

## Structural Relationships among the Variables of Reading Literacy Performance in PISA 2009

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### Abstract

*This study aimed to examine and compare the structural relationships of teaching strategies and students' learning strategies that affected the reading literacy performance of PISA 2009 between Australia and Korea, which stood in the highest reading literacy score group. A structural equation model was employed as the methodology for the study. The data was obtained from the PISA 2009 database. The sample was selected randomly, and a total of 400 cases from each country were used for the analysis. The conclusions were as follows. First, the exogenous variables of teaching strategies influenced the reading literacy performance through the mediating variable, and the goodness-of-fit indices had a reasonable fit in the level of  $\chi^2=703.523(df=173, p=.000)$ . Second, no significance was shown on any paths for the Korean model. On the contrary, for the Australian model those teaching strategies indirectly influenced the reading literacy performance through the mediating variable of memorizing.*

**Keywords:** *Reading literacy, Teaching strategies for reading, Students' learning strategies, Structural equation model*

### 1. Introduction

The OECD has been evaluating education systems and students' outcomes worldwide through PISA since 1998 to strengthen the competitiveness of each country. The primary goal of PISA is to assess students' literacy for reading, mathematics and science, and to analyze relations between students' literacy and background variants in order to help each country build their education policy and plan [1]. The PISA 2009 is noteworthy in that the domain of reading was revisited as a major focus of the assessment. The revisit included a full review of the framework for reading literacy (Print Reading Assessment, PRA) and the inclusion of new elements to reflect the literacy for digital texts (Digital Reading Assessment, DRA).

Sixty five countries participated in PISA 2009. The results of reading literacy in Australia and Korea were significantly higher than the OECD. However, Australia's reading literacy performance had declined between 2000 and 2009, while Korea significantly improved their performance over the same period. Also, the range of reading literacy scores between the 5<sup>th</sup> and 95<sup>th</sup> percentile was 325, wider for Australian students than the Korean average of 258 score points [2]. These are the starting points of this study as a comparative approach for Australia and Korea.

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According to [3], teacher-related factors were the most crucial one that influenced students' reading literacy performance of PISA 2009 in every country. This means that teacher-student interaction is an important variable as a learning psychological factor that affects students' reading achievement. In this regard, many studies also reported that teaching strategies used in the classrooms such as questions, discussions and immediate feedback had impact on students' reading literacy [4-6]. Teaching strategies influence not only students' academic achievement but also students' learning strategies. In the same context, Weinstein and Mayer (1986) claimed that students' learning strategies had correlations with their learning achievements, and cognitive strategies such as memorization and elaboration increased the cognitive activities in students' learning process resulting in a high level of achievement [7]. The findings of Weinstein and Mayer were supported by many researchers [8-10]. Thus, it is suggestive that teachers' teaching strategies have positive effects on both students' learning strategies and their learning achievements, and students' learning strategies may have mediating effect between teaching strategies and students' learning achievements.

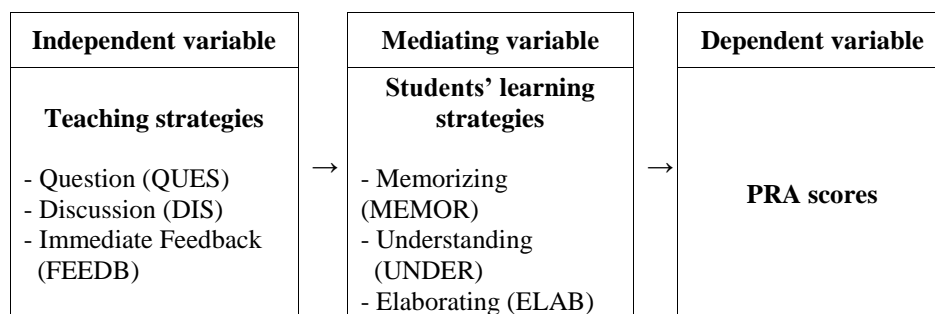
Many previous studies employed regression analysis to define primary causal relationship of variables that affected students' reading literacy. However, in this study, the structural equation model (SEM) is used as the methodology to identify the complex causality of variables by including the estimated errors, and to investigate both direct and indirect influence of variables [11].

This study aimed to examine and compare the structural relationships of teaching strategies and students' learning strategies that affected the reading literacy performance of PISA 2009 between Australia and Korea. Research questions for this study are as follows: First, what are the structural relationships among the variables of teaching strategies and students' learning strategies that affected PRA scores in Australia and Korea? Second, what are the differences between Australia and Korea in the structural relationships among the variables of teaching strategies and students' learning strategies that affected PRA scores?

## 2. Methodology

### 2.1. Hypothesized Model

Based upon the literature review, a conceptual framework of variables is displayed in Figure 1. To summarize, teaching strategies such as question (QUES), discussion (DIS), and immediate feedback (FEEDB) affect students' learning strategies, and students' learning strategies such as memorizing (MEMOR), understanding (UNDER), and elaborating (ELAB), affect PRA scores in turn.



**Figure 1. Conceptual Framework of Variables**

## 2.2. Sampling

In this study, Australia and Korea were compared, which stood in the highest PRA score group. The data was obtained from the PISA 2009 database. The sample was selected randomly by proc surveyselect method of SAS. A total of 400 cases from each country were used for the analysis.

## 2.3. Instrument

The PISA 2009 student questionnaire was used for the study. A total of 15 items were selected. The domain on teaching strategies consists of 5 items and the domain on students' learning strategies consists of 10 items. The items were measured on a 4 point Likert's scale with anchors ranging from strongly disagree (1) to strongly agree (4).

## 2.4. Variables of the Study

In this study, the variables used to test the conceptual model can be categorized as 'observed variables' and 'latent variables' as illustrated in Figure 1. Observed variables are the directly observable or measured variables, whereas latent variables are defined as the variables that are not observed or measured directly. Latent variables can be indirectly measured through observable variables. The three types of latent variables are as follows: The first latent variable is teaching strategies for reading, which consist of QUES, DIS, and FEEDB. The second latent variable is students' learning strategies that consist of MEMOR, UNDER, and ELAB. The last latent variable is PRA scores, which is the reading literacy performance in PISA 2009.

## 2.5. Data Analysis

A structural equation model was employed as the methodology for the study in order to identify the complex causality of variables by including the estimated errors, and to investigate both direct and indirect influence of variables [12]. The AMOS 20.0 software was used to analyze the data. The structural equation modeling with maximum likelihood estimation was used to evaluate the degree to which the hypothesized model fits the data, and to estimate the magnitude and relationships among the variables. In order to evaluate the model fit, Root-Mean-Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI) were used. The expected values for the good model fit interpretation were above 0.90 for GFI, AGFI, NFI, TLI and CFI indices; and between 0.05 and 0.08 for the RMSEA index [13].

## 3. Results

### 3.1. The Model Fit

The model fit determines the degree to which the SEM fits the sample data. To analyze the hypothesized model, the model fit was assessed. As shown in Table 1, the followings are the overall model fit. Goodness-of-fit indices for the hypothesized model were RMSEA=.067, GFI=.908, AGFI=.878, NFI=.930, TLI=.933, CFI=.944, and  $\chi^2=801.882$  ( $df=174$ ,  $p=.000$ ). This model fitted over the overall criteria of the indices except for AGFI.

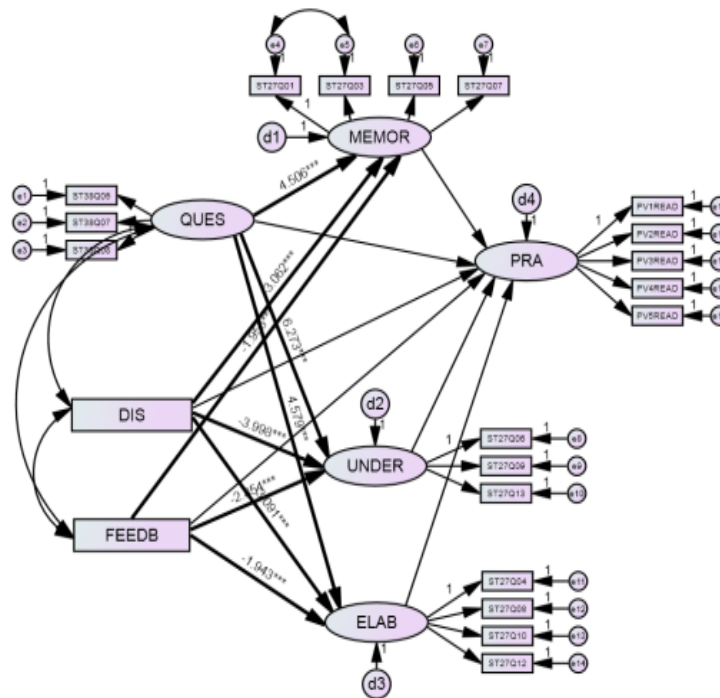
To make the hypothesized model fit well, the model was modified and threshold for modification indices (MI) was settled on 4 [14]. In this process,  $e4 \leftrightarrow e5$  indicated that there was covariance between them as shown in Figure 2, because MI was over 4. As a result, the goodness-of-fit indices for the final modified structural model turned out to be good, showing RMSEA=.062, GFI=.921, AGFI=.894, NFI=.939, TLI=.943, CFI=.953, and  $\chi^2=703.523$  ( $df=173$ ,  $p=.000$ ). In particular, AGFI became acceptable, which was

very close to .90. Thus, the model in Figure 2 suggests that the structural equation modeling analyzes the relationships among teaching strategies, students' learning strategies and PRA scores for both Australia and Korea.

**Table 1. Goodness-of-Fit Indices**

	$\chi^2$	RMSEA	GFI	AGFI	NFI	TLI	CFI
Hypothesized model	801.882 ( <i>df</i> =174, $\rho$ =.000)	.067	.908	.878	.930	.933	.944
Final structural model	703.523 ( <i>df</i> =173, $\rho$ =.000)	.062	.921	.894	.939	.943	.953

When the specific paths were examined, the results showed that teaching strategies did not directly influence the reading literacy performance, nor did students' learning strategies directly influence the scores. Furthermore, those teaching strategies such as QUES, DIS and FEEDB did not indirectly influence the reading literacy performance through the mediating variables of MEMOR, UNDER and ELAB.



**Figure 2. Final Structural Model**

### 3.2. Comparisons of Path Models of Australia and Korea

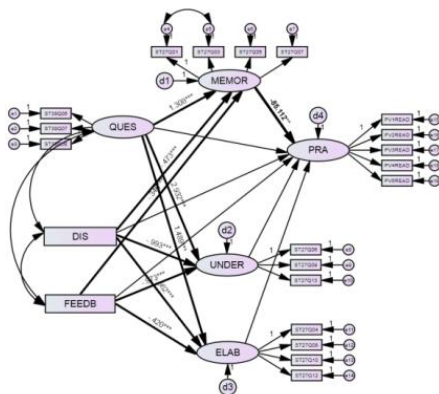
Path models of Australia and Korea were investigated to examine path differences between the two models of Australia and Korea based upon the results mentioned above. To do so, the unstandardized coefficient was used rather than the standardized coefficient for this study. The unstandardized coefficient is appropriate to estimate the differences across the groups, because it indicates the average change in the dependent variable associated with a 1 unit change in the dependent variable, statistically controlling for the other independent variables. Specific results of path models are shown in Table 2.

**Table 2. Unstandardized Coefficients of Path Models in Australia and Korea**

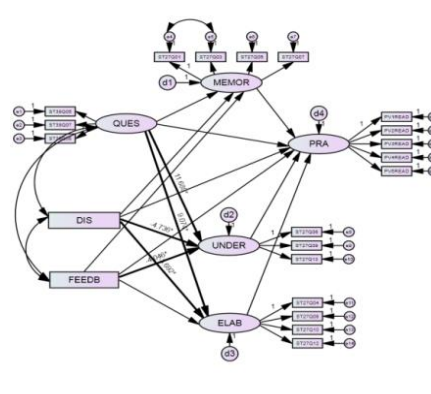
Paths	Model for Australia		Model for Korea	
	Unstandardized B	C.R.	Unstandardized B	C.R.
QUES → MEMOR	1.308	5.929***	5.341	1.951
QUES → UNDER	2.932	7.715***	11.689	1.998*
QUES → ELAB	1.489	6.173***	9.074	1.978*
QUES → PRA	3543.131	.113	1506.485	.004
DIS → MEMOR	-.473	4.958***	-2.166	-1.941
DIS → UNDER	-.993	6.026***	-4.736	-1.985*
DIS → ELAB	-.562	5.361***	-3.692	-1.974*
DIS → PRA	-1205.420	-.114	-626.342	-.004
FEEDB → MEMOR	-.346	4.423***	-1.851	-1.922
FEEDB → UNDER	-.973	6.988***	-4.046	-1.964*
FEEDB → ELAB	-.420	4.885***	-3.074	-1.904
FEEDB → PRA	-1117.996	-.114	-528.843	-.004
MEMOR → PRA	-85.112	-2.699**	9.859	.080
UNDER → PRA	-1071.582	-.101	72.731	-.002
ELAB → PRA	-39.783	-1.539	10.679	.132

\*  $p < .05$  \*\*  $p < .01$  \*\*\*  $p < .001$

As seen in Figure 3, for Korea there was statistical significance only on the five paths of QUES → UNDER, QUES → ELAB, DIS → UNDER, DIS → ELAB, and FEEDB → UNDER in the level of  $p < .05$ . However, for Australia those teaching strategies such as QUES, DIS and FEEDB indirectly influenced the reading literacy performance through the mediating variable of MEMOR, although this variable did not directly influence the reading literacy scores (Figure 4).



**Figure 3. Structural Model for Australia**



**Figure 4. Structural Model for Korea**

## 4. Discussion and Conclusion

This study aimed to examine and compare the structural relationships of teaching strategies and students' learning strategies that affected the reading literacy performance of PISA 2009 between Australia and Korea. The discussion and conclusion drawn from the study are as follows.

First, as the results of the structural model fitted the exogenous variables (QUES, DIS and FEEDB) of teaching strategies influencing students' reading literacy performance through the mediating variables (MEMOR, UNDER and ELAB), the goodness-of-fit indices had a reasonable fit, showing that the indices were  $\chi^2=703.523(df=173, \rho=.000)$ , RMSEA=.062, GFI=.921, NFI=.939, TLI=.943 and CFI=.953, and AGFI was acceptable in the value of .894. The results support the finding of Roh (2009) that teaching strategies had greater positive effects on students' reading achievement through students' learning strategies in learning the Korean language [15].

At the same time, the results of this study indicate that first of all, various students' learning strategies should be developed in order to improve the students' reading literacy performance, because teaching strategies did not directly influence the reading literacy performance. Some researchers suggested that content-specific learning strategies were more effective than general learning strategies [16]; Others insisted that cognitive and metacognitive strategies were actively used, because students' reading literacy should be developed depending on the unique characteristics of reading [17].

Second, the goodness-of-fit indices of the Australian and Korean models appeared satisfactory as a result of the analysis. This means that the structural model can be used for both Australia and Korea. When the specific paths were examined, the Korean model had no significance on most of the paths except for the five paths: QUES  $\rightarrow$  UNDER, QUES  $\rightarrow$  ELAB, DIS  $\rightarrow$  UNDER, DIS  $\rightarrow$  ELAB, and FEEDB  $\rightarrow$  UNDER. On the contrary, for the Australian model those teaching strategies such as QUES, DIS and FEEDB indirectly influenced students' reading literacy performance through the mediating variable of MEMOR, although all six variables did not directly influence the reading literacy scores. This shows that an endogenous variable of memorizing can act as a mediator between teaching strategies and students' reading literacy performance.

For Korea, the results of the study showed that teaching strategies did not directly influence the reading literacy performance although the strategies affected students' learning strategies, nor did students' learning strategies directly influence students' reading literacy performance. Therefore, it is quite suggestive that further researches should be conducted to find various other factors explaining the reading literacy scores. For Australia, however, teaching strategies did not directly influence students' reading literacy performance, but the teaching strategies indirectly influenced the reading literacy scores through a learning strategy of memorizing. This indicates that an endogenous variable of memorizing can act as a mediator between teaching strategies and students' reading literacy performance.

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