

# The varying relationship between New Zealand students' attitude to reading and reading literacy achievement

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## Abstract

Results from the 2006 Progress in International Reading Literacy Study (PIRLS) show that for New Zealand's Grade 4 students, those with a more positive attitude to reading tended to have higher reading literacy achievement (Chamberlain, 2007; Mullis, Martin, Kennedy, & Foy, 2007). However, in their analysis of PIRLS data English-speaking countries, Gnaldi, Schagen, Twist, and Morrison (2005), suggest that for Grade 4 students with low reading literacy achievement, the measure of attitude to reading requires careful interpretation due to those students' difficulty understanding the items comprising this measure. This suggests the possibility of variation, with reading literacy achievement, in the relationship between attitude to reading and reading literacy achievement. The current study uses correlation curves (Bjerve & Doksum, 1993) to investigate this variation in New Zealand's PIRLS 2006 data. It finds that, overall, the correlation between attitude to reading and reading literacy achievement varied substantially with reading literacy achievement. However, for students with reading literacy achievement between 0.5 and 1 standard deviations below the mean, and for those with reading literacy achievement just under 0.5 standard deviations above the mean, this correlation was lower than expected. This possibly indicates behavioral phenomena, test effects or a combination of both, and certainly indicates the need for further theoretical consideration and analytical work.

**Keywords:** *attitude to reading, reading literacy achievement, correlation curve*

## Introduction

### Background

Learners' attitudes, self-concepts and practices regarding learning exist in complex relationships with various aspects of their achievement. These relationships are affected, to a greater or lesser extent, by a number of other characteristics of the learner, the subject matter being learnt, the learning environment and the learners' teachers. Even the learners' attitude toward the measurement of their attitudes and achievement cannot be discounted out of hand.

By virtue of its generality, this statement is one that might apply in various theoretical framings of learning. What also might apply, regardless of theoretical framing, is the need for empirical evidence to be of sufficient sophistication to inform or be informed by theoretical concerns. Exactly what is deemed sufficient then becomes crucial.

In the special case of the relationship between school-age students' attitudes to reading and their reading literacy achievement, what has been deemed sufficient has changed over time and according to the needs of the evidence users.

In an early empirical study, Jacobson and Johnson (1967) found that although the relationship was complex, students with a more positive attitude to reading tended to have higher reading literacy achievement than those with a less positive attitude. This finding, although perhaps not universally verified, has been replicated in many different forms since. For example, Chamberlain (2007), p.29, reported that "[New Zealand] students at the high level of the SATR [Students' Attitude to Reading] Index had, on average, higher reading achievement

than those at the medium or low levels.” See also Kennedy (2008) for an international perspective.

While demanding ongoing monitoring, this type of evidence might be deemed of insufficient sophistication to address *theoretical* concerns for two major reasons.

1. This type of evidence does not account for other factors which might be correlated to either or both of attitude to reading and reading literacy achievement.
2. This type of evidence is correlational. That is, it cannot address causal or temporal aspects of the relationship between attitude to reading and reading literacy achievement.

These insufficiencies have been addressed in several ways. The first has been primarily, but not exclusively, addressed using statistical modelling techniques. Kirsch, De Jong, Lafontaine, McQueen, Mendelovits, and Monseur (2002) used descriptive statistics to conclude that regardless of socioeconomic status, students who were highly engaged in reading tended to have higher reading literacy achievement. Rowe (1991) used structural equation modelling techniques on cross-sectional data to conclude that for 7-14-year-olds (but not for 5-6-year-olds), after controlling for home-reading activities and socioeconomic status, attitude to reading was strongly associated with reading achievement (and correlated with attentiveness).

The second insufficiency has been addressed using a combination of data-oriented techniques and statistical modelling techniques. For example, by using longitudinal data and modelling techniques, Wylie, Thompson, and Lythe (2001), p.240, found that reading activity at age 6 was statistically significantly associated with reading comprehension at age 10.

These modeling techniques, while excellent, do not capture differences in variation at different data-levels (e.g., variation at the student level, variation at the class level and variation at the school level) and for this reason have been deemed by some, to be of insufficient sophistication to address theoretical concerns (Goldstein, 2003).

Schagen and Twist (2008) provide an example of sophisticated evidence using modelling techniques which incorporate data from different time-points, account for other, potentially correlated, factors and allow for differences in variation at different data-levels. They conclude that after controlling for prior achievement “The relationship between reading enjoyment and ability is ... significant and positive” and that “... the link between [reading] enjoyment and attainment may be via personal reading activities.” (Schagen & Twist, 2008, pp.4-5).

The modeling techniques mentioned above and those used extensively in educational research are (hierarchical) generalised linear models (Nelder & Wedderburn, 1972). As such, they provide a description of the (linear) effect of various factors on the outcome(s) of interest, constrained by the total (or “global”) dataset being used for investigation. There is evidence, both within the context of research focussed on reading and more generally, to suggest that global statistics, such as global (hierarchical) generalised linear models may not always provide evidence of sufficient sophistication to inform theoretical concerns.

Gnaldi, Schagen, Twist and Morrison, (2005) show that the reliability and discrimination indices (usually global statistics) of various attitude items in the PIRLS 2001 dataset measuring attitude to reading, were different at different reading literacy achievement levels.

More generally, in the context of item response theory models, there is also evidence to suggest that models generated using global data (in this case, multinational, multiple cohort

educational data) do not always provide the appropriate type of evidence (in this case, national trends over time in reading literacy achievement) (Schagen, Twist & Rutt, 2008; Gebhardt & Adams, 2007).

Although it is in the context of medical statistics and somewhat removed from research focussed on reading, Bjerve and Doksum (1993) describe a situation where the strength of association between a response variable (triglyceride levels) and a covariate (cholesterol levels) is different over different regions of values for the covariate (cholesterol levels). This also might be considered indirect evidence of the value of local statistical analysis in investigating the relationship between attitude to reading and reading literacy achievement.

This is not to say that the modelling techniques mentioned above are necessarily insufficient. They are simply global. This global character may be a desirable quality from the perspective of research evidence users. For example, policy makers are often concerned with research evidence which is as broadly applicable as possible within the appropriate context. However, this global character may not address theoretical concerns.

What Gnaldi et al. (2005) and Bjerve and Doksum (1993) suggest is that statistical research focussed on reading should be concerned with how one quantity (such as reading literacy achievement) varies with another (such as attitude to reading), but how the relationship between them varies. This is a particularly interesting issue when, as in the current paper, the two quantities (reading literacy achievement and attitude to reading) are continuous.

## **Objectives**

The current study investigates how the relationship between attitude to reading and reading literacy achievement varies with reading literacy achievement among New Zealand's Grade 4 students.

The following questions guide the analysis and discussion.

1. How does the correlation between attitude to reading and reading literacy achievement vary with reading literacy achievement?
2. Gender, ethnicity and other factors are known to be associated with both attitude to reading and reading literacy achievement (for example, Baker & Wigfield, 1999; Chamberlain, 2008).
  - a. How do these factors vary with reading literacy achievement?
  - b. As reading literacy achievement varies, do patterns in the variation of these factors correspond to patterns in the variation of the correlation between attitude to reading and reading literacy achievement?

## **Methodology**

### **Data**

The data used in the current work was New Zealand's English medium PIRLS 2006 student background data. Chamberlain (2007) provides detailed descriptions of PIRLS 2006 in New Zealand. At the international level PIRLS is described by Martin, Mullis and Kennedy (2007) and Mullis, Martin, Kennedy and Foy, (2007). In New Zealand, PIRLS 2006 was conducted in both the English and Māori languages. Initial investigations revealed very different factor structures for attitude to reading in these two languages (see Table 1). Subsequent investigation was restricted to the English medium PIRLS 2006 data as the size of this dataset

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was compatible with the current analytic approach, whereas the Māori medium PIRLS 2006 data was too small.

## Analyses

The relationship between reading literacy achievement and attitude to reading within New Zealand's PIRLS 2006 data is the focus of this paper. No inferences are drawn about this relationship at the national population level. Because of this, unweighted data is used in all analyses. However, because of the complex sample design used in PIRLS, replication methods are used when producing error estimates.

For all variables used in factor analyses, missing data was imputed as the variable's mean prior to the analysis. This allowed data sets of maximal size to be used in the analyses. To control for any unwanted affects of imputation, all analyses were repeated with imputation-free data with largely the same results. These imputation-free analyses are not reported here for reasons of brevity.

The measure of reading literacy achievement used in this paper, labelled ASREARSC, is the national PIRLS Rasch item-response score referred to in Foy & Kennedy, (2007, p. 24). This Rasch score has been standardised to have mean 0 and standard deviation 1. This Rasch score was chosen as a measure reading literacy achievement rather than any of the PIRLS plausible value measures because of the focus on the collected data as opposed to the national population. The measures of attitude to reading used in this paper were obtained using factor analysis (with varimax rotation) on the items that contribute to the PIRLS SATR and SRSC (Students' Reading Self-Concept) indices (Mullis, Martin, Kennedy & Foy, 2007). The factor loadings for these factor analyses are described in Table 1. Although the factor analyses revealed several factors underlying the items that contribute to the PIRLS SATR and SRSC indices, the only factors used in this paper are those labelled NZSATR06. This index has mean 0 and standard deviation 1.

[Take in Table 1 about here]

Subsequent to its creation, the NZSATR06 index was transformed to address slight heteroscedasticity with respect to reading literacy achievement. Using NZSATR06 as a measure of attitude to reading and ASREARSC as a measure of reading literacy achievement, the variation, with *reading literacy achievement*, in the correlation between attitude to reading and reading literacy achievement was measured in New Zealand's PIRLS 2006 dataset. The current approach to doing this was inspired by Bjerve and Doksum (1993).

Bjerve and Doksum (1993) describe a theoretical situation where the strength of association between a response variable and a covariate can be different over different regions of values for the covariate. They theoretically recast Galton-Pearson correlation as a function of the covariate: to a given value,  $x$ , of the covariate, this function assigns the correlation between the covariate and the response variable for those data points whose covariate values are "local" (or close) to  $x$ .

They then illustrate this theory with a data-based example where the response variable is a measure of patient triglyceride levels and the covariate is a measure of patient cholesterol levels. One important subtlety not addressed by this example is that Bjerve and Doksum's (1993) theory assumes that the correlation is only a function of the covariate and is independent of the choice of "local" neighbourhood of  $x$ .

The current work adopts a more data-oriented approach to describing variation in strength of association between two variables. Simply put, it describes this variation by plotting a running correlation between the response variable (a measure of attitude to reading) and covariate (a

measure of reading literacy achievement) against a running mean for the covariate.

More precisely, suppose that a dataset consists of  $N$  data points and contains values of a response variable,  $Y$ , and a covariate,  $X$ . Suppose the dataset is ordered by the values of the covariate. Of interest in the current work is the value of the Galton–Pearson correlation between the response variable and covariate when restricted to the subset consisting of the  $i$ th through the  $(i + j)$ th data points plotted against the mean of the covariate similarly restricted. Here  $i$ ,  $j$  and  $i+j$  are all no larger than  $N$ . The collection of all such values as  $i$  and  $j$  vary is referred to as the  $X$  correlation fan of  $Y$ .

Fixing  $i$  and letting  $j$  vary recovers a version of Bjerve and Doksum’s (1993) correlation curve. Fixing  $j$  and letting  $i$  vary shows the dependence of local correlation on the choice of local neighbourhood. Given the choice of  $X$  and  $Y$ , the  $X$  correlation fan of  $Y$  is canonical and, in particular, is independent of choice of local neighbourhood.

The PIRLS 2006 dataset (for English medium instruction in New Zealand) consists of 5990 students. Figure 1 shows the  $i = 1000$ ,  $i = 3000$ ,  $i = 4000$  and  $i = 5990$  cross-sections (correlation curves) of the reading literacy achievement (ASREARSC) correlation fan of attitude to reading (NZSATR06). Regression lines are also plotted. It is worth noting that correlation estimates are sensitive to the ranges of the variables involved. In particular, limiting the range of values of one of the variables will tend to reduce the computed correlation values. This helps to explain the fact that the ‘ $i=1000$ ’ curve below shows reduced correlations compared with the other two lines.

[Take in Figure 1 about here]

Figure 2 shows the  $i = 1000$  and  $i = 4000$  cross-sections (correlation curves) of the reading literacy achievement (ASREARSC) correlation fan of attitude to reading (NZSATR06). Error estimates (at the 95% confidence level) for some data points are indicated: vertical bars indicate errors in correlation estimates; horizontal bars indicate errors in mean estimates.

[Take in Figure 2 about here]

The  $i = 1000$  cross-section of the reading literacy achievement correlation fan of the PIRLS SATR Index was also plotted and was largely the same as the same cross-section of the reading literacy achievement correlation fan of NZSATR06. This is not included here for reasons of brevity. The  $i = 1000$  cross-section of the reading literacy achievement correlation fans of each of the items that load heavily onto NZSATR06 (namely *asbgrst1*, *asbgrst2*, *asbgrst3*, *asbgrst4* and *asbgrst6*) were also plotted. All of the resulting graphs showed variation in the correlation between reading literacy achievement and attitude to reading (measured using the relevant item). However, not all of these graphs were similar. This demonstrates that the variation – with reading literacy achievement – in the correlation between attitude to reading and reading literacy achievement was not uniform across the various indicators of reading literacy achievement. Again, for reasons of brevity, these graphs are not reproduced here.

Recall that the  $X$  correlation fan of  $Y$  is essentially the collection of all plots of running correlations of  $X$  and  $Y$  against running means of  $X$ . For a categorical variable  $Z$ , the  $X$  frequency fan of  $Z$  may be defined analogously. That is, the  $X$  frequency fan of  $Z$  is essentially the collection of all plots of running frequencies of  $Z$  against running means of  $X$ .

How might these graphs be understood? From Figure 2 it seems that there are significant correlational differences at various points: high values at very low achievement (-1.5), close to mean achievement (around 0) and fairly high achievement (around 0.7), compared with low values at relatively low achievement (-0.8) and just over average achievement (0.4).

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When describing these apparent relationships causal language is used, but this should not be taken to imply a direct causal relationship in either direction between reading attitude and achievement.

Very low achieving students (-1.5) tend to have a strong relationship between attitude and achievement – so perhaps small increases in achievement can lead to quite big improvements in attitude for these students. At higher, but still below average, levels this positive relationship may stall, or even run in reverse, but at average achievement levels the link between attitude and achievement seems to be positive and significant. There is another low point in the relationship at just above average achievement, which may mean that students at that point find it hard to motivate improvements in reading achievement. However, at slightly higher levels of achievement the positive relationship becomes strong again. At the very highest levels of achievement the link between attitudes and achievement is less strong, possibly because students at those levels already have good positive attitudes.

Figure 3 shows the  $i = 1000$  cross-section of the reading literacy achievement (ASREARSC) frequency fan of gender. Error estimates (at the 95% confidence level) for some data points are indicated: vertical bars indicate errors in frequency estimates; horizontal bars indicate errors in mean estimates. Figure 4 shows the same information for ethnicity instead of gender.

[Take in Figure 3 about here]

[Take in Figure 4 about here]

The measure of socioeconomic status (SES) used in this paper was constructed using factor analysis (with varimax rotation) as described in Table 2.

[Take in Table 2 about here]

Figure 5 shows the  $i = 1000$  cross-section of the reading literacy achievement correlation fan of SES. Error estimates are as in Figure 1. This might imply that SES effects on reading achievement are stronger at the lower end of the reading achievement spectrum.

[Take in Figure 5 about here]

The  $X$  partial correlation fan of  $Y$ , controlling for variables  $A$ ,  $B$ ,  $C$  etc., can be defined analogously to the  $X$  correlation fan of  $Y$ . The analyses comprising Figures 1 and 2 were repeated using partial correlations, controlling for gender, ethnicity and socioeconomic status, instead of correlations. The resulting graphs closely resembled Figures 1 and 2 and are consequently not included here.

## Results

### Findings

There was statistically significant variation, with reading literacy achievement, in the correlation between reading literacy achievement and attitude to reading.

Overall, the correlation between reading literacy achievement and attitude to reading tended to increase with reading literacy achievement. However, there were noteworthy exceptions. In particular, for students with reading literacy achievement between 0.5 and 1 standard deviations below the mean, and for those with reading literacy achievement just under 0.5 standard deviations above the mean, the correlation between reading literacy achievement and attitude to reading was lower than expected.

The patterns of variation, with reading literacy achievement, in the correlation between reading literacy achievement and attitude to reading are not obviously explained by patterns of variation, with reading literacy achievement, in any of gender, ethnicity or the correlation between reading literacy achievement and socioeconomic status. This was confirmed by the existence of statistically significant variation, with reading literacy achievement, in the partial correlation between reading literacy achievement and attitude to reading, controlling for gender, ethnicity and socioeconomic status.

## Discussion

This section discusses two aspects of this paper: firstly, how the findings might inform theoretical understandings of attitude to reading and reading literacy achievement; and secondly, further considerations and questions raised by the statistical approach used to analyze the data.

Firstly – with regard to theory – this paper seeks to broaden the theoretical framings of the relationship between reading literacy achievement and attitude to reading. It begins to do so by providing robust evidence of variation, with reading literacy achievement, in the relationship between reading literacy achievement and attitude to reading. However, this evidence is robust in the statistical sense only: the variation in the relationship between reading literacy achievement and attitude to reading is statistically significant, but is it meaningful?

For example, does the demonstrated overall increase, with reading literacy achievement, in the correlation between reading literacy achievement and attitude to reading correspond to meaningful behavioural phenomenon in New Zealand's Grade 4 student population? In other words, is there a behavioural reason why reading literacy achievement and attitude to reading tend to be more closely associated for students with higher reading literacy achievement?

In their analysis of PIRLS data for English-speaking countries, Gnaldi et al. (2005) suggest that for Grade 4 students with low reading literacy achievement, the measure of attitude to reading requires careful interpretation due to those students' difficulty understanding the items – including statements such as “I read only if I have to” – comprising this measure. So perhaps the demonstrated overall increase – with reading literacy achievement – in the correlation between reading literacy achievement and attitude to reading is a test effect rather than a behavioural one. However, the statistically significant dip in the  $i = 1000$  cross-section of the correlation fan for students with reading literacy achievement below the mean in Figure 2, indicates that it may not just be students' difficulty understanding the items comprising the measure of attitude to reading that explains the overall increase in correlation.

It would be interesting to compare Figures 1 and 2 with similar figures using data from other countries participating in PIRLS and possibly in other PIRLS data collection cycles. It would also be interesting to analogously use NZSATR06 to measure the variation – with *attitude to reading* – in the correlation between attitude to reading and reading literacy achievement.

Secondly – with regard to the current statistical approach – in order to meaningfully use the (hierarchical) generalised linear modelling techniques mentioned in the introduction, the data being modelled should, strictly speaking, meet certain criteria (Hatcher, 1994, p.126 and p.148; Hair, Anderson, Tatham, & Black, 1998, p.70). In practice, these criteria are often mildly violated and the modelling techniques are used anyway. The reasons for this include a lack of (widespread knowledge of) better techniques and the increased, and sometimes unwanted, demands that more technical analyses place on evidence users. In addition, the statistical modelling techniques mentioned above may be robust against some violations of the criteria (Anderson & Gerbing, 1988; Joreskog & Sorbom, 1989).

In this paper attempts have been made to ensure that the data being modelled does meet the appropriate criteria *globally*. For example, the measure of attitude to reading is homoscedastic with respect to reading literacy achievement and their joint distribution is roughly normal in the global (i.e., total) New Zealand PIRLS dataset. However, the main technical concern of this paper is with variation in local modelling phenomena and, as thousands of local models were constructed, addressing the modelling criteria in each of these local datasets has not been attempted. Furthermore, it is not clear how one would address local heteroscedasticity. For example, two overlapping local datasets might each suggest different transformations to address two different cases of heteroscedasticity. How would these different local transformations be reconciled in the global dataset? Perhaps transformations for overlapping local datasets will not be “too different”, especially if, as in the current paper, the local datasets are parameterised continuously. This situation is reminiscent of overlapping coordinate patches in the geometry of manifolds (for example, do Carmo, 1992).

The measure of attitude to reading used in this paper is latent and global. That is, it is constructed from global data related to multiple manifest factors. Using this global measure, the current paper has demonstrated that the local relationship between attitude to reading and reading literacy achievement varies as reading literacy achievement varies. Alternatively, one could construct a local measure of attitude to reading and then investigate how the measure varied as reading literacy achievement varied. This need not be just methodological speculation: there might be theoretical or policy-based interest in finding that, for example, *valuing reading as a skill* more closely measured attitude to reading than *enjoyment of reading* for those with low overall attitude to reading.

### Acknowledgements and Disclaimer

The author gratefully acknowledges the contributions of Ian Schagen, Megan Chamberlain and Heleen Visser. Opinions expressed in this paper are those of the author and do not necessarily coincide with those of the New Zealand Ministry of Education.

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Table 1

*Measure of students' attitude to reading in New Zealand's PIRLS 2006 data*

PIRLS item code	Item	NZSATR06	Factor 2	Factor 3
asbgrst1	I read only if I have to.*	<b>0.39770</b>	<b>0.59453</b>	-0.17857
asbgrst2	I like talking about books with other people.	<b>0.56846</b>	-0.26619	0.18115
asbgrst3	I would be happy if someone gave me a book as a present.	<b>0.71781</b>	-0.05508	0.17707
asbgrst4	I think reading is boring.*	<b>0.68969</b>	0.40356	-0.01871
asbgrst6	I enjoy reading.	<b>0.79501</b>	0.16060	0.20754
asbgrd1	Reading is very easy for me.	0.13700	0.20048	<b>0.79076</b>
asbgrd2	I do not read as well as other students in my class.*	-0.01528	<b>0.73855</b>	0.24142
asbgrd3	When I am reading by myself, I understand almost everything I read.	0.22435	0.07622	<b>0.75748</b>
asbgrd4	I read more slowly than other students in my class.*	-0.08315	<b>0.73854</b>	0.21363

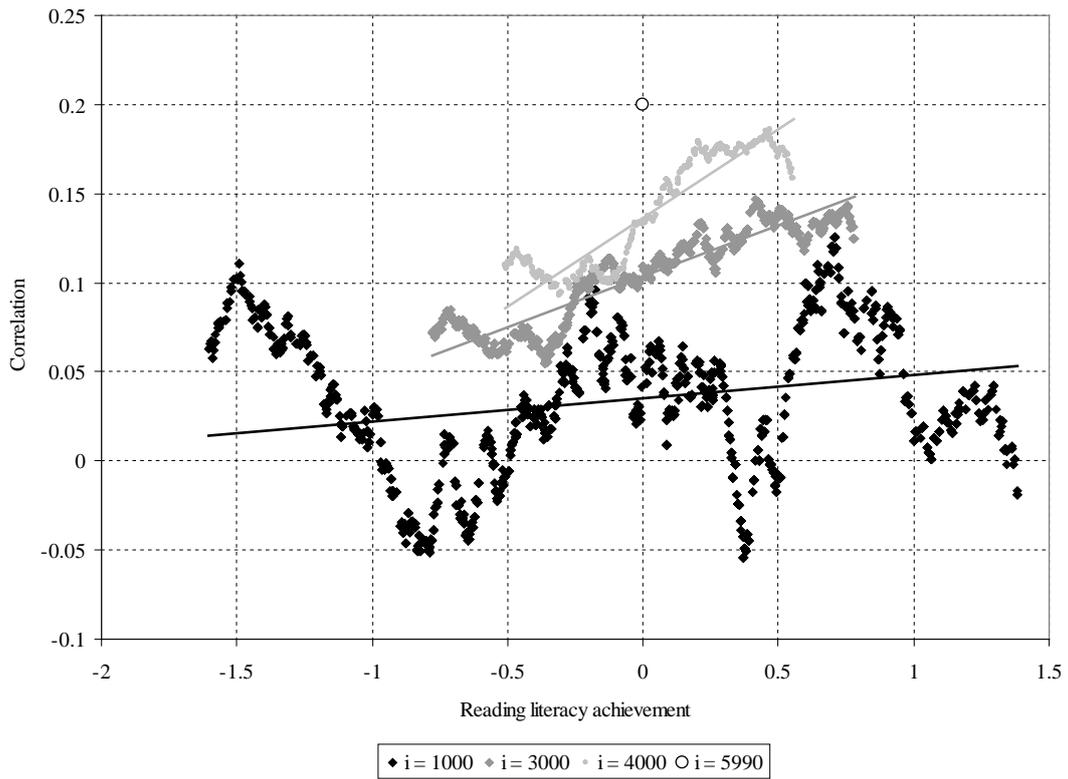
*Note.*\* indicates that the item was reverse-scored. Substantial factor loadings (i.e. those with magnitude above 0.3) are in bold. NZSATR06 explained 31% of the variation in the items in Table 1, Factor 2 explained 17% and Factor 3 explained 12%.

Table 2

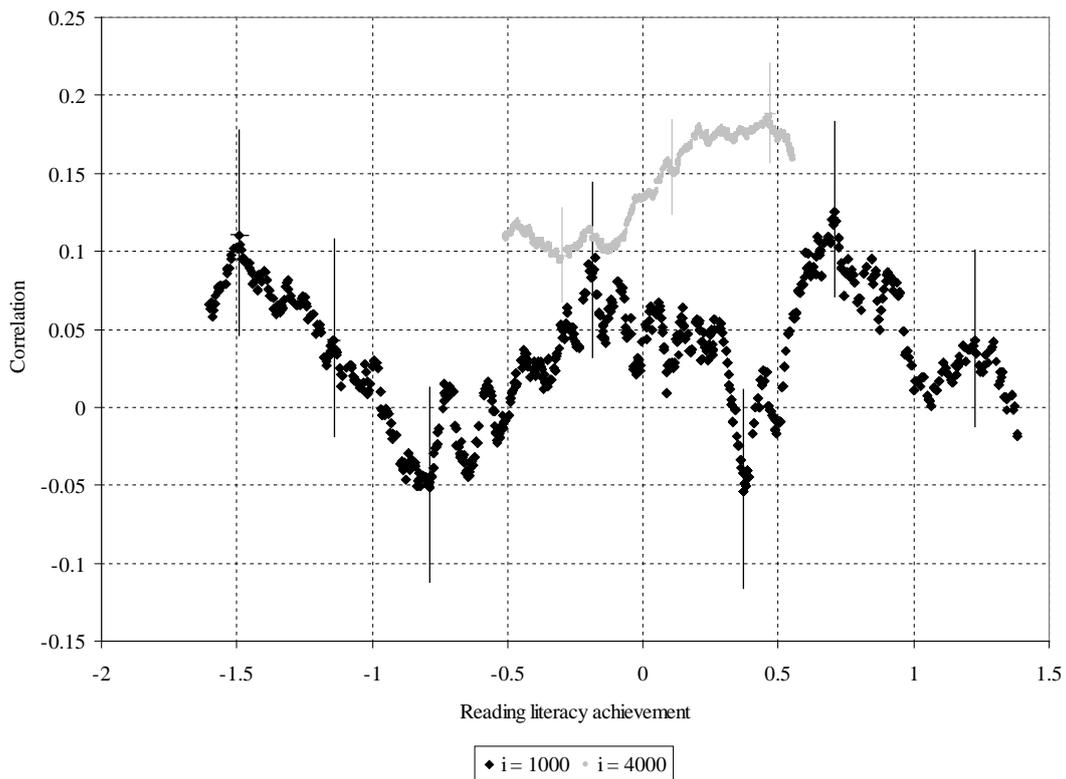
*Measure of students' SES in New Zealand's PIRLS 2006 data*

PIRLS item code	Item	SES
asbgbook	About how many books are there in your home?	<b>0.46558</b>
asbgta1	Do you have a computer in your home?*	<b>0.35176</b>
asbgta2	Do you have a study desk/table for your use in your home?*	<b>0.42851</b>
asbgta3	Do you have books of your very own in your home? *	<b>0.46192</b>
asbgta4	Do you have a daily newspaper in your home?*	<b>0.40921</b>
asbgta5	Do you have your own bedroom in your home?*	<b>0.41336</b>
asbgta7	Do you have a musical instrument in your home?*	<b>0.43502</b>
asbgta8	Do you have a clothes dryer in your home?*	<b>0.52973</b>
asbgta9	Do you have a dishwasher in your home?*	<b>0.64207</b>
asbgta10	Do you have two bathrooms in your home?*	<b>0.57191</b>

*Note.* \* indicates that the item was reverse-scored. Substantial factor loadings (i.e. those with magnitude above 0.3) are in bold. SES explained 23% of the variation in the items in Table 2.



*Figure 1.* Various cross-sections (correlation curves) of the reading literacy achievement correlation fan of attitude to reading in New Zealand's PIRLS 2006 dataset



*Note.* The  $i=1000$  cross-section was selected because of the interesting and statistically significant pattern of variation, with reading literacy achievement, in the correlation between attitude to reading and reading literacy achievement

*Figure 2.* Correlation between attitude to reading and reading literacy achievement by mean reading literacy achievement in New Zealand's PIRLS 2006 dataset.

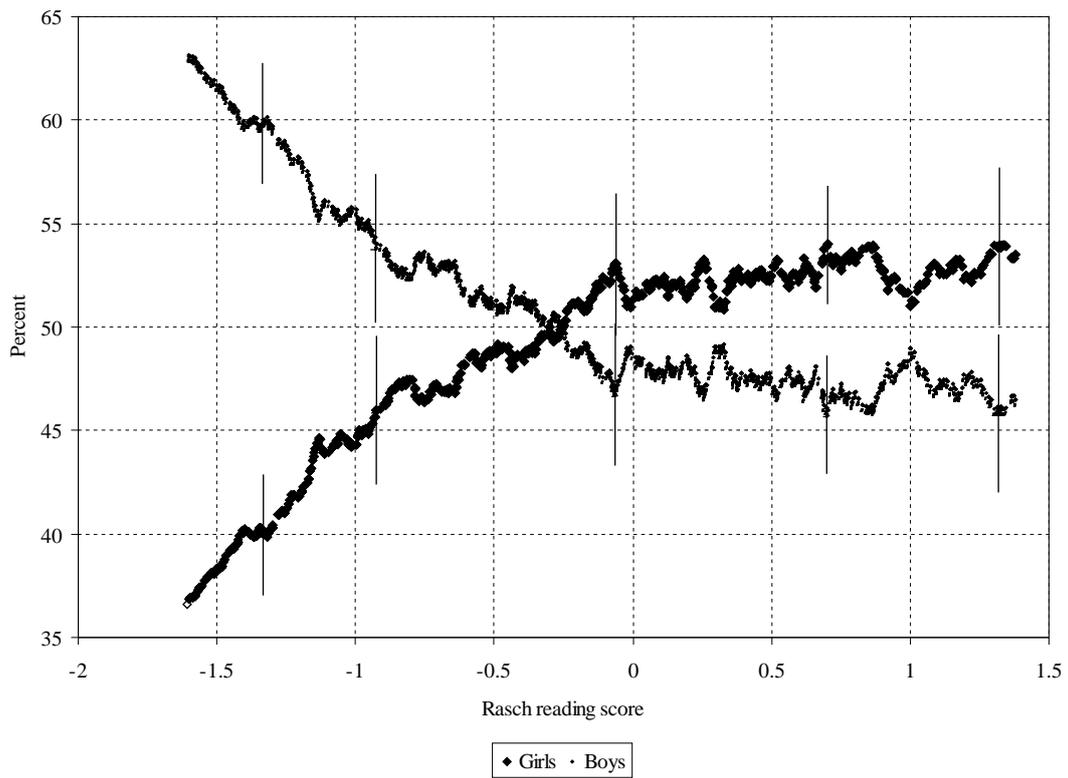
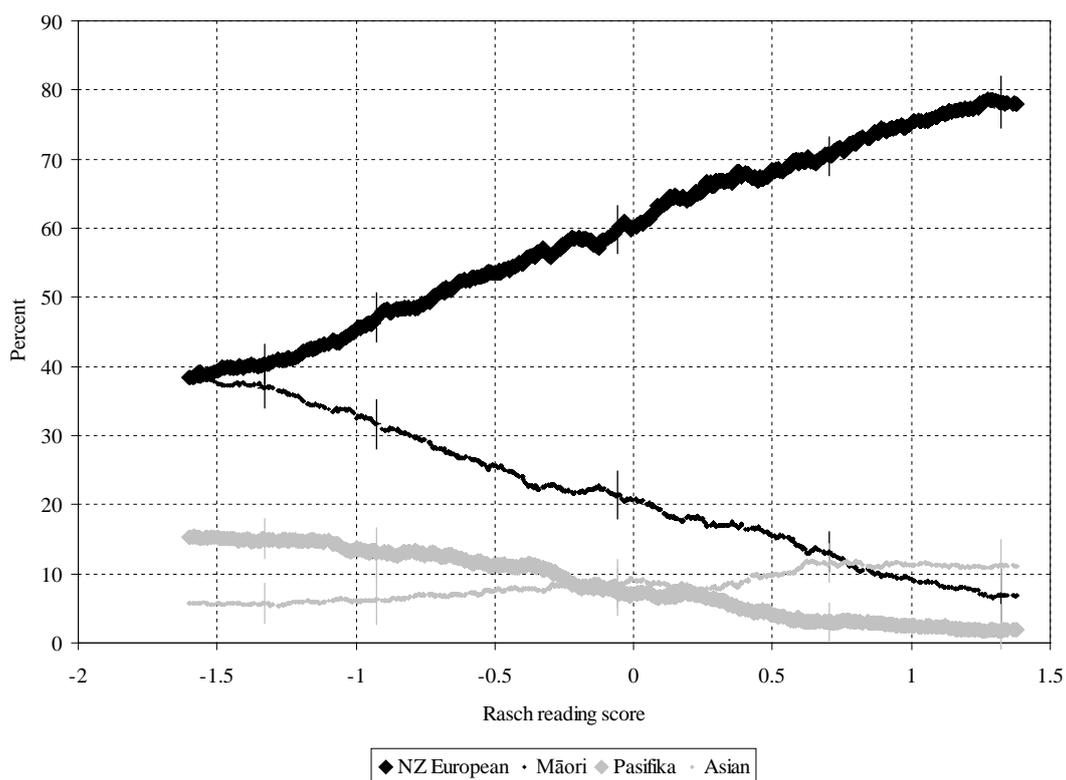
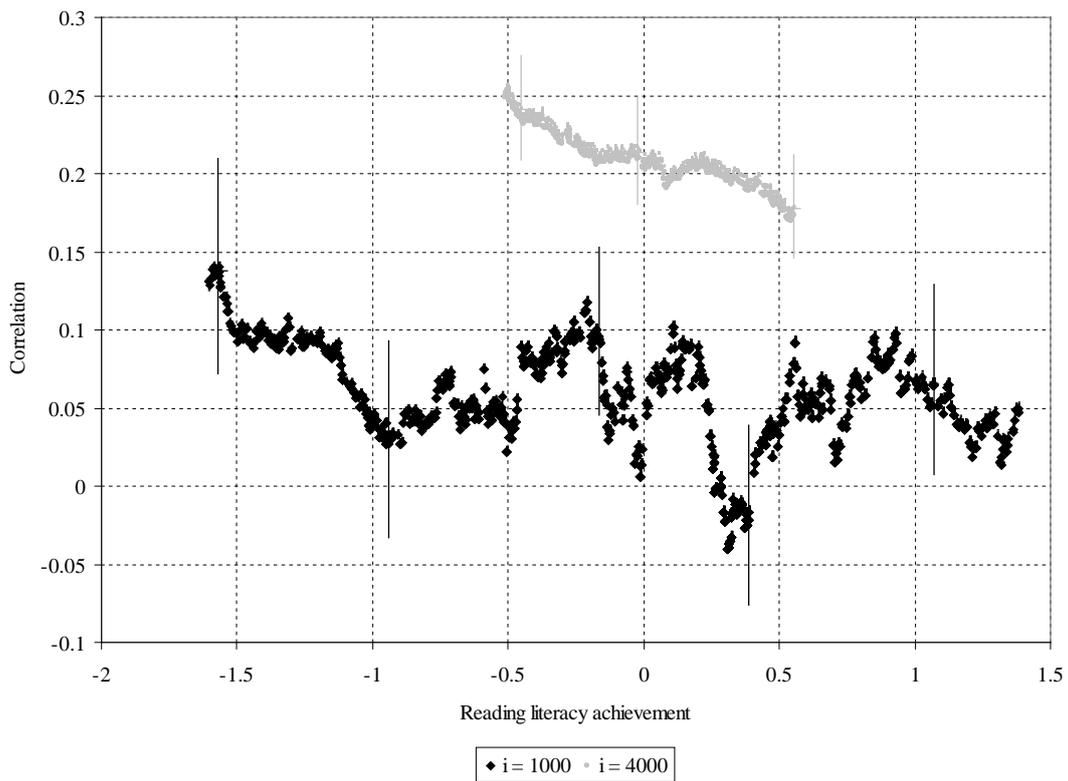


Figure 3. Percentage of girls and boys by mean reading literacy achievement in New Zealand's PIRLS 2006 dataset.



*Note.* Students of other ethnic identification made up at most 3% of any of the data subsets whose frequencies are displayed in Figure 4.

*Figure 4.* Percentage of ethnic groupings by mean reading literacy achievement in New Zealand's PIRLS2006 dataset.



*Figure 5.* Correlation between socioeconomic status and reading literacy achievement by mean reading literacy achievement in New Zealand’s PIRLS 2006 dataset.