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Exploring the Effects of Student and School Socioeconomic Status on Student Academic Achievement between Rural and Urban Areas in South Korea

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Abstract: Recently in South Korea, the social and economic gap between rural and urban areas is widening, which reduces the number of students and schools in rural areas and accelerates the aging and devastation in these regions. If students' academic achievements are influenced by their home, school, and region, fairness in education can be questioned. This study aimed to explore whether students' circumstances, such as their socioeconomic status (SES) and their school's SES affect their achievements, comparing the results in rural and urban areas. This study used multilevel modeling as its statistical tool. This study identified student and school-level variables that affect students' reading, mathematics, and science achievement by analyzing the results of the South Korean Programme for International Student Assessment (PISA) 2015 sample. The effect of students' SES and their schools' SES on student achievement in rural areas was found to be much greater than that in urban areas. Furthermore, this study found that the estimates of contextual effects of school SES on Science, Reading, and Mathematics in rural areas are greater than in urban areas, which means the academic achievement of students attending rural schools is more affected by school SES than those attending urban schools. The results of this study imply that students attending low SES schools in rural areas have unequal access to educational resources in their families and schools compared to those in high SES schools thus educational strategies or policies to support those students are needed.

Keywords: Contextual Effect, Multilevel Modeling, Programme for International Student Assessement, Socioeconomic Status

1. Introduction

Among the various variables that affect students' academic achievement, students' socioeconomic background has been known as a particularly important variable. A previous study[1] was conducted to understand how the influence of South Korean students' socioeconomic status on academic achievement changed over time. Previous studies[2][3] explored the effect of the school′s socioeconomic status (SES) on students' academic achievement.

Recently in South Korea, the social and economic gap between rural and urban areas is widening, and the educational gap seems to be widening accordingly. In the field of education, previous studies[4][5] were conducted to explore the educational gap between rural and urban areas. Kim[6] argued that legal grounds need to be presented to bridge the educational gap between cities and rural areas. Furthermore, Byun and Kim[1] pointed out that South Korea introduced market competition into the school system in the early 2000s and a new type of high school called autonomous private high schools which are independent in terms of curriculum and financial management were established. They claimed that

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educational transformation from an egalitarian approach to the market-oriented one might result to growing educational inequality. The tuition fee in autonomous private high schools is three times more expensive than that that in general high schools. Also, most of the time, autonomous high schools draw economically advantage students, which are highly capable of paying for a quality education.

If students' achievements are influenced by context characteristics, such as student's SES or school's SES, there might be an unfairness in the education systems. After all, in a fair education system, students' achievements solely come from their abilities and efforts. Therefore, it is necessary to analyze the extent to which student and school SES affects students' academic achievement. In addition, confirming whether the influence of student and school SES is different between urban and rural schools will be an important matter in reducing the educational gap between urban and rural areas. Previous studies[1-3] have identified the influence of student SES and school SES on student academic achievement. Hence, this study aims to confirm the context effect of SES, i.e., whether students with higher school SES have higher academic achievement when individual students' SES is the same comparing the results in urban and rural areas in South Korea.

This study aimed to identify student and school-level variables that affect students' academic achievement in Reading, Mathematics, and Science by analyzing the results of South Korean Programme for International Student Assessment (PISA) 2015 sample[7] with 15-year-old students as the population. In particular, this study explored how the socioeconomic status of the school affects the students' academic achievement.

PISA uses the PISA index of economic, social, and cultural status (ESCS) as an indicator of the socioeconomic status of students to measure the socioeconomic status of individual students in each country. In addition, this study explored whether the influence of school ESCS on the individual student achievement differs according to the regional size of the area to which the school belongs, and the regional size was divided into villages, cities, and metropolises.

The research questions of this study are as follows.

1. How was the school effect on students' academic achievement in urban and rural areas?
2. What student and school level variables did affect students' achievements in urban and rural areas?
3. Did student and school level SES affect students' achievements in urban and rural schools?

2. Theoretical Background

2.1 Effects of Socioeconomic Status on Academic Performance

Previous research found a positive relationship between students' SES and academic achievement. Byun and Kim[1] explored how the influence of SES on achievement has changed over time using eighth-grade South Korean students' dataset from Trends in International Mathematics and Science Study (TIMSS). They analyzed TIMSS 1999, 2001, and 2003 datasets using multilevel analysis and found that the influence of SES on mathematics achievement increased over time.

Furthermore, some studies have focused on the impact of school SES on student achievement and reported a positive relationship between a school's SES and students' academic performance. Sirin[8] found medium level of association between SES and achievement at the student level and a large degree of association at the school level. Based on the school level datasets, Perry and McConney[2][3] analyzed Programme for International Student Assessment (PISA) 2003 and 2006 datasets and found that increases in a school level SES are consistently associated with increases in students' academic performance. That indicates that when comparing two students with the same SES, the student who attends a school with a high school SES would have higher academic performance than a student who attends a school with a low school SES.

2.2 Educational Gap Between Rural and Urban Area

Previous studies investigated students' achievement gaps between rural and urban areas[4]. Jyung et al.[4] analyzed the South Korean Educational Longitudinal Study (KELS) data provided by KEDI (Korean Educational Development Institute) with multilevel analysis. They found that the achievement gap between rural and urban areas arose due to students' family background, such as parents' expectations about students' educational attainment and parents' investment in private education whereas school contexts, such as school size and school finance did not affect students' achievement. Park[5] analyzed KELS: 2005 datasets with multilevel modeling and found that variables related to students' SES, such as household expenditure on private education were the main factors that led to achievement gap between rural and urban students. However, the author found that the positive school effect, such as a positive academic climate and student-teacher relationship reduce the achievement gap between rural and urban students and thus suggested that schools in rural areas have to be supported to build a positive school climate.

2.3 Equity in Education Based on the Results of OECD PISA

OECD PISA is a triennial survey of 15-year-old students around the world and measures students' Science literacy, Reading literacy, and Mathematical literacy. Also, PISA questionnaires are about students and their family backgrounds, aspects of students' lives, aspects of learning, aspects of schools, context of instruction, and aspects of learning. Based on the results of PISA, all OECD countries and partner countries monitor the trends of their students' achievements and get an insight into educational policy and practice[7]. Among the many variables the PISA dataset offers, students' achievements and ESCS (the PISA index of economic, social, and cultural status) are useful to measure equity in education because the relationship between students' achievements and ESCS indicates equity in education. Thus, with the results of the South Korean students' sample, we can measure equity in education based on students' achievement, ESCS, and students' regional information.

3. Method

This study analyzed the results of the South Korean PISA 2015 sample with multilevel modeling as its statistical tool. This study used three different multilevel models in terms of controlling for independent variables. In PISA 2015, the 35 Organisation for Economic Cooperation and Development (OECD) countries and 37 partner countries participated in 2015 and data collection was conducted in collaboration with PISA Governing Board members and National Project Managers[7]. Based on PISA's strict and methodological standards, PISA provided a reliable dataset. Relevant data, publications, and webinars are found on PISA website[9]. PISA used a two-stage cluster sampling where schools were first selected proportionally based on region (village, town, and city), school type (public and private), then students aged 15 years were selected randomly from each selected school. Due to the sampling design of PISA, this study used multilevel analysis to investigate the effects of student and school-level variables on Science, Reading, and Mathematics achievement. Furthermore, this study explored the impact of the contextual effect of ESCS in terms of school location.

3.1 Variables

[Table 1] presents the characteristics, name, code, description, and measurement scale of variables used in this study. This study used student and school level variables. The student-level variables analyzed in this study were student background, school participation, learning time, and parent characteristics. The school-level variables were obtained from school principals' responses to the school questionnaire. The school variables used in this study were school conditiond and school climate.

[Table 1] The Characteristics, Name, Code, Description, and Measurement Scale of Variables

Characteristics of variables	Name of variable	Code of variable in PISA dataset	Description	Measurement scale
Student level				
Student background	ESCS	ESCS	Standardized variable to measure each student's socioeconomic status from 14 items	interval
	Gender	ST004Q01		Nominal (girl=1, boy=0),
	Achievement motivation	MOTIVAT	Standardized variable from 5 items	interval
School participation	arriving late for school	ST062Q03TA	how often a student is late for last two weeks	interval
	sense of belonging at school	BELONG	Standardized variable computed from 6 items	interval
Learning time	Learning time for science	SMINS	Learning time (minutes per week) - <science>	interval
	Learning time for reading	MMINS	Learning time (minutes per week) - <reading>	interval
	Learning time for mathematics	LMINS	Learning time (minutes per week) - <mathematics>	interval
	after school study time for science	ST071Q01NA	approximate hours per week in addition<science>	interval
	after school study time for reading	ST071Q03NA	approximate hours per week in addition <reading>	interval
	after school study time for mathematics	ST071Q02NA	approximate hours per week in addition <mathematics>	interval
Parent characteristics	parents perceived school quality	PQSCHOOL	Standardized variable from 7 items	interval
	parent participation in school	PPSCHOOL	Standardized variables from 10 items	
School level				
school conditions	school size	SC004Q01TA	the total enrolment at school	ratio
	student–teacher ratio	SC018Q01TA01	the ratio of enrolled students to the total number of teachers	ratio
	availability of computers	RATCMP1	the ratio of computers to the total number of students	interval
	creative extracurricular activities	CREACTIV	the total number of the following activities, such as band, orchestra choir, school play , art club that occurred at school:	interval
school climate	student behavior hindering learning	STUBEHA	Standardized variable from 5 items	interval
	teacher behavior hindering learning	TEACHBEH	Standardized variable from 5 items	interval
	school leadership	LEAD	Standardized variable from 13 items	interval

3.2 Statistical Model

This study used a multilevel model to analyze the effects of student and school-level variables on students' Science, Reading, and Mathematics achievement. This study applied three different multilevel models to investigate the contextual effect of ESCS on students' achievement as well as the effect of other student and school-level variables. The first model is a baseline model without any predictors. This model can compute the school effects based on the intra-class correlation coefficient (ICC) from the variances of achievement scores in the student and school level using equations 1 and 2 below.

(1) Baseline model
Level 1 (Student level)

$$Y_{ij} = \beta_{0j} + r_{ij},\ r_{ij} \sim N(0, \sigma^2) \tag{1}$$

Level 2 (School level)

$$\beta_{0j} = \gamma_{00} + u_{0j},\ u_{0j} \sim N(0, \tau_{00}) \tag{2}$$

Y_{ij}: science, reading, and mathematics scores

The second model is a simple model with two variables of $ESCS$ and the mean $ESCS$ in each school ($\overline{ESCS}_j$). Specifically in this study, $ESCS$ was controlled in student level model in equation 3 and $\overline{ESCS}_j$ was controlled in the school level model in equation 4. By controlling $ESCS$ and $\overline{ESCS}_j$, the variance explained by $ESCS$ and $\overline{ESCS}_j$ can be computed in the variance of students' achievement scores.

(2) Simple model
◦ Level 1: student level

$$Y_{ij} = \beta_{0j} + \beta_{1j}(ESCS - \overline{ESCS}_{..}) + r_{ij},\ r_{ij} \sim N(0, \sigma^2) \tag{3}$$

◦ Level 2: school level

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\left(\overline{ESCS}_j\right) + u_{0j},\ u_{0j} \sim N(0, \tau_{00}) \tag{4}$$

$$\beta_{1j} = \gamma_{10} \tag{5}$$

Y: Science, reading, or math achievement
$ESCS$: ESCS for a student
$\overline{ESCS}_{..}$: Mean ESCS of all students' ESCS across all schools
$\overline{ESCS}_j$: Mean ESCS in a school j

The third model is a complex model with additional student and school-level variables. Also, the grand mean centered ESCS and the group mean of ESCS are in the student and school-level equations respectively.

(3) Complex model
◦ Level 1: student level

$$Y_{ij} = \beta_{0j} + \beta_{1j}(ESCS - \overline{ESCS}_{..}) + \cdots \beta_{pj}(X_p) + r_{ij},\ r_{ij} \sim N(0, \sigma^2) \tag{6}$$

◦ Level 2: school level

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\left(\overline{ESCS}_j\right) + \cdots + \gamma_{0q}Z_q + u_{0j},\ u_{0j} \sim N(0, \tau_{00}) \tag{7}$$

$$\beta_{pj} = \gamma_{p0} \tag{8}$$

Y: science, reading, and mathematics scores
X: Level 1 (student level) variables
Z: Level 2 (school level) variables
$ESCS$: ESCS for a student
$\overline{ESCS}_{..}$: Mean ESCS of all students' ESCS across all schools
$\overline{ESCS}_j$: Mean ESCS in a school j

3.3 Contextual Effect

The simple and complex models included $(ESCS - \overline{ESCS}..)$ in the student-level equation and $\overline{ESCS}_j$ in the school-level equation. Specifically, the student-level equation contained a grand mean centered ESCS $(ESCS - \overline{ESCS}..)$ and the school-level equation contained a group mean ESCS $(\overline{ESCS}_j)$. In equation 4, γ_{01} indicated the contextual effect of ESCS. Contextual effect exists when the between-group effect which is the aggregate effect of individual characteristics $(= \overline{ESCS}_j)$ is related to the outcome variable after controlling for the individual characteristics[10]. In equation 5 γ_{10} indicated the within-school effect of ESCS, and the sum of γ_{10} and the contextual effect of ESCS (γ_{01}) is the between-school effect of ESCS. The contextual effect of ESCS is the expected score difference between two students with the same individual ESCS who attend different schools by one unit in school mean ESCS. Thus, the contextual effect indicates the increment of the achievement score due to the one-unit difference in school mean ESCS[10].

3.4 Data Analysis

The statistical program used in this study was Mplus 7.0[11]. In a multilevel analysis in social studies, HLM[12] is a popular software although it does not properly deal with missing cases by using a listwise deletion which does not use observations with missing data. On the other hand, Mplus uses observations with missing data using a missing mechanism (e.g., missing at random, MAR). Also, Mplus deals with PISA's matrix sampling design where each student just responds to some of the cognitive items and the total scores of each student are estimated with 10 plausible values which were produced by a statistical method of multiple imputations[13]. The plausible values were generated in each cognitive domain of Science, Reading, and Mathematics. Mplus with multiple imputation command computes the average of 10 parameter estimates of a statistical model with 10 plausible values.

4. Results

4.1 Descriptive Statistics

[Table 2] presents the descriptive statistics of student and school-level variables in this study in terms of three types of school locations of villages, cities, and metropolises. For the descriptive statistics, weighting was not applied to show the actual number of students and schools and the means and standard deviations of both weighted and unweighted variables were very similar, however, in multilevel analyses, weighting was applied to statistical models. The student variables measured the student background, school participation, learning time in regular classes, learning time after school, and parent characteristics. The total number of students in cities and metropolises (2,132 and 2,647 respectively) is much greater than that in villages (802). With respect to academic achievement of Science, Reading and Mathematics, students in metropolises performed the best in all three subjects, while students in cities performed better than those in villages. Students' ESCS and achievement motivation are the highest in metropolises followed by cities and villages. Students in cities are more likely to be late for school than those in metropolises and villages. The learning time in regular classes varies according to the different subjects and metropolises have the longest learning time in Science, cities have the longest in Reading, and villages have the longest in Mathematics. However, in all subjects, metropolises have the longest learning time after school followed by cities and villages. The index of parents' perceived school quality in metropolises was the highest although the values are very similar across the three locations and the index of parental involvement in school- related activities showed that parents in cities were a little more involved than those in metropolises and villages.

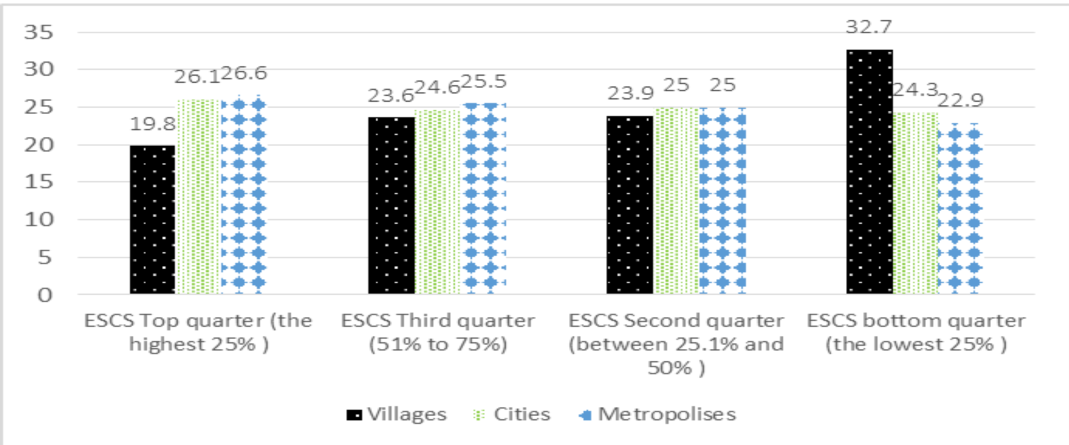
The school variables measured school context and school climate. The total number of schools in this study is 168 (27 from villages, 63 from cities, and 78 from metropolises). Regarding school context, the indexes of school size and student-teacher ratio indicate that villages are better than cities or metropolises because the indexes for villages are the lowest. In addition, the index of availability of computers in villages is the greatest (0.58) followed by metropolises (0.35) and cities (0.32). The school mean ESCS in metropolises is the greatest followed by cities and villages. Interestingly, the index of creative extracurricular activities among the schools in metropolises is the greatest followed by cities and villages. Thus, the overall school context of villages is better than that of metropolises and cities. With respect to the school climate, the indexes of student behavior hindering learning, teacher behavior hindering learning, and school leadership have the lowest in villages, which indicates that overall the school climate in villages is better than that in cities and metropolises.

[Table 2] Descriptive Statistics of the Student and School Level Variables in This Study

Factor	Variable name	School location			
		Villages (<100,000)	Cities (100,000-1,000,000)	Metropolises (>1,000,000)	Total
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Level 1: Student level (Ns)		802	2,132	2,647	5,581
Student background	Boy (Ns)	421	1,050	1,441	2,912
	Girl (Ns)	381	1,082	1,206	2,669
	Science	510.46 (91.62)	513.02 (94.97)	518.13 (96.27)	515.08 (95.15)
	Reading	511.97 (97.83)	522.08 (99.09)	528.73 (100.20)	523.78 (99.59)
	Math	509.79 (97.11)	512.61 (98.65)	517.35 (98.20)	514.45 (98.24)
	ESCS	-0.35 (0.68)	-0.19 (0.68)	-0.16 (0.68)	-0.20 (0.68)
	Index of achievement motivation	0.24 (0.97)	0.31 (0.98)	0.39 (0.99)	0.34 (0.98)
School participation	Arriving late for school	1.21 (0.52)	1.29 (0.64)	1.26 (0.59)	1.26 (0.60)
	Index of sense of belonging at school	0.08 (0.87)	0.13 (0.86)	0.21 (0.91)	0.16 (0.89)
Learning time in regular classes	Science	160.97 (43.87)	170.70 (70.20)	173.60 (77.91)	170.67 (71.08)
	Reading	196.38 (67.81)	203.14 (64.91)	199.16 (75.68)	200.28 (70.65)
	Math	216.33 (69.19)	208.24 (69.87)	209.52 (84.02)	210.01 (76.85)
Learning time after school	Science	3.22 (3.65)	3.43 (4.06)	3.52 (4.46)	3.44 (4.20)
	Reading	3.69 (4.12)	3.88 (4.60)	3.94 (4.50)	3.88 (4.48)
	Math	6.44 (5.48)	7.17 (6.03)	7.65 (6.37)	7.29 (6.13)
Parent characteristics	Index of parents' perceived school quality	-0.04 (.89)	-0.08 (0.88)	-0.03 (0.87)	-0.05 (0.88)
	Index of parental involvement in school-related	3.80 (2.99)	4.07 (2.91)	3.85 (2.82)	3.92 (2.88)

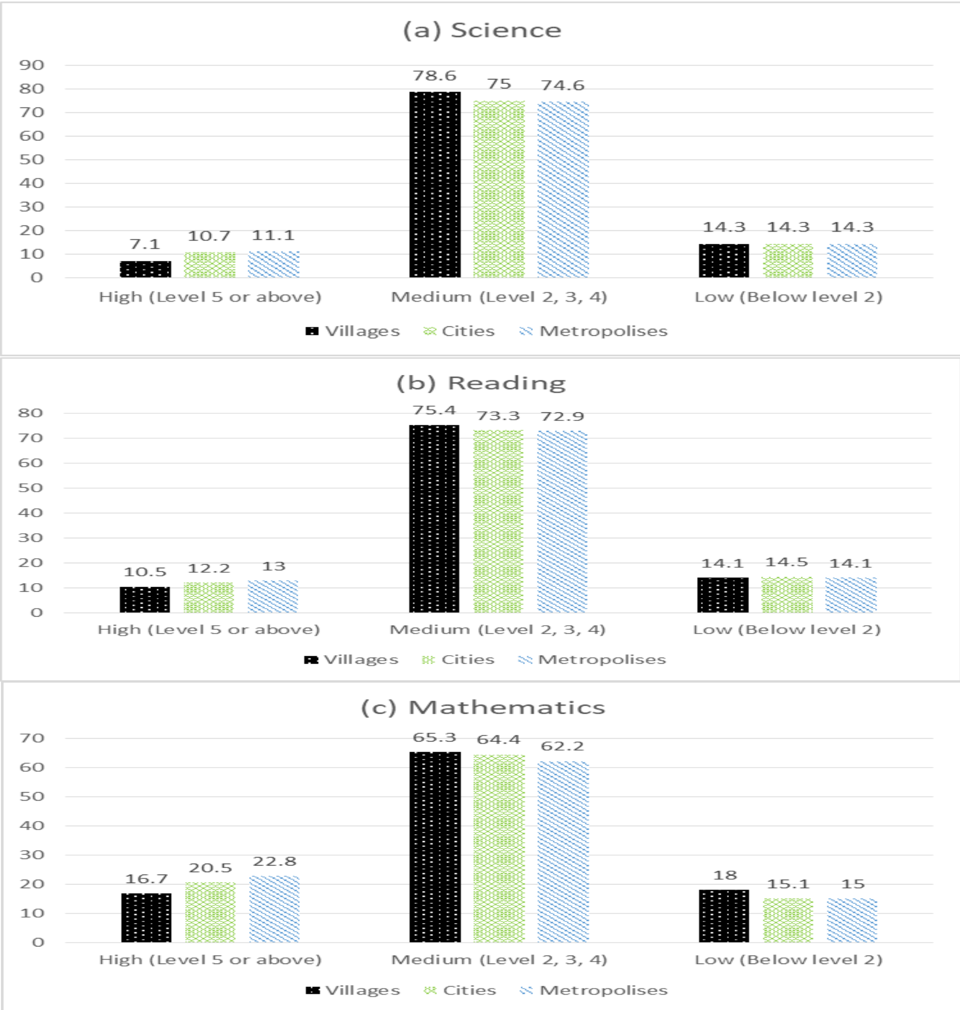
	activities				
Level 2: School level (Ns)		27	63	78	168
School context	Index of school size	578.95 (302.26)	946.89 (302.08)	1052.96 (321.86)	944.31 (349.37)
	Index of student-teacher ratio	12.62 (3.22)	15.51 (2.23)	15.54 (2.98)	15.11 (2.94)
	School mean ESCS	-0.36 (0.32)	-0.19 (0.35)	-0.16 (0.30)	-0.20 (0.33)
	The index of availability of computers	0.58 (0.50)	0.32 (0.35)	0.35 (0.42)	0.37 (0.42)
	Index of creative extracurricular activities at school	2.22 (0.65)	2.49 (0.63)	2.29 (0.78)	2.35 (0.71)
School climate	Index of student behavior hindering learning	-0.56 (1.27)	-0.24 (1.22)	-0.26 (1.08)	-0.30 (1.17)
	Index of teacher behavior hindering learning	-0.95 (0.96)	-0.45 (0.95)	-0.36 (1.00)	-0.48 (0.99)
	Index of school leadership	-0.20 (0.68)	-0.08 (1.01)	-0.06 (0.99)	-0.09 (0.96)

[Fig. 1] presents the percentages of students in ESCS quartile groups. The highest percentage of students (32.7%) is found at ESCS bottom quarter of villages. The percentages of students in [Fig. 1] and the ESCS means in [Table 2] indicate that in terms of students' ESCS, there are more socioeconomically disadvantaged students in villages than in cities and metropolises. These results are consistent with the results of previous studies[4][5][6] pointing out the education gap between rural and urban areas.



[Fig. 1] Percentage of Students at ESCS Groups across Different School Locations

[Fig. 2] shows this the percentages of students at high, medium, and low achievement groups according to achievement levels, where PISA uses 6 achievement levels form level 1 to level 6. [Fig. 2] shows that the percentages of high achievement groups (level 5 or above) in metropolises are the greatest followed by cities and villages in (a) Science, (b) Reading, and (c) Mathematics. The achievement gap between rural and urban areas in [Fig. 2] were found in previous studies[4][5][6].



[Fig. 2] Percentage of Students at Three Achievement Groups in (a) Science, (b) Reading, and (c) Mathematics across Different School Locations

4.2 Estimates of Multilevel Modeling Results

[Table 3] presents the estimates of variances in level 1 (student) and level 2 (school) and the intra-class correlation coefficients (ICCs) from the baseline, simple, and complex models in villages, cities, and metropolises when the dependent variable is each of Science, Reading and Mathematics achievement scores. Interestingly in the baseline model, the level 1 and 2 variance estimates and ICCs for villages are much greater than those for cities and metropolises. Furthermore, in the simple and complex models, the level 2 variance estimates for villages are not statistically significant whereas those for cities and metropolises are statistically significant. The simple model includes ESCS and mean ESCS in the level 1 and 2 models respectively. The complex model includes level 1 and 2 variables as well as ESCS and mean ESCS. Thus, this indicates that both ESCS and mean ESCS explained most of the students' Reading, Mathematics, and Science variability among schools in villages.

[Table 3] The Estimates and Standard Errors (SE) of Level 1 (student) and Level 2 (school) Variances, and Intra-class Correlations (ICC) from Baseline, Simple, and Complex Models in Science, Reading, and Mathematics

Subject	Model	Variance	Villages	Cities	Metropolises	Total
science	Baseline	Level 1	7154.37*(605.76)	7193.67* (497.48)	7374.73* (502.47)	7266.23* (324.15)
		Level 2	2181.83*(680.42)	1647.08* (438.04)	1950.01* (478.76)	1910.25* (305.52)
		ICC	0.23	0.19	0.21	0.21
	Simple	Level 1	6895.42* (550.23)	6997.19* (456.58)	7127.44* (487.19)	7039.07* (299.84)
		Level 2	835.17 (482.16)	625.56* (170.48)	607.62* (217.82)	669.41* (142.70)
		ICC	0.11	0.08	0.08	0.09
	Complex	Level 1	5964.68* (474.95)	6023.47* (454.21)	6194.95* (427.44)	6151.67* (294.64)
		Level 2	109.12 (111.48)	299.71* (138.92)	163.54* (80.18)	310.30* (85.49)
		ICC	0.02	0.05	0.03	0.05
Reading	Baseline	Level 1	7532.02* (775.39)	7180.63* (516.74)	7418.87* (538.08)	7354.40* (320.57)
		Level 2	2486.19* (796.33)	1922.88* (542.22)	2166.06* (502.10)	2162.72* (343.35)
		ICC	0.25	0.21	0.23	0.23
	Simple	Level 1	7171.187* (719.315)	6944.57* (471.76)	7164.72* (502.02)	7079.12* (298.32)
		Level 2	1022.812 (560.185)	897.85* (225.35)	835.67* (275.20)	909.02* (175.53)
		ICC	0.12	0.11	0.10	0.11
	Complex	Level 1	5940.732* (562.215)	5725.31* (439.55)	5888.24* (369.81)	5906.85* (256.40)
		Level 2	248.529 (140.254)	515.80* (200.86)	289.51* (119.21)	463.53* (116.09)
		ICC	0.04	0.08	0.05	0.07
Math	Baseline	Level 1	7967.58* (808.27)	7384.33* (541.41)	8142.83* (616.27)	7825.79* (373.82)
		Level 2	3369.32* (1391.85)	1964.99* (630.63)	2493.99* (573.17)	2657.30* (481.58)
		ICC	0.30	0.21	0.23	0.25
	Simple	Level 1	7561.06* (808.63)	7105.52* (471.31)	7670.32* (541.77)	7427.71* (341.63)
		Level 2	1163.462 (656.39)	587.28* (176.67)	624.95* (254.89)	746.25* (192.34)
		ICC	0.13	0.08	0.08	0.09
	Complex	Level 1	6602.91* (825.70)	6023.83* (371.99)	6723.50* (457.94)	7427.71* (341.63)
		Level 2	122.18 (128.43)	313.54* (132.87)	225.13* (106.79)	746.25* (192.34)
		ICC	0.02	0.05	0.03	0.09

*p<0.05

[Table 4] presents the estimates of intercept, student ESCS, and school contextual effect of ESCS from the baseline, simple, and complex models when the dependent variable is student performance in Science, Reading, and Mathematics across different school locations of villages, cities, and metropolises. As previous study[1][2][3] found the positive relationship between student or school level SES and students' academic performance, all student and school ESCS estimates are positive in [Table 4]. In all subjects, with a simple model, the greatest estimate of the contextual effect of ESCS was found in metropolises, whereas with a complex model, it was found in villages. Furthermore, with a complex model cities has the lowest estimate of the contextual effect of ESCS in all three locations. Interestingly, among the three subjects, ESCS had the greatest contextual effect on Mathematics.

[Table 4] The Estimates of Intercept, Student ESCS, School Contextual Effect of ESCS from the Baseline, Simple and Complex Models in the Villages, Cities, and Metropolises when the Dependent Variable Is Each of Science, Reading, and Mathematics Scores

Subject	Model	Parameter	Villages (<100,000)	Cities (100,000-1,000,000)	Metropolises (>1,000,000)	total
Science	Baseline	Intercept	488.02* (14.29)	505.04* (6.25)	504.56* (7.30)	500.18* (5.36)
	Simple	Intercept	517.01* (13.34)	519.88* (6.08)	524.74* (4.07)	526.93* (3.68)
		Student ESCS	25.53* (7.73)	23.47* (6.56)	26.81* (4.16)	25.26* (3.61)
		School contextual effect of ESCS	78.30* (15.36)	80.03* (18.69)	90.35* (12.71)	81.62* (9.32)
	Complex	Intercept	546.29* (38.24)	501.69* (41.19)	526.54* (27.29)	513.99* (19.39)
		Student ESCS	16.42* (7.06)	18.92* (6.07)	16.98* (4.46)	17.63* (3.54)

		School contextual effect of ESCS	**75.33*** (22.18)	34.47 (19.96)	53.95* (11.75)	51.19* (11.29)
Reading	Baseline	Intercept	491.89* (15.60)	505.33* (6.77)	503.54* (7.51)	500.95* (5.77)
	Simple	Intercept	523.46* (14.78)	519.34* (6.94)	524.22* (5.44)	527.80* (4.31)
		Student ESCS	25.60* (9.11)	24.24* (5.95)	27.89* (4.37)	25.99* (3.53)
		School contextual effect of ESCS	86.55* (20.33)	75.00* (21.06)	90.24* (16.27)	81.49* (10.68)
	Complex	Intercept	527.91* (47.99)	489.74* (57.84)	529.89* (31.53)	515.36* (23.00)
		Student ESCS	16.65* (8.10)	16.29* (5.62)	15.95* (4.26)	16.50* (3.26)
		School contextual effect of ESCS	**91.84*** (25.55)	47.41* (22.73)	56.79* (14.83)	58.80* (12.29)
Math	Baseline	Intercept	488.86* (18.71)	514.52* (7.009)	515.58* (9.07)	507.67* (6.90)
	Simple	Intercept	523.38* (15.339)	530.28* (5.71)	539.17* (3.90)	539.64* (4.21)
		Student ESCS	30.89* (9.30)	30.13* (6.42)	35.16* (4.83)	32.31* (3.97)
		School contextual effect of ESCS	99.52* (17.69)	85.17* (17.96)	109.11* (11.80)	97.66* (9.57)
	Complex	Intercept	510.06* (33.51)	494.81* (53.97)	523.75* (30.21)	505.64 (21.76)
		Student ESCS	18.43 (9.52)	22.24* (5.70)	20.47* (4.69)	20.42* (3.88)
		School contextual effect of ESCS	**125.17*** (22.86)	44.09* (2.26)	61.81* (15.19)	68.20* (12.83)

*p<0.05, Bold indicates the greatest estimates of school contextual effect among villages, cities, and metroplises.

[Table 5] shows the results of complex models in different school locations when the dependent variable is performance in Science. Regarding the student background variables, ESCS and achievement motivation had significant positive effects on Science in all three locations, however, gender did not significantly affect Science. Among other student-level variables, arriving late for school had significant negative effects on Science across all three locations, and a sense of belonging at school negatively affected Science in metropolises. In addition, learning time after school had a significant negative effect on science in villages and cities. Parental involvement in school-related activities had a significant positive effect in cities.

Regarding school-level variables, school size and student-teacher ratio did not have a significant effect on Science in three locations. However, the contextual effect of school mean ESCS had a significant positive effect on Science in villages and metropolises. In metropolises, the availability of computers and student behavior hindering learning had significant negative effects, however, creative extracurricular activities at school and school leadership had significant positive effects on Science in villages.

[Table 5] Estimates and Standard Errors (SE) of Regression Coefficients from Complex Model in Science

Factor	Variable name	School Location			
		Villages (<100,000)	Cities (100,000-1,000,000)	Metropolises (>1,000,000)	Total
		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
	Level 1 (Student)				
Intercept		546.29* (38.24)	501.69* (41.19)	526.54* (27.29)	513.99* (19.39)
Student background	Gender (girl=1, boy=0)	-11.03 (9.55)	4.13 (6.64)	4.88 (4.98)	0.88 (4.36)
	ESCS	16.42* (7.06)	18.92* (6.07)	16.98* (4.46)	17.63* (3.54)
	Index of achievement motivation	22.25* (5.85)	22.54* (4.24)	18.84* (5.06)	20.39* (2.76)

School participation	Arriving late for school	-31.50* (9.15)	-19.05* (5.04)	-24.28* (6.85)	-22.75* (3.56)
	Index of sense of belonging at school	-4.29 (4.98)	-3.40 (4.59)	-7.50* (3.76)	-4.84 (2.69)
Learning time	Learning time in regular lessons	0.12 (0.13)	0.11 (0.07)	0.10 (0.06)	0.11* (0.04)
	Learning time after school	-3.23* (1.37)	-1.74* (0.83)	-0.10 (0.81)	-1.78* (0.60)
Parent characteristics	Index of parents perceived school quality	2.57 (4.97)	5.54 (3.61)	1.22 (3.89)	2.94 (2.39)
	Index of parental involvement in school-related activities	-2.26 (1.43)	2.26* (0.89)	2.24 (1.24)	1.51* (0.67)
	Level 2 (School)				
School conditions	Index of school size	0.03 (0.06)	0.02 (0.02)	0.03 (0.02)	0.01 (0.01)
	Index of student-teacher ratio	-2.15 (2.41)	0.91 (1.67)	-1.41 (1.54)	0.11 (1.17)
	Contextual Effect of School mean ESCS	75.33* (22.18)	34.47 (19.96)	53.95* (11.75)	51.19* (11.29)
	The index of availability of computers	1.40 (11.78)	-24.07 (13.10)	-38.07* (9.76)	-10.59 (6.95)
	Index of creative extracurricular activities at school	17.45* (7.09)	-5.60 (7.64)	1.60 (3.70)	2.60 (3.71)
School climate	Index of student behavior hindering learning	-5.69 (5.74)	-7.26 (4.86)	-10.78* (3.19)	-8.75* (2.85)
	Index of teacher behavior hindering learning	3.71 (5.91)	-4.06 (4.77)	1.22 (3.57)	-1.45 (2.59)
	Index of school leadership	15.82* (7.79)	2.43 (3.27)	0.58 (3.45)	4.13 (2.66)

*p<0.05

[Table 6] presents the results of complex models in different school locations when the dependent variable is performance in Reading. Among the student background variables, gender had a significant positive effect on reading in cities and metropolises, and girls performed better than boys because gender was coded so that boys = 0 and girls = 1. ESCS and achievement motivation had significant positive effects on reading across all different school locations. Among other student-level variables, arriving late for school had significant negative effects on Reading in all locations. Learning time in regular classes did not significantly affect Reading whereas learning time after school had a significant negative effect on Reading in villages and metropolises. Parents' perceived school quality did not significantly affect Reading whereas parental involvement in school-related activities had a significant positive effect only in cities.

Regarding school-level variables, school size was not significant and the student-teacher ratio had a significant negative effect on reading only in metropolises. The contextual effect of school mean ESCS had a significant positive effect on reading in all school locations. The availability of computers and student behavior hindering learning had significant negative effects only in large cities and creative extracurricular activities at school had a significant positive effect on reading in villages.

[Table 6] Estimates and Standard Errors (SE) of Regression Coefficients from Complex Model in Reading

Factor	Variable name	School location			
		Villages (<100,000)	Cities (100,000-1,000,000)	Metropolises (>1,000,000)	Total
		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
	Level 1 (Student)				
Intercept		527.91* (47.99)	489.74* (57.84)	529.89* (31.53)	515.36* (23.00)
Student background	Gender (girl=1, boy=0)	20.96 (12.56)	35.07* (8.80)	32.50* (5.57)	30.53* (5.42)
	ESCS	16.65* (8.10)	16.29* (5.62)	15.95* (4.26)	16.50* (3.26)
	Index of achievement motivation	22.33* (6.76)	19.08* (3.51)	17.20* (4.50)	18.61* (2.79)
School participation	Arriving late for school	-34.48* (8.27)	-13.22* (5.38)	-21.12* (8.35)	-19.22* (4.31)
	Index of sense of belonging at	-1.53 (5.70)	2.26 (3.86)	-5.88 (3.93)	-3.40 (2.70)

	school				
Learning time	Learning time in regular lessons	0.13 (0.10)	0.10 (0.08)	0.12 (0.07)	0.11* (0.05)
	Learning time after school	-3.56* (1.04)	-1.66 (0.89)	-21.12* (8.35)	-2.218* (0.49)
Parent characteristics	Index of parents perceived school quality	-1.53 (5.70)	2.26 (3.86)	-0.12 (3.585)	0.65 (2.44)
	Index of parental involvement in school-related activities	-1.39 (1.75)	2.25* (1.05)	1.78 (1.46)	1.33 (0.75)
	Level 2 (School)				
School conditions	Index of school size	0.02 (0.036)	0.02 (0.02)	0.03 (0.02)	0.01 (0.01)
	Index of student-teacher ratio	-1.01 (2.99)	-0.16 (2.24)	-2.93* (1.44)	-1.24 (1.20)
	Contextual Effect of School mean ESCS	91.84* (25.55)	47.41* (22.73)	56.79* (14.83)	58.80* (12.29)
	The index of availability of Computers	0.33 (15.57)	-12.84 (14.01)	-33.98* (11.18)	-11.22 (7.75)
	Index of creative extracurricular activities at school	17.77* (7.59)	-3.37 (8.47)	4.12 (5.09)	3.69 (4.16)
School climate	Index of student behavior hindering learning	3.41 (7.06)	-5.79 (5.70)	-9.07* (4.24)	-6.46* (3.22)
	Index of teacher behavior hindering learning	-2.59 (5.67)	-6.10 (6.44)	-0.51 (4.15)	-4.18 (3.12)
	Index of school leadership	10.88 (7.37)	1.47 (4.37)	3.49 (3.93)	3.97 (3.31)

*p<0.05

[Table 7] presents the results of complex models in different school locations with performance in Mathematics. Regarding the student background variables, gender was not statistically significant in all locations. ESCS had a significant positive effect in cities and metropolises and the achievement motivation had a significant positive effect in all locations as previous research[1] found a positive relationship between students' SES and academic achievement. Among other student-level variables, arriving late for school had significant negative effects on Mathematics in all locations, and learning time in regular lessons had a significant positive effect on Mathematics only in villages.

Regarding school-level variables, the contextual effect of school mean ESCS had significant positive effects in all locations as previous studies[2][3] found a positive relationship between school-level SES and students' academic performance. The availability of computers had a significant negative effect in cities and metropolises, and student behavior hindering learning had a significant negative effect in metropolises.

[Table 7] Estimates and Standard errors (SE) of Regression Coefficients from Complex Model in Mathematics

Factor	Variable name	School location			
		Villages (<100,000)	Cities (100,000-1,000,000)	Metropolises (>1,000,000)	Total
		Estimate (SE)	Estimate (SE)	Estimate (SE)	Estimate (SE)
	Level 1 (Student)				
Intercept		510.06* (33.51)	494.81* (53.97)	523.75* (30.21)	505.64* (21.76)
Student background	Gender (girl=1, boy=0)	-9.91 (10.87)	3.81 (7.12)	-6.12 (5.78)	-2.70 (4.39)
	ESCS	18.43 (9.52)	22.24* (5.70)	20.47* (4.69)	20.42* (3.88)
	Index of achievement motivation	21.88* (6.74)	23.74* (4.02)	23.44* (6.51)	22.91* (3.28)
School participation	Arriving late for school	-26.47* (11.89)	-15.37* (4.84)	-20.82* (6.89)	-19.17* (3.91)
	Index of sense of belonging at school	4.07 (5.66)	1.17 (4.36)	-5.57 (3.72)	-0.15 (3.03)
Learning time	Learning time in regular lessons	0.24* (0.08)	0.07 (0.07)	0.06 (0.05)	0.10 (0.04)
	Learning time after school	-0.88 (1.20)	0.14 (0.54)	0.27 (1.01)	-0.04* (0.55)
Parent characteristics	Index of parents perceived school quality	3.84 (5.38)	5.28 (3.59)	-0.82 (4.56)	2.08 (2.78)
	Index of parental involvement in school-related activities	-3.10 (1.69)	1.20 (1.29)	1.66 (1.56)	1.11 (0.89)

	Level 2 (School)				
School conditions	Index of school size	0.03 (0.056)	0.02 (0.02)	0.02 (0.02)	0.01 (0.01)
	Index of student-teacher ratio	-1.19 (2.51)	0.49 (2.26)	-0.12 (1.523)	0.25 (1.24)
	Contextual Effect of School mean ESCS	125.17* (22.86)	44.09* (2.26)	61.81* (15.19)	68.20* (12.83)
	The index of availability of computers	18.58 (13.75)	-33.29* (13.72)	-37.03* (12.71)	-6.57 (8.82)
	Index of creative extracurricular activities at school	16.04 (8.91)	3.78 (7.03)	4.02 (4.94)	7.11 (4.22)
School climate	Index of student behavior hindering learning	2.33 (6.22)	-5.86 (4.53)	-11.23* (4.11)	-7.97* (2.88)
	Index of teacher behavior hindering learning	0.19 (6.37)	-1.88 (5.65)	3.00 (3.72)	-0.40 (3.11)
	Index of school leadership	15.90 (9.01)	1.30 (3.74)	1.13 (4.94)	3.96 (3.64)

*$p<0.05$

5. Conclusion

This study aimed to explore whether students' circumstances, such as their SES and their school's SES affect their achievements, comparing the results in rural and urban areas. Regarding research question 1, this study found that the school effect for villages was greater than cities and metropolises based on the results of the baseline model without control of any independent variables. However, both student ESCS and school ESCS fully explained the school effect on Science, Reading, and Mathematics achievement in villages.

Regarding research question 2, in three types of school locations, the index of achievement motivation had significant positive effects on students' performance, whereas arriving late for school had significant negative effects on students' performance. Student-level ESCS had positive effects on Science, Reading, and Mathematics performance in all school locations except for villages where ESCS did not have a statistically significant effect on Mathematics, and the school-level ESCS had significant positive effects on Science, Reading, and Mathematics performance in three types of locations except science performance in cities. In metropolises, the index of availability of computers had significant negative effects on students' achievement, which indicates that students use school computers for entertainment instead of educational purposes. The index of student behavior hindering learning had a significant negative effect on students' achievement only in metropolises.

Regarding research question 3, this study found that the contextual effect of ESCS on students' achievements was the greatest in villages. Thus, students who attend rural schools are more affected by school SES than those who attend urban schools. Also, this study found there are more socioeconomically disadvantaged students in villages than in cities and metropolises. Furthermore, the results of this study indicate that the new market-oriented educational policy in South Korea leads to more serious inequity in education especially in rural areas than in urban areas. Thus, new education policies and practices are needed to improve equity in education in rural areas.

The limitation of this study is that it analyzed the results of PISA 2015 and did not examine the educational gap after COVID-19. Therefore, in a follow-up study, it will be necessary to analyze the educational achievement gap between rural and urban schools after COVID-19 by analyzing PISA 2022 data that will be released in December 2023.

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