

Mediated gender differences in reading achievement 1

Mediated gender differences in reading achievement of 14-year old  
students in 15 educational systems

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Despite the development of other channels of communication, the ability to read with understanding remains of paramount importance in modern society. Therefore, one of the main tasks of education is to provide students with the necessary skills to become proficient readers. Those people with a limited reading ability are at a considerable disadvantage, unable to participate fully in many processes and activities in society.

In most societies the education of children has been organized in some kind of formal system, usually divided into primary and secondary schooling with primary schools focussing on the development of reading skills on which secondary schools can build. While often no formal teaching of reading occurs beyond the primary school level, learning at the secondary school level requires that students should be able to read in order to acquire further knowledge.

It is the importance assigned to the ability to read by society and schools which has resulted in a substantial amount of research in the area of reading, its sociological, psychological, physiological and pedagogical aspects. Particular attention has been given to differences in the reading achievement of boys and girls. While some research studies provided evidence of girl's superiority over boys (Bleakley et al., 1988; Brown, 1991; Purves, 1973; Shangi, 1983; Spearritt, 1977; Swan, 1978), others found no differences between the sexes (Gross, 1978; Hogrebe et al., 1985; Knickerbocker, 1989; McGaw et al., 1989; Wilson, 1975) or even reported that boys performed better than girls (Sanguinetti, 1983).

The majority of these studies, however, focus mainly on the level of reading achievement and whether or not differences may be found as to which sex achieves at a higher level. Moreover, these surveys are frequently correlational in nature or examine the impact of only one single background variable, such as gender, on the outcome measure at a time. Less frequent are attempts to include several background variables in the analysis, extracting their separate contributions to explaining the variance in achievement. Even fewer analyses again are designed to incorporate many predictor variables and to examine their interrelationships as well as their effects on the outcome measures.

Previous research, therefore, indicates that the relationship between gender and reading achievement is not as simple as to say

that girls generally outperform boys in reading. In addition, concerns in society regarding gender differences together with the widespread assumption that somehow being a girl or a boy does make a differences to achievement patterns in reading seem to justify the pursuit of other avenues of investigation to determine exactly in which ways this variable works to influence performance in reading. In this context, the present article focuses on the way in which student's gender operates through other student background variables to influence achievement in reading of 14-year-old students.

### The Data

The data set employed in the analyses is reported in this paper part of the 1970-71 IEA-Six-Subject Study in which an

investigation was undertaken of student achievement in the content areas of science, literature, English and French as foreign languages, civic education and reading comprehension. The Reading Comprehension Study is reported

Table 1 List of educational systems participating in the IEA-Reading Comprehension Study, 1970-71

Educational System	N of students in sample
Belgium (Flemish)	699
Belgium (French)	570
Chile	1356
England	3284
Finland	2323
Hungary	7039
India	2985
Iran	1436
Israel	2032
Italy	7538
Netherlands	1254
New Zealand	1995
Scotland	2011
Sweden	2490
United States of America	7065*

\* In the United States of America the number of students includes students who took the reading comprehension test as well as those who did the science test.

by Thorndike (1973) who, as the Chairman of the study's

international committee, was mainly responsible for the development of the instruments and the analyses undertaken once the data had been collected.

The International Association for the Evaluation of Educational Achievement (IEA) is an international organization of research workers in the field of education who, since the late 1950s, have undertaken a number of empirically oriented surveys which have aimed at identifying factors that influence school achievement. The emphasis in studies conducted by IEA is on cross-national comparisons to analyse potential differences, similarities or unique features of the participating educational systems. Thus, it is possible to compare different educational provision and methods on a large scale in an attempt to draw conclusions concerning the impact that the examined factors have on student achievement in schools.

Table 1 lists the educational systems which took part in the Reading Comprehension Study and the number of students involved in the respective samples. It should be noted that a distinction is made between Belgium Flemish and Belgium French as two separate educational systems although, politically, Belgium is considered to be one country. Thus, the data collected in the survey includes evidence for 14 countries but 15 educational systems.

One of the three target populations for the study were 14-year-old students since the majority of this age group was found in the last grade of compulsory schooling in many of the participating countries. Hence, the age group was of particular interest regarding the level of reading ability of students who were about to enter adult life and the workforce.

All 14-year-olds who, for various reasons, were not in school as well as students who, because of severe mental disabilities, did not attend normal school programs were excluded from the target population. In some countries, language minority groups or geographically remote students were also excluded from the target

population. The primary sampling unit in the Reading Comprehension Study was randomly selected schools. Within schools, a random sample of students in the defined target population was tested.

Apart from paper-and-pencil reading achievement tests, background questionnaires were administered to students, teachers and schools. Furthermore, a national case study questionnaire, gathering information on certain characteristics of the educational systems involved in the survey, was completed by every participating country.

The achievement measures included a reading speed test, a word knowledge test and a reading comprehension test. The reading speed test was composed of 40 short paragraphs which had to be read and understood in order to answer correctly the related

questions, with a time limit of four minutes. Forty word pairs, which had to be judged by the student as being synonyms or antonyms within 10 minutes, formed the word knowledge test. The reading comprehension measure consisted of two tests containing eight passages and 52 multiple-choice items.

The data were analyzed using block-wise regression which was considered the most appropriate method of analysis at the time of the IEA-Reading Comprehension Study to determine factors predicting students' reading comprehension test scores. Four blocks of variables were formed, namely, home and student background variables, school and placement variables, school treatment variables and personal attribute variables. The analyses, which were undertaken for each country separately, showed that in the majority of countries the variables measuring the students' home background such as occupational and educational level of the parents and the availability of books accounted for more variance than the other variables.

Nevertheless, in five countries, the school placement variables, that is the type of program in which students were enrolled, were found to be stronger predictors of reading achievement.

Two major limitations were encountered in the data analysis undertaken by Thorndike and his co-workers. First, the block-wise regression analysis procedures available in 1971-72 did not permit the construction of latent variables or constructs for data reduction purposes. Secondly, it was not possible to examine the interrelationships between the predictor variables with this procedure.

Today, however, due to the enhanced power of microcomputers and the development of appropriate computer programs, other analytical tools are available that allow a more sophisticated examination of the data.

## The Model

Analyses involving several variables and the interrelationships between them have their origin in the technique of path analysis which is aimed at surpassing correlation as mere association and is directed towards the examination of causal relationships between variables. Originally developed in the biological sciences (Wright, 1934) path analysis was later adapted to the social sciences by Duncan (1966). In view of the complexity of reality, path analysis procedures necessarily include many variables thus permitting the examination of multivariate structural relationships. These relationships and their underlying assumptions, then, are systematically structured and presented in what is usually referred to as a "path model". It should be noted, however, that any model is only as good as the theoretical considerations on which it is based, regardless of the statistical technique which, at a later stage, is employed

to analyze the model. Furthermore, while aiming at explaining as much of the phenomenon under examination as possible, the

researcher, in order to make a useful contribution, should attempt to: (1) keep the model as simple as possible; and (2) develop a general model. These objectives have to be kept in mind to design a model which is not only comprehensible but which, in addition, is relatively stable thus providing further understanding of how the actual world works.

Figure 1 Model of individual student factors influencing reading achievement at the 14-year-old level

In order to arrive at the latter goal it seems useful to examine a particular model using different sets of data which allow a replication and comparison of results. A researcher who is able to construct a model in which the effects between variables are relatively stable across different data sets might have a valid argument for greater generality or robustness of the model. One method of providing such evidence is the use of studies such as the IEA Reading Comprehension Study which have been conducted cross-nationally, because of the greater variability obtained from data sets drawn from across different countries. Results may then be compared across countries by a close examination of the patterns in which variables interact.

Figure 1 presents a model of factors influencing student achievement in reading comprehension at the 14-year-old level. The model was developed based on:

- the general assumptions underlying model building in educational research,
- previous research findings, and
- screening of all individual student variables to select those variables that: (a) were markedly related to reading achievement; and (b) maintained strength in all 15 educational systems (see Lietz, 1992).

In accordance with conventions regarding the graphical representation of path models, manifest or observed variables on which information is actually gathered are shown in small rectangular boxes while in the rounded corner rectangles, latent variables or constructs which are derived from the manifest variables are given. Arrows pointing from manifest to latent variables (e.g. Expected Education and Occupation to Expectations) show that the manifest variables are considered to form the latent variable. Where arrows point from the latent

variable to the observed variable, the construct is argued to be reflected by the observed variable (e.g. Reading Achievement to Reading Subtests C and D). Furthermore, as indicated by the arrows between constructs, all variables, except for the antecedents on the far left may be influenced by any of the preceding variables in the model either directly or indirectly, through other constructs.

Figure 1 depicts a fully-recursive path model in which all possible paths between constructs have been specified. It is an advantage of the highly flexible nature of PLSPATH that it allows modifications to be readily made according to the interim results produced. Hence, in the final model for each educational system presented below, only those paths were retained which contributed substantially to explaining a dependent latent variable. In view of the sample design and the sample size of the data sets available, only path coefficients  $\geq 1.10$  were considered to contribute substantially to the explanation of other variables in the model and were therefore retained in the analyses reported in this paper. For more detailed discussions on general cut-off criteria and procedures for these types of analyses see Harman

(1976), Pedhazur (1982) Keeves (1991).

#### The Method

For the current analyses it was necessary to select a multivariate technique which satisfied certain requirements. This technique should be capable of:

- handling many variables and composite scales simultaneously;
- providing an appropriate form of information reduction;
- being used flexibly;
- providing estimates of direct and mediated effects; and
- being computationally and technically manageable with large data sets.

After consideration of both the above requirements as well as earlier experiences in analyzing large-scale assessment data from various countries (Anderson et al., 1989; Cheung et al., 1990; Keeves, 1992; Postlethwaite and Wiley, 1991), Partial Least Squares Path Analysis (PLSPATH) was chosen as the most suitable multivariate technique for the present analyses.

#### Partial Least Squares Path Analysis (PLSPATH)

At the present time, Partial Least Squares Path Analysis (PLSPATH) (Wold, 1982) is one of the more commonly used programs which allows the combination of similar variables into constructs or latent variables, thus reducing the many observed variables to a manageable number.

PLSPATH is based on the use of ordinary least squares estimation procedures and is conceptually related to principal component analysis, canonical correlation analysis, and regression analysis. The word 'partial' refers to the fact that, initially, PLS PATH calculates an estimate for each latent variable, which is derived from the corresponding manifest variables, thus partitioning the hypothesized inner model into its component constructs. Once the program has assigned these estimated values for each latent variable, the paths between these constructs are computed by calculating least squares estimates between the latent variables in the model. The analysis proceeds iteratively until all estimates are found to hold stable values.

Observed variables entered into PLS PATH are not necessarily assumed to be normally distributed, and categorical or even dichotomous variables such as sex of student can be entered into the model without distorting its interpretability. While this characteristic of PLS PATH is advantageous for the present study, one of its restrictions is that data may only be analyzed at one level at a time. In other words, analyses may only be undertaken at either the student, or the teacher, or the school level. As pointed out earlier, data collected in the IEA Reading Comprehension Study, included not only information on variables gathered at the student level but also on questions answered by teachers and school principals. Although models of reading

Table 2 Direct effects of gender on other constructs in the model of individual student factors influencing reading achievement at the 14-year-old level

Direct Effects

	.17	.15	.11	...	.20	.19	...	...	.14	...	...	...
.10												
	...	.22	...	...	...	...	...	...	...	-.16	...	...
...												
	...	...	...	...	...	...	...	...	-.10	-.12	...	...
-.13												
	...	...	-.13	-.10	-.22	-.10	-.16	-.19	-.19	...	-.10	-.19
...												

... the effect was discarded with  $b < |.10|$  (see Lietz (1992) pp. 44-46, 76)

achievement might be developed from theory incorporating variables from different levels, substantial problems arise from

the inclusion of data that are obtained at different levels into one model, when the analysis is carried out at only one level. These problems arise from the two methods commonly employed when data are combined from two or more levels into a single-level analysis are: (1) the aggregation of data collected at the lower level (e.g. student) to the higher level (e.g. the school), or (2) the disaggregation of higher level data to the lower level, for example by assigning school-level data to each individual student (e.g. books available in a school library). Both techniques, aggregation and disaggregation, quite typically introduce bias, meaning an over- or under-estimation of the estimates of effects associated with variables which were aggregated or disaggregated. In addition, inappropriate variance estimates may be obtained to test the estimates of such parameters for statistical significance (Keeves and Sellin, 1990). Since it is beyond the scope of this article to discuss the issues of aggregation and disaggregation bias in more detail, the reader is referred to Cheung et al. (1990), Cheung and Tsoi (1990), Sellin (1990).

By using data obtained at the student level only and by not including information which had been gathered at the school, classroom or teacher level, some of the conceptual problems associated with units and levels of analysis were avoided. The problems of developing appropriate procedures to investigate complex multilevel data sets through the use of latent variable path analysis remained unsolved and no straightforward indication of the significance of the solution could be given, because it was not possible to estimate accurately the variance components. However, the amount of explained variance of the outcome measure, reading achievement may be used as an indication of the appropriateness of a model for a particular country and a means to compare models across countries.

The model presented in Figure 1 was examined for each of the 15 educational systems separately using the computer program PLSPATH version 3.01 (Sellin, 1989) to estimate the relationships between the variables. The results of the analyses undertaken are discussed in the following section.

## The Results

The most striking result of the analyses was the fact that Gender had no direct effect on Reading Achievement. In other words, being a boy or a girl did not directly contribute to any substantial differences in the level of reading achievement. However, Gender had

Figure 2 Model for Belgium Flemish Figure 3 Model for Belgium

## French

Figure 4 Model for Chile Figure 5 Model for England

Figure 6 Model for Finland Figure 7 Model for Hungary

Figure 8 Model for Iran Figure 9 Model for Israel

Figure 10 Model for Italy Figure 11 Model for The Netherlands

Figure 12 Model for Scotland Figure 13 Model for Sweden

Figure 14 Model for the United States of America

an impact on other variables in the model. Indeed, certain patterns of the way in which Gender operated to influence other variables in the model emerged across the educational systems for which data were analyzed.

Table 2 summarizes the direct effects of Gender on other constructs in the model which were estimated from the analyses for those educational systems from which data were available. India and New Zealand do not appear in the table since Gender had no direct or total effect on any of the variables in the model in those countries. Due to the fact that being a boy was coded 1 and being a girl was coded 2, negative path coefficients indicate that an effect is dominated by boys while positive coefficients indicate a dominance of girls.

Gender directly influenced Motivation, Educational Competence, Expectations and Reading Interest. Boys demonstrated a higher level of Reading Interest as well as higher expectations with respect to future education and occupation. Girls, on the other hand displayed a greater degree of motivation by spending more time per week on homework than boys and generally having a more

positive disposition towards school work. For those two educational systems in which Gender had a direct impact on Educational Competence, no such general statement could be made. While in Belgium French girls showed higher Educational Competence, relatively more boys than girls were involved in academically-oriented programs in the Netherlands.

In order to examine the way in which Gender operated to influence Reading Achievement, Figures 2 - 14 present in addition to the direct effects Gender had on other constructs in the model the effects those constructs had on subsequent variables in the model. One figure is shown for each educational system in which Gender had a direct effect on any of the other latent variables in the model. Particular attention should be given to those paths which directly link a construct influenced by Gender to the outcome measure, Reading Achievement. For greater clarity, the graphical representation of the results in Figures 2 - 14, do not include the complete final model of factors influencing reading achievement at the 14-year-old level but only those paths and path coefficients to which Gender contributed in a particular country.

The graphical representations of paths and direct effects in Figures 2-14 allow the identification of three main patterns across the 13 educational systems of the way in which gender operates to influence reading achievement.

#### 1. Gender ' Motivation ' Reading Achievement

In Belgium French and Hungary, Gender had a direct effect on Motivation which, in turn, contributed directly to the explanation of differences in Reading Achievement. This finding suggested that, to arrive at the same level of achievement in reading, girls were generally doing a greater weekly amount of homework.

#### 2. Gender ' Educational Competence ' Reading Achievement

Gender operated through Educational Competence to influence Reading Achievement in Belgium French as well as The Netherlands. In this context, the size of the path coefficient from Educational Competence to Reading Achievement in the Dutch model was surprisingly high. This suggests that boys in The Netherlands showed higher educational competence which, in turn, had a relatively large positive effect on Reading Achievement emphasizing the highly discriminating nature between vocationally and academically-oriented students of the Dutch educational system.

#### 3. Gender ' Reading Interest ' Reading Achievement

In England, Iran, Israel, Scotland and Sweden, Gender directly influenced only one other latent variables, namely, Reading



	Reading for Pleasure	.64	.70	.55	.66	.44	.76	.51
.55		.38	.70	.69	.48	.85		
	Newspaper Reading	.57	.41	.73	.63	.87	.56	.78
.82		.33	.60	.74	.43			
	Magazine Reading	.82	.81	.88	.85	.56	.78	.73
.71							.74	.73
							.88	.86
								.75
	Score on Subtest C	.88	.90	.93	.93	.93	.91	.85
.91		.91	.94	.92	.94			
	Score on Subtest D	.90	.90	.93	.94	.92	.91	.82
.91		.92	.94	.93	.94			

Notes:

\* Only those latent variables are listed on which Gender had a direct or indirect effect.

d deleted prior to or during exploratory analysis (see Lietz, 1992)

The factor loadings for the manifest variables forming Reading Interest in Table 3 show that it was either Newspaper Reading or Magazine Reading which most strongly determined the construct. In no country was the variable measuring hours spent on Reading for Pleasure the dominant manifest variable.

Magazine Reading as well as Newspaper Reading were composite scales derived from items measuring the type or section of newspapers or magazines read. As part of the preliminary analyses of the Reading Comprehension Study, Thorndike (1973) formed weighted combinations of those items which best predicted the reading comprehension score.

The sections of newspapers which were involved in the construction of Newspaper Reading consisted of news, home, science and comics with the last named having the highest weighting. Magazine Reading involved a combination of adventure, history, science fiction, current events, myths and humour which contributed most to the scale.

Thus, there is empirical evidence to support the hypothesis that Reading Interest has a positive impact on boys' reading achievement when it involves the reading of certain sections of newspaper and particular types of magazines. A practical implication of this finding might be to ensure that school or classroom libraries not only provide different kinds of books but also a variety of magazines and newspapers to foster the reading interest of boys. Moreover, teachers may promote and encourage not only the reading of books for entertainment but also the reading of magazines or newspapers for particular purposes. In summary, it might be argued that, although Gender had no direct effect on performance in reading, being a boy or a girl influenced the way in which students arrived at their respective levels of reading achievement.

## Conclusion

No direct or total effect from Gender to Reading Achievement could be identified for any of the 15 educational systems. This result supported research findings which had shown no differences between boys and girls in reading achievement (Gross, 1978, 1978[2]; Belloni and Jongsma, 1978; Klein, 1979; Hogrebe et al., 1985).

However, results of the analyses showed that Gender differences

appeared to exist with respect to the way in which boys and girls attained their level of reading achievement. Moreover, patterns of how this variable influenced subsequent constructs in the model emerged from a comparison of results across different educational systems.

Effects of Gender were mainly mediated through three other latent variables in the model, namely Motivation, Educational Competence and Reading Interest to influence Reading Achievement. While girls generally demonstrated a higher level of motivation, boys showed a greater interest in reading. Closer scrutiny of those instances where boys displayed a greater interest in reading than girls revealed that the reading interest was not characterized by the volume of reading but rather the type of material read, namely newspapers and magazines.

In summary, the analyses suggested that in order to study gender effects on performance in reading in a more meaningful way it is necessary to go beyond the examination of simple relationship between sex of student and achievement and to explore other variables through which gender may have an effect on reading achievement.

In this way, patterns might emerge and to identify variables which operate differently for boys and girls. This, in turn, may then be taken into consideration when planning to provide the best possible opportunities at the secondary school level for the teaching and learning of reading which is one of the most important skills for life.

## References

- Anderson, L. W., Ryan, D. W., and Shapiro, B. J. (eds.) 1989 The classroom environment study. International studies in educational achievement. Pergamon Press, Oxford.
- Bleakley, M., Westerberg, V. and Hopkins, K. 1988 The effect of character sex on story interest and comprehension in children. American Educational Research Journal, 25 1, 145-55.
- Brown, B.W. 1991 How gender and socioeconomic status affect reading and mathematics achievement. Economics of Education

Review, 10 (4), p. 343-357.

Cheung, K. C. and Tsoi, S. C. 1990 Model specification and related issues. In K. C. Cheung et al. The analysis of multivariate data in educational research: Studies of problems and their solutions. International Journal of Educational Research, 14 (3), Pergamon Press, Oxford. 245-256.

Cheung, K. C., Keeves, J. P., Sellin, N. and Tsoi, S. C. 1990 The analysis of multilevel data in educational research: Studies of problems and their solutions. International Journal of Educational Research, 14, (3), Pergamon Press, Oxford.

Duncan, O.D. 1966 Path analysis: Sociological examples. American Journal of Sociology, 72, 1-16.

Gross, A. D. 1978 Sex-role standards and reading achievement: A study of an Israeli kibbutz system. The Reading Teacher, 32, 149-156.

Harman, H. H. 1976 Modern factor analysis. University of Chicago Press, Chicago, IL.

Hogrebe, M. C., Nist, S. L. and Newman, I. 1985 Are there gender differences in reading achievement? An investigation using the High School and Beyond data. Journal of Educational Psychology, 77, 716-724.

Keeves, J. P. (ed.) 1992 The IEA study of science III. Changes in science education and achievement, 1970-1984. Pergamon Press, Oxford.

Keeves, J. P. and Sellin, N. 1990 Some problems of analysis. In K. C. Cheung et al. The analysis of multilevel data in educational research: Studies of problems and their solutions. International Journal of Educational Research, 14, 215-319.

Knickerbocker, J. L. 1989 Sex differences in reading achievement: A review of recent research. Ohio Reading Teacher, 24 (2), 33-42.

Lietz, P. 1992 Factors influencing reading achievement at the 14-year-old level in 15 educational systems. Unpublished Masters thesis. The Flinders University of South Australia, Adelaide.

McGaw, B., Long, M. G., Morgan, G. and Rosier, M. 1989 Literacy and numeracy in Victorian schools: 1988. ACER Research Monograph No. 34. Australian Council for Educational Research, Hawthorne, Vic.

Pedhazur, E. J. 1982 Multiple regression in behavioral research: Explanation and prediction. Holt, Rinehart, and Winston, New York.

Postlethwaite, T. N. and Wiley, D. E. 1991 The IEA Study of Science II. Science achievement in twenty-three countries. Pergamon Press, Oxford.

Purves, A. C. 1973 Literature education in ten countries. International studies in education II. Almqvist and Wiksell, Stockholm.

Sanguinetti, J. A. 1983 Academic achievement, school quality and family background: Study in seven Latin American countries. ERIC

document no.: ED233448.

Sellin, N. 1989 PLSPATH version 3. 01. Application manual.  
Hamburg, Germany.

Sellin, N. 1990 On aggregation bias. In Cheung, K. C. et al. The  
analysis of multivariate data in educational research: Studies of  
problems and their solutions. International Journal of  
Educational Research, 14 (3). Pergamon Press, Oxford, 257-268.

Shangi, L. M. 1983 Racial stratification, sex, and mental  
ability. A comparison of five groups in Trinidad. Journal of  
Black Studies, 14, 69-82.

Spearritt, D. 1977 Measuring reading comprehension in the upper  
primary school. Australian Government Publishing Service,  
Canberra.

Swan, D. 1978 Reading standards in Irish schools: A national  
survey of reading standards and related aspects of first year  
pupils in post-primary schools in the Republic of Ireland, 1971-  
72. ERIC document no.: ED258149.

Thorndike, R. L. 1973 Reading comprehension education in fifteen  
countries. International studies in evaluation III. Almqvist and  
Wiksell, Stockholm.

Wilson, J. A. 1975 Over- and underachievement in reading and  
mathematics. The Irish Journal of Education, 9, 69-76.

Wold, H. 1982 Soft modeling: The basic design and some  
extensions. In K. G. Jöreskog and H. Wold (eds. Systems under  
indirect observation. Part III. North Holland Press, Amsterdam.

Wright, S. 1934 The method of path coefficients. Annals of  
Mathematical Statistics, V, 161-215.