Gyehoon Oh (University of Wisconsin-Madison)
Effects of Socioeconomic Status of School Population on Student Math Achievement Growth

Purpose of the Study

It has been widely reported that individual backgrounds such as social class and race structure residential options in the United States (Massey, 1996; Massey & Denton, 1993). A highly structured pattern of residential segregation along racial and social class dimensions leads, in turn, to school segregation by social class and race (Orfield *et al.*, 1996). Thus, schools are often categorized or differentiated according to the social class and racial composition of the communities and student population. Then, what would be the consequences of the social composition of schools for what happens inside the school as an institutional organization for learning? This study is particularly interested in examining the effect of the socioeconomic composition of schools on student math gains between 10^{th} and 12^{th} grades.

Since the publication of the Coleman Report, the social class compositional effect has been examined by many researchers (Bryk & Driscoll, 1988; Caldas & Bankston, 1997; Chubb & Moe, 1990; Gamoran & Berends, 1987; Jencks & Mayer, 1990; Meyer, 1970; Rumberger & Palardy, 2005; Thornton & Eckland, 1980; Willms, 1986). However, the findings have been inconsistent across studies. The inconsistent results of previous research have been attributed to its methodological and conceptual problems (Jencks & Mayer, 1990; Rumberger & Palardy, 2005). First, the most fundamental problem has been known as a "self-selection bias", which is caused by inadequate distinction between contextual effects and family effects (Chubb & Moe, 1990; Jencks & Mayer, 1990; Kahlenberg, 2001; Willms, 1986). We need to distinguish between school-level effects and individual- and family-level effects in order to identify whether the effects of school composition occur because the school contextual differences caused by the distribution of student population affect school outcomes or because students attending high SES schools are simply from more academically oriented and motivated backgrounds.

Another problem lies in the assumption of linearity of compositional effects. Some previous studies have shown that the compositional effects differ across students with different backgrounds (Jencks & Mayer, 1990; Mayer, 1991; Rivkin, 2000; Rusk, 1998; Willms, 1986). For example, Jencks & Mayer (1990) found that the mean SES of schools had a greater impact on the test scores of Blacks than of Whites. Rivkin (2000) found that school racial composition had no significant effect on 12^{th}-grade composite test scores for Blacks. However, the findings from other studies indicate that the compositional effect is about the same for students with differing levels of social class (Rumberger & Palardy, 2005; Willms, 1986). Most of these studies used regression analysis and estimated the contextual effects separately for different groups or estimated school-by-background interaction effects. However, using a regression method in analyzing hierarchically structured data may cause some problems, such as aggregation bias, misestimated precision, and the unit of analysis problem (Bryk & Raudenbush, 1992).

The final problem is related to the question of why and how the socioeconomic composition of schools affects student outcomes. Although some recent studies attempted to identify the mechanism through which compositional effects occur (Rumberger & Palardy, 2005), there are few studies which included detailed information on school characteristics that may mediate the relationship between the two. It is needed to include more comprehensive school-level characteristics to identify why and how the socioeconomic composition matters.

This study attempts to address the methodological and conceptual problems which were raised in previous studies and thereby, to provide better understandings of the socioeconomic compositional effects on student outcomes, math gains. First of all, in order to better disentangle compositional effects from family and individual effects, this study seeks to control for a wide range of family- and individual-level variables including student sociodemographic backgrounds, family backgrounds, student initial achievement, student motivation and practices, and parents' practices with regard to their children's education. While most previous studies have controlled for family status variables, the indicators of what parents actually do have been often disregarded. Given the results of previous research that parent involvement positively affects student outcomes (Epstein, 1987; Ho & Willms, 1996), it will be highly

likely that the omission of such measures results in a self-selection bias. Secondly, this study attempts to extend and to improve upon previous studies by using a more appropriate and advanced statistical method for multi-level analysis, Hierarchical Linear Modeling. By doing so, it will be able to better estimate not only the effects of school-level characteristics on student math gains, but also the group-based differences in effects of school socioeconomic composition on student gains in math. Finally, this study seeks to better identify how and why the composition of student bodies affects educational outcomes by including four school-level factors as potential mediators, that is, intervening variables between the two: (1) other compositional characteristics of student population in a school, racial composition and average achievement; (2) structural characteristics, in terms of school sector, location, and size; (3) school resources; (4) school processes, in terms of school environment created by the behaviors and beliefs of fellow students, teachers, and parents.

Focusing on the issues described above, this study addresses the following research questions: (1) does the socioeconomic composition of schools affect student gains in standardized math test scores above and beyond the family- and individual-level effects? (2) If so, what are the underlying mechanisms through which the social composition of schools affects student achievement? (3) Are students from specific backgrounds more affected than others by the composition of student population in a school?

Method

Data

Data for this study are drawn from the first two waves of the Education Longitudinal Study: 2002 (ELS:2002). The baseline sample includes a national sample of 752 high schools with 10^{th} grades and over 15,000 high school sophomores who were randomly selected within each school. For the present analyses, the sample is limited to individuals who remained enrolled within the same school from the spring of 2002 through the spring of 2004. The sample excludes cases that are missing a number of variables needed in analytical models. I also eliminated schools that have 4 or fewer student respondents. Therefore, data for this study are composed of 8,761 students nested within 685 schools.

Measures

The dependent variable of this study is students' gains in math between the tenth and twelfth grades. Since it may be assumed that the math gain between the tenth and twelfth grades is not independent of how much a student knows in the tenth grade, the 10^{th}-grade score on math is used as an independent variable in equations (Morgan & Sorensen, 1999). Other individual- and school-level variables used in the analyses are as follows.

Individual-level variables: To address the problem of a selection-bias, a wide range of family- and individual-level variables are used in this study, including the measures of student demographic backgrounds, family backgrounds, student motivation and practices, and parents' practices with regard to their children's education. Student demographic background variables include gender and race. Family background variables include family SES and family structure. Students' plan to take SAT and perspectives of math are included as measures of student motivation. Students' years of advanced math course-taking and hours per week spent on math homework are used to control for student motivation and academic practices that may be related to math achievement. Finally, the measures of parent involvement include parent control of student activities, discussion of school-related issues, school contact regarding negative issues such as poor performance and problem behavior, school contact regarding positive academic issues such as course selection and school program, and parent involvement in school activities and events. Many of individual-level variables are composite measures which are developed using multiple items. In creating

composite measures, either factor analysis or reliability analysis was used to ensure the validity and reliability of measures.

School-level variables: Four types of school-level variables are developed: (1) school compositional variables include the level of school poverty concentration based on the percent of students receiving free or reduced price lunch, percent of white students, and school mean of 10^{th}-grade math standardized test scores; (2) structural variables include school sector, urbanicity, and school size; (3) resource variables include a composite measure of administrators' reports of the extent to which learning is hindered by lack of resources in their schools and number of full-time math teachers; (4) school process consists of a composite measure of school social climate, two measures of academic climate (student morale and percent of 10^{th} graders in college preparation program), two measures of staff climate (teacher morale and the extent to which teachers press students to achieve), and school mean of parent involvement in school activities and events as a measure of parent participatory climate.

Analytical Methods

Hierarchical linear modeling (HLM) is used in order to disentangle school-level contextual effects from the individual- and family-level effects on math gains (Bryk & Raudenbush, 1992). The HLM analyses are conducted in following steps.

First, as a preliminary analysis, an unconditional model is estimated with only the dependent variable, math gains, and no other student- or school-level variables in order to identify whether there is significant variance in math gains between schools. Since this study is also interested in variance in some specific student-level slopes, it is additionally examined whether student SES, racial, and gender slopes vary across schools. The chi-square statistics indicate that the intercept and racial slope significantly differ from one school to the other, however, student SES and gender slopes do not vary across schools.

Based on such preliminary analyses, I specify the intercept and racial slope as random and represent it as a function of a set of school-level variables and unobservable school characteristics, that is, a random error term. Since this study seeks to identify the mechanism through which the socioeconomic composition of student body in a school affects student math gains, a series of random intercept and racial slope models are separately estimated with or without each type of school-level variables. In Model 1, the indicator of school SES, the percent of students receiving free or reduced price lunch, is entered. In Model 2, two additional compositional variables, percent of white students and school mean of 10^{th}-grade math test scores, and structural characteristics of school, sector, urbanicity, and school size, are added. In Model 3, two indicators of school resources, number of full-time math teachers and administrators' report of school resources, are additionally entered. In a final and full model, a number of school process variables are also added, including indicators of school social climate, academic climate, staff climate, and parent participatory climate.

In estimating models, all continuous student-level variables are centered around their group means and dichotomous student-level variables are not centered. In the case of school-level variables, continuous variables are grand-mean centered and dichotomous variable are not centered.

Results and Discussion

The results from a series of multilevel models show that the socioeconomic composition of student population in a school is significantly associated with student math gains between the tenth and twelfth grade, above and beyond the individual and family effects and that the significant socioeconomic compositional effect is mediated by some school-level characteristics.

Specifically, the result of Model 1 indicates that the effect of percent of students receiving free or reduced price lunch in a school is statistically significant, suggesting that attending a school with high

concentration of lower social class students decrease student gains in math. Although the coefficient is only -.104, which may not be considered as very substantial, it is still statistically significant, and the significant effect of school socioeconomic composition remains even after controlling for other compositional and structural characteristics of school in Model 2 and school resource variables in Model 3. The significant, negative effect of attending schools in which lower class students are concentrated disappears when school process variables are entered in the final model. The result indicates that two of school process variables are significantly related to student gains in math standardized tests: percent of 10^{th} graders in college preparation program in a school and mean of parent school involvement in a school. It shows that students make greater gains in schools with higher percent of 10^{th} graders in college preparation and in schools with more parents involved in school activities and events. Particularly, the effect of mean of parent school involvement, .571, is not only highly significant ($p < .001$), but also quite substantial in magnitude. As such, it may be inferred from the analysis that the effect of socioeconomic composition of school student population is explained by school academic climate and parent participatory climate. In other words, students attending schools with higher proportion of lower class students make less gains in math standardized tests because students in those schools have fewer chances to interact with academically oriented peers and to benefit from the contributions made by parents.

In this full model, a couple of other school-level variables are found to significantly affect student gains in math. They include Catholic schools, school mean of 10^{th} grader test scores, and number of full-time math teachers in a school. Attending Catholic schools positively affects student math gains. The number of full-time math teachers in a school is also positively associated with math gains. However, it turns out that school mean of 10^{th} grade math test scores has a negative relationship with school mean gains in math. Similarly, individual-level initial achievement in math, 10^{th}-grade test scores in math, also negatively affects student gains in math. The results indicate that students make greater gains in math when their previous achievement scores are lower and a school's mean gains in math is greater when it is composed of students who have lower 10^{th}-grade math test scores. Some previous studies on achievement growth have also revealed that achievement at time 1 has a negative relationship with achievement gains between time 1 and time 2 (Blau *et al.*, 2001; Morgan & Sorensen, 1999). As Morgan & Sorensen (1999) point out, it may be attributable to either ceiling effects or regression toward the mean between the tests.

This study is also interested in examining whether the effect of socioeconomic composition of a school would differ across students from different backgrounds. As Blau and her colleagues (2001) have examined whether the neighborhood contexts operate differently depending on individual-level characteristics such as gender, race, and SES, by allowing these individual-level variables to vary randomly in a second level equation of HLM, I have similarly examined if the effect of school compositional context differs for minority students and White students. The result shows that 'being minority' slope decreases with the increases in the percent of students receiving free or reduced price lunch in a school. It means that increases in poverty of student bodies decrease test gains in math for minority students relative to white students, suggesting that racial gap in math test gains is wider in schools with more proportion of students from lower class background. The result also indicates that racial gap becomes wider in schools which have more parents involved in school and more full-time math teachers. The negative effect of parent participatory climate of a school on minority slope may occur because involved parents are usually from middle-class, white backgrounds and because these parents' narrow and particularistic concerns toward their own children often make them act in ways that separate their own children from those of lower social status, as some qualitative studies on parent involvement suggest (Brantlinger, 2003; Brantlinger *et al.*, 1996; Lareau, 2000, 2003; McGrath & Kuriloff, 1999). However, it seems not clear why the number of full-time math teachers has a negative effect on minority slope.

Finally, the result of full model shows that a number of student-level variables are significantly associated with student math gains, including gender, SES, family structure, plan to take SAT, student perspectives of math, years of advanced math course-taking, parent control, and the extent to which parents contact school about negative things. Specifically, being female, coming from lower SES families,

and living in a nontraditional family negatively affect math gains between 10th and 12th grades. Parent control and school contact regarding negative issues have also negative effects on math gains. Students' plan to take SAT and years of advanced math coursework are positively related with student gains in math.

The findings of this study reveal the importance of compositional context of student population in a school not only in determining how much a student makes gains in math standardized tests between 10th and 12th grades, but also in shaping racial gaps in math achievement growth.

References

Blau, J. R., Lamb, V. L., Stearns, E., & Pellerin, L. (2001). Cosmopolitan environments and adolescents' gains in social studies. *Sociology of Education, 74*(2), 121-138.

Brantlinger, E. A. (2003). *Dividing classes: How the middle class negotiates and rationalizes school advantage*. New York: RoutledgeFalmer.

Brantlinger, E. A., Majd-Jabbari, M., & Guskin, S. L. (1996). Self-interest and liberal educational discourse: How ideology works for middle-class mothers. *American Educational Research Journal, 33*(3), 571-597.

Bryk, A. S., & Driscoll, M. E. (1988). *The high school as community: Contextual influences and consequences for students and teachers*: National Center on Effective Secondary Schools, University of Wisconsin-Madison.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models: Applications and data analysis methods*. Newbury Park: Sage Publications.

Caldas, S. J., & Bankston, C. (1997). Effect of school population socioeconomic status on individual academic achievement. *Journal of Educational Research, 90*(5), 269.

Chubb, J. E., & Moe, T. M. (1990). *Politics, markets, and america's schools*. Washington, D.C.: Brookings Institution.

Epstein, J. L. (1987). Toward a theory of family-school connections: Teacher practices and parent involvement. In K. Hurrelmann, F. Kaufman & F. Losel (Eds.), *Social intervention: Potential and constraints*. New York: Walter de Gruyter.

Gamoran, A., & Berends, M. (1987). The effects of stratification in secondary schools: Synthesis of survey and ethnographic research. *Review of Educational Research, 57*, 415-435.

Ho, S.-C. E., & Willms, J. D. (1996). Effects of parental involvement on eighth-grade achievement. *Sociology of Education, 69*(2), 126.

Jencks, C., & Mayer, E. (1990). The social consequences of growing up in a poor neighborhood. In L. J. L. & M. G. H. McGeary (Eds.), *Inner-city poverty in the united states* (pp. 111-186). Washington, D.C.: National Academy Press.

Kahlenberg, R. D. (2001). *All together now: Creating middle-class schools through public school choice*. Washington, D.C.: Brookings Institution Press.

Lareau, A. (2000). *Home advantage: Social class and parental intervention in elementary education* (2nd ed.). Lanham, Md.: Rowman & Littlefield Publishers.

Lareau, A. (2003). *Unequal childhoods: Class, race, and family life*. Berkeley: University of California Press.

Massey, D. S. (1996). The age of extremes: Concentrated affluence and poverty in the twenty-first century. *Demography, 33*(4), 395-412.

Massey, D. S., & Denton, N. A. (1993). *American apartheid: Segregation and the making of the*

underclass. Cambridge, Mass.: Harvard University Press.
Mayer, S. E. (1991). How much does a high school's racial and economic mix affect graduation rates and teenage fertility rates? In C. Jencks & P. Peterson (Eds.), *The urban underclass* (pp. 321-341). Washington, D.C.: Brookings Institutions.
McGrath, D. J., & Kuriloff, P. J. (1999). "they're going to tear the doors off this place": Upper-middle-class parent school involvement and the educational opportunities of other people's children. *Educational Policy, 13*(5), 603-629.
Meyer, J. W. (1970). High school effects on college intentions. *American Journal of Sociology, 76*(1), 59-70.
Morgan, S., L., & Sorensen, A., B. (1999). Parental networks, social closure, and mathematics learning: A test of coleman's social capital explanation of school effects. *American Sociological Review, 64*(5), 661.
Orfield, G., Eaton, S. E., & Harvard Project on School Desegregation. (1996). *Dismantling desegregation: The quiet reversal of brown v. Board of education*. New York: New Press.
Rivkin, S. G. (2000). School desegregation, academic attainment, and earnings. *Journal of Human Resources, 35*(2), 333-346.
Rumberger, R. W., & Palardy, G. J. (2005). Does segregation still matter? The impact of student composition on academic achievement in high school. *Teachers College Record, 107*(9), 1999-2045.
Rusk, D. (1998). To improve poor children's test scores, move poor families. *Abell Report, 11*(2: June-July), 1-8.
Thornton, C. H., & Eckland, B. K. (1980). High school contextual effects for black and white students: A research note. *Sociology of Education, 53*(4), 247-252.
Willms, J. D. (1986). Social class segregation and its relationship to pupils' examination results in scotland. *American Sociological Review, 51*(2), 224-241.