. Boys are superior to girls in three regions while only Italy's girls are superior to boys. The result of seven countries reached significant difference, and boys' confidence in science is superior to girls'.

[Take in Table 3 about here]

(b) The results of confidence in science by the frequency of using survey language are shown on the Table 4. The results of Taiwan, Singapore, the U. S., the Netherlands, and Italy reached significance. The common phenomenon of the five countries is that the more frequent they use survey language, the more confidence they have. The seven countries' results as a whole reached significant difference. The tendency shows the more frequent they use survey language the more confidence they have, same as interest in science.

[Take in Table 4 about here]

C. Background Variables on Science Achievement

(a) The results of science achievement by genders are shown on the Table 5. Only the results of Taiwan, the U.S., and the Netherlands reached the significance. And seven countries' result as a whole reached the significant difference, while boys' is superior to girls'.

[Take in Table 5 about here]

(b) Table 6 showed all the countries' results reached significance, indicating the frequency of using survey language does impact on the science achievement. The four group students of Taiwanese and the U. S. are the same, mutually reached significance under Scheffe Post Hoc comparison, which means the more frequent they use survey language the better science achievement they have.

[Take in Table 6 about here]

2. The Results of Interest, Confidence, and Performance in Science by Different Family Environment Variables

A. Family Environment Variables on Interest in Science

(a) The results of interest in science by the family book collection are shown on the Table 7. Only the result of the Netherlands and Australia did not reached significance. The conditions of every country on the significant difference vary by the Post Hoc comparison, but they all show that the more books one's family has, the more interest in science student has.

[Take in Table 7 about here]

(b) The results of six countries' interest in science by students attending cramming school and tutor lessons reached significance, except for the Netherlands, shown on the Table 8. These countries have the tendency that students attending cramming school and tutor lessons have more interest in science than others. The seven countries' results as a whole reached significance, where students attending cramming school and tutor lessons have more interest than those who "almost never" attending cramming school.

[Take in Table 8 about here]

B. Family Environment Variables on Confidence in Science

(a) The results of confidence in science by family book collection are shown on the Table 9. All countries' results reached the significance, which means the more books one's family has, the more confidence in science he or she has.

[Take in Table 9 about here]

(b) The results of confidence in science by students attending cramming school and tutor lessons are shown on the Table 10. Although all countries' results reach significance, which means the different frequency of attending cramming school and tutor lessons would impact on the students' confidence in science. The more frequent Asian students attend extra lessons, the more confidence they have. But the western countries show the phenomenon oppositely.

[Take in Table 10 about here]

C. Family Environment Variables on Science Achievement

(a) The results of science achievement by family book collection are reached significance in all the countries, shown on the Table 11. It indicated that the more books one's family has, the better science achievement he or she has.

[Take in Table 11 about here]

(b) The results of science achievement by students attending cramming school and tutor lessons are shown on the Table 12. All countries' results reach significance and those who "almost never" attend extra lessons have better science achievement.

[Take in Table 12 about here]

3. The Correlations and Variance Analysis among Interest, Confidence, and Science Achievement

According to Table 13, it is not highly correlated between the interest and science achievement, coefficient between 0.03-0.14. The correlation between confidence and achievement is higher than interest, which showed confidence is a better indicator for 4th graders' achievements. The Variance Analysis in Table 14 and Table 15 also showed the more confidence students have, the better achievement they have.

[Take in Table 13 about here]

[Take in Table 14 about here]

[Take in Table 15 about here]

4. An Analysis on Interest, Confidence, and Science Achievement of Students from Asian and Western Countries

It is acquired that the interest and confidence in science and science achievement of students in both regions reached significant difference, shown on Table 16. Obviously, Asian countries have better achievement than Western countries, but less interest and confidence in science.

[Take in Table 16 about here]

Conclusion

After the statistic analysis we have the following conclusions:

1. The background of students is influential on the 4th graders' interest, confidence, and science achievement. Gender is an obvious factor to influence the interest. The frequency of using survey language would influence on the confidence and science achievement.
2. The number of books one's family has positive impact on the interest, confidence, and science achievement. As to the cramming school attendance, the consequences are on the contrary for Asian and western countries. It shows that the influence of cramming school on the science achievement may emphasize on the flexible inferences and abilities of generalization and analysis that are the key to success science education for both Asian and Western countries.
3. The interest, confidence, and science achievement are positive correlated. The confidence is more correlated than the interest.
4. The 4th graders in Asian countries have lower interests and confidence in science than those in Western countries. However the former have better science achievement than the latter.

Reference

Chen, C-C (2001). Rediscover the functions of schools—within the factor of family background variation. *Bulletin of Taitung Teacher's College,* Part 1, 12, pp. 115-144.

Chen, S-H (1996). The understanding of aboriginal children about biological concept from science teaching materials. *Bulletin of Hualian Teacher's College*, 6, pp. 217-240.

Gonzalez, E.J., Galia, J., & Li, I. (2004). Scaling methods and procedures for the TIMSS 2003 mathematics and science scales. In M.O. Martin, I.V.S. Mullis, & S.J. Chrostowski (Eds.), *TIMSS 2003 Technical Report* (pp. 252-273). Chestnut Hill, MA: International Study Center, Boston College.

Hsu, C-Y (2002). *The Comparison of Elementary Technology Curriculums in Taiwan, the Britain, the U.S., and Australia.* Master Thesis of Taichung Teacher's College.

Krugly-Smolska, E. (1995). Culture influences in science education. *International Journal of Science Education*, 17(1), pp. 45-58.

Lee, T-I(1989). The correlations between elementary students' natural science learning performance and their mandarin, mathematic learning performance, education, and family background. *Bulletin of Taipei Teacher's College*, 2, pp. 191-232.

Martin, M.O. (2005). *TIMSS 2003User Guide for the International Database.* (Ed.) Chestnut Hill, MA: Boston College.

Zellman, G. L. (1998).Understanding the impact of parent school involvement on children's educational outcomes. *The Journal of Educational Research*, 91(6), pp. 370-380.

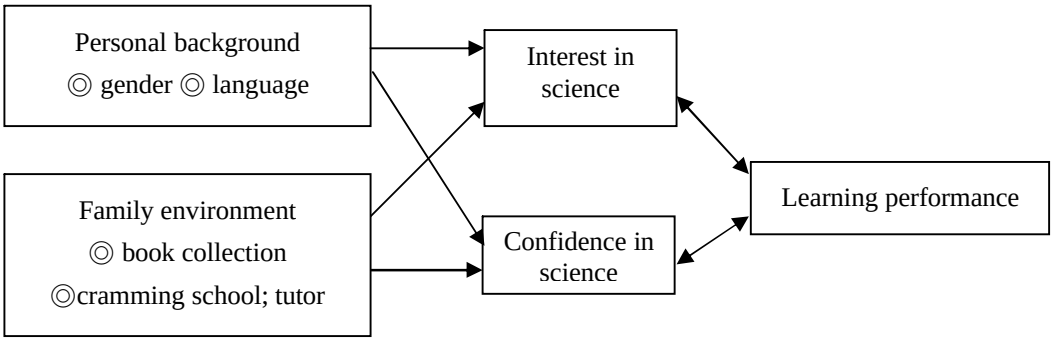

Fig.1: The research framework

Table 1: T-test on interest in science by different genders of students from countries

Countries	N	Female		Male		t-value
		Mean	Standard Deviation	Mean	Standard Deviation	
Taiwan	4604	6.25	1.69	6.40	1.82	-3.51***
Singapore	6587	6.32	1.70	6.42	1.75	-2.20*
Japan	4402	6.19	1.55	6.45	1.60	-5.50***
The U. S.	9358	6.53	1.77	6.49	1.86	1.14
The Netherlands	2726	5.83	1.73	5.79	1.82	0.69
Italy	4161	6.52	1.45	6.37	1.60	3.17**
Australia	4170	6.74	1.59	6.83	1.68	-1.62
Total	36008	6.38	1.68	6.43	1.77	-2.49*

*: p<.05 **: p<.01 ***: p<.001

Table 2: One-way ANOVA on interest in science by frequency of using survey language

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4595	Between Groups	11.85	3	3.95	1.27	
	Within Groups	14273.98	4591	3.11		
Singapore N=6568	Between Groups	172.23	3	57.41	19.45***	4＞2＞1
	Within Groups	19374.80	6564	2.95		3＞2＞1
Japan N=4365	Between Groups	8.91	3	2.97	1.19	
	Within Groups	10877.28	4361	2.49		
The U. S. N=9152	Between Groups	37.16	3	12.39	3.76*	2＞1
	Within Groups	30122.21	9148	3.29		
The Netherlands N=2712	Between Groups	5.13	3	1.71	0.54	
	Within Groups	8545.09	2708	3.16		
Italy N=4122	Between Groups	9.5658	3	3.19	1.36	
	Within Groups	9671.08	4118	2.35		
Australia N=4141	Between Groups	8.73	3	2.91	1.09	
	Within Groups	11078.28	4137	2.68		
Total N=35655	Between Groups	105.64	3	35.21	11.86***	4＞1; 3＞1
	Within Groups	105822.63	35651	2.97		2＞1

*: p<.05 ***: p<.001 4: always 3: usually 2: sometimes 1: never

Table 3: T-test on confidence in science by different genders of students from countries

Countries	N	Female		Male		t-value
		Mean	Standard Deviation	Mean	Standard Deviation	
Taiwan	4606	11.20	2.63	11.74	2.79	-6.76***
Singapore	6593	9.89	2.73	10.68	3.00	-11.13***
Japan	4395	10.95	2.33	11.52	2.54	-7.83***
The U. S.	9314	12.39	2.90	12.70	2.89	-5.21***
The Netherlands	2673	12.42	2.23	12.52	2.43	-1.21
Italy	4099	12.58	2.32	12.39	2.46	2.58*
Australia	4141	12.65	2.64	12.77	2.67	-1.38
Total	35821	11.65	2.83	12.02	2.85	-12.23***

*: p<.05 ***: p<.001

Table 4: One-way ANOVA on confidence in science by frequency of using survey language

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4597	Between Groups	509.74	3	169.92	23.16***	4> 3> 2
	Within Groups	33704.57	4593	7.34		
Singapore N=6575	Between Groups	1919.64	3	639.88	79.13***	4> 3> 2
	Within Groups	53135.58	6571	8.09		4> 3> 1
Japan N=4358	Between Groups	19.28	3	6.43	1.07	
	Within Groups	26222.40	4354	6.02		
The U. S. N=9112	Between Groups	1506.56	3	502.19	60.91***	4> 3> 2
	Within Groups	75093.32	9108	8.25		4> 3> 1
The Netherlands N=2659	Between Groups	232.86	3	77.62	14.44***	4> 2; 3> 2
	Within Groups	14275.91	2655	5.38		
Italy N=4061	Between Groups	238.21	3	79.40	13.98***	4> 2
	Within Groups	23043.68	4057	5.68		
Australia N=4113	Between Groups	50.64	3	16.88	2.40	
	Within Groups	28931.79	4109	7.04		
Total N=35745	Between Groups	14617.64	3	4872.55	633.44***	4> 3> 2
	Within Groups	272850.35	35471	7.69		4> 3> 1

***: p<.001 4: always 3: usually 2: sometimes 1: never

Table 5: T-tests on science achievement by different genders of students from countries

Countries	N	Female		Male		t-value	Difference Condition
		Mean	Standard Deviation	Mean	Standard Deviation		
Taiwan	4660	548.52	59.77	555.43	67.13	-3.71***	F< M
Singapore	6665	563.96	77.25	561.23	87.43	1.35	
Japan	4521	541.78	64.83	545.72	72.12	-1.93	
The U. S.	9800	525.93	74.93	530.51	80.10	-2.92**	F< M
The Netherlands	2909	522.07	47.88	530.17	47.29	-4.59***	F< M
Italy	4282	512.25	80.76	516.06	80.83	-1.54	
Australia	4257	522.23	72.49	523.90	78.93	-0.72	

Total	37094	535.27	73.16	538.56	78.35	-4.19***	F< M

*: p<.05 ***: p<.001

Table 6: One-way ANOVA on science achievement by frequency of using survey language

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan	Between Groups	1018034.73	3	339344.91	88.50***	4> 3> 2> 1
N=4651	Within Groups	17817823.94	4647	3834.26		
Singapore	Between Groups	5211705.87	3	1737235.29	289.74***	4> 2> 1
N=6644	Within Groups	39812666.28	6640	5995.88		3> 2> 1
Japan	Between Groups	660450.93	3	220150.31	48.28***	4> 3> 2
N=4481	Within Groups	20414781.39	4477	4559.92		4> 3> 1
The U. S.	Between Groups	5115789.00	3	1705263.00	310.89***	4> 3> 2> 1
N=9577	Within Groups	52509296.48	9573	5485.15		
The Netherlands	Between Groups	399919.39	3	133306.46	62.20***	4> 3> 2
N=2889	Within Groups	6183577.95	2885	2143.36		4> 3> 1
Italy	Between Groups	694727.53	3	231575.84	36.30***	4> 3> 1
N=4239	Within Groups	27018153.07	4235	6379.73		4> 2
Australia	Between Groups	573337.44	3	191112.48	34.28***	4> 2; 4> 1
N=4225	Within Groups	23534425.86	4221	5575.56		3> 2; 3> 1
Total	Between Groups	5221820.09	3	1740606.70	310.86***	3> 4> 2
N=36706	Within Groups	205505118.73	36702	5599.29		3> 4> 1

***: p<.001 4: always 3: usually 2: sometimes 1: never

Table 7: One-way ANOVA on interest in science by family book collection

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan	Between Groups	116.41	4	29.10	9.43***	5> 2; 5> 1; 4> 2
N=4587	Within Groups	14148.00	4582	3.09		4> 1; 3> 1
Singapore	Between Groups	41.39	4	10.35	3.47**	4> 1
N=6516	Within Groups	19389.42	6511	2.98		
Japan	Between Groups	30.55	4	7.64	3.07*	4> 1
N=4390	Within Groups	10919.89	4385	2.49		
The U. S.	Between Groups	113.59	4	28.40	8.68***	5> 1; 4> 1; 3> 1
N=9201	Within Groups	30073.79	9196	3.27		2> 1
The Netherlands	Between Groups	9.61	4	2.40	0.76	
N=2698	Within Groups	8508.74	2693	3.16		
Italy	Between Groups	92.05	4	23.01	9.88***	5> 2; 5> 1; 4> 1
N=4114	Within Groups	9569.48	4109	2.33		3> 1
Australia	Between Groups	9.18	4	2.29	0.86	
N=4128	Within Groups	11019.51	4123	2.673		
Total	Between Groups	365.42	4	91.36	30.88***	5> 3> 1; 5> 2> 1
N=35634	Within Groups	105415.62	35629	2.96		4> 3> 1; 4> 2> 1

5: > 200 books 4: 101-200 books 3: 26-100 books 2: 11-25 books 1: 0-10 books

*: p<.05 **: p<.01 ***: p<.001

Table 8: One-way ANOVA on interest in science by students attending cramming school and tutors lessons

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4589	Between Groups	159.99	3	53.33	17.31***	4> 1; 3> 1
	Within Groups	14086.61	4571	3.08		2> 1
Singapore N=6522	Between Groups	83.11	3	27.70	9.31***	4> 2; 4> 1
	Within Groups	19444.28	6531	2.98		3> 1
Japan N=4383	Between Groups	67.28	3	22.43	9.02***	4> 1; 3> 1
	Within Groups	10648.72	4282	2.49		2> 1
The U. S. N=9156	Between Groups	178.85	3	59.62	18.34***	4> 2; 4> 1
	Within Groups	29581.36	9100	3.25		3> 1
The Netherlands N=2647	Between Groups	20.89	3	6.96	2.19	
	Within Groups	8426.55	2648	3.18		
Italy N=4053	Between Groups	51.81	3	17.27	7.40***	4> 3; 4> 2
	Within Groups	9294.50	3984	2.33		4> 1
Australia N=4100	Between Groups	81.36	3	27.12	10.31***	3> 1; 2> 1
	Within Groups	10670.45	4055	2.63		
Total N=35450	Between Groups	607.38	3	202.46	68.55***	4> 3> 1
	Within Groups	103950.38	35195	2.95		4> 2> 1

4: almost everyday 3: once or twice a week 2: sometimes 1: almost never
***: p<.001

Table 9: One-way ANOVA on confidence in science by family book collection

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4575	Between Groups	1296.34	4	324.09	45.20***	5> 4> 2> 1
	Within Groups	32868.09	4584	7.17		3> 2> 1
Singapore N=6535	Between Groups	1480.32	4	370.08	45.37***	5> 3> 1; 5> 3> 2
	Within Groups	53159.18	6517	8.16		4> 3> 1; 4> 3> 2
Japan N=4286	Between Groups	285.27	4	71.32	11.96***	5> 1; 5> 2; 5> 3
	Within Groups	26109.19	4378	5.96		4> 1; 4> 2; 4> 3
The U. S. N=9104	Between Groups	1985.06	4	496.27	60.55***	5> 3> 2> 1
	Within Groups	74995.71	9151	8.20		4> 3> 2> 1
The Netherlands N=2652	Between Groups	327.54	4	81.89	15.37***	5> 3> 1; 5> 2
	Within Groups	14076.73	2642	5.33		4> 1
Italy N=3988	Between Groups	543.22	4	135.81	24.31***	5> 2> 1; 4> 2> 1
	Within Groups	22615.47	4048	5.59		3> 2> 1
Australia N=4059	Between Groups	631.30	4	157.83	22.82***	5> 4> 2; 5> 4> 1
	Within Groups	28325.51	4095	6.92		5> 3> 1
Total N=35199	Between Groups	7433.75	4	1858.44	235.46***	5> 4> 3> 2> 1
	Within Groups	279755.49	35445	7.89		

5: > 200 books 4: 101-200 books 3: 26-100 books 2: 11-25 books 1: 0-10 books
***: p<.001

Table 10: One-way ANOVA on confidence in science by students attending cramming school and tutors lessons

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4578	Between Groups	172.27	3	57.42	7.75***	4> 1; 4> 2
	Within Groups	33903.31	4574	7.41		3> 1
Singapore N=6545	Between Groups	238.16	3	79.39	9.51***	1> 2; 3> 2
	Within Groups	54593.69	6541	8.35		4> 2
Japan N=4281	Between Groups	133.35	3	44.45	7.40***	4> 1; 4> 2
	Within Groups	25669.58	4277	6.00		4> 3
The U. S. N=9063	Between Groups	1335.85	3	445.28	53.97***	1> 2; 1> 3
	Within Groups	74747.05	9059	8.25		1> 4
The Netherlands N=2602	Between Groups	109.84	3	36.61	6.72***	1> 3
	Within Groups	14154.11	2598	5.45		
Italy N=3930	Between Groups	323.62	3	107.87	19.02***	1> 2; 1> 3
	Within Groups	22261.63	3926	5.67		1> 4
Australia N=4038	Between Groups	57.84	3	19.28	2.74*	3> 4
	Within Groups	28349.80	4034	7.03		
Total N=35037	Between Groups	3793.25	3	1264.42	157.68***	1> 4> 2
	Within Groups	280930.19	35033	8.02		1> 4> 3

4: almost everyday 3: once or twice a week 2: sometimes 1: almost never
*: p<.05 ***: p<.001

Table 11: One-way ANOVA on science achievement by family book collection

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4642	Between Groups	1904789.67	4	476197.42	131.52***	5> 3> 2> 1
	Within Groups	16789073.44	4637	3620.68		4> 3> 2> 1
Singapore N=6587	Between Groups	6811649.07	4	1702912.27	305.72***	5> 4> 3> 2> 1
	Within Groups	36663504.40	6582	5570.27		
Japan N=4507	Between Groups	1252847.34	4	313211.83	70.98***	5> 2> 1; 4> 2> 1
	Within Groups	19865349.91	4502	4412.56		3> 2> 1
The U. S. N=9628	Between Groups	6556920.64	4	1639230.16	310.66***	5> 3> 2> 1
	Within Groups	50777452.52	9623	5276.68		4> 3> 2> 1
The Netherlands N=2878	Between Groups	624186.67	4	156046.67	75.96***	5> 3> 2> 1
	Within Groups	5902308.79	2873	2054.41		4> 2; 4> 1
Italy N=4229	Between Groups	505608.69	4	126402.17	19.88***	5> 2> 1; 4> 2> 1
	Within Groups	26859527.39	4224	6358.79		3> 2> 1
Australia N=4210	Between Groups	2167011.21	4	541752.80	104.80***	5> 3> 2> 1
	Within Groups	21738386.09	4205	5169.65		4> 3> 2> 1
Total N=36681	Between Groups	17020023.90	4	4255005.98	816.04***	5> 3> 2> 1
	Within Groups	191236148.47	36676	5214.20		4> 3> 2> 1

5: > 200 books 4: 101-200 books 3: 26-100 books 2: 11-25 books 1: 0-10 books
***: p<.001

Table 12: One-way ANOVA on science achievement by students attending cramming school and tutors lessons

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4629	Between Groups	438314.67	3	146104.89	37.38***	1> 2; 1> 3
	Within Groups	18081744.54	4626	3908.72		1> 4
Singapore N=6606	Between Groups	2770577.76	3	923525.92	148.48***	1> 3> 2> 4
	Within Groups	41064673.51	6602	6220.04		
Japan N=4399	Between Groups	282589.85	3	94196.62	20.38***	1> 2; 1> 3
	Within Groups	20312597.88	4395	4621.75		
The U. S. N=9514	Between Groups	9119517.78	3	3039839.26	615.09***	1> 2> 3> 4
	Within Groups	46999418.66	9510	4942.11		
The Netherlands N=2745	Between Groups	309565.00	3	103188.33	48.03***	1> 2; 1> 3
	Within Groups	5888282.55	2741	2148.22		1> 4
Italy N=4097	Between Groups	1935845.81	3	645281.94	108.50***	1> 2> 4
	Within Groups	24342979.42	4093	5947.47		1> 3
Australia N=4130	Between Groups	1971569.70	3	657189.90	129.61***	1> 2> 3> 4
	Within Groups	20921618.59	4126	5070.68		
Total N=36120	Between Groups	9712919.38	3	3237639.79	603.55***	1> 3> 2> 4
	Within Groups	193744624.59	36117	5364.36		

4: almost everyday 3: once or twice a week 2: sometimes 1: almost never
***: p<.001

Table 13: Correlation summary of interest and confidence with science achievement of seven countries' students

Correlation Coefficient	Taiwan	Singapore	Japan	The U. S.	The Netherlands	Italy	Australia
Interest	.03*	.05**	.14**	.04**	.04*	.08**	.04**
Confidence	.24*	.22**	.22**	.31**	.39*	.24**	.23**

**: p<.01

Table 14: One-way ANOVA on science achievement related to interest in science of seven countries

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4604	Between Groups	14916.29	2	7458.14	1.85	
	Within Groups	18603068.31	4601	4043.27		
Singapore N=6587	Between Groups	195856.833	2	97928.417	14.846***	H> M> L
	Within Groups	43428634.512	6584	6596.087		
Japan N=4402	Between Groups	369762.41	2	184881.21	40.59***	H> M> L
	Within Groups	20036534.15	4399	4554.79		
The U. S. N=9358	Between Groups	44522.66	2	22261.33	3.80*	Not significant to each other
	Within Groups	54751792.08	9355	5852.68		
The Netherlands N=2726	Between Groups	30286.50	2	15143.25	6.65**	H> M
	Within Groups	6200943.62	2723	2277.25		L> M

Italy N=4161	Between Groups	96948.88	2	48474.44	7.58**	H> L
	Within Groups	26596201.71	4158	6396.39		
Australia N=4170	Between Groups	26897.00	2	13449.50	2.37	
	Within Groups	23673870.41	4167	5681.27		
Total N=36008	Between Groups	357919.14	2	178959.57	31.74***	H> M> L
	Within Groups	203010323.11	36005	5638.39		

*: p<.05 **: p<.01 ***: p<.001

Table 15 One-way ANOVA on science achievement related to confidence in science of seven countries

Countries	Variation source	Sum of Square	df	Mean Square	F	Post Hoc Comparison
Taiwan N=4606	Between Groups	1293036.08	2	646518.04	172.36***	H> M> L
	Within Groups	17265949.27	4603	3751.02		
Singapore N=6593	Between Groups	2165874.89	2	1082937.44	172.98***	H> M> L
	Within Groups	41255837.21	6590	6260.37		
Japan N=4395	Between Groups	1007840.54	2	503920.27	114.48***	H> M> L
	Within Groups	19332426.00	4392	4401.74		
The U. S. N=9314	Between Groups	5401593.85	2	2700796.93	513.32***	H> M> L
	Within Groups	48988840.90	9311	5261.39		
The Netherlands N=2673	Between Groups	532030.25	2	266015.12	127.83***	H> M> L
	Within Groups	5556096.80	2670	2080.94		
Italy N=4099	Between Groups	1419900.90	2	709950.45	116.82***	H> M> L
	Within Groups	24892199.55	4096	6077.20		
Australia N=4141	Between Groups	1246820.08	2	623410.04	117.38***	H> M> L
	Within Groups	21976529.34	4138	5310.91		
Total N=35821	Between Groups	6697446.53	2	3348723.26	615.57***	H> M> L
	Within Groups	194852792.87	35818	5440.08		

***: p<.001

Chart 16: T-test on interest and confidence in science and science achievement by Asian and Western 4th graders

Variables	Region	N	Mean	Standard Deviation	T Value	Difference
interest in science	Asian	15593	6.34	1.70	-6.573***	Asian< Western
	Western	20415	6.46	1.74		
confidence in science	Asian	15594	10.91	2.78	-56.780***	Asian< Western
	Western	20227	12.56	2.68		
science achievement	Asian	15864	554.0578	73.9905	-38.788***	Asian> Western
	Western	21369	523.8425	74.7853		

***: p<.001