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Learning strategies and reading performance: PISA 2009 results for Poland

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Reading is often central to educational research since its mastery is usually considered a prerequisite and vital to wider study. Reading gaps, however, are frequently reported, not only between countries, but also nationally (e.g., between boys and girls or students with different socio-economic backgrounds). This paper focuses on effective learning strategies that can help narrow those gaps. For new insight into the effectiveness of various reading strategies, the PISA 2009 data for Poland were analysed. The intention was to study association between different strategies and reading performance and its relation to gender, socio-economic background and reading achievement level. Using linear regression and quantile regression models, some strategies (e.g., summarising) were identified as more effective and others were even counter-productive (e.g. memorisation). The observed effects varied between performance levels and according to gender, especially for strategies negatively associated with performance. This evidence suggests that although some strategies may be of equal benefit to all learners, others are potentially harmful to certain groups of students.

Keywords: education, cognitive psychology, metacognitive strategies, PISA data, reading.

Reading skills are key to learning and indispensable as the "first step" to acquiring knowledge (Alvermann and Earle, 2003; Scharlach, 2008; Spoerer, Brunstein and Kieschke, 2009), thus reading development is often central to educational research. One of the most intensively studied aspects of reading in the last few decades has concerned learning strategies and methods (Dunlosky, Rawson, Marsh, Nathan and Willingham, 2013; Karpicke and Grimaldi, 2012). Today, even young learners are expected to comprehend complex texts and answer complicated questions that call for independent interpretation and integration of numerous knowledge sources (Ortlieb, 2013). Therefore, how to enhance learners' reading skills effectively is a more important research question now than ever before.

Teaching learning strategies is often seen as a way to boost comprehension and

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to facilitate future use of information learnt (Dunlosky et al., 2013). This is especially important as research has shown that appropriate strategies are associated with greater reading enjoyment and better performance (Carretti, Caldarola, Tencati and Cornoldi, 2014; Keskin, 2013; McDaniel, Howard and Einstein, 2009; OECD, 2010; Thiede and Anderson, 2003). However, little help is available to select strategies which are preferentially more effective for defined groups. Further, the plurality of available strategies demands more empirical evidence to avoid confusion and enable informed choice (Dunlosky et al., 2013; Pressley, Goodchild, Fleet, Zajchowski and Evans, 1989). Since student awareness of effective learning techniques is low (Kraayenoord, 2010; OECD, 2010), even at college level (Karpicke, Butler and Roediger, 2009), further systematic research in this area is acutely needed, particularly as effective techniques can be taught and effects are usefully retained (Cummins, 1983; Elosúa, García-Madruga, Vila, Gómez-Veiga and Gil, 2013; Kraayenoord, 2010; McDaniel et al., 2009; Thonis, 1983). There is evidence that "learning how to learn" favours lower achieving students and those from less privileged backgrounds (Barry, 2002; Cantrell, Almasi, Carter, Rintamaa and Madden, 2010; Carlisle, Cortina and Zeng, 2010), including bilingual students, for whom the language of instruction is not their first (Muniz-Swicegood, 1994). Furthermore, it is believed that teaching how to read effectively can help equalise educational opportunities. One of the major problems faced by modern education is the large and widening gender gap in reading performance. This has grave social consequences, such as the low level of male participation in tertiary education (see Table V.2.4 in OECD, 2010). The "reading gap" also separates according to socio-economic status. Lack of adequate reading skills arrests educational progress (OECD, 2010). Learning strategies can play a crucial role in closing these "reading gaps", as research shows that lower achieving students also have lower awareness about how to read and learn efficiently (Alderson, 2000; Baker and Brown, 1984; Pitts, 1983). Use of effective strategies and techniques can be a real and ready-to-apply solution for these problems, as they can be taught relatively easily by teachers prepared using the approach devised by Kamil et al. (combination of: direct instruction, modeling, own practice and independent practice; Kamil, Pearson, Moje and Afflerbach, 2011).

One important issue that somehow impedes research into learning strategies is the lack of clarity of the precise understanding of the term "strategy". Even a brief glance at the terms used to describe learning techniques reveals that the field is far from unified in terms of terminology. In this article, learning strategies are understood as general approaches to learning and reading, which foster deeper understanding and more effective learning. Prominence is given to the so-called "cognitive" and "metacognitive" strategies among those described by the literature. These are classically defined as "self-regulatory utilisation of thought processes" (James, 1890) or "control of information processing" (Gagné, Yekovich and Yekovich, 1993). Strictly, what is most commonly understood by the term, "(meta) cognitive strategy", is the use of one's own knowledge about self, task, strategies and previous experience to direct one's cognitive processes to efficiently monitor and regulate other processes in order to achieve a set goal or objective (Flavell, 1976; Flavell and Wellman, 1977). Classification of (meta)cognitive strategies is also somewhat complex and unclear (Kang, 1997; Oxford, 1990), one of the most frequent taxonomies subdivides them into surface, deep and meta (Chiu, Chow and McBride-Chang, 2007). Surface strategies are most often associated with rote learning and the memorising of

material by using crude techniques, such as rehearsal. Deep strategies are related to more refined processing of knowledge, e.g., transferring information previously learnt to new knowledge areas, whereas meta-strategies are described as processes that regulate actions (Hacker, 1998). Another popular classification separates cognitive and metacognitive strategies (Phakiti, 2006). The first contains the more basic processes of comprehension, retrieval and recall, while the metacognitive include more advanced processes for planning, monitoring and evaluation. Cognitive strategies are defined in this way as using simple mental operations to foster learning, e.g., using specific memorising techniques, whereas metacognitive strategies are more complex operations to regulate basic actions. Yet another important classification splits strategies into two broad groups according to: learning attitudes and habits and metacognitive strategies (OECD, 2010). The first includes transferring information from one area of study to another, memorisation techniques and control and evaluation of the whole study process. The second covers strategies used to understand, remember and summarise. As can be seen, classifications often overlap or even contradict, as e.g., control strategies, described by the OECD as more of a learning approach or habit, are appraised by many other taxonomies as the most typical examples of the best and most advanced metacognitive strategies (Phakiti, 2006), whereas summarising, defined according to the OECD as a proper metacognitive strategy is relegated by many others to a mere learning technique (Dunlosky et al., 2013). In order to avoid further confusion all strategies described in this article will be referred to as "metacognitive strategies" to explain self-aware use of higher cognitive processes to foster learning and reading comprehension.

This article explores the PISA 2009 datasets which provide the study data on student reading achievement, as well as scales reflecting use of the five metacognitive strategies: summarising, understanding and remembering, memorisation, elaboration and control. Summarising covers a group of techniques that lead to better text comprehension through the ability to create effective text summaries. This strategy serves to identify the most important parts of a text, expressing them in one's own words. This strategy is often thought as one of the most important and effective (Kraayenoord, 2010; Pressley and Afflerbach, 1995). The second, understanding and remembering, is ability to elicit the memory of text, e.g., through effective rehearsal techniques (discussing its content with other people v.s. rereading) and understanding, e.g., by identifying the most important parts (Dunlosky et al., 2013). Memorisation is defined as trying to enable recall of text and its details, most often by repetitive rereading. This is considered an ineffective strategy, leading to lower retrieval and to brittle and transient learning effects (Isaacs and Carroll, 1999; Mayer, 2008). Elaboration is a strategy that helps to link old and new information or enables the relation of classroom knowledge to everyday experience (OECD, 2010). It is regarded as a strategy that leads to a deeper understanding of concepts, more efficient application of knowledge in real life and easier retrieval from memory (Chiu et al., 2007). Control strategies are frequently seen as the most characteristic examples of metacognitive strategies (Kraayenoord, 2010) and defined as monitoring the reading purpose, planning and supervising literate activities, to determine whether the text has been successfully understood and to evaluate the whole process (Iwai, 2011; Phakiti, 2006).

Awareness of strategies and ability to use them is one of the important predictors for reading success, though other factors are also associated with the final outcome (Coulter,

2004; Gersten, Fuchs, Williams and Baker, 2001; Li and Chun, 2012). One of the most frequently studied is motivation (Becker, McElvany and Kortenbruck, 2010; Kraayenoord and Schneider, 1999; McKoon and Ratcliff, 1992). Less subject to investigation, but equally important, are factors related to reading habits, such as diversity of reading materials or frequency of online reading and enjoyment of reading. Recent research highlights that motivation, engagement, use of effective strategies and positive approaches towards reading are mutually reinforcing and that reciprocal influences between all these phenomena lead to improvement of reading skills (Aunola, Leskinen, Onatsu-Arvilommi and Nurmi, 2002).

The present study

In this study the links between PISA reading test results, metacognitive strategies and reading habits were examined[1]. In particular four research questions were addressed:

- What is the association between the strategies and reading performance?
- What is the association between learning habits and reading performance?
- How do these associations vary by gender and by proficiency level?
- Could at least some students' use of different metacognitive strategies be shown to be associated with their reading performance by controlling for the effects of gender and socio-economic status? (Chiu et al., 2007; Dunlosky et al., 2013).

How these effects interact and how they might vary between groups of students, however, was of particular interest. There was only one strategy expected to have a negative association, often being linked with lower achievement, and that was the use of memorisation, (Kraayenoord, 2010). The effect of learning habits and learning engagement variables (diversity, enjoyment and reading online) was also predicted to be positive (Aunola et al., 2002). Adoption of strategies was expected to reduce gender differences (girls tend to outperform boys in reading achievement; Halpern, 2000), with strategies being of disproportionate benefit to boys (see OECD, 2010). It was also anticipated that students demonstrating low levels of performance would benefit relatively more than the higher-performers from use of strategies (Barry, 2002; Carlisle et al., 2010; Ortlieb, 2013). It should be noted, however, that while there is some evidence on how associations between strategies used and reading performance vary between groups of students (see OECD, 2010), the nature of this study is exploratory. The research questions addressed should be further probed to extend understanding of how different students might benefit from available learning strategies. Even though reading performance has been extensively studied, only a few reports have investigated gender differences in the application of learning strategies (e.g., Logan and Johnston, 2009).

Method

Data

This study uses the data from the Organisation for Economic Cooperation and Development (OECD) Programme for International Student Assessment (PISA), the largest international study that is conducted every three years. PISA measures achievement of 15-year-olds across OECD and other participating countries (for main results see OECD, 2010, and for technical details see OECD, 2012).

In the following analysis, the Polish sample of 4917 students drawn from 185 schools was used from the PISA 2009 study. The benefits of using PISA data over other national datasets is that student outcomes, strategies

[1] Motivational factors were not measured in PISA 2009, so they could not be included in the following analysis.

and habits are measured in a way comparable between countries, while the study also uses state-of-the-art methodology for educational research (in particular, sampling procedures, test construction and result scaling). Thus, the data are highly reliable (OECD, 2010) and results can also be compared to other countries. Additionally, the data reflect consensus between international experts with regard to what should be measured and how, not specifically addressing current issues in the Polish educational system. Interest here is primarily centred on more general patterns of student learning, so this characteristic of the PISA dataset suited the goals of this study very well.

The PISA 2009 student assessment focused on reading. Additional student questionnaires collected detailed information on how students read, their attitudes towards reading, and how schools or teachers prepared students for reading. Detailed information on student family characteristics and school resources was also available. In this study the ESCS, which is the composite index constructed by the OECD, was used to reflect student family socio-economic background. Here dummy variables were also used to denote females and students from non-nuclear families (single or mixed parents). Previous research has shown that these indicators are strongly related to student achievement (Clark, 1988).

The most important variables in this study are related to student metacognitive strategies and to their reading habits. Reading habits are reflected by three indices that were constructed from student responses by the OECD team. These measured the diversity of reading materials (how many different materials such as newspapers, magazines and books the students read), student enjoyment of reading (did students enjoy reading or did they only read obligatory texts) and whether students read digital materials (see OECD, 2010, for detailed definitions of all these indices). All these scales were derived with the help of IRT models (partial credit model with weighted maximum likelihood estimation; OECD, 2012; Warm, 1985) and scaled to zero mean and unit standard deviation for the OECD average (average calculated over OECD countries with all countries equally weighted).

There are five indices measuring metacognitive strategies in the PISA 2009 dataset. These are: summarisation, understanding and remembering, memorisation, elaboration and control strategies. To measure student awareness of effective ways to summarise text and foster its understanding, the following methodology was used: after reading a complicated text students were asked to rank their estimation of the effectiveness of the strategies they would use to write a summary of text that they had just read. Their rankings were then compared with the expert ranking, which also ranked strategies from most to least effective. High scores indicated that student and expert rankings had a high degree of overlap, meaning that students knew which strategies they should use to enhance their text processing. An example of an effective summarisation strategy was, "I carefully check whether the most important parts in the text are represented in the summary", whereas an ineffective example was, "I try to copy out as many sentences as possible". Awareness of effective understanding and recall strategies was tested in a similar way: after reading a text, students were asked to rank strategies they would use to understand and remember the text better, from the most to least effective. Again, their rankings were compared to those prepared by the experts and similarly scored. Strategies, such as "After reading the text, I discuss its content with other people" were considered effective, whereas those, such as "I read the text aloud to another person" were classified as ineffective by the experts.

This data collection was part of the PISA 2009 assessment.

Memorisation, elaboration and control strategies were measured by a self-report questionnaire, in which students indicated how often they used a given strategy when they studied (four response categories from "almost never" to "almost always"). Examples of memorisation strategies included, "I try to memorise everything that is covered in the text" or "I read the text over and over again". Elaboration strategies were represented by questions such as, "I try to relate new information to prior knowledge acquired in other subjects", or "I figure out how the text information fits with what happens in real life". Use of control strategies was evaluated by questions such as, "I start by figuring out what exactly I need to learn" or "I check if I understand what I have read".

Enjoyment of reading, reading diversity materials and online reading were also evaluated by self-report. Students indicated how much they agreed with certain statements to assess their enjoyment of reading (e.g., "Reading is one of my favourite hobbies") or how often they read certain types of reading material (e.g., fiction, non-fiction, comics) to estimate the variety of their reading and online reading (e.g., reading fora, news, e-mails). All the above measures were scaled to zero mean and unit standard deviation across the OECD countries.

Data analysis

To address the research questions, linear regression models and quantile regression models were applied. In all cases an extensive set of control variables was used, as well as a full set of indices measuring the five strategies. Control variables included the ESCS index, female (dummy-coded), non-nuclear family (dummy-coded), and indices for reading diversity, reading enjoyment and online reading. The linear regression model is given by the equation below:

$$PV(\text{reading}) = \beta_0 + \beta_1 meta_i + \beta_2 x_i + \varepsilon_i \quad (1)$$

where: $meta_i$ is a vector representing the use of meta-strategies for each student i and x_i is a vector of control variables listed above.

This model was run for all students and separately for boys and girls. In addition, a model with interactions between all the variables and a dummy denoting females was estimated to test whether coefficients generated for boys and girls differed statistically.

The quantile regression model was estimated across the achievement spectrum. Nine models for each achievement decile were estimated for all students but also separately for boys and girls. These models followed the linear regression model given above but were estimated on conditional quantile functions for different achievement quantiles. The results are presented in tables in the text and in the Appendix, providing estimated coefficients and standard errors. Quantile regression results can be interpreted similarly to those reported for linear regression with the difference that the latter provides coefficients conditional on averages. Quantile regression coefficients are estimated for conditional quantile functions and are usually reported for different deciles to summarise association between a chosen set of predictors and the whole outcome distribution (see Koenker and Hallock, 2001).

The reported regression coefficients are unstandardised but can be related to the standardised PISA reading scale which has a mean of 500 and standard deviation of 100 score points over the OECD countries (weighting each country equally). For technical information regarding scaling, estimating regression models and quantiles with the PISA data please refer to the PISA 2009 technical report (OECD, 2012).

The PISA study uses advanced methodology to account for different sources of error. Plausible values were available from

the dataset to estimate models with achievement results that compensated for measurement errors when estimating result precision. All models were estimated, using all five plausible values for reading, averaging coefficients over the five estimates. The BRR replication method was also used to estimate sampling errors and variation over plausible values to estimate measurement error. The results were calculated using the formulas provided by the survey organisers (see OECD, 2012) and were obtained by means of the Stata statistical package using user--written routines for running linear and quantile regressions with PISA data (see Jakubowski and Pokropek, 2013).

Results

Polish students awareness, reported use of metacognitive strategies and reported learning habits were compared to the OECD averages. The awareness of Polish students about which summarisation strategies are effective was close to the OECD average, but awareness of understanding and remembering strategies was much lower. Otherwise, Polish students reported very high use of other metacognitive strategies, outscoring their peers especially in the use of memorisation strategies. Polish students also reported average enjoyment of reading, lower diversity of reading materials and a much higher online reading frequency compared with the OECD average (see Table 1 for more details). Regarding the research questions posed, these results showed a difference between boys and girls in their awareness of reading strategy effectiveness and also in the use of strategies they reported. Polish girls reported much higher use of memorisation than Polish boys and this difference was

Table 1
Mean use of metacognitive strategies and learning habits in Poland in comparison to the OECD average (M = 0; SD = 1)

Variable	Entity	Boys	Average	Girls
Summarisation	Poland	-0.20	-0.02	0.15
	OECD	-0.18	-0.01	0.17
Understanding and remembering	Poland	-0.30	-0.16	-0.02
	OECD	-0.13	0	0.13
Memorisation	Poland	0.25	0.42	0.60
	OECD	-0.09	0	0.09
Elaboration	Poland	0.25	0.24	0.23
	OECD	0.04	0	-0.04
Control	Poland	-0.11	0.08	0.26
	OECD	-0.13	0	0.14
Reading enjoyment	Poland	-0.36	0.02	0.39
	OECD	-0.31	0	0.31
Diversity of reading	Poland	-0.19	0	0.18
	OECD	-0.09	0	0.09
Online reading	Poland	0.51	0.44	0.37
	OECD	0.03	0	-0.03

Source: own calculations based on: OECD, 2010. All indices are standardized to a zero mean and unit standard deviation for all OECD countries, weighting countries equally.

greater than the OECD average. Moreover, Polish boys reported reading online much more than Polish girls – this difference also far exceeded the average gender difference for online reading in the OECD countries. The other gender differences for Polish students were of similar magnitudes as for the OECD average.

The correlations between the continuous predictors in this study, presented in Table 2, showed that reported use of memorisation and elaboration had only a very weak relationship with reading results. Other variables seemed to show a modest relationship. Another interesting observation is that summarisation and understanding and remembering strategies correlated moderately with each other, but had no relationship with memorisation, elaboration and control strategies, while the latter also had moderate to strong inter-relationships. This might have related to the measurement method, since the first two strategies were evaluated using a different approach to the remaining three (see the Data section above). This effect can be almost certainly attributed to the PISA 2009 methodology, as all the metacognitive strategies should be inter-correlated according to some reports (Phakiti, 2006; Vermunt and Vermetten, 2004). See Table 2 for more details.

The above results may be partially explicable in terms of measurement problems. The scale reliability seems acceptable or even good, but validity of the results poses more problems, as the proposed factorial structure was not validated by confirmatory factor analysis (CFA). Please consult tables A5 and A6 in the Appendix for reliability and CFA data. Thus, the following results should be regarded with caution, owing to the potential measurement issues.

Regressions were performed to show how these indicators related to reading performance, controlling for student background and gender. Table 3 shows the regression of the above indicators and control variables on plausible values for reading. Additionally, results are presented from separate regressions for boys and girls, while the final columns show results of the regression with interaction terms with gender included, in order to test for statistical difference between coefficients for boys and girls. The models are described in the methods sections above.

Table 2
Correlations between the dependent variable and continuous predictors

Variable	1	2	3	4	5	6	7	8	9
1. Reading	–								
2. Summarisation	0.46***	–							
3. Understanding	0.32***	0.41***	–						
4. Memorisation	0.07***	0.02	0.01	–					
5. Elaboration	0.08***	0.01	0.06***	0.41***	–				
6. Control	0.29***	0.19***	0.17***	0.59***	0.57***	–			
7. Diversity of reading	0.25***	0.13***	0.08***	0.22***	0.25***	0.30***	–		
8. Reading enjoyment	0.43***	0.27***	0.22***	0.17***	0.20***	0.34***	0.34***	–	
9. Online reading	0.21***	0.07***	0.05***	0.16***	0.19***	0.22***	0.25***	0.08***	–

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Regression results for all students suggested that three strategies: summarisation, understanding and control, were positively associated with performance. Two strategies, memorisation and elaboration, were negatively associated with reading performance. The other variables had the expected signs with female dummy, non-nuclear family dummy and ESCS coefficients, confirming better scores for girls, worse scores from students from non-nuclear families, and the positive effect of good socio-economic background. Regression also confirmed that students who enjoyed reading, read diverse materials and read online performed better. These results conformed with those presented in the main results from PISA 2009 study (see OECD, 2010).

Table 3

Regression with plausible values for reading as the dependent variable and meta-cognitive strategies as independent variables. Results for all students and by gender[*]

		Dependent variable: plausible values in reading			
Independent variables		All students	Boys	Girls	Difference: girls–boys
Summarisation	coef.	*22.67*	*22.04*	*22.88*	0.84
	SE	1.40	1.85	1.71	2.29
Understanding	coef.	*7.34*	*7.23*	*7.43*	0.20
	s.e.	1.24	1.94	1.45	2.38
Memorisation	coef.	*-7.69*	*-7.93*	*-8.70*	-0.77
	SE	1.79	2.89	2.12	3.60
Elaboration	coef.	*-5.94*	*-6.06*	*-5.45*	0.61
	SE	1.74	2.61	2.02	3.02
Control	coef.	*12.26*	*15.63*	*9.22*	-6.41
	SE	1.67	2.66	2.20	3.49
Female	coef.	*20.50*	–	–	–
	SE	2.36	–	–	–
ESCS	coef.	*22.30*	*25.89*	*19.28*	*-6.61*
	SE	1.59	2.05	2.08	2.56
Nonnuclear family	coef.	*-10.90*	*-13.43*	*-8.23*	5.20
	SE	3.00	4.63	3.72	5.73
Diversity of reading	coef.	*4.74*	*6.73*	0.72	*-6.00*
	SE	1.60	2.17	1.97	2.80
Reading enjoyment	coef.	*16.55*	*14.14*	*18.97*	4.82
	SE	1.40	2.70	1.43	3.00
Online reading	coef.	*5.22*	*6.55*	2.97	-3.59
	SE	1.27	1.78	1.87	2.66
Constant	coef.	*506.54*	*506.76*	*527.71*	–
	SE	2.31	2.49	2.85	–
R^2	–	0.42	0.37	0.40	0.43

[*] Statistically significant (0,05) results are in italics.

Results by gender showed no statistically significant difference between boys and girls. On average, the associations between meta-cognitive strategies and reading achievement were similar with only small but statistically non-significant differences. Coefficients of only two variables differed between boys and girls. The effect of ESCS was stronger for boys and boys who read more diverse materials performed better, while on average there was no effect from variety in girls' reading materials. This might be related to the fact that girls in general read more widely, compared with boys (see Table 1). The interaction term for control strategies was close to significance, being stronger for boys than for girls.

The quantile regression presented in Figure 1 offers some insight and illustrates the potentially misleading analysis of "average students". Quantile regression estimated results over the whole performance spectrum, allowing comparison of support for student learning at different levels of achievement by the various strategies. The results are shown again for all students and by gender. Figure 1 depicts quantile regression coefficients for different achievement levels and according to the five strategies discussed in the paper. For example, the coefficient for use of memorisation strategies was around –5 for students scoring in the lowest 10% in the PISA reading test, but for those in the top 10% it amounted to around -10. Full regression results are available in the appendix (Table A2).

The results of quantile regression analysis revealed that associations between some metacognitive strategies and outcomes were indeed inconsistent between proficiency levels. The most prominent result was a much larger negative coefficient for the elaboration strategy in the low-achieving group than in the high-achieving group. The converse was observed for memorisation, which demonstrated a less pronounced

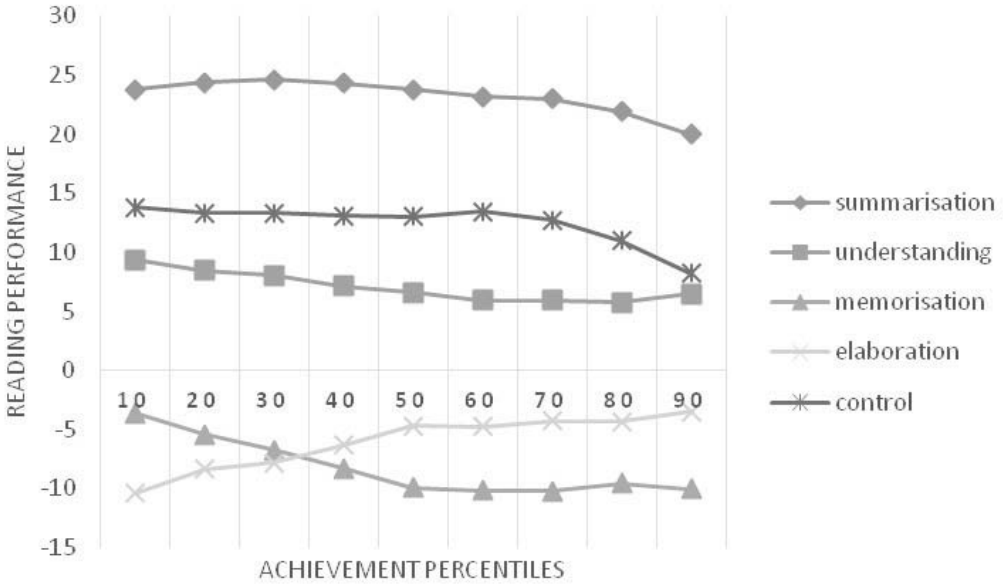

Figure 1. Results of quantile regression analysis based on all students.

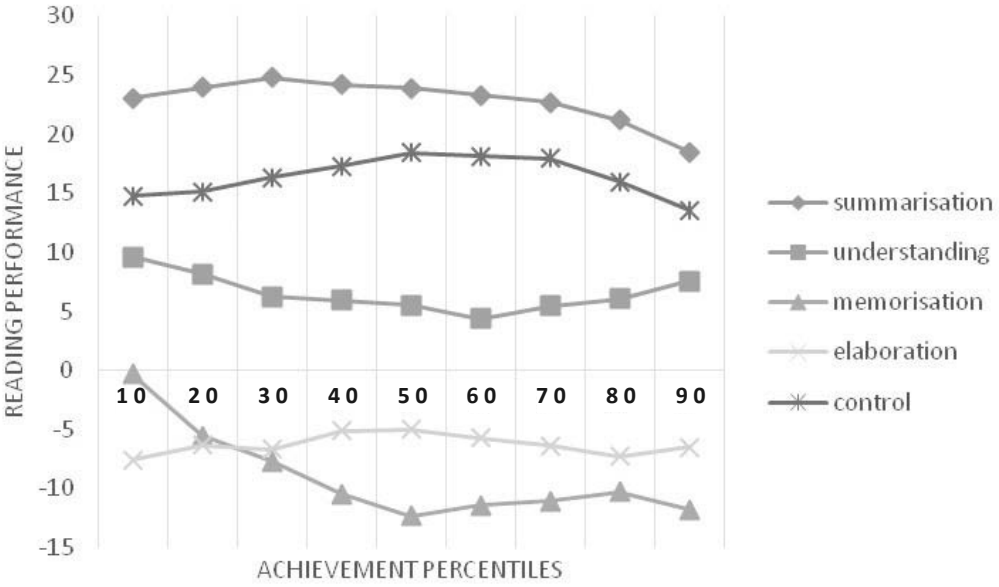

Figure 2. Quantile regression results for boys.

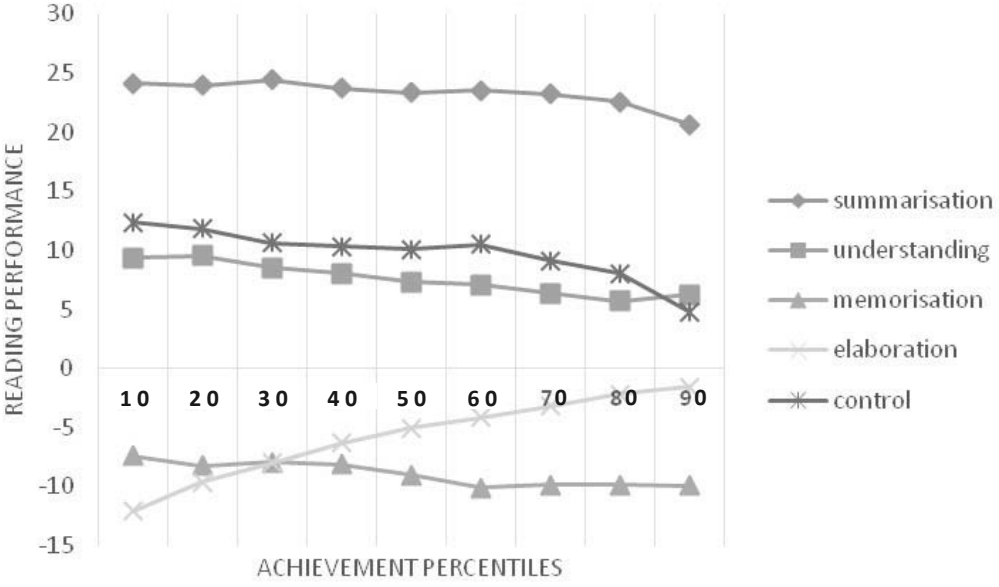

Figure 3. Quantile regression results for girls.

association for low-achieving students and much larger negative coefficients for better performing students, although the difference in coefficients between the lowest and top 20% were not statistically significant (see Table A1 in the Appendix). All other coefficient differences were not statistically significant.

Figures 2 and 3 present similar results according to gender. This analysis uncovers differential effects of elaboration and memorisation strategies between low- and high- performing boys and girls. For boys, the elaboration strategy was only slightly negatively associated with achievement across the whole performance spectrum. By contrast, elaboration was only negatively associated with performance for low achieving girls, while seemingly neutral for achievement at higher performance levels. Quite different effects were observed for memorisation – the other strategy that is known to be negatively associated with performance. In this case, lack of, or only slightly negative association with performance for low achieving boys was observed. However, for high achieving boys this was a strategy that was clearly negatively associated with achievement. For girls there was no visible pattern with negative association almost equal across the performance spectrum. For other strategies the results are less clear cut, maybe except for the control strategy for girls which was more positively associated with performance among low- compared with high-achievers. The other interesting finding was that coefficient for control strategies did not vary between low-achieving boys and girls, but sharply differed after the medium level of proficiency (around the 40th percentile). The observed curvilinear relations between reading proficiency and understanding and control for boys were not significant and could be related to the measurement issues raised above.

Discussion

The results point to positive association between metacognitive strategies and reading performance. The strongest association was related to high awareness of effective summarisation strategies. The two exceptions were use of memorisation and elaboration strategies, which both reflected lower performance levels. Counter-productive effects from using a memorisation strategy are often found in the literature (Callender and McDaniel, 2009; Roediger and Karpicke, 2006; Vermunt and Vermetter, 2004; Weinstein, McDermott and Roediger, 2010). This strategy is mostly used by externally motivated (Becker et al., 2010) and undirected learners (Vermunt, 1996), who have very low awareness of how to learn effectively (Phakiti, 2006) and prefer to choose easily accessible strategies (such as rereading, reciting or memorising facts), in part, owing to erroneous belief about what is beneficial to learning (Koriat, 2007).

Memorisation is considered to be a strategy that yields transient learning results and does not contribute to formation of deeply structured knowledge (Mayer, 2008), moreover, it characterises poor readers, so its negative association with reading performance was predictable. Interestingly, the degree of its relation depended on proficiency: the negative association was greater for high-achieving students (especially boys). This result can be explained by the theory of learning pattern dissonance which asserts that high-achieving students tend to benefit from using deep cognitive strategies and self-regulated learning, whereas low-achieving students succeed by virtue of externally-regulated learning (e.g., by teacher or parents) and using surface strategies (Beishuizen and Stoutjesdijk 1999; Meyer, 2000). Any discrepancy from this pattern results in "dissonance" and lowers results obtained. This mechanism might explain the large negative result from

sticking to ineffective, surface strategies by higher-achieving students in the PISA test.

Another interesting result was the negative association between use of elaboration strategies and reading performance. This may be related to the barrier to effective use of elaboration strategies. Elaboration, as defined in PISA 2009, requires not only a high level of previous knowledge (Dunlosky et al., 2013; Karpicke and Grimaldi, 2012), but also good cognitive skills, mainly involving a high span of working memory (McDaniel, Roediger and McDermott, 2007). This may explain the small and negative association between elaboration and reading performance in this study. It is noteworthy, that this association is only significant for low-achieving girls (see Table A2 in the Appendix). It is possible that the use of the elaboration strategy should not be measured according to self-reports, as students probably report how they struggle to use this strategy and, as it is difficult to successfully implement, they would mostly then report failed attempts. This could explain why self-reported use of the elaboration strategy has no relation to reading performance in many studies (e.g. Chiu et al., 2007; OECD, 2010). The more negative association for low-achieving girls could also be a by-product from socially--desirable responding (OECD, 2010).

The much stronger association between use of the control strategy and boys' reading performance is another intriguing result. This effect, especially since it only presented at the medium level of proficiency, may be attributed to boys' lower motivation and persistence, as compared with girls (Honigsfeld and Dunn, 2003), and to boys' more serious problems with school discipline (Jones and Wheatley, 1990). Boys were also more characterised by a random, undirected style of learning (Lau and Yuen, 2010; Severiens and Ten Dam, 1997), which is often linked with lower exam results (Vermunt and Vermetten, 2004). These problems with motivation, discipline and chaotic learning style may impede many boys from achieving good results and use of control strategies (planning, self-regulation, evaluation) should otherwise help them to overcome the tendency. Girls are often characterised as more motivated, responsible and by a more stepwise approach to processing of learning materials (Honigsfeld and Dunn, 2003; Vermut and Vermetten, 2004).

In general, use of strategies had a stronger association with performance for lower--achieving students. This confirms previous research findings (Cain, Oakhill, Barnes and Bryant, 2001; Dunlosky et al., 2013; Elosúa et al., 2013) and suggests that strategies may be effective in attenuating differences between high and low-achievers.

This study brings also some interesting findings concerning learning habits. Online reading was not significantly related to reading performance for girls, but a positive predictor for boys. In a similar way, variety of traditional reading materials was not significant for girls, but retained a positive association for boys. On the other hand reading enjoyment had a slightly stronger association for girls (see Table 3). Boys tended to read online much more than girls and also read much less varied materials (see Table 1), so probably for most boys, reading online represented the very few occasions on which they actually read, whereas for girls, online practice was not critical, since they read sufficient traditional materials. This also explains why reading material variety is more critical for boys – those who read a greater variety profit more than others, whereas as girls mostly tend to read more widely and so it does not prove to be a significant predictor for them. Enjoyment of reading has greater associations for girls than boys, which may be explained by gender related sources for motivation, but as the PISA study did not cover those measures, this suggestion can only be tentative, probably worthy of further study (for gender differences in learning motivation see:

Severiens and Ten Dam, 1997; Vermunt and Vermetten, 2004).

Some caveats regarding the PISA data should be added – the reliability of the self--descriptive scales is satisfactory (see Table A5), but their theoretical validity is however dubious, since the proposed factorial model did not fit the data well (see Table A7). Moreover, modification of the proposed model to improve the fit suggested that memorisation was not easily discriminated from the other two (see Table A6). It seems that for future research, measurement tools with improved validity would be needed and that self-report methods may not be suited to assessment of learning strategies.

Conclusions

This study reveals that metacognitive strategies and learning habits are strongly associated with reading performance. Most strategies and habits had a positive relation with reading performance, and of which summarisation and enjoyment of reading had the strongest associations. Memorisation and elaboration were negatively associated with reading. The former is considered to be ineffective, while the latter is probably too difficult for most students. The control strategy proved to be much more important for boys as it probably helped them to overcome generally unfavourable male characteristics, e.g. low motivation, undirected learning and poor discipline. Memorisation has a more pronounced negative effect on high-achieving students which might be related to "dissonance" between learning patterns and ability. In general, the overall importance of strategies seems to be of greater significance to lower-achieving students.

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Appendix

Table A1
Quantile regression — effects of strategies and learning habits

Variable	q20	q50	q80	*Z*
Summarisation	24.31***(1.59)	23.89***(1.39)	21.86***(1.55)	1.10
Understanding	8.37***(1.59)	6.47***(1.35)	5.67***(1.47)	1.25
Memorisation	-5.32**(1.97)	-9.97***(1.67)	-9.37***(1.87)	1.49
Elaboration	-8.57***(1.89)	-4.65**(1.60)	-4.31*(1.75)	-1.65
Control	13.47***(2.17)	13.17***(1.84)	11.04***(1.95)	0.83
Gender	24.75***(3.24)	18.76***(2.70)	14.45***(2.90)	2.37
ESCS	21.52***(1.74)	22.00***(1.48)	21.95***(1.58)	-0.18
Nuclear family	8.02 (4.84)	7.20*(3.28)	2.77 (4.50)	0.79
Mixed family	-39.22**(15.31)	-33.21***(9.64)	-41.56***(10.82)	0.12
Diversity of reading	6.18***(1.75)	4.84***(1.56)	3.67*(1.67)	1.04
Reading enjoyment	16.06***(1.52)	16.13***(1.27)	16.89***(1.37)	-0.41
Online reading	5.02***(1.55)	5.19***(1.28)	5.54***(1.33)	-0.25
Mean	443.28 (5.24)	502.07 (3.60)	560.10(4.67)	

Note: standard errors are in parentheses; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. *Z* statistic points to statistical difference between coefficients when $Z > 1.645$. The *Z* statistic was calculated using the method presented in Paternoster, Brame, Mazerolle and Piquero (1998). Pseudo-R^2 for all quantile regression models in this section was around 0.25.

Table A2
Quantile regression – all students (q10–q90)

Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Summarisation	23.78	*24.36*	*24.6*	*24.3*	*23.77*	*23.17*	*23*	*21.9*	*19.96*
	2.87	1.99	1.88	2	2.27	1.9	1.96	2.04	2.46
Understanding	*9.35*	*8.43*	*8.01*	*7.14*	*6.6*	*5.96*	*5.92*	*5.75*	*6.45*
	2.96	2.14	1.71	1.57	1.66	1.67	1.59	1.78	2.67
Memorisation	-3.61	*-5.42*	*-6.75*	*-8.32*	*-9.93*	*-10.17*	*-10.23*	*-9.59*	*-10.04*
	3.2	2.75	2.47	2.1	2.6	2.56	2.11	2.93	2.88
Elaboration	*-10.43*	*-8.38*	*-7.83*	*-6.29*	*-4.7*	*-4.75*	-4.29	-4.33	-3.48
	3.53	2.63	1.96	1.87	2.11	2.22	2.59	2.64	3.77
Control	*13.79*	*13.3*	*13.3*	*13.08*	*13.05*	*13.42*	*12.71*	*10.97*	8.2
	3.41	2.88	2.56	1.99	2.56	2.23	2.49	3.06	4.19
Gender	*28.67*	*25.17*	*20.52*	*20.04*	*19.05*	*17.14*	*15.24*	*14.21*	*13.92*
	5.63	4.13	3.38	3.75	3.43	3.59	3.59	4.29	5.01
ESCS	*22.87*	*21.74*	*22.28*	*22.14*	*22.04*	*21.78*	*21.76*	*22.07*	*20.78*
	3.25	2.54	2.19	1.9	1.79	2.26	2.34	2.14	2.71
Nonnuclear family	*-22.05*	*-12.06*	-9.9	-9.76	*-9.76*	*-10.53*	-8.53	-6.09	-2.46
	8.45	5.82	5.27	5.11	4.29	4.89	5.95	4.54	6.2

Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Diversity of reading	4.59	*6.38*	*5.75*	*4.47*	*4.77*	*4.46*	3.96	3.44	2.47
	3.43	2.55	2.18	2.01	1.88	2.11	2.41	2.58	3.07
Reading enjoyment	*15.89*	*15.92*	*16.34*	*16.15*	*16.27*	*16.93*	*16.67*	*17.12*	*18.43*
	2.41	1.84	1.8	1.97	1.81	1.94	2.23	2.04	2.46
Online reading	4.58	*5.3*	*4.96*	*5.03*	*5.18*	*4.99*	*5.2*	*5.24*	*7.1*
	2.59	2.35	1.74	1.51	1.55	1.73	1.75	1.89	2.83

Table A3
Quantile regression – boys (q10–q90)

Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Summarisation	*23.07*	*23.98*	*24.77*	*24.18*	*23.88*	*23.32*	*22.68*	*21.17*	*18.5*
	4.42	2.92	2.95	3.03	2.98	2.43	3.04	2.83	3.79
Understanding	9.57	8.18	6.24	5.94	5.5	4.35	5.48	6.05	7.58
	4.34	3.4	3.05	2.54	2.66	2.8	3.18	3.15	3.95
Memorisation	-0.29	-5.54	*-7.73*	*-10.49*	*-12.3*	*-11.43*	*-11.04*	*-10.26*	*-11.79*
	5.16	4.35	3.84	3.69	3.81	5.58	3.9	4.25	4.4
Elaboration	-7.61	-6.31	-6.68	-5.13	-4.97	-5.71	-6.4	-7.26	-6.48
	5.36	4.29	3.56	2.99	3.19	4.09	4.59	4.23	5.24
Control	*14.74*	*15.11*	*16.33*	*17.3*	*18.43*	*18.15*	*17.93*	*15.95*	*13.55*
	6.99	5.41	4.88	3.72	3.91	4.41	4.42	4.86	5.54
ESCS	*26.99*	*27.69*	*27.73*	*26.28*	*24.95*	*24.64*	*24.68*	*25.33*	*24.33*
	4.41	3.64	3.41	2.67	2.76	3.11	3.29	3.4	4.12
Nonnuclear family	-21.89	-19.11	-13.31	*-14.03*	*-13.08*	-12.65	-9.52	-8.15	-2.55
	14.25	10.38	7.96	7.13	6.58	7.54	7.56	8.8	11.64
Diversity of reading	8.48	8.3	*8.02*	5.96	*6.83*	*6.71*	7	5.95	4.04
	4.5	3.24	2.88	3.17	3.41	2.84	3.26	3.47	5.22
Reading enjoyment	*11.99*	*11.08*	*12.33*	*13.37*	*13.54*	*14.75*	*14.5*	*15.71*	*18.65*
	4.74	3.75	3.76	3.55	3.86	3.59	4.29	3.68	4.68
Online reading	4.62	*6.03*	*6.67*	*7.31*	*7.09*	6.9	*7.33*	*7.42*	*8.43*
	3.46	2.6	2.76	2.74	2.76	2.25	2.74	2.84	3.43

Table A4
Quantile regression – girls (q10–q90)

Variable	q10	q20	q30	q40	q50	q60	q70	q80	q90
Summarisation	*24.14*	*23.93*	*24.44*	*23.71*	*23.34*	*23.53*	*23.22*	*22.56*	*20.65*
	3.69	2.63	2.67	2.66	2.6	2.52	2.56	3.33	3.35
Understanding	*9.36*	*9.52*	*8.51*	*8.06*	*7.29*	*7.1*	*6.33*	*5.72*	*6.21*
	3.97	2.41	2.18	2.22	2.34	2.35	2.37	2.51	2.96
Memorisation	*-7.41*	*-8.27*	*-7.96*	*-8.13*	*-9.03*	*-10.11*	*-9.86*	*-9.86*	*-9.95*
	4.61	3.83	3.7	2.64	3.06	2.83	3.03	2.89	4.36
Elaboration	*-12.09*	*-9.6*	*-7.98*	*-6.33*	-5.03	-4.16	-3.2	-2.18	-1.55
	4.68	3.24	2.69	2.36	2.83	2.72	3.25	3.13	3.78
Control	*12.38*	*11.82*	*10.6*	*10.34*	*10.05*	*10.52*	*9.11*	*8.06*	4.81
	4.04	3.72	3.53	2.93	3.42	2.68	3.32	3.3	4.42
ESCS	*20.33*	*18.41*	*18.54*	*18.79*	*20.22*	*19.31*	*19.46*	*18.85*	*16.93*
	4.04	2.96	3.19	2.79	3.21	2.73	3.4	2.94	3.35
Nonnuclear family	-16	-8.84	-6.14	-6.81	-6.8	-8.73	-6.78	-2.98	-3.06
	12.13	7.66	5.17	6.08	6.32	6.12	7.72	5.79	7.38
Diversity of reading	-0.06	1.5	2.16	0.83	0.47	0.41	0.21	-0.53	1.18
	4.6	3.44	3.52	2.79	3.06	2.62	3.14	3.44	4.75
Reading enjoyment	*19.65*	*19.98*	*19.41*	*19.00*	*19.14*	*18.48*	*18.55*	*18.37*	*17.88*
	2.87	1.97	2.12	2.19	2.45	2.18	2.55	2.74	2.54
Online reading	4.39	2.45	2.89	2.39	2.47	2.48	2.33	2.89	5.48
	3.89	3.49	2.14	1.89	2.2	2.56	3.18	3.4	4.71

Table A5
Reliability data (Cronbach's alpha) for PISA 2009 self-descriptive scales reported in the study

		Reliability	
Scale	Number of items	Poland	OECD median
Summarisation*	5	0.65	0.66
Understanding*	6	0.66	0.63
Memorisation	4	0.62	0.69
Elaboration	4	0.72	0.75
Control	5	0.73	0.75
Diversity of reading	5	0.60	0.56
Reading enjoyment	11	0.89	0.90
Online reading	7	0.86	0.77

* Summarisation and understanding were not measured by self-descriptive scales.

Table A6
Confirmatory factor analysis for student questionnaire on learning approaches (use of memorisation, elaboration and control strategies)

Measurement	Std. Coeff.	OIM S.E.	*z*	*p*	95% C.I.	
st27q01 <- memorisation	0.47	0.01	31.61	0.00	0.44	0.50
st27q03 <- memorisation	0.48	0.02	31.26	0.00	0.45	0.51
st27q05 <- memorisation	0.34	0.02	20.44	0.00	0.31	0.38
st27q07 <- memorisation	0.57	0.01	39.48	0.00	0.54	0.60
st27q04 <- elaboration	0.59	0.01	48.71	0.00	0.57	0.61
st27q08 <- elaboration	0.59	0.01	49.20	0.00	0.57	0.62
st27q10 <- elaboration	0.71	0.01	68.43	0.00	0.69	0.73
st27q12 <- elaboration	0.64	0.01	55.68	0.00	0.61	0.66
st27q02 <- control	0.43	0.01	30.93	0.00	0.40	0.45
st27q06 <- control	0.68	0.01	68.82	0.00	0.66	0.70
st27q09 <- control	0.65	0.01	63.30	0.00	0.63	0.67
st27q11 <- control	0.66	0.01	64.63	0.00	0.64	0.68
st27q13 <-control	0.55	0.01	45.68	0.00	0.53	0.57
Variances						
var(e.st27q01)	0.78	0.01	–	–	0.75	0.81
var(e.st27q03)	0.77	0.01	–	–	0.74	0.80
var(e.st27q05)	0.88	0.01	–	–	0.86	0.91
var(e.st27q07)	0.68	0.02	–	–	0.65	0.71
var(e.st27q04)	0.65	0.01	–	–	0.63	0.68
var(e.st27q08)	0.65	0.01	–	–	0.62	0.68
var(e.st27q10)	0.50	0.01	–	–	0.47	0.53
var(e.st27q12)	0.60	0.01	–	–	0.57	0.63
var(e.st27q02)	0.82	0.01	–	–	0.80	0.84
var(e.st27q06)	0.53	0.01	–	–	0.51	0.56
var(e.st27q09)	0.57	0.01	–	–	0.55	0.60
var(e.st27q11)	0.56	0.01	–	–	0.54	0.59
var(e.st27q13)	0.70	0.01	–	–	0.67	0.73
var(memorisation)	1	–	–	–	–	–
var(elaboration)	1	–	–	–	–	–
var(control)	1	–	–	–	–	–
Covariances						
cov(e.st27q01, e.st27q03)	0.28	0.02	18.08	0.00	0.25	0.31
cov(e.st27q01, e.st27q02)	0.24	0.01	15.89	0.00	0.21	0.27
cov(e.st27q03, e.st27q04)	0.21	0.01	14.12	0.00	0.18	0.24
cov(e.st27q03, e.st27q02)	0.21	0.01	13.78	0.00	0.18	0.23
cov(e.st27q05, e.st27q07)	0.26	0.02	16.35	0.00	0.23	0.29
cov(memorisation, elaboration)	0.62	0.02	30.18	0.00	0.58	0.67
cov(memorisation, control)	0.94	0.02	54.78	0.00	0.91	0.98
cov(elaboration, control)	0.76	0.01	61.81	0.00	0.73	0.78

Note: own calculations based on the PISA 2009 datasets. Variable names are identical to those available in the data. Please refer to the PISA questionnaire and technical reports available online on the OECD PISA website for further details.

Table A7
Goodness of fit for proposed and modified models

	Model	
Fit indices	Proposed	Modified
chi-2	1845.404	802.856
p	0.000	0.000
df	62	57
RMSEA	0.078	0.053
p	0.000	0.071
AIC	144 337.260	143 304.712
BIC	144 608.240	143 607.952
CFI	0.884	0.952
TLI	0.855	0.934
SRMR	0.050	0.034
CD	0.946	0.925

Note: fit indices and their cut-off points selected on the basis of Hu and Bentler (1999).
Cut-off points: CFI-0.95; RMSEA-0.06; SRMR-0.08.