EDUCATION POLICY ANALYSIS ARCHIVES

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Volume 12 Number 23 **May 31, 2004** **ISSN 1068-2341**

The Influence of School Policy and Practice on Mathematics Achievement During Transitional Periods

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Citation: Holt, J., & Campbell, C., (2004, May 31). The influence of school policy and practice on mathematics achievement during transitional periods. *Education Policy Analysis Archives, 12*(23). Retrieved [Date] from http://epaa.asu.edu/epaa/v12n23/.

Abstract
In this study, the effects of school policies and practices on math achievement growth, as students transitioned from middle to high school, were examined while controlling for school contextual variables. A pattern of accelerated growth in mathematics achievement from grades 8 to 12 occurred, in which higher achieving students in mathematics at grade eight accelerated more than lower achieving students in mathematics growth during the transition from middle to high school. Controlling for school context, school policy promoting parent involvement and academic counseling had significant positive impacts on the acceleration in growth during this period. The implications of using multilevel growth models to study growth during transition periods are discussed.

The goal of this line of research is to determine how school policy and school context interplay to influence a child's success in mathematics. Past research has typically focused on variables influencing math success, as measured by achievement on mathematics standardized tests at designated grade levels. Yet, little is known about changes in mathematics achievement over time (i.e., growth), especially at critical developmental phases. Further, contributions to this field that distinguish the influence of school policies and practices from school context would be particularly useful.

The general purpose of this research was to investigate the effects of school policies and practices in moderating the changes in achievement that occurs during key transition periods. Specifically, we were interested in examining (a) the growth patterns in math achievement, including both the instantaneous rate of change at grade 8 (i.e., linear growth), as well as the change in growth rate from grades 8 to 12 (i.e., acceleration or deceleration) and (b) school policy, practice, and context variables associated with these growth patterns.

In the present study, “school policy” refers to internal rules of operation established by the institution. Such policies are developed primarily by officials of the institution as are decisions of maintaining such policies. The term “school practice” refers to the institution’s implementation or enforcement of such policies. “School context” describes environmental variables characteristic of a school, but that are typically exogenous to the policies and practices of its school administrators and teachers. In our exploratory analyses of the data, particular policy and context variables associated with math achievement growth were identified. Consequently, the scope of the following literature review is limited to studies examining variables relevant to this study.

School Policy and Math Achievement

Recent studies have found math performance to be positively related to school policies intended to create a safe school community (Borman & Rachuba, 2001). Through effective discipline practices (Clark, 2000; Freiberg, Connell, & Lorentz, 2001), parental involvement (Brown, 1996; Ford, Follmer, & Litz, 1998), and in-school counseling programs (Bleuer & Walz, 1993; Lapan, Gysbers, & Sun 1997; Shoffner & Vacc, 1999), schools can cultivate an overall atmosphere conducive to student learning. Collectively, research seems to suggest that policies which make good use of in-school time have greater potential for improving achievement for all learners, thereby closing the achievement gap between racial majority and minority students.

School policy: Effective disciplinary practices. The overall goal of school disciplinary policies is to maintain an orderly environment so that teachers are better able to teach and students are better able to learn. Barton, Coley, and Wenglinsky (1998) found that student disorder interrupted not only school safety, but decreased student achievement as well. To ensure institutional order, some principals have elected to implement tough discipline responses such as “zero tolerance policies,” reporting that strict consequences are absolutely necessary for maintaining school safety (Holloway, 2001/2002). Similarly, Echlelbarger and colleagues (1999) found that when misconduct is not confronted, misbehaving students are likely to infer that such behavior will be tolerated. The researchers concluded that zero tolerance policies may send a clearer message to students about the consequences associated with actions that do not comply with school policy, thereby setting standards for expected behavior.

Conversely, Van Acker (2002) argues that although discipline policies are intended to curtail undesirable behavior, such efforts may sometimes reinforce the very action they are intended to suppress. Instead, shifting discipline from reducing negative incidents to promoting positive functioning is recommended. Others also have advocated for disciplinary practices that provide guidance for desired behaviors as opposed to merely enforcing punitive consequences (Shingles & Lopez-Reyna, 2002).

School policy: Involving parents. Most would agree that parental involvement in their child’s education has many advantages (Brown, 1996; Ford, et al., 1998; Jones, 2001; Littman, 2001; Mulhall, Flowers, & Mertens, 2002). Such benefits have been found in research using National Education Longitudinal Study (NELS) data where parental aspirations (Fan, 2001; Fan & Chen, 2001; Thomas, 1998) and involvement (Brown, 2000, Ma & Klinger, 2000) contributed significantly to students’ mathematics test scores.

Consistent with literature citing positive effects of parental involvement on mathematics achievement, school policy supporting parental involvement programs has been shown to promote student gains in overall achievement and application of mathematical concepts. In particular, differing levels of parental involvement (high vs. low) counterbalanced effects of gender and socioeconomic status (SES) on math achievement (Shaver & Walls, 1998). These studies highlight the importance of school-supported programs that include parental involvement in students' educational progress. *School policy: In-school counseling programs.* Effective school counseling programs have the potential to contribute to school improvement by enhancing school climate and raising student achievement (Bleuer & Walz, 1993; Lapan et al., 1997; Shoffner & Vacc, 1999). Although this connection may seem intuitively obvious, empirical studies supporting this link are limited. One study by Fouad (1995) tested this connection by examining urban inner-city middle school students' math achievement following a 1-year intervention program. An experimental/control method was employed to test the efficacy of school counseling program interventions. In experimental classrooms, a 6-week math and science career awareness model was infused into the 8th grade curriculum. In addition to curricular enhancements, field trips, illustrative activities, and guest speakers were utilized to increase students' occupational knowledge. In addition, math achievement was analyzed and compared between the two groups. Students exposed to career-linking activities significantly outperformed their control-group peers on mathematics homework and tests (although the achievement was not linear). Moreover, by comparison, students in the experimental group showed greater effort and class participation, had better attendance, and were more likely to take additional math classes (particularly minority students) than students who did not participate in school counseling intervention programs. Similarly, Lopez (2001) found that for at-risk Latino high school students, counseling interventions related to higher math grades for students in college preparation courses, but not for students in the remedial track.

School policy and math achievement growth. Providing students with academic counseling and assistance in coursework selection could have direct implications for both principals and counselors when adopting school policy. In particular, research shows that prior success in mathematics increases the likelihood of future mathematics achievement. Schneider, Swanson, and Riegle-Crumb (1997) investigated the relationship between school policy requiring course sequencing and math performance. Examining data from NELS: 88-94, the researchers found course sequencing in 10th grade to be the greatest predictor of mathematics coursework in 12th grade. Moreover, high school students who participated in advanced mathematics classes showed greater gains in mathematics achievement than their peers who did not take additional math courses beyond graduation requirements. In contrast, however, Hoffer (1997) found school policy requiring an additional math course did not significantly help or hurt mathematics achievement scores.

Math Achievement and School Context Variables

The relationship between school context and mathematics achievement is well documented (Demery, 2000; Ma & Klinger, 2000; Patton, 2001; Roscigno, 2000; Thomas, 1998). Defined as environment characteristics generally not under the control of school policy (e.g., percentage minority, free and reduced lunch, single family households), school context is an important variable to consider when evaluating educational effectiveness and student learning. Selected research investigating these variables is highlighted below.

School context: Percentage minority enrollment, school crime, and SES. Although National Assessment of Educational Progress (NAEP) data indicate general gains in mathematics and reading performance, racial difference in mathematical performance is well documented (Hall, Davis, & Bolen, 1999; Lockhead, Thorpe, Brooks-Gunn, Casserly, & McAloon, 1985). For example, since 1990, NAEP score differences between African-American and Caucasian students have widened (Hoff, 2000; Lubienski, 2002). Despite controlling for socioeconomic status (SES; i.e., as measured by participation in free or reduced school lunch programs) White students still outperformed black students in mathematics (Rugutt, 2001).

The relationship between criminal activity (e.g., gang affliliation, drug abuse) and drop out rates is also evident (Arfaniarromo, 2001; Belitz & Valdez, 1994). Looking at school context variables, Roscigno (2000) found racial inequalities in school enrollment, social class composition, and school crime to negatively mediate mathematics achievement during late elementary and beginning middle school years. Similarly, Battin-Pearson, Newcomb, and Abbott (2000) found poor academic performance and dropping-out behavior related to general deviance, SES, and bonding to antisocial peers.

School context: Single-parent families. Investigating the connection between single-parent homes and academic performance, Pong (1997) found schools with a higher percentage of students from single-parent families have lower achievement scores in comparison to schools comprised predominately of two parent households. The researcher did note, however, that when strong social relations with a parent are controlled for, the negative achievement gap among students from single-parent and step families is reduced significantly.

School context and math achievement growth. Most of the work in math achievement has focused on variables related to math achievement; however, some authors have extended the realm of study to include math achievement growth (Muthén, 1997). Muthén determined that there is non-linear math achievement growth from grade 8 to grade 10; however, he was not able to identify factors related to that change. Using NELS:88 data, Muller (1998) found that the gender gap in mathematics performance, particularly achievement gains between grades 8 and 10, were only found when parental involvement was not controlled for. As a school context variable, SES related positively to achievement growth over time, particularly between grades 1 and 6 (Jimerson, Egeland, & Teo, 1999).

As described, there is a strong literature base linking school policies and practices to mathematics achievement. Yet, it is not clear if these same factors account for mathematics achievement growth. As students transition from middle to high school, there is the potential for the achievement gap to widen significantly due to unequal math achievement growth. Consequently, the goal of this study is to build a model for predicting math achievement growth based on the prior literature on effective school policies and practices and to test this model using random coefficients growth modeling.

Methods

In order to assess school context, Raudenbush and Willms' (1995) definition for Type B school effects will serve as the guiding framework – the difference between a student's performance in one school and the performance that would have been expected had that student attended another school with identical context, but with a practice of average effectiveness. In other words, Type B school effects control for school contextual variables (e.g., percent free and reduced lunch), while examining the effects of school policy and practice variables (e.g., school disciplinary policies). As Raudenbush and Willms (1995) point out, Type B effects are most important for evaluation studies of school effectiveness. Keeping within this framework, the influence of school policies and practices on math achievement growth were examined while controlling for school contextual variables. Moreover, the effects of school policies and practices in moderating the changes in achievement growth that occurred as students transitioned from middle to high school were investigated.

Data Source

Data from the National Educational Longitudinal Survey of 1988 (NELS:88) was used in this study. The NELS:88 survey was designed to assess educational transitions from middle school through early adulthood, by assessing educational achievement and student, parent, teacher, and school variables that may be related to educational achievement. This nationally representative survey has been conducted for the twelve-year period from 1988 to 2000, tracking students initially in 8th grade through high school and college and into the workforce. During the years 1988 to 1992, students were tracked through the transition from middle school into high school and to high school completion. Participants were surveyed three times during this period: 1988, 1990, and 1992. For this study, only students who participated in all three of these survey years (n = 16,489) were selected. These students were from 1,011 different schools,

Math Achievement

Math achievement was assessed by the IRT-scaled mathematics achievement score. The math test used in the NELS:88 assessed basic math computational skills, as well as more advanced skills of problem solving and comprehension. This score was vertically scaled to enable measurement of change in achievement during the survey period.

Variables Related to Math Achievement

All of the control and explanatory variables used in this study came from the school administrator questionnaire. This questionnaire was administered to the building principal, headmaster, or another knowledgeable administrator and was designed to collect information about the overall academic climate of the school. Variables were selected from the administrator questionnaire data that would relate to the study purpose; to investigate variables related to mathematics achievement growth to determine how school context and policy interplay to influence mathematics achievement during key transition periods.

The school contextual effects explored in this study are listed in Table 1. These variables were selected based on their expected relationship to math achievement growth and their lack of multicollinearity ($r < .7$). Initially the school climate variables (k = 10 for base year and k = 11 for first follow-up) were correlated with achievement as individual indicators in the exploratory phase, as previous reports have indicated that although composite school climate variables were not related to achievement, individual variables were related to achievement (Peng, 1995). In contrast to Peng's findings, the individual school climate variables used in this study had two distinct correlation patterns with the growth parameters; one for the attendance school climate variables and the other for the illegal activities school climate variables. Hence, for purposes of this analysis, two school climate composite variables were created for both base year and first follow-up. The first consisted of the three attendance-related items: tardiness, absenteeism, and class cutting and the second consisted of seven (base year) to eight (first follow-up) serious and/or illegal activities (i.e., physical conflict, robbery or theft, vandalism, alcohol use, use of weapons, gang activity, physical abuse of teachers, and verbal abuse of teachers).

Table 1
Potential School-Level Predictors of Math Achievement Growth

Contextual Variables	Policy and Practice Variables
Base Year	
Percentage Hispanic	Teacher base salary
Percentage African-American	Number of teachers with graduate degree
Percentage single-parent	Standardized tests to assign students to assign 8th graders to high school courses
Student emphasis on learning	Counselors influence assigning high school courses
Teacher morale	Teachers influence assigning high school courses
School absenteeism school climate composite	Parents influence assigning high school courses

School violence school climate composite	Tests influence assigning high school courses
Students face competition for grades	Math club available to 8th graders
	Discipline is emphasized at the school
	School environment is flexible
	Academic counseling exists for students
	Behavioral counseling exists for students
	Vocational counseling exists for students
	Student-teacher ratio
First Follow-up	
Percent of 10th graders who dropped-out	Middle school and high school administrators meet
School absenteeism school climate composite	Math ability grouping
School violence school climate composite	Senior graduation exam
Percent on free and reduced lunch	Number of math teachers
	Graduation requirements for math
	Number of higher-level math courses offered
	Number college advanced math courses offered
Second Follow-up	
Percent receiving remedial math	Major new curricular programs established
	Grouping students by ability changed
	School-wide changes in instructional methods

The school-level policy and practice variables examined are listed in Table 1. The criteria that were used to select these variables were a lack of multicollinearity among variables ($r < .7$) and a theoretical expectation that they would correlate with math achievement growth, and relate to the contextual variables – achievement relationships.

Data Analysis Procedures

Traditional approaches for analyzing longitudinal survey data utilize repeated measures ANOVA or MANOVA techniques. These methods have severe constraints on the form of the data. Perhaps the two biggest problems in longitudinal research are that all subjects must have an equal number of data points and the data points must have equal spacing. Inevitably data cannot be collected for all participants at each time period resulting in increased attrition rates as data collection progresses. In traditional data analytic approaches using listwise deletion, participants without full data for all time points are discarded. This often results in a data set that is greatly reduced, biased, and unrepresentative of the original sampled population. To overcome these limitations, this study employed a multilevel, random coefficients growth modeling technique, which does not require full data or equal spacing of data and allows for random variation in growth curve coefficients (Raudenbush & Bryk, 2002; Muthén & Curran, 1997). Using this method, data were not listwise deleted when data were missing on some waves of the study, but rather all data points were used in the estimation of the growth parameters. We took advantage of these growth modeling techniques to enable us to more accurately model the transition from middle school to high school in terms of mathematics achievement.

Multilevel Growth Models

In this study, growth was not assumed to be linearly related to time; that is growth was allowed to accelerate or decelerate as time increased (quadratic growth). When students' cognitive changes coincide with transitions across developmental stages or transitions in learning environments, achievement growth patterns would be expected to change and this change would not be detected with methods employed to assess linear growth. Because transition in growth was of particular interest in this study, multilevel, polynomial growth models were used to measure the acceleration or deceleration in math achievement growth rate that occurred across this learning environment transition. Key features present in the multilevel model used in this study include: (a) observations are nested in individuals, allowing for different number and spacing of observations across individuals; (b) an acceleration/deceleration parameter is explicitly added to the linear growth model; (c). average achievement, linear growth, and rate of change in growth rates are allowed to vary across schools; and (d) conditional models are formed at the school level, to determine variables of the school that are related to average achievement, linear growth, and acceleration/deceleration.

Missing data were imputed for the school-level variables using mean imputation procedures in order to have complete data for analyses using the algorithm HLM3 (Raudenbush, Bryk, Cheong, & Congdon, 2000). Although, missing data can be tolerated at lower levels of analysis in HLM3, complete data is needed at the highest level of analysis, in this case the school level. The amount of imputed missing data ranged from 1.8% to 20.8% with an average of 9.1% across the 15 school-level variables used in the hierarchical linear models (HLM). However, missing data were still present on the math achievement measures for individual students. The time series variable, grade, was centered at grade eight for interpretability. Therefore, average achievement and the instantaneous growth rate at grade eight were estimated. Additionally, the acceleration or deceleration in growth was estimated from grades 8 to grade 12.

The data analysis proceeded in three phases. In Phase I, unconditional growth models were examined to determine if math achievement growth was linear or curvilinear. During this phase, empirical Bayes (EB) residuals of linear and quadratic growth estimates were also generated for the exploratory phase. In the exploratory phase, Phase II, these EB residuals were correlated with potential school-level predictor variables (see Table 1) to determine where strong and weak relationships with math achievement growth existed. These results, along with theoretical-based decision-making, were used to determine potential predictors of math achievement growth. In Phase III, conditional models of growth were formulated using the variables determined in Phase II. The relationships of these variables to linear and quadratic growth were tested with multilevel polynomial growth models.

Results

Phase I

Unconditional models of both linear and quadratic growth were tested using multilevel modeling. It was necessary to constrain student-level linear and quadratic growth estimates in order for the maximum likelihood estimates to reach convergence using the HLM3 algorithm (Raudenbush et al., 2000). The deviance statistic was statistically significantly different when the quadratic term was added to the model, chi-square = 2173.009, df = 4, $p < .001$, indicating that the quadratic model provided a better fit to the data than the linear model. Further, the coefficients (denoted by *g*for both linear and quadratic growth were positive (g_{100} = 2.471 and g_{200} = 0.5950), indicating that both math achievement and the change in math growth increased as students progressed in grade level. As shown in Table 2, the correlations between the residuals for linear growth were negatively correlated with both average achievement and quadratic growth, whereas average achievement and quadratic growth were positively related. This indicated that schools with higher average achievement had flatter linear growth rates but steeper acceleration from grades 8 to 12 than schools with lower average achievement. Empirical Bayes (EB) residuals for average achievement, linear growth, and quadratic growth were outputted for further analysis.

Table 2
Intercorrelations Among Random School-level Slopes and Intercept

Parameter	Linear Slope (b_{10})	Quadratic Slope (b_{20})
	Schools (n = 1011)	
Intercept (b_{00})	-.662	.449
Linear Slope (b_{10})		-.933

Phase II

School-level contextual and policy and practice variables were correlated with the empirical Bayes residuals from the school-level model to identify potential correlates of math achievement and growth (Raudenbush & Bryk, 2002, p. 268). The empirical Bayes residuals for the average achievement at grade 8, linear growth in achievement at grade 8, and acceleration/deceleration in growth from grades 8 to 12 were each correlated with the potential school-level predictors of math achievement. These variables are summarized in Table 1. Those with significant relationships to the residuals or with a strong theoretical basis for predicting math achievement growth were retained for Phase III (see Table 3).

Table 3
Predictors of Math Achievement Growth from School-level Policy, Practice, and Contextual Variables

Variable	Coefficient	*SE*
Mean Achievement at Grade 8	46.352***	0.285
Base year attendance school composite	-1.234*	0.619
Base year illegal activity School composite	-0.768	1.241
Base year disciplinary policy	-0.490	0.303
Base year academic counseling offered	0.705	0.953
Base year behavioral counseling offered	1.059	0.964
Base year vocational counseling offered	-1.127	0.593

Base year percent Hispanic	-0.062***	0.016
Base year percent Black	-0.070**	0.019
Base year percent single parent households	0.004	0.017
Mean growth rate at Grade 8	2.478***	0.309
Base year attendance school composite	-0.621	0.679
Base year illegal activity School composite	3.081**	1.147
Base year disciplinary policy	0.009	0.346
Base year academic counseling offered	-1.680	1.095
Base year behavioral counseling offered	0.843	1.098
Base year vocational counseling offered	-0.687	0.687
Base year percent Hispanic	0.016	0.022
Base year percent Black	0.027	0.026
Base year percent single parent households	-0.036	0.019
Mean change in growth rate	0.593***	0.073
Base year attendance school composite	0.183	0.165
Base year illegal activity School composite	-0.724**	0.254
Base year disciplinary policy	0.034	0.084
Base year academic counseling offered	0.563*	0.268
Base year behavioral counseling offered	-0.221	0.284
Base year vocational counseling offered	0.132	0.165
Base year percent Hispanic	0.001	0.006
Base year percent Black	-0.002	0.007
Base year percent single parent households	0.010*	0.005
First follow-up school promotes parent involvement	0.094***	0.023
First follow-up disciplinary policy	-0.105**	0.030
First follow-up attendance school climate composite	0.044	0.076
First follow-up illegal activity School climate composite	-0.017	0.037
First follow-up percent drop-out in 10th grade	0.0005	0.002
First follow-up percent on free and reduced lunch	-0.005**	0.002

*$p < .05$; **$p < .01$, ***$p < .001$

Phase III

The variables retained from Phase II were used to model math achievement, math achievement growth, and acceleration/deceleration in growth in a three-level hierarchical model. The contextual variables used as predictors of level-one average achievement at grade 8, growth rate at grade 8, and the acceleration from grades 8 to 12 included: the school climate absenteeism composite, the school climate illegal activities composite, percent African-American, percent Hispanic, and percent single parent. Additionally, the first follow-up absenteeism composite, the school climate illegal activities composite, the percent of 10th graders who dropped out, and the percent on free and reduced lunch were used as predictors of quadratic growth from grades 8 to 12.

The selected base year policy and practice variables that were entered as predictors of level-one average achievement and linear growth at grade 8, and quadratic growth from grades 8 to 12 included base year disciplinary policy, academic counseling, vocational counseling, and behavioral counseling. Additionally, first follow-up disciplinary policy and whether the school promotes parent involvement were added as predictors of quadratic growth from grades 8 to 12.

As presented in Table 3, there were several statistically significant predictors of both average school achievement and growth. Of particular interest in this investigation were the predictors of growth. None of the base year policy and practice variables were significant predictors of linear growth at grade 8, although base year participation in illegal activities was positively associated with linear growth $g_{102} = 3.081$, $p < .01$. The contextual variables that statistically significantly predicted acceleration in math achievement included: the first follow-up attendance school climate composite, $g_{202} = -.1054$, $p < .01$; the base year illegal activity school climate composite, $g_{204} = -.7236$, $p < .01$; base year percentage of single-parent households, $g_{2014} = .0099$, $p < .05$; and percentage on free and reduced lunch in the first follow-up, $g_{2015} = -.0051$, $p < .01$. The school policy and practice variables that contributed to acceleration in growth, controlling for the contextual effects, included whether academic counseling was offered in the base year, $g_{208} = .5927$, $p < .05$; whether the school promoted parent involvement at the first follow-up, $g_{201} = .0940$, $p < .001$; and whether discipline was emphasized in the school at the first follow-up, $g_{202} = -.1054$, $p < .01$. Adding the school policy and practice variables accounted for a significant amount of the unexplained variance in math achievement and growth beyond that explained by the school context variables, (increment in chi-square) = 56.72, df = 14, $p < .001$.

Discussion

The average school achievement growth trajectory accelerated during the transition from middle to high school and the variance in acceleration was related to contextual variables and school policies and practices. This is particularly relevant for schools considering strategies for improving mathematics achievement growth by countervailing negative influences of SES and other contextual variables.

School crime (i.e., physical conflicts, robbery, vandalism, alcohol use, possession of weapons, physical and verbal abuse of teachers) was positively related to math achievement growth at grade 8 but negatively related to acceleration patterns in mathematics achievement. Although, these results may seem counter-intuitive, they are consistent with the negative correlation between linear and quadratic growth. That is, schools with lower math achievement had steeper math growth at grade 8, but less acceleration in growth over time, and these schools also had more school crime. Although, these schools with high crime have more potential, as seen by their steeper growth rate in grade 8, this growth tapers off as students progress across the transition from middle to high school. This is consistent with previous research reporting the severe consequence of lowered academic performance in schools with high levels of crime (Roscigno, 2000). However, these results contrast with Peng's (1995) findings of no relationship between school climate variables and measures of achievement. It is important to note that

Peng defined school climate very broadly, including both contextual and policy variables. In this study, however, we constructed school climate composites that were comprised of more homogenous items thereby measuring more well-defined constructs.

The percentage of single parent households with children attending the school in the base year was positively related to acceleration. Although contrary to previous research and as noted by Pong (1997), it is possible that the schools that had positive effects of single parenting also had strong parent-child relations, thereby reducing the potential negative impact of single parent households.

The percentage of households in the school qualifying for free and reduced lunch in the first follow-up was negatively related to acceleration. In other words, schools with families from lower SES strata had less acceleration in math achievement from grades 8 to 12 than schools with families from higher SES strata. This finding is consistent with prior research demonstrating the inverse relationship between SES and achievement growth in mathematics over time (Jimerson, Egeland, & Teo, 1999; Rugutt, 2001).

It appears that during these transition periods, inequity gaps are increased due to the higher acceleration rate for students from higher SES strata. Therefore, our findings suggest that policies directed toward closing the mathematics achievement gap between high and low SES groups would be more effective if implemented prior to the transition from middle school to high school.

School policy and practice variables were also related to acceleration in math achievement, controlling for school context. Schools with policies emphasizing parental involvement were found to have greater acceleration in mathematics achievement than schools without such an emphasis. This finding supports earlier research documenting the importance of a stable home environment and parental involvement in their children's academic success (Brown, 2000, Ma & Klinger, 2000; Pong, 1997). Moreover, school policies that emphasize parental involvement could offset the negative effects of SES on mathematics achievement as noted by Shaver and Walls (1998). It is critical that school policy makers, particularly in schools with large numbers of students from low SES backgrounds, plan courses of action that draw upon the positive effects of parental involvement when developing models of best practice in education. Effectiveness of educational policies is likely to be strengthened when common goals are acknowledged in both home and school. Moreover, a holistic view of school policy can aid in buffering the negative influences of poverty that threaten the academic success of students at risk.

This study also confirmed the importance of academic counseling, in that school policies supporting academic counseling had greater accelerated growth trajectories in mathematics from 8th to 12th grade. This likely occurs through individualized advisement, whereby school counselors and students collaborate on course selection and career planning. This is consistent with previous work in which school counseling programs were associated with a better school climate and higher achievement levels (Bleuer & Walz, 1993; Lapan et al., 1997; Shoffner & Vacc, 1999). This finding is particularly important for economically poorer schools where low mathematics test scores are more common. Schools with policies supporting fully developed counseling intervention programs showed greater achievement regardless of socioeconomic level. This suggests that schools that support academic counseling may be able to offset the negative effects of SES through promotion of activities leading to academic success, thereby facilitating acceleration in students' academic growth during critical phases in their educational experiences.

Moreover, disciplinary policy was negatively related to acceleration in math achievement. This was likely not strictly due to the effects of disciplinary policies, but rather the school atmosphere that requires more disciplinary policies. Although school climate related to attendance problems and illegal activities was controlled for in this study, there might be other school climate variables that were not assessed in NELS that might require disciplinary policies, such as negative or discriminatory attitudes among students that could result in school procedures to maintain control.

Analysis of growth trajectories in this study indicates that there is a positive association between average math achievement in the school and acceleration in growth. Hence, we can surmise that schools that emphasize parental involvement and provide academic counseling can produce dramatic effects in math achievement growth for high achieving students, because these variables increase the acceleration in academic growth that occurred during the transition from middle school to high school.

This study also demonstrates the effectiveness of polynomial growth models to study variables related to transitional periods in which growth rate changes. These transitional periods may be due to developmental transitions or to changes in the environment, as was the case in this investigation. In the example provided here, students were transitioning from middle to high school and during this time their growth rate changed. The polynomial growth model was sensitive to this change in growth that occurred as a result of the school transition. By using multilevel modeling, the growth trajectories were allowed to vary across schools. The variance in growth could then be modeled by school-level variables, a strength of multilevel modeling. By controlling for contextual effects and investigating the effects of policy and practice variables through the use of Type B effects (Raudenbush & Willms, 1995), we determined the effects of school policies and practices in schools with similar contexts during these transitional periods. This has particular importance in the study of growth periods that have significant acceleration, because the rate of growth is actually increasing. Therefore, any school policy or practice initiated at this time, which affects acceleration can have dramatic effects on achievement since this is a period of rapid growth.

With the availability of increasingly sophisticated analytic procedures that allow the modeling of growth trajectories, there is the opportunity to reframe questions about educational success to study the variables related to rate of change and acceleration in rate of change. School effects need not center around differences in mean achievement level among schools, but rather around the differences in achievement growth rates and acceleration across schools. Targeting achievement growth, rather than average achievement may significantly improve current understanding of cognitive changes during key transition periods.

Note

Both authors contributed equally to the research and writing of this article.

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