A Comparison of Boys' and Girls' Feelings of Self-Confidence in Arithmetic Computation

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Des études précédentes ont démontré que dans le domaine des mathématiques, les filles réussissent mieux que les garçons aux exercices d'un niveau intellectuel peu élevé tandis que les garçons s'en tirent mieux dans les exercices d'un niveau intellectuel plus élevé.

Notre étude veut comparer l'attitude de confiance en soi qu'ont manifestée les garçons et les filles face à leur réussite dans le domaine du calcul arithmétique, au résultat qu'ils ont effectivement atteint. 2786 garçons et 265 filles de la cinquième à la huitième année ont participé à l'étude.

On a présenté à nos sujets un test qui comprenait un certain nombre d'exercices portant sur les nombres entiers et les quatre opérations de base; on les a tout d'abord invités à évaluer, à l'aide d'une échelle, le degré de confiance en soi vis-à-vis de leur réussite de ces exercices. Puis on leur a demandé de faire le test.

On a utilisé l'analyse de la variance pour plusieurs variables (*multivariate analysis of variance*) pour l'analyse de nos données. Vingt différentes comparaisons ont été faites entre les garçons et les filles: au niveau du rendement, quatorze favorisaient les filles de façon significative; au niveau de l'attitude de confiance en soi, dix-sept favorisaient les garçons et six les favorisaient de façon significative.

In her review of the literature on sex differences in mathematics learning, Fennema (1974a) reported that after the fourth grade, when achievement differences begin to appear, they favored boys if higher-level cognitive tasks were being measured and girls if lower-level tasks were being measured. Among the major studies supporting this finding are the National Longitudinal Study of Mathematical Ability (NLSMA) conducted by the School Mathematics Study Group (SMSG) (Wilson et al.) and, more recently, the mathematics assessment conducted as part of the National Assessment of Educational Progress (NAEP) (Education Commission of the United States, 1975).

The NLSMA data were gathered over a 5-year period during the last decade. Over 112,000 students from 1500 schools in 40 states participated in the study. At the grades 4–6 level, girls generally outperformed boys in tests of computational skill but, with older students, fewer significant differences in computation were found. The results of tests designed to measure acquisition of higher-level cognitive skills overwhelmingly favored the boys over the girls (Fennema, 1974a).

The NAEP project tested approximately 2500 individuals in 1972/73

at each of four age levels: 9-year-olds, 13-year-olds, 17-year-olds, and adults between 26 and 35 years of age. Overall, the mathematics assessment supported the view that boys outperform girls in that subject. The October 1975 newsletter of the NAEP (*Puzzles and Paradoxes*, 1975) described the boys' advantage as being overwhelming. One of the few instances of girls outperforming boys occurred in the area of arithmetic computation. However, this situation was only temporary, since by age 17 the advantage had switched to the boys and remained in the males' favor for adults as well.

In a different realm, several researchers have studied the relationship between achievement and some measure of self-esteem, self-concept, or self-confidence. Aiken (1972) found that mathematics attitude was positively related to self-confidence in grade 8 males and that mathematics attitude was positively related to achievement. Leviton (1975) reported a consistent, moderate correlation between self-concept and academic achievement. Bailey and Bailey (1974) found that at the fourth-grade level females rated the typical female student as being higher in ability than the typical male student. By the eighth grade, there were no such differences despite the fact that the girls had a higher actual ability level. In reporting their results, they state that ". . . at the eighth grade level, the males overrated their actual ability, while the females tended to underrate their actual ability."

For boys and girls below the tenth grade, Primavera (1974) and Bohan (1973) both found no significant differences in self-esteem scores as measured by the Coopersmith Self-Esteem Inventory. Primavera also found a significant positive correlation between self-esteem and achievement in mathematics for girls but not for boys. Fennema (1974b) reported the results of several studies which tended to support the hypothesis that "girls feel inadequate when faced with a variety of mathematical situations."

The present study compared boys' and girls' achievement in arithmetic computation with their feelings of self-confidence to perform such computations. Rather than obtain a general measure of self-esteem or self-concept, a test was developed to assess the degree of self-confidence of boys and girls to perform a specific mathematical task. This measure could then be compared to a measure of achievement in the performance of that task. As a result, it would be possible to compare girls' feelings of self-confidence with those of boys. Computational skill was selected as the mathematical content area because the literature showed it to be an area where the girls could be expected to outperform the boys.

METHOD

All of the students enrolled in grade 5 through 8 in the public schools of Richmond, B.C. formed the target population for the study. Of the subjects taking part, approximately 2% provided incomplete data and so had to

be excluded from the study. Complete data were obtained on 5440 subjects. A breakdown of this figure by sex and by grade is shown in table 1.

Table 1 / Number of Students Tested

Grade	Boys	Girls	Total
5	708	655	1360
6	728	746	1474
7	747	664	1411
8	606	589	1195
Total	2786	2654	5440

Each student was administered an instrument which had been designed for the study and which consisted of two main parts. In the first part of the test students were asked to express their degree of self-confidence in their methods of performing the four basic operations with whole numbers: addition, subtraction, multiplication, and division. This was accomplished by having the students choose, for each operation, one response from an ordered selection of five responses ranging from an expression of certainty that their method of performing the operation was correct to a feeling of certainty that their method was incorrect. As an example, the item dealing with addition is displayed in figure 1. Similar items for subtraction, multiplication, and division made up the remainder of the first section of the test.

How sure are you that your way of ADDING is correct?
(a) I'm positive that my way is correct.
(b) I'm pretty sure that my way is correct.
(c) I don't know if my way is correct or not.
(d) I'm pretty sure that my way is wrong.
(e) I'm positive my way is wrong.

Figure 1: Self-Confidence Item for Addition

The second part of the test consisted of four subtests, one for each of the four operations. The subtest dealing with division of whole numbers contained 8 items, whereas each of the other three contained 12 items. Each subtest was constructed to include at least two items at each of several levels of generality of application of the algorithm concerned. For example, the subtraction test consisted of the following kinds of items:

(*a*) two consecutive zeros in the minuend, with regrouping;
(*b*) one zero in the minuend, with regrouping;
(*c*) subtraction with regrouping;
(*d*) subtraction without regrouping.

Also, four of the items on the subtraction subtest were presented in horizontal format.

Both parts of the test were administered to the students in one sitting by their regular class teacher, and all of the schools administered the test during the same one-week period. No time limit was imposed but the teachers were informed that pilot testing of the instrument had shown that 40 minutes was a more than adequate estimate of the length of time required for completion of the test by virtually any student. Teachers were asked to explain the structure of the tests to their students.

In an attempt to minimize the number of basic fact errors made by students, thereby permitting the study to focus upon competence with algorithm, each student was given tables of addition and multiplication facts to use during the test. Teachers were asked to spend a few minutes familiarizing their students with the use of these tables. In spite of this precaution, basic fact errors were found to account for slightly more than 17% of all the errors made by the students. This may have been due, at least in part, to the students' lack of experience with tables in the format used.

The major questions to be answered by the statistical analysis of the data concerned the relationship between self-confidence and achievement for girls and for boys. Because of a hypothesized lack of independence among the measures of the independent variables, multivariate analysis of variance was chosen as the means of analysis.

RESULTS

The maximum scores on the addition, subtraction, multiplication, and division subtests were 12, 12, 12, and 8, respectively. The four self-confidence items were scored on a scale ranging from 1 to 5, with 5 indicating a high degree of self-confidence and 1 a low degree. Summary statistics on the achievement and self-confidence portions of the test are presented in tables 2 through 5 below.

For both boys and girls the results displayed in tables 2 and 3 show that achievement scores increase each year except for the boys' result in addition in grade 8. Also, there is a consistent decrease in achievement for both boys and girls as one reads across any row of these tables. That is, regardless of grade or sex, if these results were expressed as percentages, the addition result would be highest and the division result lowest.

Of particular interest to this study is the fact that the girls' means are consistently higher than the boys' means. This is true for each of the 20 achievement means.

The self-confidence results, which are shown in tables 4 and 5, parallel the achievement results in two of the areas mentioned earlier. The self-confidence scores, with the exception of addition for grade 8 boys, increased

Table 2 / Boys' Achievement Scores

	+		−		×		÷	
Grade	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
5	10.88	1.85	9.84	2.65	8.74	3.08	3.80	2.76
6	11.08	1.90	10.44	1.95	9.97	2.23	5.09	2.55
7	11.26	1.65	10.59	1.90	10.36	1.87	5.65	2.32
8	11.22	1.81	10.75	1.71	10.61	1.67	5.89	2.17
Overall	11.11	1.81	10.40	2.12	9.90	2.40	5.09	2.59

Table 3 / Girls' Achievement Scores

	+		−		×		÷	
Grade	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
5	11.21	1.52	10.23	2.23	9.45	2.62	4.46	2.65
6	11.36	1.18	10.47	2.10	10.10	2.12	5.50	2.33
7	11.37	1.65	10.76	1.81	10.67	1.88	6.20	2.18
8	11.60	0.83	10.92	1.51	10.85	1.51	6.21	1.95
Overall	11.38	1.35	10.58	1.96	10.25	2.15	5.57	2.41

Table 4 / Boys' Self-Confidence Scores

	+		−		×		÷	
Grade	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
5	4.36	0.70	4.19	0.72	4.11	0.86	3.68	1.03
6	4.42	0.64	4.32	0.69	4.27	0.73	3.94	0.88
7	4.58	0.60	4.50	0.60	4.40	0.69	4.08	0.82
8	4.57	0.55	4.51	0.61	4.43	0.66	4.13	0.77
Overall	4.48	0.63	4.38	0.67	4.30	0.75	3.95	0.90

Table 5 / Girls' Self-Confidence Scores

	+		−		×		÷	
Grade	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
5	4.29	0.69	4.16	0.75	4.10	0.79	3.74	0.90
6	4.40	0.60	4.29	0.64	4.20	0.69	3.88	0.83
7	4.49	0.58	4.42	0.61	4.34	0.66	4.08	0.77
8	4.59	0.53	4.52	0.58	4.43	0.61	4.13	0.77
Overall	4.44	0.61	4.34	0.66	4.26	0.70	3.95	0.84

with each year and, in each grade, the self-confidence scores for addition, subtraction, multiplication and division form a decreasing sequence.

In comparing boys' and girls' self-confidence scores, however, the situation is very different from the achievement comparisons. Despite the fact that the girls consistently outperform the boys as regards achievement, in only 3 out of the 20 cases is the girls' mean self-confidence score greater than that of the boys.

To analyze the achievement and self-confidence differences between boys and girls, multivariate analysis of variance was employed to compare the boys' vector of self-confidence and achievement scores to that of the girls. Separate analyses were conducted for each grade and then for the overall group. The results of these analyses are displayed in table 6.

Table 6 / F-Ratios for Multivariate Analysis of Variance of Confidence and Achievement Scores

Grade	*d.f.*	*F*
5	8, 1351	5.74***
6	8, 1465	4.09***
7	8, 1402	4.92***
8	8, 1186	3.80***
Overall	8, 5431	13.71***

***$p < 0.001$.

The multivariate analyses indicated the presence of significant differences between the vector of boys' scores and the vector of girls' scores at each grade level and for the overall group. Univariate F-values were then calculated in order to identify the specific sources of those differences. The results of this analysis are shown in table 7.

In general, these results show several significant differences in favor of the girls as regards achievement scores. Of the 20 F-ratios computed on measures of achievement, 15 were significant and each of these differences favored the girls. As regards self-confidence 6 of the 20 F-ratios were significant, and all of these differences favored the boys.

Of particular interest are the individual grade comparisons which show 11 of 16 differences significantly in favor of the girls as regards achievement and no confidence comparisons significantly in favor of them. The most extreme instance occurs in the case of grade 5 addition. In this case the boys were significantly more self-confident than the girls while the girls' achievement was significantly better than that of the boys.

DISCUSSION

The results reported in this paper generally support the findings of other studies comparing sex differences in mathematics and in self-concept.

Table 7 / Univariate *F*-values for Comparison of Self-Confidence and Achievement Scores

		Self-Confidence				Achievement			
Grade	*d.f.*	+	−	×	÷	+	−	×	÷
5	1,1358	4.07*	0.93	0.06	1.27	12.19***	8.86**	20.56***	20.41***
6	1,1472	0.36	0.99	3.40	2.14	12.12***	0.09	1.30	9.95**
7	1,1409	8.28**	5.41*	3.75	0.00	1.52	2.76	9.08**	20.81***
8	1,1193	0.55	0.27	0.00	0.00	21.91***	3.14	6.49*	7.20**
Overall	1,5438	6.61*	3.84*	4.05*	0.03	38.87***	11.37***	30.45***	51.39***

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

In particular, the present data are supportive of Bailey and Bailey's (1974) general finding that boys tend to overrate their ability while girls tend to underrate theirs.

One significant feature of the present analysis is that it focuses upon the one component of mathematics learning where, between the fourth and tenth grade levels, girls have been shown to be superior in achievement to boys. At the same time, rather than employ a global measure of self-concept or self-esteem, an effort was made to measure the students' feelings of self-confidence as regards the performance of those computational skills.

Further studies in this area might concentrate upon an investigation of the effects of manipulating the self-confidence variable. It may be the case that, beginning in an area of mathematics where girls do outperform boys, girls' self-confidence in mathematics can be enhanced. If such is the case, the literature would seem to indicate that teachers might be able to expect enhanced achievement in mathematics from their female students.

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