Sex Differences In Mathematical Performance Among Chinese Middle School Students

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ABSTRACT

There have been many studies investigating sex differences in mathematical performance among Caucasian students but to date, few such studies involving Asian students. A number of studies have been carried out comparing mathematical performance of Asian and non-Asian students and these have showed a general superiority of Asian students.

This paper reports the results of a study of Chinese students from the central Chinese city of Wuhan. It compares the performance of boys and girls in the first year of secondary school in three mathematical areas - logic, space and numeracy. The results from this study reveal no significant differences in the mean scores in the logic sub-test but significant differences in favour of the boys in space and numeracy sub-tests. A significant difference in the variance was revealed in the numeracy scores of the girls compared with the boys but there was no significant difference in the logic and space sub-tests.

INTRODUCTION

Much research effort has been concentrated on investigating the differences between girls and boys in relation to mathematical performance. There have been many studies investigating the effect of gender on mathematical performance including for example Clements & Wattanawaha (1979), Fullerton (1992) and the many references included in these works. Many report gender differences affecting mathematical performance. In particular, Clements and Wattanawaha presented a table that summarised the sex differences in mathematical achievement until that time. Wattanawaha (1977) in a similar (but not identical) study to the present one, found that boys in Australia performed significantly better than girls in all areas tested.

There have been many studies reporting and attempting to explain the superiority in mathematics of Asian students over their non-Asian peers including Stevenson et al. (1990), Stevenson (1987), Stigler, Lee & Stevenson (1987) and Au & Harackiewicz (1986).

Few studies however, have been published investigating gender differences in mathematical performance amongst Asian students. Xu and Farrell (1992) in a study carried out in Shanghai reported no statistical differences between sexes except in one school on one measure. Turner (1993) in a study comparing the performances of 12-13 years old Australian and Chinese students reported slight differences between boys and girls in mean performances in spatial ability, numeration and logic skills. Stevenson et al also compared the performances in a number of areas of mathematics by grade 1 and grade 5 boys and girls in Beijing and Chicago. Their results showed that in Chicago boys outperformed girls in all areas but although Beijing girls in grade 1 were faster than the boys, in other areas the magnitude and direction of sex differences was equivalent to the Chicago group. The Beijing group of students however were superior to the Chicago group in all areas tested.

EDUCATION IN CHINA

The Chinese education system is based on six years of elementary school, followed by up to six years of middle school or secondary school. Middle school is divided into junior and senior middle schools. Education is compulsory up to the end of junior three or third year of secondary school. The ages of students entering middle school is typically 12 - 14 years of age but can be higher. The curriculum is centrally determined by Beijing and the selection of text books is quite limited.

Classes can consist of between 40 to 55 students and conditions, even in the better schools, are quite spartan by Western standards. Formal classes are held six days per week and often from 7.30 am until 4 pm. Despite these long hours, students are both attentive and energetic and show a refreshing interest in mathematics as a subject. A great deal of emphasis is placed on education in China as it is seen as a path to a better lifestyle. Students are constantly under pressure to perform well and this pressure comes from parents, teachers and peers.

There are different categories of middle school and the top or 'key' schools attract fierce competition for entry as it opens up opportunities to attend university and to ultimately better job opportunities. Up to 80 per cent of students attending key schools go on to tertiary studies. Among second ranking schools, this figure drops to just 20 per cent; for the lowest ranked middle schools, it is unusual for any students to continue to tertiary studies.

In this particular study, a test was given to junior 1 (first year at secondary school) middle school students in March of 1992 or about midway through the academic year. A total of 235 students sat the test of which 128 were boys and 103 were girls. The four remaining students did not identify their sex and were excluded from the analysis.

The students were drawn from each category of school in the central Chinese city of Wuhan in Hubei Province. Although Wuhan is a large city, it does not have a large foreign population and in comparison with such cities as Beijing, Shanghai or Guangzhou, the foreign influence is minimal. It is thus well situated for comparative studies of this type allowing studies involving 'typical' urban Chinese students.

One school from each of the categories was involved in the study. The study group comprised five classes - one from a key school and two each from the non-key schools. No streaming of students takes place within schools and although selection for 'key-school' entry takes place at the end of elementary school, it was assumed the sample was representative of the wider urban school population. It is acknowledged, however that these assumptions may not be valid and a wider sampling of both schools and pupils may be warranted in any future studies.

METHOD

The instrument used in this study was the Monash Assessment of Mathematical Performance (MAMP) test that was developed by Clements between 1975 and 1977. Its main purpose (Clements and Wattanawaha, 1979) was for use as a gross screening device by teachers of grade 7 subjects. It contains eight questions on mathematical logic, eight spatial questions and twenty questions on number skills, in all 36 items. Questions of varying degrees of difficulty are included and the item difficulty figures for each question, based on Victorian data, comes with the test.

The test was given in Chinese, but few answers required translation into English and all marking was completed by the author.

To ensure the translation into Chinese was accurate and error free, questions were translated into Chinese and using the reverse blind translation method, the questions were translated back to English by a different person.

Some minor adjustments were made to some questions to reflect local conditions. There were no other allowances made for lack of any familiarity of style or content in the test. Thus, any cultural bias would be expected to work against the students in this study and be reflected in lower rather than higher scores.

In China, it is not normal to give prices in the equivalent of dollars and cents but instead with dollars, ten cent multiples and cents. The currency units are yuan (or kwai), jiao, fen (largest to smallest) so 5 yuan 2 jiao is equivalent to 5 yuan 20 fen. Questions involving currency were adjusted to reflect realistic local prices and local idioms were used where possible. The test was given during regular class times, under examination conditions.

Questions were marked as either correct or incorrect. Those questions that had a number of components were scored as correct if all components were correct or wrong if one or more components were incorrect.

RESULTS

The mathematics curriculum in China follows very traditional lines so it was expected that students would perform relatively poorly in some areas when compared with the Australian data. In particular, it was not expected that the Chinese students would perform well on the *space* sub-test because of the traditional methods of teaching and the traditional mathematics curriculum in place in China. This turned out to be not the case and this has been reported elsewhere (Turner, 1993).

If it is assumed that Chinese students follow similar performance patterns to their counterparts elsewhere, then it might be expected that Chinese boys will perform better on the various sub-tests than the girls. In the analysis of the data, this assumption is followed.

The interest in the outcome is influenced by the history of China since 1948. Equality of the sexes has been inscribed in the constitution since that date and it is pertinent to investigate whether this has been translated into the equality of performance.

The data were analysed in several ways. Descriptive statistics were calculated and these are summarised in Table 1. The table shows the breakdown of the various statistics for both the boys and the girls. As can be seen, the median scores for both groups are the same at the accuracy displayed. The mean scores exposed some differences and the significance of these were analysed.

Table 1: Descriptive statistics

		logic	space	number	total
Boys (128)	Mean	5.70	5.94	16.59	28.23
	Median	6	6	17	29
Girls (103)	Mean	5.63	5.55	15.78	26.96
	Median	6	6	17	28

Analysis of the means using a t-test assuming unequal variances and a single tail test of significance were performed. A single-tail test was adopted because of the assumption that the boys would perform at a higher level than the girls. These figures are summarised in Table 2.

It can be seen that for this group of students at least, there is no significant difference at the 0.05 level between the boys' scores and the girls' scores for the *logic* sub-test. On the *space* sub-test, the situation is different and there is a significant difference in the scores in favour of the boys. For the *numeracy* sub-test, the pattern is similar and the boys were significantly better than the girls, but this time the results are significant at the 0.01 level. Not surprisingly, the boys were significantly better (at the 0.05 level) than the girls on the total score as this is dependant on the sub-test scores.

Table 2: Test of equality of means

		logic	space	number	total
	df	217	207	187	198
	t	0.33°	2.13 *	2.55 **	2.22 *

° not significant
* significant for $p < 0.05$
** significant for $p < 0.01$

Also of interest is the comparison of the variations in the scores and these are summarised in Table 3. On all sub-tests, the boys' scores showed a lower standard deviation (and hence variance) than the girls. Analysis of variance was carried out for each of the tests to determine the significance of the variation between the two groups. The results of these calculations are presented in Table 4.

Table 3: Variation in Scores

		logic	space	number	total
Boys (128)	Standard Deviation	1.62	1.28	2.03	3.85
	Variance	2.62	1.63	4.10	14.84
Girls (103)	Standard Deviation	1.64	1.43	2.65	4.64
	Variance	2.69	2.03	7.04	21.57

It can be seen in Table 4 that the differences in the variances are not significant for either the *space* or *logic* sub-tests but the difference in the *number* sub-test was significant and this has affected the total scores. It is also the *number* sub-test that realised the most significant difference in the means. This is a somewhat surprising result as strong emphasis in China is placed on numeracy skills.

Table 4: Test of variances

	logic	space	number	total
F-ratio	1.03	1.24	1.72 *	1.45 *
Critical value	1.28	1.28	1.28	1.28
* significant for $p<0.05$				

The overall results are similar to those of Stephenson et al who found in both the Chinese and Chicago groups that boys performed better than girls in most of the areas investigated but by and large, the Chinese students performed better than the Chicago students. In an earlier analysis (Turner, 1993) of the data from this study present study showed that the Chinese students outperformed Australian students overall on each of the sub-tests.

DISCUSSION

These results indicate that there are no significant differences between the boys and the girls tested on the *logic* tasks. There are, however, significant differences on *space* and *number* tests indicating that Chinese boys may be better at these tasks than Chinese girls. On the *number* tasks there is significantly more variation among the girls tested than the boys. In contrast, the data from Wattnawaha's Australian study demonstrated that boys outperformed girls on all tests.

The material used in the test was unfamiliar in style and content for the Chinese students and a bias may be expected to work against them. This proved to be not the case.

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