SEX DIFFERENCES IN ASAT AND RETENTIVITY

FOR

THE 1983 ANNUAL CONFERENCE

Raymond Adams
Australian Council for Educational Research

ABSTRACT

Over the years 1977 to 1982 a sizeable difference in performance on ASAT has been observed between the males and females. A mathematical model based on the differences in the proportion of the boys age cohort and the girls age cohort remaining at Year 12 was constructed in an attempt to explain the performance differences. It was found that such a model could be used to predict the difference but it could only effectively explain a part of the differences.

Since ASAT was first used in the Australian Capital Territory in 1977, sex differences in performance between males and females have been observed. It has been of some concern that over the six year period from 1977 to 1982 there has been an increase in the magnitude of these differences in performance. During this same period the proportions of the age cohorts of both female and male students remaining at the Year 12 level have increased. Moreover this increase has been greater for girls than boys.

It is possible then that we may be able to explain the changes in the differences in observed scores in terms of the changes in the differences in the proportion of the boys' age cohort and the proportion of the girls' age cohort remaining at the Year 12 level.

During the period 1977 to 1982 the total number of students sitting the ASAT examination has increased steadily and the absolute difference between the number of boys and the number of girls has remained relatively constant. However, the difference between the proportions of the age cohorts for boys and girls has increased. In 1977, 40.2 per cent of the boys' age cohort and 49.4 per cent of the girls' age cohort remained at Year 12. In 1982, these proportions had risen to 42.6 per cent and 54.7 per cent respectively. As this difference has increased it may be possible that there has been an increase in the number of less able girls staying on at school. This results in the mean score for the girls being less than the mean score for the boys.

Table 1 Proportion of Age Cohort Remaining at Year 12

	Males			Females		
	Age Cohort	Number at Year 12	Proportion of Cohort	Age Cohort	Number at Year 12	Proportion of Cohort
1977	1964	789	0.402	1837	907	0.494
1978	2066	853	0.413	1939	926	0.478
1979	2118	917	0.433	2003	1060	0.529
1980	2105	861	0.409	2017	986	0.489
1981	1990	843	0.424	2025	1082	0.534
1982	1981	844	0.426	1956	1069	0.547

The Hypothesis to be tested is that observed differences between the mean scores of male and female students on ASAT are associated with the differences in the proportions of the age cohorts of male and female students who remain at school to the Year 12 level and sit for ASAT.

A Model for the Effects of Selection

Using only the information on the proportions of the age cohorts remaining at Year 12 it may be possible to construct a model to explain the observed differences in mean ASAT scores. This approach follows that employed by McIntosh (1959) and by Walker in Husén (1967).

The most simple assumptions are that:

1 The scores on ASAT would have been normally distributed over the full age cohort of boys and the full age cohort of girls if they had remained at Year 12.

2 These two hypothetical normal distributions are identical.

3 Only the best students remain at Year 12.

The normal curve represents the expected performance on ASAT if the full age cohorts of boys and girls had remained at Year 12. For both the boys' cohort and the girls' cohort this distribution would be identical.

The shaded region above the cut-off point, k, represents those students that have actually remained until Year 12. Since a greater proportion of the girls' age cohort remain than boys the cut-off point will be further to the left for girls than boys.

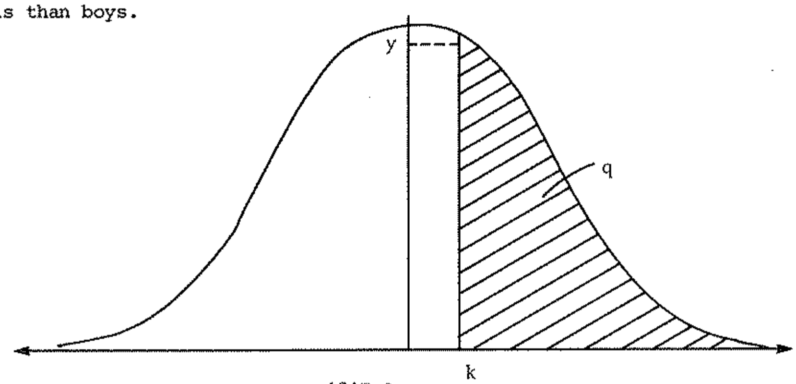

Figure 1 A Hypothetical Distribution of ASAT Scores for the Whole Age Cohort Showing the Proportion q Above the Cut-off Point k.

On the basis of this model we can calculate the expected mean scores for both the boys and the girls for each of the years 1977 to 1982. The formulae are

$$\text{Expected mean} = \frac{y}{q}$$

where q = proportion of cohort who remain

y = the ordinate of the normal curve at the cut-off point k

The difference between the expected boys' mean scores and the expected girls' mean scores can be calculated and plotted against the difference in the observed scores to test the hypothesis stated above.

A Modified Model

The assumption of perfect efficiency in retentivity (assumption 3) is an oversimplification of the actual process involved in selecting the students that remain until Year 12. In effect assumption 3 states that the 50 per cent of students that sit ASAT are the 50 per cent of students that would achieve the highest scores if the whole age cohort had sat ASAT.

This simplification may be overcome by allowing a correlation, r, between the variable operating to select the students who remain until Year 12 (we may call this the retentivity variable) and the ASAT score. This correlation can be different for boys and girls but in both cases it would be expected to be large. The special case of r = 1 for both boys and girls gives us the original model.

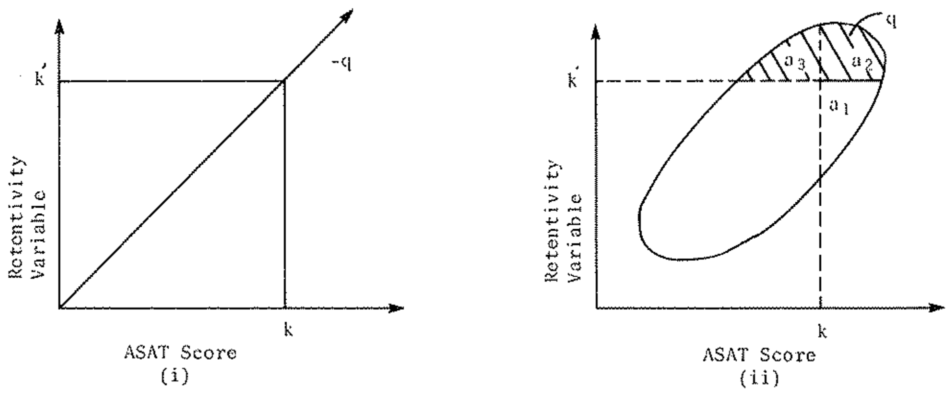

Figure 2 Correlation Surfaces Relating ASAT Score to the Retentivity Variable

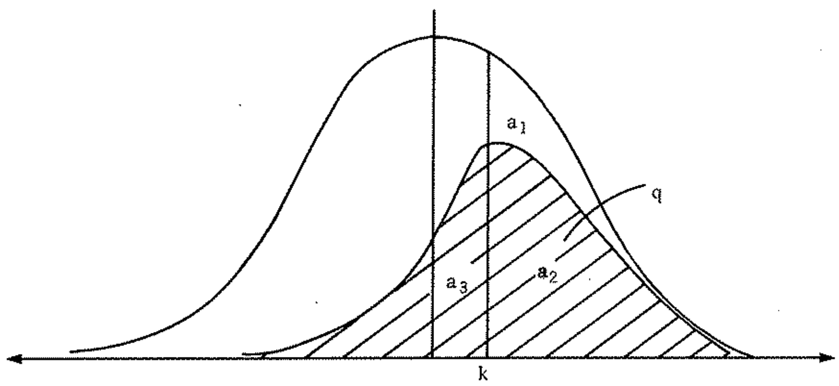

Figure 3 A Hypothetical Distribution of ASAT Scores for the Whole Age Cohort Showing the Proportion Retained.

In the original model the proportion of the cohort remaining at Year 12 will lie above T on the straight line in Figure 2 (i). When perfect efficiency of selection is not assumed Figure 2 (ii) illustrates the relationships between ASAT score and the variable determining selection. The regions marked a_2 and a_3 make up the proportion q that remain in Year 12. Those students in the region a_1 would have achieved above the cut-off score, k, if they had remained while those students in the region a_3 remain at school yet achieve below k.

The region a_3 and a_1 must contain equal numbers of students if the cut-off score k corresponds to the cut-off point of the retentivity variable, k'. As r increases these regions become smaller.

With this new model the expected mean score becomes $r\frac{y}{q}$ where r is the correlation defined above.

Although the true values of r for the boys and girls can not be determined it is possible to try various combinations to see if the fit of the model can be improved.

Table 2 Expected and Observed Differences in ASAT Scores

	Expected Score			Observed Score		
	Boys	Girls	Difference	Boys	Girls	Difference
1977	0.962	0.807	0.155	67.5	64.9	2.6
1978	0.943	0.833	0.110	68.8	65.8	3.0
1979	0.908	0.752	0.156	68.8	64.7	4.1
1980	0.950	0.816	0.134	68.9	65.7	3.2
1981	0.924	0.744	0.180	69.6	64.4	5.2
1982	0.919	0.724	0.195	70.2	63.4	6.8

Testing the Models

Using the data from Table 1 the formulae for the first model were applied. Expected scores in standard score form for the boys and girls were calculated and the differences between these expected scores were compared with the differences between observed scores calculated with a mean value of 65 and a standard deviation of 14.

The correlation between the expected and observed scores is 0.83 with $p<0.05$.

For the testing of the modified model an iterative procedure was used that allowed the correlation to vary independently for boys and girls.

Table 3 illustrates the correlations between the expected difference in ASAT scores and the observed difference in ASAT scores when the correlation, r, is allowed to vary for 0.6 to 1.0 for the boys and girls.

The value of 0.833 in the lower right hand cell is the result achieved from the original model. The value of 0.833 occurs along the diagonal because the differences in the expected scores are all multiplied by a common factor and the relationship between expected and observed differences remains the same.

For the cells below the line the expected boys' score exceeds the expected girls' score.

For the values above the dotted line the expected girls' score exceeds the expected boys' score in at least one of the years. This occurs if we allow the value r for the boys to be considerably less than the value of r for the girls. The boys' scores are then allowed to spread further down as the area of regions a_3 and a_1 become larger (Figure 3) and eventually their expected mean scores will become less than the girls' expected mean scores.

Table 3 Correlation Between Observed and Expected Differences in Scores for the Modified Model

Boys r \ Girls r	0.6	0.7	0.8	0.9	1.0
0.6	.833	.857	.871	.879	.884
0.7	.795	.833	.855	.868	.878
0.8	.743	.801	.833	.853	.865
0.9	.676	.759	.806	.833	.851
1.0	.595	.706	.771	.809	.833

Discussion

Figure 4 (i) shows the relationship between the observed score difference and the expected score differences. From the regression equation we can see that when the expected difference, x, is zero then the original model predicts an observed difference of -0.18 standard score units. This may be explained by 2 factors. First, one all-boys school whose students might have been expected to score well on ASAT was excluded from the calculation. This group comprised about one-twelfth part of the total sample of boys who sat for ASAT. Secondly, it is generally acknowledged that some more able and middle ability boys leave school to obtain places in technical colleges or full-time employment while a higher proportion of their female counterparts remain at school.

The modified model can be used to allow for the effects of these two factors by taking the correlation between the retentivity variable and ASAT scores to be greater for girls than boys. It can be seen from Table 3 that this assumption does improve the fit of the model to the data.

In Figure 4 (ii) where we take $r_{boys} = 0.75$ and $r_{girls} = 0.85$ the model predicts a difference of 0.16 standard score units if retentivity effects are accounted for i.e. x = 0. This residual may be explained by some combination of the following factors: (1) curricula differences through different subject choices for boys and girls, (2) test and item bias, and (3) differences in attitudes and expectations between the sexes.

The gradient of the regression lines in Figure 4 are more difficult to interpret. They appear to indicate a relationship between the three factors mentioned above and retentivity.

All the relationships that have been studied must be considered to some degree uncertain. With only six observations available the results of 1982 have a strong influence on the regression line. It will be essential to examine the relationships again with added data from 1983.

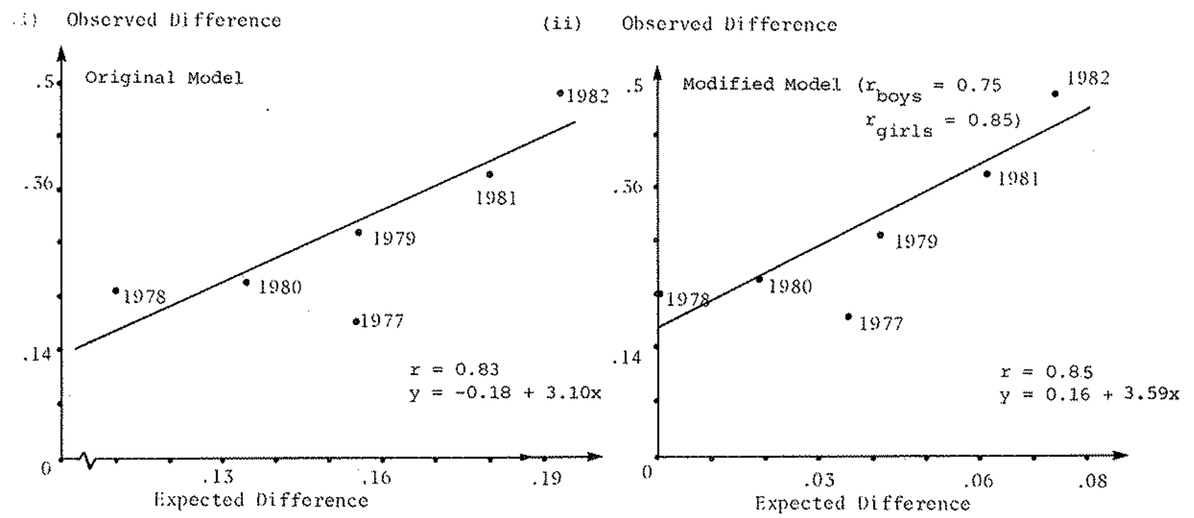

Figure 4 Plots of the Expected Differences in ASAT Score Against Observed Differences in ASAT Score.

Conclusion

A mathematical model was constructed to determine if different retention patterns between boys and girls can be used to explain observed differences in ASAT scores. It was found that a strong relationship exists between the observed scores and retention patterns, yet the magnitude of the observed score differences are three to four times greater than the amount of difference that can be explained by retentivity alone.

Three other factors are suggested as contributors to the observed score differences between the scores: (1) curricula differences, (2) test and item bias and (3) attitudes and expectations.

References

McIntosh, D.M. Educational Guidance and the Pool of Ability. University of London Press, London, 1959.

Walker, D.A. In International Study of Achievement in Mathematics. Vol. 11, (ed. Husen, T.) Almqvist & Wiksell, Stockholm, 1967.