Nordic comparisons in PIRLS 2006

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Abstract

PIRLS 2006 data of Iceland, Sweden, Denmark and Norway were analyzed to examine which general and country-specific factors influence reading comprehension performance in these Nordic countries. The full data set contains 13082 cases. In a first step, multilevel models were constructed for each country on the basis of half of the students randomly selected, with homes/students nested within schools/teachers. In the second step of the analysis, the Norwegian model was cross-validated using the other halves of the four subsamples in one multilevel model. It was assessed which variables and constructed scales the four countries had in common and where differences existed between the countries with respect to reading comprehension performance. The dependent variables consisted of the means of the five 'plausible values' for the total score, for information and literary texts, and for straightforward and inference questions. However, the standard deviation of the plausible values was included in all models as a covariate to increase the accuracy of the estimates. The main findings include that girls do better than boys, but only on inference questions. Older students score higher than younger students. With respect to language minority groups we found that if the father is born in the country, students do better, especially in Iceland. If the student speaks the language of the test prior to school entry, he scores higher on straightforward questions. At the student level, a positive attitude towards reading was positively related to both text types and both question types, the latter two even more so in Iceland. If no negative things happened at school, the performance on the total score was higher, especially in Sweden. The use of the internet has a negative correlation with reading comprehension, except in Iceland, where more use of the internet is beneficial for performance on information texts and on straightforward questions. At the home level the number of children's books at home estimated by the parents made a difference, as did the assessment by the students of the number of books at home. The higher the level of education of the father and the mother, the better the students perform. Finally at the home level the language activities conducted with the students before they went to school and the reading level of the students prior to school entry assessed by the parents were positively related to the total reading score. Rather surprisingly, no effects of teacher and school variables were found at all.

Keywords: *secondary analysis, multilevel modeling, reading comprehension, Nordic*

countries

Introduction

The purpose of the study was to look for general and country-specific factors that influence reading comprehension performance in order to find ways of improving reading comprehension where it is of moderate or low quality. Country-specific factors will inform us about the significance of cultural and educational system differences that may set limitations to the way in which reading performance may be improved. In particular, we will look at the situation in Norway, where recently a new curriculum for reading has been introduced.

Methodology

The data were analyzed according to the following plan. First, we looked at whether the items had discriminative power and whether we could reduce the data by combining items to form a scale (so-called constructed scales). For both issues, we used the strategy of splitting the data file at random into two parts, so that the results of identifying discriminative items and constructing scales in one part of the data could be cross-validated against the results in the other part. Because our main goal is to compare Norway with the other Nordic countries, we did not repeat the scale analyses for the other countries, but assumed that the scales would have similar properties. An overview of the scales and variables we report on below, can be found in the Appendix.

Second, we multiply imputed missing data, using the SPSS 15 missing values procedure MVA (regression imputation). However, we estimated the missing values on the basis of the whole file, in order to get optimal estimates. All analyses were repeated on the imputed data sets to detect whether imputing the missing values had an effect on the modeling process described below.

Next we ran GLM (Multivariate Analysis of Covariance) to find out which items or constructed scales contributed to variability in the total comprehension score, the score for narrative texts, and the score for expository texts. These scores were defined as the dependent variables, whereas sex, language (only for Norway: the languages are Bokmål and Nynorsk), and being an immigrant student (or not) were defined as independent variables. Age, all other items and constructed scales were considered as covariates. Significant covariates were then used as independent variables in the next and final step: multilevel analysis.

Our final step was multilevel analysis; we used MLwiN 2.0 (Rasbash, Steele, Browne, & Prosser, 2005) to assess which factors (either isolated variables or constructed scales)

determined the means of the five 'plausible values' for overall reading comprehension, comprehension of expository texts, comprehension of narrative texts, and straightforward and inference questions. The standard deviation of the plausible values was included in all models as a covariate to increase the accuracy of the estimates for the mean of the plausible values. Within the multilevel analyses, we first assessed the influence of main factors. We assessed interactions only for factors in which we had a theoretical interest (age, sex, immigrant student, SES, and whether or not the students were in a combination class), or for factors that we assumed to be main factors, but for some reason did not have an influence on their own. In short, all relevant variables were entered first, and then the model was reduced by taking out variables that did not significantly contribute to explaining variance in the dependent variables. The student variables were entered first, then the home variables, then the teacher variables, and finally the school variables.

We expected that age would be important, as children within one class can vary widely with respect to age and therefore with respect to maturity, which may lead them to differentially profit from not only instruction at school, but also from stimulation at home. As previously noted, gender differences in reading performance appeared to be relatively large in Norway in PIRLS 2001, and so we were interested in determining which factors mediate these differences. Therefore, when all variables were entered, we looked at possible interactions with age and gender.

The main reason to use multilevel modeling is that the PIRLS design pertains to a home/student level, which is nested under the school/teacher level. The home and the student level need to be combined because they are dependent: there is always one student belonging to one household. In doing the same for the teacher and school combination, we ignored the fact that there were a few schools with more than one class (and teacher) taking part in PIRLS 2006. Furthermore, with multilevel modeling it is possible to more precisely examine the interaction patterns of factors at different levels.

Please note that the values we present below do not correspond with the international exhibits. This has several reasons. First, we report on the analyses conducted on only half the cases, so figures can differ slightly by chance. Second, intercepts and estimates become weighted in a multilevel analysis. However, the interpretations we give below are not any different than when we would have analysed the whole data set. Instead, they are even more reliable, because they are confirmed against the other half of the data, and, the means of the five plausible values result in very reliable estimates.

In the analysis with all four countries we ran the multilevel analysis in the same way as described above, but now we added interactions with the countries in order to see whether a variable or scale plays a more important or a less important role for that specific country.

Unfortunately, we encountered a few problems with scaling. Therefore, the scales Self-concept of reading, Time spent (on watching TV/DVD, reading books and reading on the Internet), and Reading-related activities at home are not used in the analyses we report on below.

Findings and Discussion

Results of the data reduction phase can be found in Van Daal, Begnum, Solheim and Adèr (2007).

The Norwegian Model

In a first step, multilevel models were constructed for each country on the basis of half the students randomly selected from the four subsamples, with homes/students nested within schools/teachers. The results for the Norwegian model are presented in Table 1. Positive values of the estimates mean that the variable or scale is positively related to the dependent variable. Negative values indicate a negative relationship. However, if a variable or scale has a reversed direction, the estimates have also a negative value, if there exists a positive relationship between the dependent and independent variable. If scales or variables have a reversed scale, this is indicated in the table, in brackets next to the variable or scale name.

(Take in Table 1 about here)

In Norway, girls do better than boys on literary texts and on inference questions. Older students do generally better than younger students. If the student speaks Norwegian prior to school entry (s)he does better on especially information texts and on straightforward questions. Other findings with respect to the homes include that students do generally better when their father and mothers are born in Norway, and independently, if the education levels of the father and mothers are higher. Moreover, the better the reading skills at school start and the more language activities undertaken in the home, and the more books in the home, the better the students perform on all aspects of reading comprehension. At student level we find that the more positive the attitude towards reading is, the less negative things happen at school (only for straightforward questions), and the less use of the internet student make, the better the reading comprehension performance. No teacher or school factors that influence reading comprehension could be detected.

The Norwegian model compared with Denmark, Sweden and Iceland

In Table 2 the Norwegian model is compared with the models for Denmark, Sweden and Iceland. The gender effect is confirmed, however not in Sweden for literary texts, and not in

Denmark and Sweden for inference questions. The age effect is also confirmed, however not at all for Denmark. Speaking the language of the test before school entry is confirmed across the other three countries, as are effects of father born in the country, and levels of education of the parents, but again, this does not seem to be the case for Denmark. Whether the mother is born in the country of residence is not important at all in the other three countries. The number of books in the home is relevant in all countries, though the assessment of the number of children's books by the parents is not completely in line with the students' ratings in the other three countries. Finally, there is absolute agreement on factors like the level of reading skills at school start and the language activities undertaken at home. At the student level, there is agreement on the use of the internet, though much less on the attitude towards reading and the influence of negative things happening at school.

(Take in Table 2 about here)

How Denmark, Sweden and Iceland differ from Norway

So far about the communalities between the four Nordic countries. In Table 3 it is indicated where Denmark, Sweden and Iceland may differ from Norway. We list here the variables and scales that were significant in either of these three countries, but not in Norway. The school climate (rated by the principals) seems to be of importance in Sweden. Not having a negative attitude towards reading is an important factor in all three countries, as are activities undertaken by the students after reading in class and having things at home (TV, own study, own computer, etc). For Denmark only, the various formats used by teachers to assess reading performance play a role, as is emphasizing comprehension in the earlier grades. Well-being at school is a decisive factor for Sweden only, as is the use of the computer. Not having problems at school, and to a lesser extent, teacher satisfaction do play a role uniquely in Iceland.

(Take in Table 3 about here)

A model for all Nordic countries

In another multilevel analysis, the Norwegian model was cross-validated using the other halves of the four subsamples. It was assessed which variables and constructed scales the four countries had in common and where differences existed between the countries with respect to reading comprehension performance. Differences were now defined as interaction effects, that is, whether a variable is more or less important for a specific country. The dependent variables consisted of the means of the five 'plausible values' for the total score, information and literary texts, and straightforward and inference questions. Again, the standard deviation of the plausible values was subsumed in all models to increase the accuracy of the estimates for the means of the plausible values. The results of this analysis are presented in Table 4. The

gender effect was significant for the inference questions only. The age effect was significant as well, although for some aspects for some countries more, and for other countries less. Whether the language of the test is spoken prior to school entry, is of relevance for the performance on straightforward questions. Activities undertaken after reading in class are important for understanding literary texts, and for answering both types of questions. If the father is born in the country, the students do better at all aspects, except answering straightforward questions. If the mother is born in the country, students do better at inference questions. The number of books at home (both according to the ratings by students and by their parents) is of importance. Also at the home level, language activities and the reading skill before school start make a difference. At the student level, having a positive attitude towards reading is beneficial for reading comprehension. To a lesser extent, negative things happening at school and the use of the internet matter less. As for interactions with countries, we see that, in contrast to the other countries, in Iceland more computer use goes with better reading comprehension performance (only information texts and straightforward questions). In the other countries less use of computers is better for reading comprehension. Finally, the only other consistent pattern of interactions concern Iceland, where language activities before school start matter less than in the other countries.

(Take in Table 4 about here)

Conclusion and Implications

The first issue we would like to discuss is the consistency of the results. If we compare the Norwegian model (Table 1) with the model for all four Nordic countries (Table 4) we find the following factors that are significant in both models. Gender, age, language of test spoken before school start, mother and father born in the country, positive attitude towards reading, negative things happened at school, number of books and children's books at home, levels of education of the mother and father, language activities before school start, and reading skill before school start. Effects of gender, age, negative things happened at school, number of books and children's books at home, language activities before school start, and reading skill before school start were also found in an earlier analysis of the Norwegian data (Van Daal, Solheim, Nøttaasen, and Begnum, 2007), in which the factors concerning the immigrant children (speaking the language of the test before going to school, father and mother born in the country) were not included. Thus we can say that the reading comprehension is a skill that is built upon early language development, because the factors that we found to be of influence have mainly to do with the situation at home before the children start school.

This is in line with the well-established fact that language development starts long before children go to school. Newborns are initially able to discriminate between all sounds of the

world's languages. However, in time, a gradual refinement of recognizing the sounds of the language in which the child grows up takes place, while discrimination of the sounds of other languages completely disappears (Jusczyk, 1997; Vihman, 1996). From studies with children at risk of dyslexia, we know that their phonological representations are less stable (Elbro, 1996) and that they therefore have trouble acquiring a properly functioning vocabulary (Scarborough, 1990). Hart and Risley (1995) reported pronounced differences in vocabulary among three-year-old children. These differences were completely dependent on the number of words used in the children's home environments. Moreover, as Scarborough and Dobrich (1994) found, about 10% of reading ability can be explained by reading aloud to children.

A rather surprising finding is that the use of the internet was negatively related to reading comprehension, albeit only to information texts and straightforward questions. In contrast, there existed a positive relation between the use of the internet (and the use of computers) in Iceland. This is certainly a topic for further investigation, because we could not confirm that children who don't use the computer and the internet that much, read more books. We are currently conducting a project in which we examine in more detail whether the same of other factors play a role in the reading comprehension performance of immigrant children to Norway. The influence of the number of books at home (as an aspect of 'cultural capital') and age is well established and is therefore not further discussed in this paper.

In general, the Nordic countries have much in common with respect to factors that determine reading comprehension performance: number of books at home, level of education of the father, language activities before school start, and reading skill before school start. There is slightly less communality with respect to level of education of the mother, negative things happened at school, and positive attitude towards reading. However, the gender effect (on inference questions) cannot be replicated in Denmark and Sweden, the age effect does certainly not play a role in Denmark, the language of test spoken before school start (on straightforward questions) is not of importance in Denmark and Iceland, and there is no effect of the mother being born in the country on inference questions in Sweden and Iceland. Together with the finding that reading level before school start is relatively less important in Denmark, we can hypothesize that Denmark has a school system that does not capitalize on differences that exist between children when they go to school, instead, the school system is more of an equalizer in that country.

Finally, as we took the Norwegian model as a starting point, it might be worthwhile to see what the implications are for Norway. However, it is very hard to say what should be changed at school and teacher level, because we found that these variables were not of influence at all. What we can say, though, is that children in Norway stand a better chance if there reading skill is better when they go to school. The way to improve the reading skill before school entry is to

support parents to undertake reading and language-related activities before school start. And as already said, we have a project underway to examine how we can make immigrant children to Norway better readers.

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Table 1: Estimates and standards error (in parentheses) multilevel model, Norwegian data only (empty cell = non-significant effect).

Variables and constructed scales	Total score	Information texts	Literary texts	Straightforward questions	Inference questions
Variability of plausible values	-0.593(0.145)	-0.358(0.133)		-0.249(0.111)	-3.42(0.113)
Gender (+ = girl; - = boy)			8.795(2.668)		6.840(2.462)
Age	15.282(4.265)	16.124(4.408)	10.958(4.517)	15.688(4.789)	12.319(4.169)
Language of test spoken before school start (+ = yes; - = no)	15.665(5.654)	17.918(6.014)		17.072(6.284)	
Mother born in country (+ = yes; - = no)	3.148(0.999)				8.876(4.295)
Father born in country (+ = yes; - = no)	16.928(3.730)	14.026(3.816)	18.713(3.781)	19.530(4.192)	14.962(3.955)
Number of books in the home (student rating)	5.543(1.156)	6.343(1.185)	5.394(1.223)	6.219(1.295)	4.464(1.128)
Positive attitude towards reading (- = very pos.; + = less pos.)	-27.703(2.279)	-30.203(2.356)	-24.992(2.446)	-29.153(2.539)	-26.392(2.263)
Negative things happened at school (- = yes; + = no)				20.394(5.877)	
Use of internet (- = every day; + = never)	5.788(1.813)	8.957(1.851)		8.521(2.125)	
Number of children's books in the home (parent rating)	5.232(1.360)		7.207(1.426)	5.844(1.516)	4.849(1.326)
Level of education father	3.570(0.907)	2.579(0.930)	4.121(0.953)	2.998(1.013)	4.235(0.884)
Level of education mother		4.501(1.029)	2.808(1.052)	3.528(1.112)	3.461(0.973)
Language activities at home before school start (- = often; + = never)	-19.892(4.495)	-16.685(4.631)	-24.039(4.741)	-21.169(5.014)	-17.678(4.391)
Reading skill before school start (parent rating; - = very well; + = not at all)	-12.090(1.612)	-14.121(1.662)	-9.552(1.696)	-12.168(1.780)	-12.690(1.567)

Table 2: Multilevel models, Norwegian model (N) compared with Denmark (D), Sweden (S), and Iceland (I) models (v= significant effect).

Variables and constructed scales	Total score				Information texts				Literary texts				Straightforward questions				Inference questions			
Country	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I
Variability of plausible values	v	v	v		v			v					v	v	v		v			v
Gender (+ = girl; - = boy)				v					v	v		v				v	v			v
Age	v			v	v		v	v	v			v	v		v	v	v		v	v
Language of test spoken before school start (+ = yes; - = no)	v		v		v		v				v		v		v				v	v
Mother born in country (+ = yes; - = no)	v																v	v		
Father born in country (+ = yes; - = no)	v		v	v	v		v	v	v		v	v	v			v	v		v	v
Number of books in the home (student rating)	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Positive attitude towards reading (- = very pos.; + = less pos.)	v	v		v	v		v	v	v		v		v		v		v		v	v
Negative things happened at school (- = yes; + = no)			v	v			v	v			v	v	v		v				v	
Use of internet (- = every day; + = never)	v	v	v	v	v	v	v			v	v	v	v		v	v		v	v	v
Number of children's books in the home (parent rating)	v	v		v		v		v	v	v		v	v	v		v	v			v
Level of education father	v	v	v	v	v	v		v	v	v	v	v	v	v	v	v	v	v	v	v
Level of education mother			v		v		v	v	v		v	v	v		v	v	v		v	v
Language activities at home before school start (- = often; + = never)	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Reading skill before school start (parent rating; - = very well; + = not at all)	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v

Table 3: Multilevel models, significant effects in Denmark (D), Sweden (S), and Iceland (I) models that were not significant in Norway (v= significant effect, - = non-significant effect).

Variables and constructed scales	Total score				Information texts				Literary texts				Straightforward questions				Inference questions			
Country	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I
School climate	-	v	v		-	v	v		-		v		-		v		-		v	
Negative attitude towards reading (reversed scale)	-	v	v	v	-	v	v	v	-	v	v	v	-	v	v	v	-	v	v	v
Activities after reading in class	-	v	v	v	-	v		v	-	v	v	v	-		v	v	-	v	v	
Things at home	-	v	v	v	-	v		v	-	v	v	v	-	v		v	-	v	v	v
Various formats used for assessment	-	v			-	v			-				-	v			-	v		
First emphasis on comprehension	-	v		v	-	v			-	v			-	v			-	v		
Instruction affected by shortages	-	v			-				-				-				-			
Teacher helps to develop reading strategies	-		v		-	v	v		-		v		-		v		-		v	
Reading skill at school start (principal's rating)	-				-				-	v			-	v			-			
Number of years at preschool (reversed scale)	-		v		-				-				-				-			
Use of computer	-		v		-		v		-		v		-		v		-		v	v
Well-being at school	-		v	v	-		v		-			v	-		v		-		v	
Problems at school	-			v	-			v	-			v	-			v	-			v
Teacher satisfaction	-			v	-			v	-				-			v	-			
Availability of resources for treating reading difficulties	-			v	-			v	-				-				-			
Resources used for reading instruction	-				-			v				v	-			v	-			v

Various areas of teacher training	-				-			v				v	-			v	-			

Table 4: Multilevel model estimates and standard errors (in parenthesis) for all countries: Norway (N), Denmark (D), Sweden (S), and Iceland (I), (interaction with country: - = factor less important for the country; + factor more important for the country; * = not significant as a main effect for all countries (although not significant, the effect should be factored in to assess the interaction effects)).

Variables and constructed scales	Total score				Information texts				Literary texts				Straightforward questions				Inference questions			
Country	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I	N	D	S	I
Variability of plausible values	0.145(0.072)				Not significant				Not significant				0.245(0.059)				Not significant			
Gender (+ = girl; - = boy)	Not significant				Not significant*				Not significant				Not significant				4.492(1.219)			
							-													
Age	12.271(2.455)				Not significant				6.037(1.997)				12.966(2.665)				7.320(2.706)			
		-					+	+						-				-		+
Language of test spoken before school start (+ = yes; - = no)	Not significant				Not significant				Not significant				16.267(3.356)				Not significant			
					+				+	+	+	+								
Activities after reading in class	Not significant				Not significant				7.902(1.016)				6.576(1.135)				6.456(1.090)			
																		-		
Mother born in country (+ = yes; - = no)	Not significant				Not significant				Not significant				Not significant				10.484(2.207)			
Father born in country (+ = yes; - = no)	9.395(1.966)				6.396(2.168)				9.345(1.898)				Not significant				6.934(1.956)			
								+												
Number of books in the home (student rating)	5.998(0.647)				6.085(0.679)				5.267(0.642)				5.464(0.701)				5.027(0.604)			

Positive attitude towards reading (- = very pos.; + = less pos.)	-24.007(1.203)				-24.311(1.259)				-22.866(1.200)				-21.690(1.396)				-22.696(1.186)			
																-				-
Negative things happened at school (- = yes; + = no)	10.850(3.172)				Not significant				Not significant				13.171(3.387)				Not significant			
			+												+					
Use of internet (- = every day; + = never)	5.733(0.991)				8.198(1.169)				Not significant				9.947(1.258)				Not significant			
								-								-				
Things at home (- = yes; + = no)	Not significant				Not significant				Not significant				-45.727(6.803)				Not significant			
															+	+				
Number of children's books in the home (parent rating)	3.266(0.804)				4.327(0.763)				3.113(0.807)				4.128(0.866)				2.332(0.761)			
	+								+				+				+			
Level of education father	2.116(0.437)				2.353(0.461)				2.433(0.437)				2.291(0.472)				2.485(0.409)			
Level of education mother	3.998(0.467)				3.699(0.490)				3.438(0.464)				4.068(0.504)				3.514(0.436)			
																	-			
Language activities at home before school start	-11.066(2.558)				-9.901(2.653)				-9.693(2.488)				-13.279(2.484)				-10.441(2.359)			
				-				-				-								-
Reading skill before school start	-13.309(1.174)				-22.225(1.143)				-13.064(0.995)				-13.841(1.247)				-15.012(0.939)			
		-			+					+				-		-		-		

Appendix: Variables and scales extracted from the questionnaires

Variables and constructed scales	Constructed scale	Questionnaire	Item
Gender (+ = girl; - = boy)		Student	1
Age		Student	2
Language of test spoken before school start (+ = yes; - = no)		Student	18
Mother born in country (+ = yes; - = no)		Student	23
Father born in country (+ = yes; - = no)		Student	24
Number of books in the home (student rating)		Student	20
Positive attitude towards reading (- = very pos.; + = less pos.) ' I like talking about books with other people'	v	Student	14
Negative things happened at school (- = yes; + = no) 'Something was stolen from me'	v	Student	17
Use of internet (- = every day; + = never) 'Look up information for school'	v	Student	12
Number of children's books in the home		Home	16
Level of education father		Home	18
Level of education mother		Home	18
Language activities at home before school start (- = often; + = never)	v	Home	2
Reading skill before school start (parent rating; - = very well; + = not at all)	v	Home	7
School climate (teachers' job satisfaction, teachers' expectations, etc)	v	School	22
Negative attitude towards reading (reversed scale) 'I read only if I have to'	v	Student	14
Activities after reading in class 'I answer questions in a workbook'	v	Student	7
Things at home (computer, study desk, books of your own)	v	Student	21
Various formats used for assessment (multiple choice questions, listening to students read aloud, etc)	v	Teacher	26
First emphasis on comprehension (in year 4 – earlier)	v	School	13
Instruction affected by shortages (lack of qualified staff, of supplies, of school buildings and grounds, etc)	v	School	18
Teacher helps to develop reading strategies	v	Teacher	17
Reading skill at school start (principal's rating)	v	School	9
Number of years at preschool (reversed scale)	v	Home	5
Use of computer (how often at home, at school, etc)	v	Student	11

Well-being at school 'I like being in school'	v	Student	16
Problems at school (student tardiness, cheating, etc.)	v	School	23
Teacher satisfaction	v	Teacher	41
Availability of resources for treating reading difficulties	v	Teacher	23
Resources used for reading instruction	v	Teacher	12
Various areas of teacher training	v	Teacher	35