Examining the Impact of Language Proficiency on Mathematics Achievement Using a High-Stakes Achievement Test

Seon-Hi Shin and Ah-Young Kim
(Seoul National University)

Shin, Seon-Hi and Ah-Young Kim. (2011). Examining the Impact of Language Proficiency on Mathematics Achievement Using a High-Stakes Achievement Test. *Language Research* 47. 2, 175-189.

The study investigated the relationship between Korean 9th grade students' Korean language proficiency and their math achievement using the data from the 2008 National Assessment of Educational Achievement (NAEA) administration. It also examined the effects of various contextual characteristics surrounding schools and students on student achievement. The contextual effects were further compared between two language proficiency groups. The findings of the study showed that father's education, amount of conversation with parents, and self-reported effectiveness of learning were positively related to student math achievement in both language groups. However, the higher language proficiency group reported higher ratings in those aspects. In addition, male students outperformed their counterparts in the test, regardless of their language proficiency level.

Keywords: language proficiency, mathematics achievement, contextual effects

1. Introduction

Numerous studies suggest that language proficiency affects mathematics achievement for children (Abedi, Bailey, Butler, Castellon-Wellington, Leon, & Mirocha 2005, Abedi, Leon, & Mirocha 2003, Abedi & Lord 2001, Balow 1964, Beal, Adams, & Cohen 2010, Brown 2005, Butler & Castellon-Wellington 2005, Chang, Singh, & Filer 2009, Freeman & Crawford 2008, Fry 2007). It is not surprising to find a vast volume of literature on the language-learning relationship because language is believed to be the gateway for learning and the vehicle that facilitates acquisition of new knowledge through direct and indirect interaction with teachers and peers, as well as through the reflective processes of introspection (Francis & Rivera 2007).

Language proficiency alone, however, does not fully explain the differences in students' math achievement. Several other factors are believed to affect learners' math performance, such as socioeconomic status (SES) (Abedi 2004, Beal et al. 2010, Brown 2001, 2005, Krashen & Brown 2010), school curriculum/student support (Garcia, Lawton, & Diniz de Figueiredo 2010, Han & Bridglall 2009), and teaching quality (Friend, Most, & McCrary 2009). In addition, parents' educational level (Abedi et al. 2005) and student gender (Benbow & Stanley 1980, Gallagher, De Lisi, Holst, McGillicuddy-De Lisi, Morely & Calahan 2000, Leahey & Guo 2001, Mau & Lynn 2000) are reported to influence students' achievement.

In recent years, Korean students have shown high performances in international achievement tests (Mullis, Martin, & Foy 2008, OECD 2010). However, some students are reported to experience academic failure due to their lack of language proficiency (Choi 2008, Choi 2010, Kwon 2006, Un 2009, Won 2007). The current study aimed at investigating the relationship between Korean students' Korean language proficiency and their math achievement. In addition, it examined the effects of various contextual characteristics surrounding schools and students on student performance. The contextual effects were further compared between high and low language proficiency groups. In particular, the research questions of the study include

1. Does language proficiency affect students' achievement in mathematics?
2. How do contextual variables affect students' mathematics achievement in relation to their language proficiency?
3. Which contextual variables affect students' achievement in mathematics regardless of language proficiency?

2. Methods

2.1. Data Sources

The present study analyzed the mathematics scores of the National Assessment of Educational Achievement (NAEA) administered to a sample of Korean 9th graders in public schools in 2008. The NAEA (Ban 2006) is a government-mandated achievement test to assess whether students have acquired content knowledge and performance skills aligned to common educational standards in five content domains such as Korean language arts (KLA), Mathematics, Science, English, and Social Studies. The test provides test takers from three grade levels – 6, 9, 11(12 since 2010) – with scale scores and performance levels. The goal of NAEA is to examine and improve the quality of school education at the national level. Specifically, the purpose of assessing KLA is to examine students' achievement level of Korean and, based on this information, explore ways to enhance learning of Korean. In ninth grade, Korean language subject measures five areas of listening, reading, writing, grammar, and literature (Lee & Chung 2010). On the other hand, the NAEA mathematics test administered to 9th grade students is constructed to measure whether students have attained learning objectives stated in the curriculum for the grade. The content areas covered by the test include number operation, geometry, regularity and function measurement, probability and statistics, and algebra. The scale score for the grade 9th test was developed in 2003 such that the mean should be 260 and the standard deviation 8.5 score points (Ban 2006). The scale was maintained through IRT-based equating until 2010 when a new scale was developed.

The students who took the test were asked to fill out a survey questionnaire. Their teachers and principals were also surveyed. For this study, students' test scores were merged with their survey responses and further with the principals' survey responses before conducting data analyses. The principal's responses to the survey items provided information of the characteristics of the school that a student attended whereas the student's survey responses conveyed his or her personal background information. After merging the files, the number of student records being used in the analysis was 33,524. The records were further split into the two language groups using KLA level scores—high and low proficiency groups. In the original data, there were four achievement levels in each subject matter test: Below basic, Basic, Satisfactory, and Above satisfactory. When a student attained at the level of Satisfactory or higher the student was included in the high language group; otherwise, a student was grouped in the low language group.

2.2. Data Analysis Procedure

The NAEA test was administered to randomly selected students. The data collection design was a two-stage sampling design. A sample of schools was selected from a complete list of schools containing the student population of interest, and then students were randomly selected within the selected schools. Furthermore, surveys were administered to students and schools' principals to gather the contextual information surrounding schools and students. Thus, the data were multilevel with students at the lower level and schools at the upper level. When a conventional multiple regression is applied to multilevel data, the Type-I error rate associated with a significance test is known to be inflated (Bryk, & Raudenbush 1992, Littell, Milliken, Stroup, & Wolfinger 1996, Verbeke & Molenberghs 2000).

Therefore, the data were analyzed by formulating a 2-level hierarchical linear modeling (HLM) for each language ability group. For each group, the outcome variable at the first level was the math scale score and the predictor variables at the same level were contextual variables created from the student's survey responses. The model intercept was assumed to be random and the predictor variables at the second level were school-related background variables created from the principal's responses to the survey. For selecting the predictor variables for this study, a careful review of the survey questionnaire along with a literature review was performed. The contextual variables and their corresponding survey questions are shown in Table 1. As is shown in the table, gender was the only dichotomous variable with males coded as 1 and females as 2.

The following is the conditional HLM for the study:

$$Y_{ij} = \{\beta_{00} + \beta_{01}(\text{MATR}) + \beta_{02}(\text{ADDCLS}) + \beta_{03}(\text{LVLCLS}) + \beta_{04}(\text{TCHENTH}) + \beta_{10}(\text{GENDR})_j + \beta_{20}(\text{DADEDU})_j + \beta_{30}(\text{MOMEDU})_j + \beta_{40}(\text{NBOOKS})_j + \beta_{50}(\text{CONVS})_j + \beta_{60}(\text{SLFEFF})_j\} + \{d_{0j} + e_{ij}\}, \quad (1)$$

where Y_{ij} is the math scale score for student i in school j, and the first and second curly brackets contain the fixed and random effects of the model, respectively. The two random effects are assumed to be normally distributed with mean 0 and variance σ^2 or τ^2 each. The random effects are also assumed to be independent of each other. Centering will be done around the grand mean for all predictors except gender to facilitate the interpretation of the model intercept, although the interpretation of the intercept was not of primary interest in this study. Hence, the intercept, β_{00} means the math score that a typical male student would expect to obtain when his scores on the other predictors were identical to their grand means.

The unconditional model is presented as follows:

$$Y_{ij} = \beta_{00} + \{d_{0j} + e_{ij}\}, \quad (2)$$

where the only fixed effect of the model is the intercept and it indicates the grand mean of the math scale score for the language ability group under investigation. The sum of the two coefficients, $\beta_{00} + d_{0j}$, represents the average math scale score for the jth school while the residual, e_{ij} stands for the deviation score of the ith student in the jth school from the group average score.

Table 1. Predictors and Corresponding Survey Questions

Name of predictor (Score composition)	Level of predictor	Survey question
MATR	2	How hard does your school try to provide students with material resources such as school facilities, classroom devices and materials? 1 – Not at all 5 – Quite a lot
ADDCLS	2	How hard does your school try to provide students with supplementary lessons or autonomous learning enhancement? 1 – Not at all 5 – Quite a lot
LVLCLS	2	How hard does your school try to provide students with instruction by achievement level? 1 – Not at all 5 – Quite a lot
TCHENTH	2	How would you describe your teachers' enthusiasm for teaching? 1 – Very low 5 – Very high
GENDR	1	Student gender. 1 – Male 2 – Female
DADEDU	1	What is your father's highest degree? 1 – Middle school graduation 4 – Graduate school graduation or higher degree
MOMEDU	1	What is your mother's highest degree? 1 – Middle school graduation 4 – Graduate school graduation or higher degree
NBOOKS	1	How many books except textbooks or supplementary books do you read a month? 1 – Very few 6 – More than 9 books
CONVS	1	How often do you have a conversation with your parents? 1 – Seldom 4 – Almost everyday
SLFEFF (Mean of item scores)	1	Check a right description of your learning in the following list. I can understand things in most subject matters fast. I can identify critical pieces of information out of what is taught in class well. I know how to study effectively. I can connect what I learned previously with new content just learned in class. I can tell what I know from what I don't in the content that I have learned in class. I can understand complex and difficult content easily. I can remember what I have learned in class well. I can summarize verbally important information while studying. 1 –Not at all 4 –Very much

Note. The variable SLFEFF indicates self-reported effectiveness in learning.

3. Results

3.1. Descriptive Statistics

Twenty five missing cases occurred in creating the dichotomous language proficiency grouping variable (0 – Satisfactory or higher, 1 – Basic or lower). The numbers of the students of the two groups were 21,191 and 12,308 each. The high language proficiency group scored an average of about 266 points in the math test whereas the low language proficiency group scored about 155 points on average. This implies that language proficiency is positively related with math proficiency. Namely, as a student is more proficient in test language the student is more likely to earn a higher math score. More females were included in the high language ability group. However, more males pertained to the low language ability group. Table 2 shows these descriptive statistics by language group. The descriptive statistics of the remaining predictor variables are also presented in Table 2. As is shown in the table, those predictor variables at the student level showed higher scores on average in the high language ability group. The variables reflecting school background information were based on the school principal's responses to the school survey questionnaire. Since the students from the same school were split into two language groups in the analysis, the school information was identical for both groups. Thus, the de-

Table 2. Descriptive Statistics of Explanatory and Outcome Variables

Variable	Ability					
	High ability			Low ability		
	N	Mean	Std	N	Mean	Std
Math Score	21191	266.38	8.80	12308	254.67	5.53
MATR[1]	994	4.08	0.65	994	4.08	0.65
ADDCLS[1]	995	3.78	0.73	995	3.78	0.73
LVLCLS[1]	996	3.73	0.69	996	3.73	0.69
TCHENTH[1]	993	4.09	0.67	993	4.09	0.67
GENDR[2]	10274[M]			8413[M]		
	10917[F]			3895[F]		
DADEDU	18676	2.63	0.73	9266	2.35	0.73
MOMEDU	18549	2.42	0.66	9118	2.23	0.66
NBOOKS	21163	2.52	1.44	12274	2.13	1.32
CONVS	21156	3.26	0.82	12268	2.96	0.91
SLFEFF	21175	2.61	0.45	12287	2.24	0.45

[1]The descriptive statistics of school-level predictors are identical for both language groups.
[2]The dichotomous variable shows frequencies.
[M]Frequency for males.
[F]Frequency for females.

scriptive statistics for the school-level variables remain the same between the two groups in Table 2. The predictor variables at the school level showed an average rating score of 3.74 to 4.08 which are negatively skewed on a 1-5 scale, indicating that the principals were inclined toward higher rating scores on the survey questions.

3.2. HLM

The results of the unconditional HLM analysis on the 2008 data show that the expected math score (β_{00}) of the high language proficiency group was higher than that of its counterpart (Table 3). The expected scores were interpreted as such given the condition that the predictor variables should take on their average scores. This finding was consistent with the result of the descriptive statistics which showed that the average math score of the high language ability group was higher compared to the low language ability group. Looking at the variances, both language groups showed a relatively low degree of intra-class correlation, meaning that the math scores between schools were much more homogenous than those between students.

In the results of the conditional HLM analysis, more significant results came out in the high language proficiency group (Table 4). All four predictors which turned out significant in the low language proficiency group were also significant in the other language group. These predictors were student gender (GENDR), father's educational level (DADEDU), degree of conversation with parents (CONVS), and self-reported effectiveness of learning (SLFEFF), respectively. Except for gender, all three predictors showed a positive relationship with math achievement. That is, as the educational degree of student's father became higher, as the student had a conversation with parents more often, and as the student reported higher efficiency in learning, the student's score tended to become higher. On the other hand, gender showed a negative

Table 3. Parameter Estimates of the Unconditional Model

Fixed effect coefficient (*SE*)	Language ability	
	High	Low
Intercept, β_{00}	266.61* (0.10)	255.04* (0.08)
Random effect	**Language ability**	
	High	Low
Intra-class correlation, ρ	0.07	0.07
Level-1 variance, σ^2	72.05	31.71
Level-2 variance, τ^2	5.66	2.12

$^*p < .05$

effect. This effect means that the female students scored lower in the math test than their counterparts on average within each language group. The four predictors were at the student level. None of the predictors at the school level turned out significant in the low language proficiency group.

In addition to the four significant predictor variables at the student level, the mother's education level (MOMEDU) was positively associated with student achievement in the high language proficiency group. For this group, the number of general books at home except textbooks or supplementary books (NBOOKS) was negatively related with student math achievement. Among the school-level predictors, only instruction by achievement level (LVLCLS) turned out significant and the effect was negative for the high language ability group. The effect was negative but not strong enough to be significant for the low language ability group. This indicates that as a school reported to make more efforts in providing curriculum instruction by achievement level the students tended to score lower in the math test. This effect stood out in the high language ability group with statistical significance. However, there was no sufficient evidence to believe that the effect of a variable was either positive or negative in the population when the variable was not statistically significant at the rejection level of .05. For instance, the coefficient of the predictor, ADDCLS was negative but not statistically significant. Following the convention of inferential statistics, this negative effect was interpreted as not authentic

Table 4. Parameter Estimates of the Conditional Model

Fixed effect coefficient	Language ability	
	High	Low
Intercept, β_{00}	267.8610*	255.3495*
MATR, β_{01}	0.1989	0.0013
ADDCLS, β_{02}	-0.0503	0.0931
LVLCLS, β_{03}	-0.2912*	-0.0148
TCHENTH, β_{04}	0.1678	0.0375
GENDR, β_{10}	-2.1795*	-0.8874*
DADEDU, β_{20}	1.2734*	0.9531*
MOMEDU, β_{30}	0.9365*	-0.0571
NBOOKS, β_{40}	-0.1766*	0.04629
CONVS, β_{50}	0.4330*	0.1510*
SLFEFF, β_{60}	6.7452*	2.4188*
Random effect	Language ability	
	High	Low
Level-1 variance, σ^2	59.56	27.79
Level-2 variance, τ^2	3.09	1.64

$^{*}p < .05$

but a mere result from sampling fluctuation.

When the predictors were added to the model, the observed variance at each level was reduced by 17% for the high language ability group, and by 12% for the low language ability group (Figure1). This means that the predictors as a whole could explain the observed variance by such percentages. The percentage of the reduction in the variance dramatically increased at the school level for both language groups. They were 45% and 23% for the high and low language proficiency groups each. However, the large percentage should not be misleading in interpretation. The intra-class correlation presented earlier showed that only 7% of the total variance happened at the school level. Therefore, the amount of explanation really means that 45% of the 7% of the total variance was explained by the student-level predictors in the high language ability group for instance.

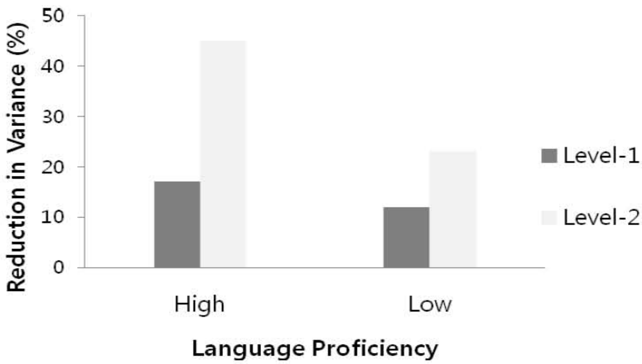

Figure 1. Reduction in Variance.

4. Discussion

The purpose of this study was to examine the effect of Korean language proficiency and contextual variables on mathematics performance for ninth grade students. Findings indicated that language proficiency was positively related to math performance. Previous research, using English proficiency data, has also found similar results. For example, Beal et al. (2010) found that English reading skill was significantly related to math performance for 9th grade students in the U.S., whereas measures of English conversational proficiency (speaking and listening) were not. In addition, she suggested that there may be a minimum reading level associated with improvement in math performance. Specifically, the regression analysis indicated that math performance was essentially flat for students with reading scale scores below 550 on the California English Language Development test (CELDT), whereas there was linear improvement in math as reading scores increased above 550.

provement in math as reading scores increased above 550. Thus, the findings of this study in combination with literature suggested that the test language proficiency—whether it being English or Korean—had an impact on math performance.

Moreover, results indicated that the following four variables affected math performance across language proficiency levels: student gender, father's educational level, amount of conversation with parents, and self-reported effectiveness of learning. Regarding gender, male students outperformed female students at both the high and the low language proficiency levels. This finding was in line with prior research, which indicated that males were better than females in math (Benbow & Stanley 1980, Gallagher et al. 2000, Leahey & Guo 2001, Mau & Lynn 2000).

Similarly, parents' educational level influenced math performance across language proficiency levels. In fact, parents' educational level is a very strong predictor of students' math achievement (Abedi et al. 2005, Montoya 2010). For example, Montoya (2010) explored factors underlying the achievement gap between White and Hispanic students using the North Carolina public school database. She found that parents' educational level was the most important individual variable: on average, white students had better educated parents and that translated to higher test scores on math and reading. Likewise, in this study, students' father's educational level affected math performance across language proficiency groups. For the high language proficiency group, mother's educational level affected math performance as well. This is not surprising, considering that parents' educational level is an index of one's socioeconomic status (SES), which has been known to influence academic performance (Abedi et al. 2003, Brown 2001, Krashen & Brown 2010). It is worth noting that the mean education levels of both parents turned out higher for the high language proficiency group than its counterpart in this study (Table 2). This implies that parent education may also influence their child's performance level of academic language.

Interestingly, findings indicated that the amount of conversation a student has with his or her parents had a positive effect on students' math scores across language proficiency groups. A previous study which analyzed the 2009 NAEA data using hierarchical generalized linear modeling also reported that the more time high school students spent in conversation with parents they tended to score higher in the test (Ban & Shin 2011). Although a literature review led to few studies on the relationship between conversation amount and language performance, the data of this study showed that the high language proficiency group engaged in more conversation with their parents (Table 2).

Furthermore, students' self-reported effectiveness of learning had a positive effect on students' math scores across language proficiency groups. The students from the high language proficiency group reported a higher degree of the effectiveness on average, which may indicate a positive relationship between language proficiency and learning effectiveness. As seen in Table 1, in this study, learning effectiveness measured one's perceived capability to learn and to study. Thus, it involves one's self-confidence in learning. The results from this study are in accordance with previous findings. For example, Loveless (2006) analyzed data from the Trends in International Mathematics and Science Study (TIMSS) in 2003 and found that learners who expressed confidence in their own math abilities outperformed learners who lacked confidence. Thus, not surprisingly the current data indicated that students' confidence level positively influenced their academic performance.

In addition to the four contextual variables discussed above (i.e., student gender, father's educational level, amount of conversation with parents, and self-reported effectiveness of learning), two more variables influenced math performance at the high proficiency group: the number of books and the instruction by achievement level. It needs to be reminded that the books did not include textbooks and curriculum-related supplementary books. Findings indicated thatthe number of books students had at home showed a negative effect on math performance. This somewhat makes sense since math skills are hardly believed to be affected by the amount of books outside the curriculum a student reads. Nevertheless, the number of books at home may affect reading performance. For example, Kirmizi (2011) investigated the relationship between levels of reading comprehension strategy use, reading attitudes, and the amount of reading per year among fourth and fifth grade students in Turkey. The findings showed that there was a negative and low-level relationship between daily time spent on reading and the level of strategy used, and a positive and low-level relationship between the level of strategy used and the number of books that a child reads per year. The high language proficiency group reported a larger number of books at home in this study. The difference in the average number of books at home between the two language groups may reflect the impact of reading on academic language proficiency.

Instruction by achievement level was the only school-level predictor that affected math performance. In fact, previous research indicated that instructing students by achievement level affected students' mathematics achievement in varying degrees depending on learners' English language ability. For instance, Chang et al. (2009) found that when examined cross-sectionally, achievement grouping had a negative effect on the math achievement from kindergarten to fifth grade. Contrarily, Hoffer (1992) found both positive and negative effect of grouping on math performance. In detail, Hoffer compared average student achievement growth in reading and math from the seventh to the ninth grades in grouped and non-grouped schools. Placing students into a high-group generally had a weak positive effect, while placing them in a low-group had a stronger negative effect. Ability grouping thus appears to benefit advanced students, but harm lower students, and have a negligible overall effect as the benefits and liabilities cancel each other out.

In the current study, as the school made more efforts to provide classes according to different achievement levels, the school's overall performance in the math test tended to be lower. This tendency was strong enough to be statistically significant in the high language proficiency group. Unlike unique student characteristics, the school's characteristics were shared by both language groups. Hence, the effect of a school predictor can be understood as the common school effect across the language groups. With that being said, the schools scoring a lower average math score appeared to report that they made more efforts of providing classes by achievement level.

5. Conclusion

The findings of this study provide some suggestions for educational administrators and policy makers in the Korean middle school context. The effort of grouping students into different achievement levels had a negative effect on math performance at the high language proficiency level. Therefore, at the school level, such grouping may not necessarily be beneficial for improving students' math performance. More contextual factors at this level need to be examined in future research

At the individual student level, several contextual variables (e.g., student gender, father's educational level, amount of conversation with parents, self-reported effectiveness of learning, number of books read) affected students' math achievement regardless of their language proficiency level. Thus, these factors should be taken into account when the impact of language proficiency on math achievement is investigated in future studies if the data are accessible. As shown in the descriptive statistics, parental factors such as parents' education level and time for conversation with children, and a home environment factor such as having more books at home may make a difference in students' language proficiency. Encouraging students to have more confidence in learning may help them improve their language proficiency.

The findings of this study are based on a year's data, hence study implications are limited. The significant effects found in the study need to be replicated in a comprehensive longitudinal study with cumulative years of data. Although such endeavor was beyond the scope of this paper, this study can add to collective efforts of the educational community to deepen an understanding of the educational phenomenon regarding "the role of language proficiency on students' academic achievement".

References

Abedi, J. and Lord, C. (2001). The language factor in mathematics tests. *Applied Measurement in Education* 14.3, 219-134.

Abedi, J., Leon, S., and Mirocha, J. (2003). *Impact of student language background on content-based performance: Analyses of extant data* (CSE Tech. Rep. No. 603). Los Angeles: University of California, National Center for Research on Evaluation, Standards, and Student Testing.

Abedi, J. (2004). The No Child Left Behind Act and English language learners: Assessment and accountability issues. *Educational Researcher* 33.1, 4-14.

Abedi, J., Bailey, A., Butler, F., Castellon-Wellington, M., Leon, S., and Mirocha, J. (2005). *The validity of administering large-scale content assessments to English language learners: An investigation from three perspectives*. Los Angeles: University of California, National Center for Research on Evaluation, Standards, and Student Testing.

Balow, I. H. (1964). Reading and computation ability as determinants of problem solving. *Arithmetic Teacher* 11*,* 18-22.

Ban, J. (2006). The development of the National Assessment of Educational Achievement. *Korean Journal of Educational Evaluation* 19.2, 113-135.

Ban, J. and Shin, S. (2011). Trend of the effects of multilevel contextual variables on student achievement: 2003-2009 NAEA Data Analysis. *Korean Journal of Educational Evaluation* 24.3, 685-712.

Beal, C., Adams, N. M., and Cohen, P. R. (2010). Reading proficiency and mathematics problem solving by high school English language Learners. *Urban Education* 45.1, 58-74.

Benbow, C. P. and Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? *Science* 210*,* 1262-1264.

Brown, C. L. (2001). *The equitability of the Maryland School Performance Assessment Program for limited English proficient students: A study of third graders.* Unpublished doctoral dissertation, The George Washington University, Washington, DC.

Brown, C. L. (2005). Equity of literacy-based math performance assessments for English language learners. *Bilingual Research Journal* 29.2, 337-497.

Bryk, A. S. and Raudenbush, S. W. (1992). *Hierarchical linear models*. Newbury Park, CA: Sage Publications.

Butler, F. A. and Castellon-Wellington, M. (2005). Students' concurrent performance on tests of English language proficiency and academic achievement. In J. Abedi, A. Bailey, F. Butler, M. Castellon-Wellington, S. Leon, and J. Mirocha (Eds.). *The validity of administering large-scale content assessments to English language learners: An investigation from three perspectives* (pp. 47-83). Los Angeles: University of California, National Center for Research on Evaluation, Standards, and Student Testing.

Chang, M., Singh, K., and Filer, K. (2009). Language factors associated with achievement grouping in math classrooms: A cross-sectional and longitudinal study. *School Effectiveness and School Improvementm* 20.1, 27- 45.

Choi, J. (2008). Task of sustantialization of teaching Korean in the multicultural era. *Bilingual Research* 37, 287-316.

Choi, S. (2010). *The analysis of school life adaptation on the students in multicultural families.* Unpublished doctoral dissertation, Kyungpook National University, Daegu.

Francis, D. J. and Rivera, M. O. (2007). Principles underlying English language proficiency tests and academic accountability for ELLs. In J. Abedi (Ed.). *English language proficiency assessment in the nation: Current status and future practice* (pp. 13-31). Davis, CA: The University of California, Davis.

Freeman, B. and Crawford, L. (2008). Creating a middle school mathematics curriculum for English-language learners. *Remedial and Special Education* 29.1, 9-19.

Friend, J., Most, R., and McCrary, K. (2009). The impact of a professional development program to improve urban middle-level English language learner achievement. *Middle Grades Research Journal* 4.1, 53-75.

Fry, R. (2007). *How far behind in math and reading are English language learners?* Retrieved from http://pewhispanic.org/files/reports/76.pdf

Gallagher, A. M., De Lisi, R., Holst, P. C., McGillicuddy-De Lisi, A. V., Morely, M., and Calahan, C. (2000). Gender differences in advanced mathematical problem solving. *Journal of Experimental Child Psychology* 75, 65-190.

Garcia, E. E., Lawton, K., and Diniz de Figueiredo, E. (2010). *The education of English language learners in Arizona: A legacy of persisting achievement gaps in a restrictive language policy climate.* Retrieved from http://civilrightsproject.ucla.edu/research/k-12-education/language-minority-students/the-education-of-english-language-learners-in-arizona-a-legacy-of-persisting-achievement-gaps-in-a-restrictive-language-policy-climate/garcia-az-ell-gaps-2010.pdf

Han, W.-J. and Bridglall, B. L. (2009). Assessing school supports for ELL students using the ECLS-K. *Early Childhood Research Quarterly* 24, 445-462.

Hoffer, T. B. (1992). Middle school ability grouping and student achievement in Science and Mathematics. *Educational Evaluation and Policy Analysis* 14.3, 205-227.

Kirmizi, F. S. (2011). The relationship between reading comprehension strategies and reading Attitudes. *Education* 39.3, 289-303.

Kwon, S. (2006). Study on the language education policy for multicultural family. *Korean Language Education Research* 27, 223-251.

Krashen, S. and Brown, C. L. (2010). The ameliorating effects of high socioeconomic status: A secondary analysis. *Bilingual Research Journal* 29.1, 185-196.

Leahey, E. and Guo, G. (2001). Gender differences in mathematical trajectories. *Social Forces* 80, 713-732.

Lee, C. and Chung, E. (2010). *2009 National Assessment of Educational Achievement: Korean Language Arts.* Seoul, Korea: KICE.

Littell, R. C., Milliken, G. A., Stroup, W. W., and Wolfinger, R. D. (1996). *SAS system for mixed models.* Cary, NC: SAS Institute.

Loveless, T. (2006). *The 2006 Brown center report on American Education: How well are American student learning?* Washington DC: The Brookings Institution.

Mau, W. C. and Lynn, R. (2000). Gender differences in homework and test scores in mathematics, reading and science at tenth and twelfth grade. *Psychology, Evolution and Gender* 2, 119-125.

Montoya, S. (2010). *Exploring family, neighborhood and school factors in racial achievement gap.* Retrieved on November 24, 2011, from http://www.rand.org/pubs/rgs_dissertations/RGSD259.html

Mullis, I., Martin, M., and Foy, P. (2008). *TIMSS 2007 international mathematics report*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

OECD. (2010). *PISA 2009 results: Executive summary.* Retrieved from http://www.oecd.org/dataoecd/34/60/46619703.pdf

Un, S. (2009). *A study on factors influencing school adjustment of bicultural children*. Unpublished doctoral dissertation, Soongsil University, Seoul.

Verbeke, G. and Molenberghs, G. (2000). *Springer series in statistics: Linear mixed models for longitudinal data.* New York, NY: Springer-Verlag.

Won, J. (2007). The role of Korean language education in multicultural era. *Korean Language Education Research* 27, 23-49.

Seon-Hi Shin and Ah-Young Kim
Measurement and Statistical Research Department
TEPS Center, Language Education Institute
Seoul National University
1 Gwanak-ro, Gwanak-gu, Seoul 151-742, Korea
E-mail: shinseonhi@snu.ac.kr, akim@snu.ac.kr

Received: November 30, 2011
Revised version received: December 12, 2011
Accepted: December 26, 2011