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The Effects of Learning Strategies on Mathematical Literacy: A Comparison between Lower and Higher Achieving Countries

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Abstract

The purpose of the current study is to explore the effects of learning strategies on Mathematical Literacy (ML) of students in higher and lower achieving countries. To address this issue, the study utilizes PISA2002 data to conduct a multi-level analysis (HLM) of Hong Kong and Israel students. In PISA2002, Israel was rated 31st in Mathematics, while Hong Kong was rated at the top of the list. The HLM analysis was implemented at the student level, as well as at the school level. The results show that controlling for other variables, in Israel, memorization strategies had the most significant negative contribution for the prediction of ML achievements, whereas in Hong Kong the control strategies had the highest contribution. These results suggest that overemphasis on memorization does not necessarily contribute to ML achievement. Yet, the efficient use of control strategies may contribute to higher achievements. The theoretical and practical implications of the study are discussed.

Key words: Memorization strategies; Control strategies; Elaboration strategies; Mathematical Literacy (ML); HLM

Introduction

The challenge we face in the 21st century calls for a fundamental change in mathematics education. The mathematical skills students need to know refer not only to basic computations, but also how to use numbers in order to analyze complicated problems, to reach logical solutions, and to estimate the efficiency of different ways of solving problems (Marilyn 2000; Smith and Mary 1998; Cai and Steven, 2002; Edward and Jinfa, 2005). Accordingly, in the PISA study, ML was defined as "the capacity to identify, understand, and engage in mathematics as well as to make well founded judgments about the role that mathematics plays in an individual's current and future life, in his social life and as a constructive and reflective citizen" (OECD, 2003, p. 23). This definition includes two major components: one is the basic capacity to perform mathematical operations, and the other is the ability to apply mathematical knowledge in solving problems in a variety of situations.

Learning Strategies

In addition to literacy, the PISA study analyzes data regarding the relationships between academic achievement and variables that may have the potential to contribute to academic achievements, such as: school attributes and its organization, students' learning modes, family background, and self-regulation in learning. PISA assumes that students cannot learn everything they will need as adults in the future. Thus, students need to acquire self-regulated learning skills, including particular learning strategies.

In the PISA study (OECD, 2003), three learning strategies were examined:

a. Index of *memorization strategies* which derives from the frequency with which students used the following strategies when studying: tries to memorize everything that might be covered, memorize as much as possible, memorize all new material for reciting it, practice by saying the material over and over.
b. Index of *elaboration strategies* which derives from the frequency with which students used the following strategies when studying: tries to relate the new material to things s/he had already learned in other subjects, or in the past, or to what s/he already knows; and tries to examine whether the new material conforms to his previous knowledge.

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c. Index of *control strategies* which derives from the frequency with which students used the following strategies when studying: self-clarification regarding the contents and skills to be learned; checking and clarifying whether the student remembers or misunderstood what s/he has learned; and looking for additional sources of information for furthering his understanding.

Learning strategies are found within the realm of simple memorization strategies used by all ages (Schneider & Pressley, 1997; Weinstein, 1988), to sophisticated strategies that individuals use for reading (Pressley & Afflerbach, 1995), mathematics (e.g., Mevarech, 1999; Schoenfeld, 1992), writing (e.g., Breiter & Scardamalia, 1987), and problem solving and reasoning (Baron, 1994; Nisbett, 1993).

The Relationships between Learning Strategies and Mathematics Literacy

Research has indicated that one of the main factors that contribute to success in mathematics is choosing efficient strategy for solving problems. Schoenfeld (1985), for example, claims that it is not enough to master the computations, but rather to develop meta-cognitive skills, such as control and elaboration strategies. Different studies show that when students use elaboration strategies intensively, their mathematical achievements improve (Baroody, 2006; Mevarech, 1999; Mevarech & Kramarski, 1997). Other studies show that students who used control strategies achieved higher scores than students who used memorization strategies (e.g., Geary, 2005; Gersten & Davis, 1999). Yet, these studies were all performed on a micro level, without looking at the educational system as a whole, or without distinguishing between the student level and the school level.

Thus, the current study focuses on the effects of learning strategies on mathematics literacy in Hong Kong and Israel, higher and lower achieving countries, respectively. Three kinds of learning strategies were examined: memorization, control, and elaboration. In addition, the study examines other variables (see the Method section) in order to take a closer look at factors enhancing or inhibiting student achievement in mathematics. Since these two countries are similar in terms of the educational system size, but largely different in terms of mathematics achievement, it is of interest to examine the factors that operate to influence student achievement in the two countries.

Method

The data of the current study are based on PISA2002 derived from the PISA site (OECD, 2007).

Population

According to PISA, the study population included all students at the ages between 15 years and 3 months, to 16 years and 2 months, who study at an educational institution, with no reference to the class or to the type of institution they study in. From this population, a random sample was chosen according to PISA regulations. Table 1 describes the distribution of the participants in the current study.

Table 1. Distribution of the study population

Israel		Hong Kong	
Student level	School level	Student level	School level
2483	165	2438	140

Measurements

Several kinds of measurements were analyzed in the current study, all derived from PISA2002: three were designated for the students and one for the principal. The questionnaires for the students included: ML examination, student's attributes questionnaire, and self-regulated learning questionnaire (SRL). The questionnaires were scored on a four-point Likert scale, ranging from (1) almost never to (4) almost always.

The questionnaire for the principal focused on school management policy. Also the principal questionnaire was scored on a four-point Likert scale, ranging from (1) strongly disagree to (4) strongly agree. Tables 2 and 3 present the items that were chosen for the current study at the student and school levels, respectively.

The Variables

Students' performance on the ML exam (pv1math): Students' scores on the ML exam were calibrated by PISA. The mean international score of the OECD countries is 500 and the standard deviation is 100. In Israel the mean score was 433 and the standard deviation 131 (the highest of all participated countries); Israel was rated as 31 out of 41 countries. Hong Kong's mean score was 560 and the standard deviation 94; HK was rated the first in mathematics. Figure 1 presents the distribution scores in mathematics literacy by percentiles in Israel and Hong Kong.

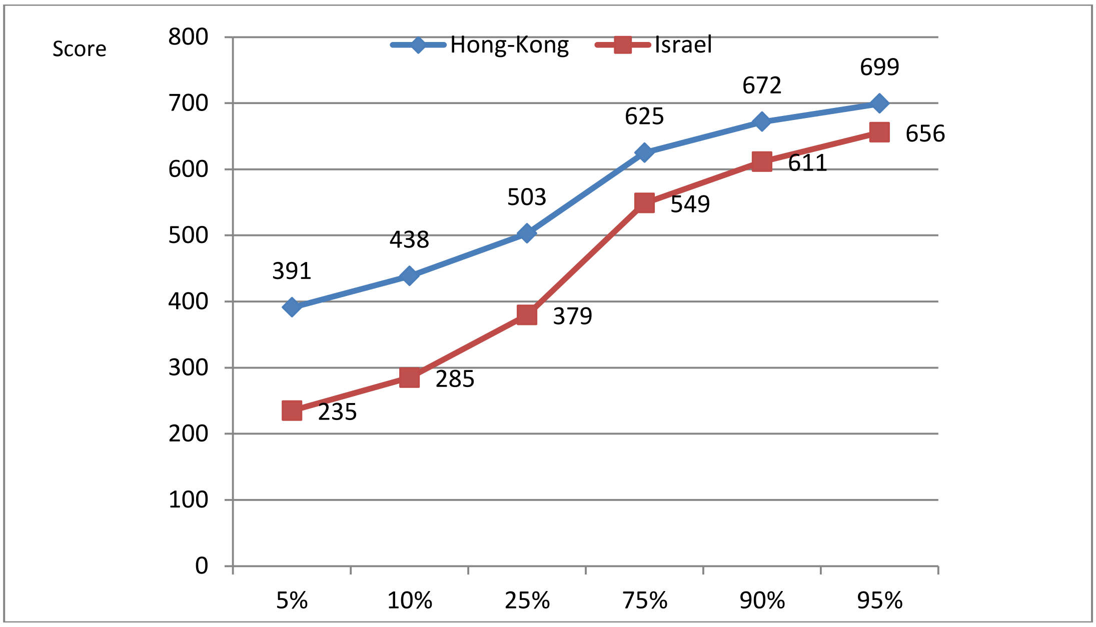

Figure 1. Distribution of ML in the countries

According to Figure 1, the ML scores of the lower achieving Israeli students (10th percentile) was 177 points lower than the ML scores of the lower achieving students in Hong Kong. Also the scores of the higher achieving students (90th percentile) in Israel were 62 points lower than that of the high achieving students in Hong Kong. Furthermore, the gap between the high and low achieving students in Israel is greater than that in Hong Kong (421 and 308 points, respectively). While in Israel the mean of the upper 90 percentile is 2.3 times more than that of the 10th lower percentile, in Hong Kong the mean of the upper percentile is 1.6 times more than that of the lower percentile.

Learning Strategies – Student Level Variables

As indicated three learning strategies were explored in the present study: memorization, control and evaluation. Below are examples of items assessing each kind of strategy:

a) Memorization strategies: 'while studying I try to memorize the material…', 'while studying I repeat the material aloud over and over again'.
b) Control strategies: 'while studying I try to find out first what do I have to learn…', 'when I study, in case I don't understand, I look for additional information'.
c) Elaboration strategies: 'while studying I try to relate the material to things I learned in the past…', 'while studying I try to think…using what I have learned'.

Figure 2 presents the mean scores of the learning strategies in Israel and in Hong Kong.

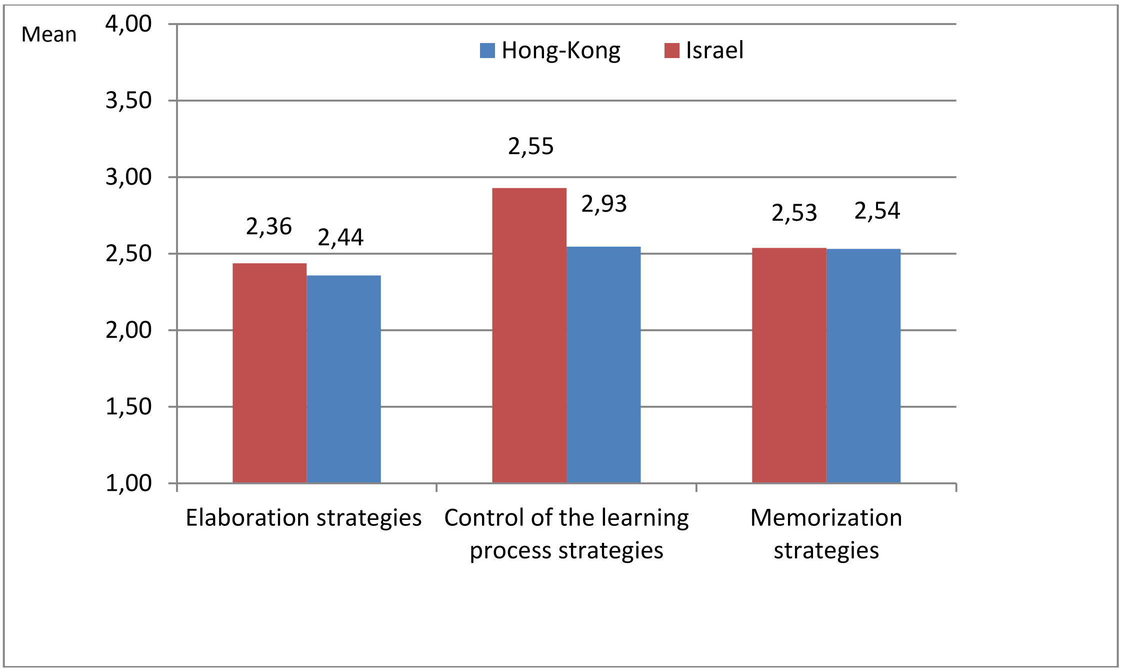

Figure 2. The means of learning strategies in the countries

In addition to learning strategies, the current study examined also other variables at the student level, as well as at the school level, which were found in previous studies as affecting students' achievements (Bos & Kuiper, 1999; Campbell, 1994; Campbell & Mandel, 1990). The variables were grouped into indices, as in PISA studies (Kotte, Lietz & Lopez, 2005, p. 116; Kotte & Lietz, 2005, p. 3). For example, socio-economic background was composed of: fathers' socio-economic index or mother's socio-economic index (the highest), mother's education level, father's education level, and number of books in the house. The scales examined at the student and at the school level, are presented in Tables 2 and 3.

Table 2. The scales at the student level

student level scales

Scale	**Variable(s) used to from scale (PISA variable name)**		**Coding/comment**
Mathach	pv1math		Rasch scaled reading score: Range: 0-1000, midpoint 500
Grade	Grade	st02q01	8-Grade 8, 9- Grade 9, 10- Grade 10
Gender	Gender	st03q01	1Female=2; male=
Class size	ST28Q02		Higher values denote more students
Socio-economic status	meamse		Scale/factor score based on five variables; high value denotes high socio-economic status
	Isei	In. Socio-Econ. Index of father or mother	
	hisei	Highest In. Socio-Econ. Index	
	Misced	Mother ISCED qualification	
	Fisced	Father ISCED qualification	
	ST37Q01	Number of books at home	
Absenteeism	meanab		Scale/factor score based on the two variables; high value denotes high degree of absenteeism
	ST29Q01	Absent from school	
	ST29Q03	Late for school	
Sense of belonging	Belong		high value denotes high sense of belonging
	St31q01	Feel an outsider	
	St31q02	Make friends	
	St31q03	Feel I belong	

student level scales			
Scale	**Variable(s) used to from scale (PISA variable name)**		**Coding/comment**
	St31q04	Feel awkward	
	St31q05	Think I'm liked	
	St31q06	Feel lonely	
Memorization strategies	memor		high value means high memorization strategies
	cc01q01	Memorise	
	cc01q05	Much as possible	
	cc01q10	Recite	
	cc01q15	Over and over	
Control of the learning process strategies	cstrat		high value means high control of the learning process strategies
	cc01q03	Need to learn	
	cc01q13	Force myself	
	cc01q19	Concepts	
	cc01q23	Important	
	cc01q27	Additional info	
Elaboration strategies	elab		high value means high memorization strategies
	cc01q09	Relate New	
	cc01q17	Real world	
	cc01q21	Relating	
	cc01q25	Fits in	

For each country, the means of the items presented in Table 2 and Table 3 were computed.

Table 3. The scales at the school level

school level scales			
Scale	**Variable(s) used to from scale (PISA variable name)**		**Coding/comment**
School size	Schlsize		Number of students in the school (2002)
Percentage of girls	pcgirls		Year 2002
School type	Schltype		1-Private, government independent 2-Private, government dependent 3 –Government
School resources	Scmatedu		Scale/factor score; high value denotes higher quality of instr. resources in school
	Sc11q04	Lack of instruct materials	
	Sc11q05	Lack of computers	
	Sc11q06	Poor library	
	Sc11q07	Poor multi	
	Sc11q08	Poor science equips	
	Sc11q09	Poor art facilities	
Teacher behavior	Teacbeha		Scale/factor score; high value denotes higher quality of instr. resources in school
	Sc19q01	Low expectations	
	Sc19q03	Stud-teach relations	
	Sc19q07	Ignoring students	
	Sc19q08	Teacher absenteeism	
	Sc19q11	Resisting change	
	Sc19q14	Teachers' strictness	
Teachers' effectiveness	Sc18q06		1-Yes 2-No
Student behavior	Studbeha		Scale/factor score; high value denotes strong hindrance of students to study properly
	Sc19q02	Student absenteeism	
	Sc19q06	Disruptions of classes	
	Sc19q09	Skipping classes	
	Sc19q10	Lack of respect	
	Sc19q13	Use of alcohol	
	Sc19q15	Bullying	
School autonomy	Schauton		Scale/factor score; high value

school level scales			
Scale	**Variable(s) used to from scale (PISA variable name)**		**Coding/comment**
	Sc22q01	Hiring teachers	denotes high school autonomy
	Sc22q02	Firing teachers	
	Sc22q03	Teacher salaries	
	Sc22q04	Salary increase	
	Sc22q05	Budget formulation	
	Sc22q06	Budget allocation	
	Sc22q07	Disciplinary policies	
	Sc22q08	Assessment policies	
	Sc22q09	Student admittance	
	Sc22q10	Textbooks	
	Sc22q11	Corse content	
	Sc22q12	Course offer	
Morale and teachers' commitment	Tcmorale		Scale/factor score; high value denotes high teachers' morale and commitment
	Sc20q01	High morale	
	Sc20q02	Enthusiasm	
	Sc20q03	Pride in school	
	Sc20q04	Value acad achvm	

Table 4 presents the means and standard deviations of the independent variables at the student level and at the school level, in Israel and in Hong Kong.

Table 4. Independent variables at the student and school levels

	Israel		**Hong Kong**	
Student level				
	N=2483		N=2438	
	M	SD	M	SD
Grade	9.95	0.36	9.85	0.88
Gender	1.50	0.50	1.50	0.50
Class size	25.67	8.66	38.22	5.61
Socio-economic status*	0.99	0.27	1.10	0.18
Absenteeism	1.91	0.76	1.16	0.36
Sense of belonging	2.32	0.34	2.50	0.25
Memorization strategies	2.54	0.76	2.53	0.62
Control of the learning process strategies	2.93	0.65	2.55	0.57
Elaboration strategies	2.44	0.76	2.36	0.59
School level				
	N=165		N=140	
	M	SD	M	SD
School size	772.78	434.11	1037.12	189.18
Percentage of girls	0.50	0.25	0.53	0.21
School type	2.78	0.43	2.94	0.26
School resources	1.99	0.77	1.61	0.65
Teacher behavior	2.14	0.66	1.86	0.54
Teachers' effectiveness	1.20	0.36	1.42	0.50
Student behavior	2.22	0.62	1.76	0.58
School autonomy**	0.47	0.74	0.51	0.50
Morale and teachers' commitment	3.27	0.41	3.09	0.40

* The socio-economic status was calculated according to CFVAR

** It was impossible to calculate the mean of school autonomy due to missing data, therefore, it is presented according to the international index mean which is 0, standard deviation 1.

Data Analysis

Part 1

Figure 3 presents the study's model. To examine the model, a Structural Equation Modeling Analysis Process was implemented, using the statistics software AMOS 22.0 (Analysis of Moment Structures) (Arbuckle, 2013). This process enables simultaneous examination of an array of variables and their interrelations, and the improvement of reliability by referring to measurement errors and structural faults. The analysis assesses the causal relations between two types of variables: exogenous variables – the independent variables, which are not affected by other variables in the model, and endogenous variables, which are affected by other variables in the model. The exogenous variables in the current study are the three learning strategies: memorization, control, and elaboration. The endogenous variable is students' achievement in ML.

The assessment of the model was done by examining the measures which point to the compatibility of the model to reality. The four measures χ^2, RMSEA, NFI, and CFI serve to find the model which is best compatible to reality (Bentler & Bonett, 1980). The results, obtained at the individual level of both countries (N= 4.921), reveals that: a. χ^2 = 48.730 (df=4) is low, yet statistically significant ($p<.000$); it means that there is no compatibility between the theoretical model and reality. Since this measure is sensitive to the sample size, its effectiveness is doubtful (Kline, 2010; Hoyle & Panter, 1995); b. the measure RMSEA (0.042) expresses proper compatibility; c. the measures NFI (0.986) and CFI (0.988) are near to 1, so that their compatibility is greater. In general, it can be said that these results point to a proper model which is compatible with the data of the study.

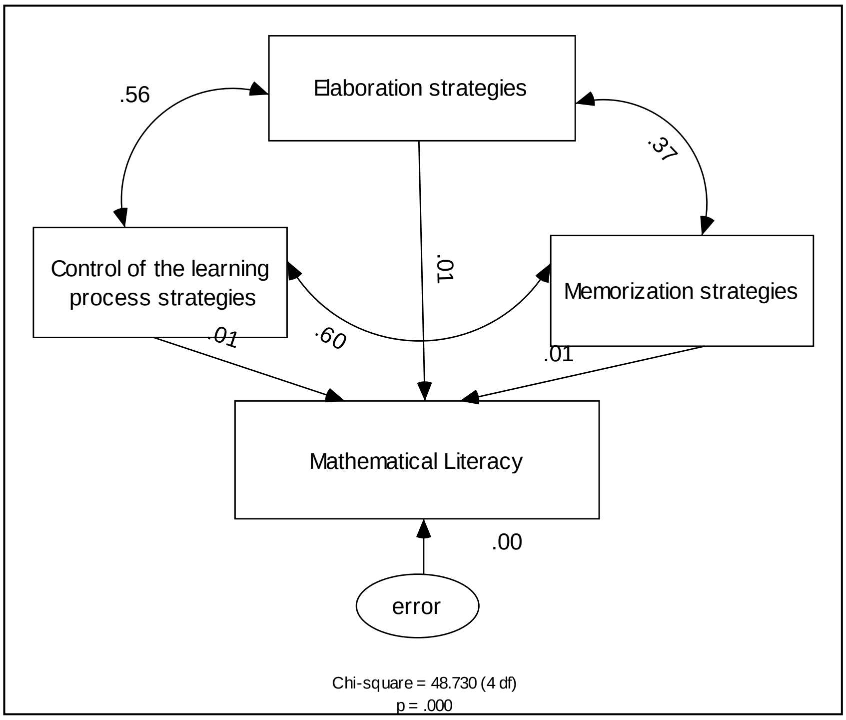

Figure 3. Hypotheses of the study model

Part 2

The use of multi-level analysis with Hierarchical Linear and Nonlinear Modeling (HLM) 6.02 (Raudenbush, Bryk & Congdon, 2005), is a standard use in the social science, medicine and biology, where the data has a structure of more than one analysis level, as in the PISA2002 study. The primary level is the student level and the secondary level is the school level, in which the student studies. It is hypothesized that a greater similarity shall be found between students who belong to the same school, in comparison to students who belong to different schools. A multi-level analysis enables to examine the effects of the macro level on the micro one, and to identify the relative contribution of each level to the prediction of the dependent variable (Kotte & Lietz, 2005; Kotte, Lietz & Lopez, 2005; Raudenbush & Bryk, 2002).

In the framework of the multi-level analysis, different models are examined which account for the variance of the dependent variable. Other variables were included in order to identify those variables which are related to the achievement level. The final model includes the constant effects which are greater than 0.05 and are statistically significant (Raudenbush & Bryk, 2002). At the first stage, SPSS files were defined for HLM model at two levels (the student level and the school level) for each country separately. At the second stage, several models were run until the final models resulted. In all analyses, the dependent variable was student's mathematic literacy score (pv1math).

Results

The results of the two-level HLM analyses are reported as follows: First, for Israel, followed by Hong Kong, and finally, the findings for the two countries are compared.

Two-Level HLM Model of Mathematics Achievement for Israel

Table 5 presents the results of the two-level HLM model for Israel: one at the student level (N=2483) and the other at the school level (N=165).

Table 5. Two-level HLM model for ML achievement - Israel*

Fixed Effects on Math Literacy	**Coefficient**	**SE**	**t- ratio**	**P**
Student level				
Grade	0.10	0.02	4.59	0.000
Gender	0.12	0.02	5.97	0.000
Class size	0.09	0.02	4.66	0.000
Socio-economic status	0.13	0.02	7.38	0.000
Absenteeism	-0.04	0.02	-2.86	0.005
Memorization strategies	-0.10	0.02	-4.61	0.000
Control of the learning process strategies	0.03	0.02	1.25	0.213
Sense of belonging	0.00	0.02	0.17	0.865
School level				
intercept Math Literacy	-0.06	0.04	-1.48	0.142
School size	0.11	0.04	2.87	0.005
Morale and teachers commitment	0.16	0.04	3.89	0.000
School autonomy	0.11	0.05	2.55	0.012
Percentage of girls	0.07	0.04	1.59	0.114
School type	-0.05	0.04	-1.20	0.233
School resources	0.03	0.05	0.58	0.561
Teacher behavior	-0.06	0.07	-0.91	0.364
Student behavior	-0.01	0.07	-0.07	0.946
Slope				
The relations between Elaboration Strategies and ML score	0.07	0.02	3.55	0.000
Teacher behavior	0.07	0.02	3.55	0.000
Reliability intercept	0.821			
Reliability slope	0.011			
Df	155			

Notes: all scores were changing models as values estimated.
The effects are in terms of standard deviations.

According to Table 5, in Israel, the lower achieving country, at the student level, the best predictor of ML is students' socio-economic (γ =.13): an increase of one point in the socio-economic status index is followed by an increase of .13 standard deviation in ML score. Among the learning strategies, the best predictor of ML is memorization with a negative sign (γ =-.10), followed by elaboration (γ =.07), whereas control strategies did not enter into the equation. Thus, the less students report on using memorization strategies and the more students report on using elaboration the higher students scored on ML.

At the school level, the best predictor was teachers' morale and commitment (γ =.16): an increase of one point in this index was associated with an increase of 0.16 standard deviation in ML score. In addition, significant interaction (the slope) was found between 'elaboration' and teachers' behavior, indicating that 'positive teacher behavior' enhances the relationships between elaboration and ML scores. It is interesting to note that at the student level in addition to control strategies, also sense of belonging did not enter into the equation, whereas at the school level, the following variables were not related to ML: percent of girls in school, kind of school, student behaviors, and educational resources. Figure 4 presents the direct effects of the HLM analysis in Israel, at the student level and at the school level.

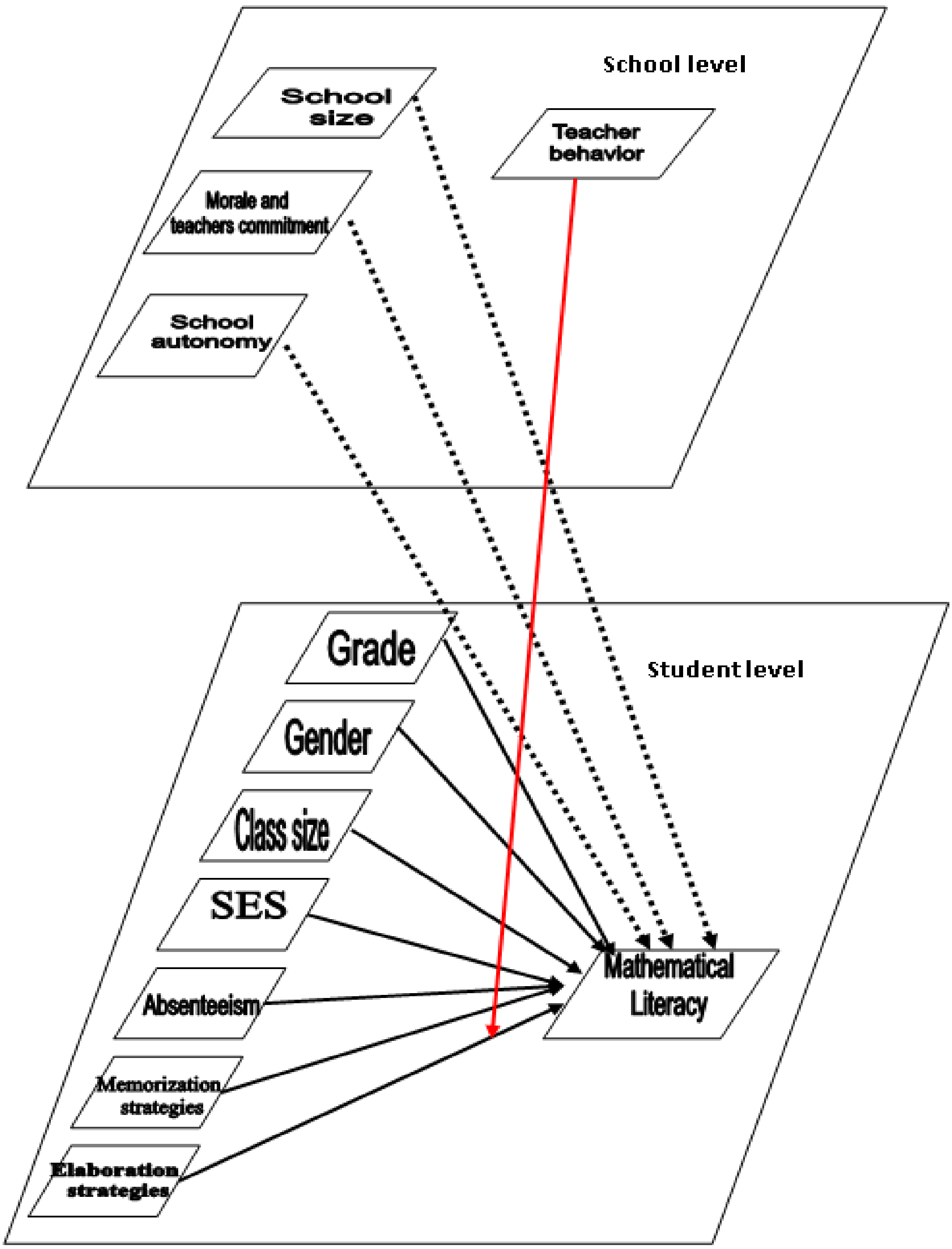

Figure 4. Final two-level HLM model of ML for Israel

As can be seen from Table 5 and Figure 4, a number of factors operate at the student level, while others operate at the school level. Thus, in Israel, at the school level, three different factors have a significant impact on mathematics achievement: Teachers' morale and commitment (γ =.16), while school size and school autonomy show similar effect size (γ =.11).

At the student level, in Israel, the highest contribution for predicting students' achievements in ML is that of the socio-economic background (γ =.13), then gender (γ =.12), grade level (γ =.10), and class size (γ =.16). Furthermore, of the three learning strategies, the highest contribution (negative) is that of the memorization strategies (β=-0.10) and then that of the elaboration strategies (β=0.07). That is, the less often a student uses memorization strategies and the more often s/he uses elaboration strategies, the higher his/her achievement in mathematics is. The control strategies were not found as contributing significantly to the prediction of students' ML achievement.

To sum, as can be seen from figure 4 and Table 5, in Israel, the variables that predict higher grades in ML achievement are:
At the student level:
In other words, students:

- From higher SES background.
- Who are boys
- Who are enrolled in a higher grade.
- Who study in classes with a larger number of students.
- Who use more often elaboration strategies.
- Who use less frequent memorization strategies.
- Who are less absent from school.

At the school level, when:

- The school is bigger.
- The teachers' morale and commitment is higher.
- The autonomy of the school is greater.
- 'Positive teachers' behavior' enhances the relations between elaboration and ML.

Two-Level HLM Model of Mathematics Achievement for Hong Kong

Table 6 presents the results of both levels in Hong Kong, one at the student level and the other at the school level.

Table 6. Two-level HLM model for ML achievement - Hong Kong*

Fixed Effects on Mathach	**coefficient**	**SE**	**t- ratio**	**P**
Student level				
Grade	0.26	0.01	19.77	0.000
Gender	0.13	0.02	8.41	0.000
Class size	0.15	0.02	7.33	0.000
Absenteeism	-0.07	0.02	-4.43	0.000
Sense of belonging	-0.04	0.01	2.88	0.004
Memorization strategies	-0.04	0.02	-2.55	0.011
Control of the learning process strategies	0.09	0.02	5.27	0.000
Socio-economic status	0.02	0.02	1.35	0.179
School level				
ML score :Intercept	-0.01	0.05	-0.32	0.750
School type	0.11	0.04	2.50	0.014
School size	0.17	0.04	4.04	0.001
Percentage of girls	0.00	0.04	0.00	1.000

Fixed Effects on Mathach	**coefficient**	**SE**	**t- ratio**	**P**
School resources				
Teacher behavior	-0.01	0.07	-0.18	0.856
Student behavior	0.11	0.07	1.48	0.142
School Autonomy	0.05	0.05	1.11	0.270
Morale and teachers' commitment	0.09	0.05	1.80	0.074
Slope				
The relations between Elaboration Strategies and ML score	0.05	0.02	2.00	0.047
Teacher behavior	0.03	0.01	1.94	0.053
Reliability intercept	0.924			
Reliability slope	0.173			
Df	131			

Notes: all scores were changing models as values estimated.
The effects are in terms of standard deviations.

According to Table 6, in Hong Kong, the higher grade achieving country, the best predictor of ML is grade level (γ =.26): higher levels are associated with higher scores on ML. Among the learning strategies, the best predictor is control (γ =.09), and followed by elaboration (γ =.05) and memorization with negative sign (γ =-.04) . Thus, an increase in one point in control strategies and in elaboration is associated with an increase of about .09 and .05 standard deviations in ML, respectively; a decrease of one point in memorization is associated with an increase of .04 standard deviations in ML. It should be mentioned that at the student level, SES is the only variable that did not enter into the equation.

At the school level, in Hong Kong, the best predictor of ML is school size (γ =.17). In addition, significant interaction, although very small, was found between elaboration strategies and teachers' behaviors on ML (γ =.03). Thus, 'positive teachers' behavior' enhances the relationships between elaboration and ML. Variables that were not related to ML at the school level are: percent of girls in school, teachers' behavior, students' behavior, learning resources, school autonomy, and teachers' morale and commitment. Figure 5 presents the direct effects according to the HLM analysis in Hong Kong at the student level and at the school level.

According to table 6 and Figure 5, it can be seen that in Hong Kong, at the school level, only public schools and bigger schools tend to have higher math scores compared to private and small schools. At the student level, the highest contribution to the prediction of the student's achievement in ML is that of students' grade level (□ γ =.26): that is, the higher the grade level is, the higher the ML achievements are. Among the three learning strategies it was found that the highest contribution is that of the control strategies (γ =.09). The next contribution is that of the elaboration strategies (γ =.05) and last is that of the memorization strategies (γ =-.04). That is, the more often a student uses control and elaboration strategies, and the less s/he uses memorization strategies, the higher his/her mathematics achievement is.

To sum, as can be seen from figure 5 and Table 6, in Hong Kong, the variables that predict higher grades in ML achievement are:

At the student level:

- Higher grade
- Boys
- When there are more students in class.
- A smaller absenteeism of the student from school.
- The lower is the sense of belonging of the student.
- Less frequent use of memorization strategies by the student.
- Frequent use of control strategies by the student.
- Frequent use of elaboration strategies by the student.

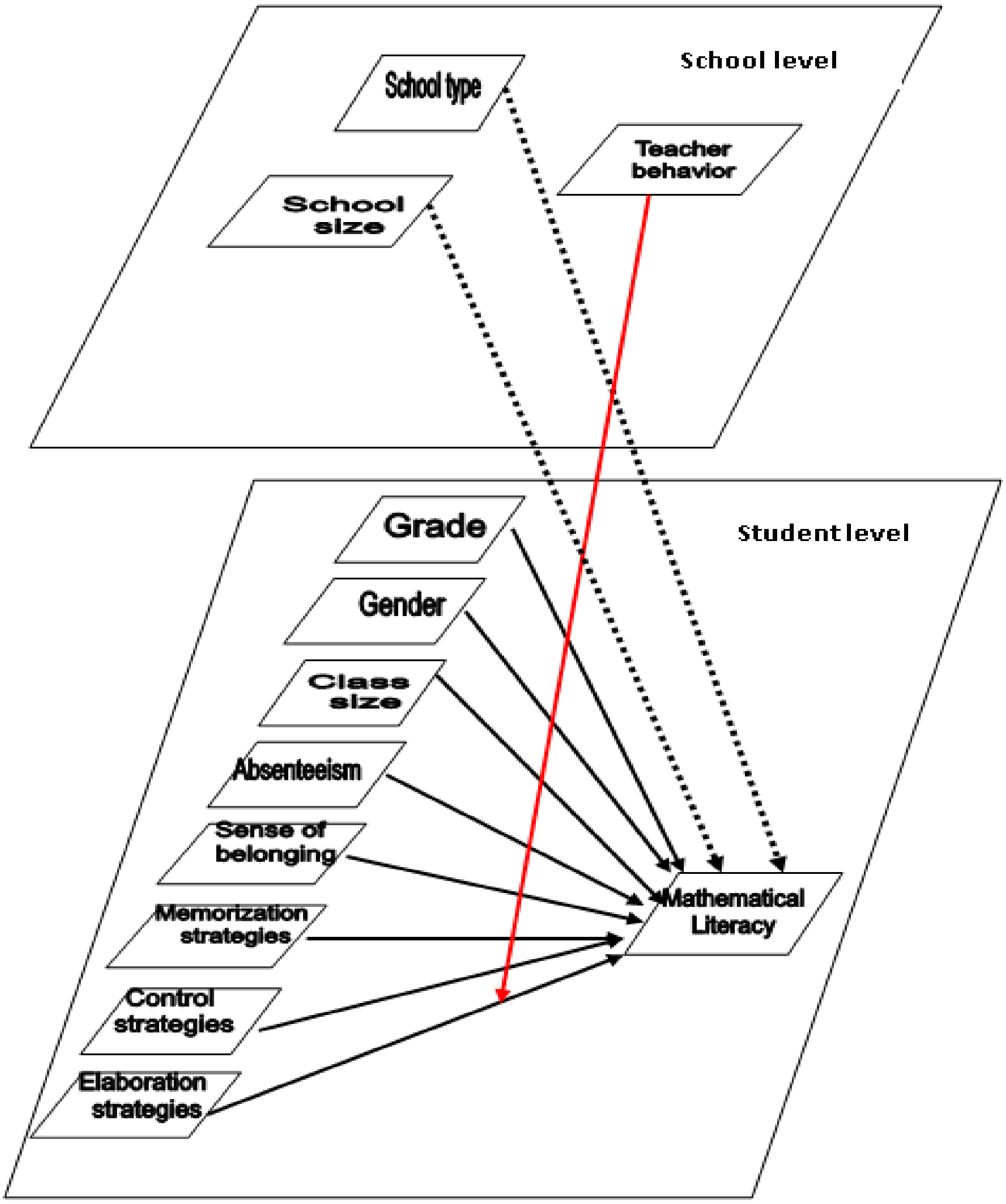

Figure 5. HLM model ML achievement - Hong Kong

At the school level:

- The type of school – students at public schools tend to achieve higher achievements than students at private schools.
- The school is bigger.
- The more 'positive' teachers' behavior the stronger is the relationship between elaboration and ML.

A Comparison between Israel and Hong Kong Findings

Comparing the results of the HLM multi-level analysis of students in Israel and Hong Kong, identifies the factors that affects students' achievements in mathematics at both countries. The findings show that only several factors are identical. At the student level, the identical factors affecting achievements in both countries are: grade level, gender, class size, absenteeism, memorization and elaboration strategies. That is, boys who study in a high grade (12th grade) which includes many students who come to school regularly, who seldom use memorization strategies and who often use elaboration strategies – achieve higher achievement in mathematics. In addition, In both countries, teachers' behaviors including: high expectations, good student-teacher relationships, attending students, low teachers' absenteeism, open to change, and not being too strict, enhances the relationships between elaboration strategies and ML. In Israel, this relationship is stronger than that in HK (γ =.07 and .03, respectively).

The different factors between the two countries are as follows. In Israel, students' socio-economic background (γ =0.13) significantly affects ML, whereas in Hong Kong, students' sense of belonging (γ =0.04) significantly affects ML. Interestingly, among the two strategies that had a significant effect on mathematics achievement (memorization and elaboration strategies), in Israel the highest contribution is that of the memorization strategies (γ =-0.10), whereas, in Hong Kong is that of control strategies (γ =.08). These findings emphasize the differences between students in Israel and in Hong Kong: whereas in Israel, the less students use memorization strategies, the higher are their ML achievements, in Hong Kong the more the students use control strategies, the higher are their achievements in ML. It should be noted that in contrast to HK, in Israel control strategies did not have significant effects on mathematics achievement.

Also at the school level significant differences were observed between Israel and Hong Kong. Whereas in Israel morale and teachers' commitment, school autonomy, and school size were found as affecting students' mathematics achievements, in Hong Kong these variables were not statistically significant – the only significant variables were school type and school size: Public schools more than private schools; larger schools more than small schools. Other school attributes were not found as affecting or contributing to the prediction of students' achievements in mathematics.

Discussion and Conclusion

Applying HLM analyses on PISA-2002 data of higher and lower achieving countries (Hong Kong and Israel, respectively) enables us to identify some of the factors that affect mathematics achievement in each country. In particular, we focused on the contributions of three learning strategies to mathematics achievement: memorization, elaboration, and control. In general, the findings show that: (a) in both countries, learning strategies have significant effects on mathematics achievement even after controlling for other variables, but significant differences were found on the effect-sizes between countries; (b) control strategies significantly contribute to mathematics literacy in the higher achieving country (Hong Kong), but had no significant effects in the lower achieving country (Israel); and (c) in both countries the mean scores on memorization and elaboration were similar, but significant differences were found on control strategies: Israeli students had higher scores compared to Hong Kong students. Distinguishing between the kinds of contribution that each strategy had in predicting mathematics achievement raises the question: what are the roles of those learning strategies in explaining students' mathematics literacy. The following sections will discuss this issue with regard to each of the learning strategies examined in this research.

Memorization Strategies and Mathematics Literacy

The negative correlations between memorization strategies and mathematics literacy are in accord with PISA conceptualization of mathematics literacy. As indicated, according to PISA, mathematics literacy refers to "students' capacity to analyze, reason, and communicate effectively as they pose, solve, and interpret mathematical problems in a variety of situations involving quantitative, spatial, probabilistic or other mathematical concepts" (OECD, 2007, p. 304). Thus, using memorization strategies is not enough for analyzing, reasoning, and communicating effectively in mathematics situations. Much more is needed in order to foster mathematics literacy, including: abilities to comprehend the problems, make connections between the problem at hand and problems the students solved in the past, and thoughtful reflection (OECD, 2006; Mevarech & Kramrski, 1997).

Interestingly, although in both countries, negative relationships were found between memorization strategies and mathematics literacy, the negative effect-size was stronger in the lower compared to the higher achieving country. Since correlation does not point toward causality, we have to be careful in interpreting the finding. It is possible that in the lower achieving country, teachers emphasize the activation of memorization strategies mainly for lower achieving students, assuming that these students cannot function at higher cognitive levels. In contrast, one may argue that in the higher achieving country, all students are exposed to strategies that enhance higher cognitive performance. Indirect support for this hypothesis comes from the study of Cohen, Kramarski, and Mevarech (2004) showing the differences between Finland and Israel in the structural relationship of classroom practices and students' literacy in the three domains of reading, science, and mathematics. The issue of how teachers foster memorization strategies and for whom merits future research.

Elaboration Strategies and Mathematics Literacy

As expected, elaboration strategies were positively related to mathematics literacy in both countries. Students who use elaboration strategies try to relate the new material to what they have learned in other subjects, or in the past, or to what they already know (OECD, 2003). These strategies complement the performance levels of the math literacy exam, from the very low levels and up. For example, in level 2 students" extract relevant information from a single source and make use of a single representational mode, … (students) are capable of direct reasoning and making literal interpretations of the results" (OECD, 2006, p. 312). Thus, students who frequently use elaboration strategies are expected to perform well on the exams that assessed mathematics literacy.

Control Strategies and Mathematics Literacy

As indicated, the control strategies were positively related to mathematics literacy in the higher achieving country (Hong Kong), but did not enter the equation in the lower achieving country (Israel). In the book "How Chinese Learn Mathematics" (Lianghuo, et al., 2006) the writers emphasize that Chinese teachers employ control strategies when they teach mathematics problem solving. For example, Shuhua (2006) explains that: "to help students acquire knowledge, teachers … pose questions to promote students' thinking, in which students review prior knowledge and make a connection to new knowledge and acquire new knowledge; to reinforce understanding of new knowledge, teachers engage students in a review of new learning and also use questions to support students' thinking and to gain new insight from the review… teachers ask questions to promote students' active thinking and connect their prior knowledge to the new learning." (p. 466). These teaching and learning processes are in accord with the index of control strategies derived from the frequency with which students use strategies in their learning studying. The question, however, of why students in the lower achieving country reported more frequent use of control strategies, but that index did not predict achievement is still open for future research.

With regard to the differences between students (within schools), it was found that in Hong Kong, students' personal attributes (grade, gender, class-size, number of absences, and sense of belonging) have a greater effect on ML achievements than in Israel. Yet, in Israel, besides the other attributes mentioned above, students' SES background had strong contribution to the prediction of mathematics achievement. Thus, the educational system in Israel, even though cannot influence the student SES, have to shape an educational policy which emphasizes classroom practices and effective use of learning strategies in order to reduce the effects of SES and improve achievements in ML.

Although there is much disagreement in the educational research community about the validity of international studies in education, and although it is questionable the extent to which one country can learn from another country, mainly because cultural factors highly affect the learning processes and the outcomes, the current study identifies some of the factors that distinguish between higher and lower achieving countries. Future studies may continue examining these factors either in natural settings or by implementing interventions that focus on learning strategies and their contribution to ML. Small scale studies have already examined the effects of learning strategies on mathematics achievement (e.g., Cohen, Kramarski & Mevarech, 2009). Yet, large scale studies are definitely needed in order to assess the contribution of the learning strategies to ML. This issue merits future research.

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