Abstract Title Page

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Title: How do students' problem solving strategies and preferences in learning environments relate to their mathematical performance? A comparative study between South Korea and the United States

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Abstract Body

Limit 4 pages single spaced.

Background / Context:

Description of prior research and its intellectual context.

Mathematics education has emerged to be of prime importance in the United States, as American students' performance has shown to be consistently and significantly lower than many other nations in the world (Rampey, Dion, & Donahue, 2009; National Center for Education Statistics, n.d.; OECD Programme for International Student Assessment, n.d.). Sparked by an interest to understand factors that are associated with such differential performance, mathematics education researchers have been drawn to international comparative research. In order to understand the differences and similarities between the U.S. and other countries across multiple dimensions of the learning and teaching of mathematics, curricula, and educational systems, international comparative studies in mathematics education have resulted in both in-depth, qualitative studies as well as hard, quantitative data analyses. Most prominent studies include those that compare the U.S. and other high-performing East Asian countries such as China, Korea, Singapore, and Japan, across elementary and middle school levels (Cai, 2000, 2002; Kaiser, Leung, Romberg, & Yaschenko, 2002; Leung, 2001; Paik, 2004; Stevenson, 1993; Stevenson & Stigler, 1992; Stigler, Lee & Stevenson, 1987; Tsao, 2004). However, there is a dearth of studies that focus on high school students, especially in comparing those of South Korea with the United States.

Purpose / Objective / Research Question / Focus of Study:

Description of the focus of the research.

The purpose of this study is to fill this gap in research, and to identify the extent to which different cultural and institutional factors influence student mathematical learning. Specifically, this will be a comparative analysis between high school students in South Korea and the United States, across three context levels: national level, school organizational level (e.g., mathematics curricula), and modes of mathematical problem solving and preference (e.g., metacognition). By using available data from the PISA 2003 study, which had a focus on mathematical learning, the author employed hierarchical linear modeling (HLM) to analyze how much variation in student performance can be accounted for by various levels of contexts, and specifically examine the relationship between student modes of mathematical problem solving and preference for learning environments and their actual learning outcomes.

The proposed study is particularly interesting in that it addresses two major concerns. First, it targets a population that has been previously under-studied before. There have been few studies that compare mathematics learning in South Korean students with American students at a younger age, but almost none with high school students. Whether it is due to political reasons, convenience, or the fact that Korea has not been participating in the high school international studies (presumably due to the preparation for extremely high stakes national testing), the dearth of such comparative research between these two countries warrants that it may be worthwhile investigating. It is conceivable that different results may emerge as South Korea has a completely different alphabetic and linguistic system from China, Japan and Singapore; different influences of western cultures (more influenced by the US in the past few decades than China, for example); as well as potentially different belief systems about competition, in contrast to Japan, whether it is in education, sports, or science.

Second, it uses a relatively new methodology to reveal the relationships between modes of learning and preference of learning environments and students' learning outcomes. In light of the ever so increasing globalization and increase in diversity of the American population, understanding similarities and differences between cognitive strategies as a function of cultural context, and their effects on mathematical performance can have practical implications for mathematics education policy, as well as a theoretical contribution to international comparative research.

Setting:
Description of the research location.

N/A

Population / Participants / Subjects:

See Data Collection and Analysis

Intervention / Program / Practice:
Description of the intervention, program, or practice, including details of administration and duration.
For Track 2, this may include the development and validation of a measurement instrument.

N/A

Research Design:
Description of the research design.

See Data Collection and Analysis

Data Collection and Analysis:
Description of the methods for collecting and analyzing data.
For Track 2, this may include the use of existing datasets.

For the *preliminary* analysis included herein, the author used a two-level hierarchical linear model (HLM) to analyze the PISA 2003 data. Country level variables such as log GDP per capita, GDP Gini index or the HPI index will be included in a three-level HLM (which is currently incomplete).

Informed by the descriptive statistics and scatter plots of the raw data, as well as the constructs measured through the items in the survey data, the author built a simple two-level hierarchical model. This preliminary model includes variables that were found to be significant predictors of mathematical performance, both at the individual and school levels. These include the individual's gender, SES, school size, pupil teacher ratio, and school level gender composition. Starting with the variances components model to test if the variances were significant at each level, the author then included student background variables and learning strategies and preference variables. Next, school level variables were included. Interaction effects between levels were examined, but none were found to be significant and were hence removed. The two-level model used for preliminary analysis is as follows:

Level-1 Model

Y = B0 + B1(SES) + B2*(Metacognition) + B3*(Elaboration) + B4*(Memorization) + B5*(Competitive) + B6*(Cooperative) + B7*(Male) + R*

Level-2 Model

B0 = G00 + G01(SchoolSize) + G02*(PercentGirls) + G03*(PupilTeacherRatio) + U0*
B1 = G10
B2 = G20
B3 = G30
B4 = G40
B5 = G50
B6 = G60
B7 = G70

The author would like to note that as this is a simplified model, the results presented herein may change with added complexity. However, this simple model suggests some striking differences that emerge as a function of cultural context in student mathematical performance.

Findings / Results:

Description of the main findings with specific details.

Some preliminary findings suggest that the two countries are similar in that the between-school variation is much smaller than the within-school variation. However, at the student level, in terms of cognitive problem solving strategies and learning environment preferences, interesting similarities and differences emerge.

For example, across the two countries, memorization techniques are negatively associated with performance, while metacognitive strategies seem to be most positively associated with performance. This result is not too surprising. The interesting difference is in the elaboration techniques. This is defined by PISA as a strategy where students engage in thinking about real world applications, solving a problem in multiple different ways, and evoking knowledge that they already know and connecting the new knowledge in a meaningful manner. This seems to be positively associated with Korean students' performance, but not related to that of American students. This is striking, especially given that, in the US, there is increasing focus on multidisciplinary ties across domains in high school. This result seems to suggest that there may be differences in the ways in which elaboration techniques are used across these two countries, and that students in Korea may have different content and contextual understanding of what it entails to use elaboration strategies than those in the US.

Another difference that emerges from this preliminary analysis is that students who prefer to work in cooperative learning environments tend to have lower mathematical scores in America, but higher mathematical scores in South Korea. Some researchers may argue that this is evidence for the collectivist-individualist framework that has been extensively used in the literature to frame differences in culture. However, interestingly, results also show that across both countries, students who prefer competitive learning environments tend to have higher mathematical performance.

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

The preliminary results indicate that the cognitive strategies and preference for learning environments share some similarities and differences across Korea and the United States. In addition, these factors are differentially associated with mathematical performance. As mentioned before, these results are based on a simple model and are amenable to change after the inclusion of country-level and other factors which have not yet been examined. However, based on these results, one could argue that significant differences exist on the use of elaboration techniques and its relationship to students' mathematical performance, as well as on the relationships between preference for cooperative or competitive learning environments and students' actual performance.

This study points to the importance of more in-depth qualitative studies that will illuminate the processes in which students engage in these problem strategies, and investigate whether there could be any universal deliverables that can be ported to other learning contexts. This study also points to the importance of understanding the overarching context in which learning occurs, as societal, institutional, cultural values can influence the relationship between cognition and performance in different ways.

Appendices

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Appendix A. References

References are to be in APA version 6 format.

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Appendix B. Tables and Figures

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Table 1. HLM Results for USA

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	485.437126	3.350850	144.870	200	0.000
SCHLSIZE, G01	0.009929	0.004943	2.009	200	0.046
PCGIRLS, G02	39.448982	35.148478	1.122	200	0.264
STRATIO, G03	-1.181355	0.787480	-1.500	200	0.135
For HISEI slope, B1					
INTRCPT2, G10	1.147540	0.089215	12.863	3614	0.000
For CSTRAT slope, B2					
INTRCPT2, G20	8.712940	1.919018	4.540	3614	0.000
For ELAB slope, B3					
INTRCPT2, G30	-6.429525	1.872511	-3.434	3614	0.001
For MEMOR slope, B4					
INTRCPT2, G40	-1.136813	1.998509	-0.569	3614	0.569
For COMPLRN slope, B5					
INTRCPT2, G50	11.111229	1.757010	6.324	3614	0.000
For COOPLRN slope, B6					
INTRCPT2, G60	-9.586109	1.236499	-7.753	3614	0.000
For MALE slope, B7					
INTRCPT2, G70	8.847670	2.553918	3.464	3614	0.001

Table 2. HLM results for Korea

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For INTRCPT1, B0					
INTRCPT2, G00	533.841642	4.489606	118.906	137	0.000
SCHLSIZE, G01	0.034008	0.012416	2.739	137	0.007
PCGIRLS, G02	5.711618	11.217843	0.509	137	0.611
STRATIO, G03	6.224250	2.400906	2.592	137	0.011
For HISEI slope, B1					
INTRCPT2, G10	0.262144	0.071362	3.673	4860	0.000
For CSTRAT slope, B2					
INTRCPT2, G20	11.582245	1.729528	6.697	4860	0.000
For ELAB slope, B3					
INTRCPT2, G30	5.435935	1.552709	3.501	4860	0.001
For MEMOR slope, B4					

INTRCPT2, G40	-10.902516	1.361919	-8.005	4860	0.000
For COMPLRN slope, B5					
INTRCPT2, G50	11.714803	1.661627	7.050	4860	0.000
For COOPLRN slope, B6					
INTRCPT2, G60	7.170359	1.683540	4.259	4860	0.000
For MALE slope, B7					
INTRCPT2, G70	12.557038	3.208651	3.913	4860	0.000
