DOCUMENT RESUME

ED 409 183 SE 060 344

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TITLE	Explaining the Negative Impact of the Transition from Middle to High School on Student Performance in Mathematics and Science: An Examination of School Discontinuity and Student Background Variables.
PUB DATE	Mar 97
NOTE	37p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28, 1997).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Academic Achievement; Educational Policy; *High Schools; *Institutional Environment; Junior High Schools; *Mathematics Education; *Middle Schools; Parent Student Relationship; Personal Autonomy; Program Evaluation; *Science Education; Social Background; Student Promotion; Student School Relationship
IDENTIFIERS	Middle School Students

ABSTRACT

As students progress through the educational system they make frequent transitions, such as from grade to grade or middle to high school. The purpose of this study is to explore how institutional discontinuities between schools affect student achievement in mathematics and science and for which types of students. This paper seeks to identify specific discontinuities that aggravate the transitional experience, and to discover support structures that buffer the effect of the transition from middle to high school on the mathematics and science progress of students. Findings indicate that students from more stable and supportive home environments show less academic difficulty as they progress through the transition. Decreases in safety and the quality of the learning environment had significantly negative effects on achievement across the transition for both mathematics and science. A decrease in the degree to which teachers push students to achieve had a positive effect on student progress, and an increase in the level of autonomy granted to students and their parents to choose courses had a negative effect on student performance. There would appear to be a need for supplemental programming during the transition between middle and high school levels. Several policy interventions are suggested for consideration. Contains 48 references. (PVD)

Explaining the Negative Impact of the Transition from Middle to High School on Student Performance in Mathematics and Science: An Examination of School Discontinuity and Student Background Variables

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Paper prepared for the Annual Meeting of the American Education Research Association, March 24-28, 1997, Chicago, IL

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As students progress through the American educational system, they make frequent transitions -- they move from one class to the next, from one grade to the next, and from one level of education to the next. All of these shifts in the educational process constitute transitions that students must negotiate as they forge their way through the educational system. Simply defined, a transition is a point at which students move from one segment of education to another. These shifts are generally associated with a cluster of changes to which the student must adapt. For instance, high school students who move from one class to another in a single day often experience changes in subject matter, teachers, instructional methods, and classmates. Likewise, as students progress from one level of education to the next they can experience numerous major discontinuities involving the school environment, educational practices, and social structures.

Evidence has shown that transitional discontinuity can have a negative impact on student academic performance. For instance, research has long documented the negative effect of frequent school transfers on the performance of students from high-mobility families (Lacey and Blane, 1979; Holland et al., 1974). In addition to these idiosyncratic school transfers, a number of transitions are systematically built into the typical structure of public school systems in the U.S. More specifically, "systemic transitions" are those that are in some way built into the school system such that all students in a particular school system make the transition at a particular point in time or level of development. These transitions can exist within schools (e.g., changing teachers and classmates across academic years in elementary school, changing classes within a single day in secondary school), as well as across schools (e.g., moving from elementary to middle school, moving from middle to high school). Research is increasingly demonstrating that systemic transitions between schools are associated with a number of changes that can be expected to have an effect on student academic progress (Blyth, Simmons, and Carlton-Ford, 1983; Crocket at al., 1989; Hawkins and Berndt, 1985).

This paper is part of a larger project investigating the effect of the systemic transition from middle to high school on student performance in mathematics and science.[1] It should be noted that the transition from the middle to high school level of education can take numerous forms. This can involve changing school institutions, moving to a new school building or wing in a school-within-a-school setting, or progressing from the middle to the high school grades within a single school facility. Regardless of the institutional circumstances under which the transition occurs, students in all settings can be expected to experience a cluster of changes associated with the transition into the high school level of education. Previous work found that the transition from the middle to high school levels of education has a negative impact on student performance, regardless of whether the transition is associated with a change in schools (Rice 1997).

The negative impact of the transition is presumably a consequence of the discontinuities that accompany the transition. More specifically, the transition from middle to high school may introduce changes in environment, educational practices, and social structures to which students must adapt. To the degree that there is discontinuity between sending and receiving schools, students may need extra support and guidance to progress successfully through these points in their educational careers (Baker and Stevenson, 1986; Ward, 1982). As a result,

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[1] This paper is based on a doctoral dissertation by the author (Rice, 1995). Throughout this work, the term "middle school" is used broadly to encompass both middle and junior high school.

student academic progress across the transition is likely to depend on background factors such as the level of educational support enjoyed by the student in the home environment.

The purpose of this study is to explore how institutional discontinuities between schools affect student achievement in mathematics and science, and for what types of students. This paper seeks to identify specific discontinuities that aggravate the transitional experience, and to discover support structures that buffer the effect of the transition from middle to high school on the mathematics and science progress of students. The focus on mathematics and science achievement as measures of student progress and educational productivity reflects the important national focus on student performance in these two subjects throughout the past decade. To the degree that problematic discontinuities and ameliorative buffers can be identified, educational policy can be designed to ease this transition for students as well as to improve one aspect of productivity in the longitudinal educational process. In particular, the study has the potential to inform numerous interesting policy issues surrounding the organization of the educational process, placement of support programs, and special resource needs of at-risk students. In this way, the study addresses issues of efficiency and equity.

Issues Central to the Transition

Several factors are likely to affect the impact of the transition on student performance. This section explores first the kinds of discontinuity that may contribute to the negative impact of the transition, and then the student background variables hypothesized to buffer the transitional experience.

Institutional Discontinuities Across the Transition from Middle to High School

At least two types of discontinuity characterize the transition from middle to high school: (1) discontinuity in environment (i.e., climate and educational policies), and (2) discontinuity in social structures. These types of discontinuity are represented in Figure 1 which depicts one way to conceptualize an educational transition between schools. The figure illustrates a student moving from School 1 to School 2. The variable *x* represents the degree to which the two schools are similar with regard to climate (e.g., school size, safety, standards) and educational policies (e.g., the degree to which teachers push students academically, the level of student autonomy in choosing courses).

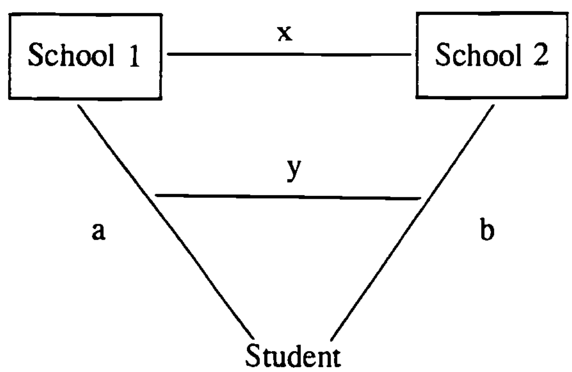

Figure 1
Discontinuity Across a School Level Transition

The variables *a* and *b* represent the social structures that a student has formed in School 1 and School 2, respectively. These social structures can be observed at the school level (e.g., the degree to which a student is demographically aligned with the entire school population in that particular school) or at a sub-school level (e.g., the success with which a student has found a social niche within the school and the quality of that niche). A student's social structures can change dramatically as he/she moves through a school transition. Thus, it is reasonable to study the consistency between a and b and how this affects student academic progress. The degree to which these social structures change from middle school to high school is represented by the variable y.

It is noteworthy that sufficient knowledge of the direction and magnitude of the variables along any two segments in the figure yields some understanding of the nature of the third segment. As I discuss a number of variables throughout this section, it will become clear that they are not independent of one another. However, each captures a different angle of what might be most important for students as they traverse from one level of education to the next and therefore warrants attention. Table 1 presents the specific discontinuity variables and hypotheses discussed throughout this section.

INSERT TABLE 1 HERE

Environmental discontinuity. Environmental discontinuity includes changes across schools in terms of climate as well as educational practices. School climate refers to how actors in the educational process perceive and characterize the school atmosphere. Researchers have found school climate to be an important determinant of student performance (Brookover et al. 1979, Good and Brophy 1986, Rutter et al. 1979). This study examines measures of school climate that are likely to change across the transition from middle to high school and thereby affect student performance. These are discussed below.

As students progressively move to more advanced levels of education, the size of the school tends to increase (NCES, 1996b). While a change in school size may be dramatic across the transition from middle to high school, the direction and magnitude of its effect is likely to depend on issues such as the continuity of individuals, the change in student diversity, and a change in the level of competition among students. Many of these variables are also considered in the model developed in this section.

Another artifact of increases in the level of education in the U.S. is a decrease in safety. In general, safety becomes a more salient concern as students progress to higher levels of education (NCES, 1996a). Schools at more advanced levels tend to be less safe and it is reasonable to suspect that a decrease in safety has a negative impact on student performance, particularly for students coming from a relatively safe environment.

The nature of the learning environment can also be expected to change across the transition from middle to high school. Some high schools are more academically-oriented than the feeder middle schools. This may stimulate more pressure and more competition. In contrast, a decline in safety or an increase in the emphasis placed on extra-curricular or social activities may have an opposite effect on the academic environment. Although it is difficult to predict the direction of the change, it seems reasonable to expect that the nature of the academic environment can change across the transition, and that change is likely to have an effect on student academic performance.

Likewise, the degree to which the students in a school work to their ability levels can be expected to have a positive or negative effect on student progress. As school level increases, the level of competition in the school might also increase, particularly in an educational system where academics are highly valued and students tend to work to their ability levels. For some students, an increase in competition may serve as an impetus to perform at optimal levels--peer pressure to do better. For others, however, it may damage motivation and confidence levels, resulting in a decrease in effort and possibly even a tendency for students to choose placement in lower academic tracks.

School standards involve the academic expectations placed on students by the school faculty. It is reasonable to suspect that standards increase as students move to more advanced levels of education (Kohut 1988), at least for some students (e.g., those placed in higher academic tracks). Further, a healthy increase in academic standards is likely to be related to an increase in student performance across the transition. On the other hand, if the change in standards is haphazard, too abrupt, or unenforced, it is reasonable to suspect that student performance decreases across the transition.

Another issue is the degree to which teachers push students academically. There is reason to believe that as students move from middle to high school, teacher expectations may become more rigorous. Likewise, the pressure that teachers place on students may become more intense. This could be a particularly positive situation for a student who has the potential to excel, but needs to be aggressively encouraged to realize that potential. However, this added pressure may be damaging for students who might already be overwhelmed by the multitude of changes occurring as they move into the high school level of education.

Student autonomy in selecting courses generally increases as students move from the middle to high school level of education. While for students with plenty of school and home guidance this additional freedom can be very fruitful, for others lacking such support mechanisms, this responsibility could be a source of stress resulting in decreased academic progress. Even more importantly, freedom to choose courses can be expected to have an effect on the course-taking practices of a student. In a case where these decisions are delegated to students who did not have such freedom in the past, without proper guidance, the pattern of courses taken may be quite inappropriate and lead to under-achievement (in courses which are too easy) or failure (in courses which are too difficult). Either scenario is likely to have a negative effect on academic progress.

Social structures. The existence and quality of school social structures can be an important predictor of a student's ability to succeed academically (Cauce and Schrebnic 1989, Winkler 1975). The stability of social structures (variable *y* in Figure 1) can be studied at two levels. First, a school level transition tends to involve some degree of discontinuity among the members of the student population. As the level of education increases school size also generally increases, making schools less neighborhood-oriented and more diverse with regard to demographic composition. This increase in diversity is expected to have a negative impact on student performance across the transition.

Second, social systems can be considered at a more individual level, paying attention to how a student locates him/herself in the larger school environment. The alignment between student and school reflects the degree to which a student shares common ground with other students in the school. Regardless of the degree to which a student is aligned with his/her school, he/she could develop a niche, a more micro-level social structure that has the potential to outweigh any lack of alignment. Stability of social structures that are supportive of educational goals can serve as a buffer as a student progresses across the transition. Due to data limitations, however, demographic composition (i.e., diversity) of the schools is the only social structure variable included in the models.

Student Background: Parent Support as a Buffer

Transitions may affect different types of students differently. The magnitude of the effect is likely to be dependent on a number of factors such as the existence and quality of support structures available to the student. Given the need for supplementary support for students across transition periods, student background attributes can be expected to have a significant impact on the effects of transition periods.[2] The resiliency of the student during the period of transition may depend not only on his/her own coping mechanisms, but also on the level of social support available from external sources. Since parents are potentially the most valuable source of educational support (Hanushek 1992; Baker and Stevenson 1986), background variables of particular interest in this study are those that measure the degree to which students receive educational support from home. Two types of parental/home support warrant consideration.

First, the ability of parents to support the educational experience of their children may have important implications for the student's progress through transitions. Ability to support encompasses goodness of fit concerns. If the student's home environment is simply not aligned with that of the school, parental support may be quite difficult to realize (Thomas and Chess 1977, Baker and Stevenson 1986). In this study, ability to support is measured by variables generally associated with at-risk status: SES, mother's level of education, single parent family, and educational resources in the home.

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[2] In contrast to the school discontinuity variables which change across the transition, I assume student background variables to remain constant over time. Clearly this is not always the case. However, it is an assumption that is built into the study due to a combination of data limitations and an emphasis on systematic changes in school factors, rather than those at home.

Willingness to support is the second component of a student's home environment which can be expected to have an impact on the effect of transition periods on student progress. Indicators of willingness to support include parents' levels of interest and participation in the schooling process (e.g., attending school events, helping with and checking over homework assignments), the degree to which parents supplement the schooling process with educational activities (e.g., museums, cultural events), and the degree to which parents talk with their children about school. I hypothesize that students lacking these kinds of support structures in the home not only have trouble in school, but also experience disproportionately more problems as they progress through educational transitions which require adjustment.

In addition to the background attributes discussed above, I explore the effect of the number of siblings a student has on his/her ability to successfully negotiate the transition from middle to high school. This variable could have a positive or a negative effect. On the positive side, a student with older siblings in particular may be more familiar with the sorts of changes that accompany the transition, and thus might experience less anxiety during the transition. Conversely, students from large families may receive less supportive attention from parents during times of need, such as a school transition. They have to share whatever supportive parental resources exist in the household with their siblings. Another background variable which can be expected to have an effect on student progress across the transition is student gender. Particularly given the focus of this study on achievement in mathematics and science, it is reasonable to surmise that there may be significant differences between males and females in coping with and adjusting to the transition.

Data and Methodology

Data

The Longitudinal Study of American Youth is a panel study of American public middle and high school science and mathematics education. Data collection began in the fall of 1987 and follow-up studies have been conducted each year thereafter through the spring of 1992. This study draws upon the data collected over all four years. The data come from the April 1992 and the October 1993 public use releases.

The base year sample of Cohort 2 includes 3,116 students who were in the 7th grade in 1987.[3] The students were drawn from middle schools which feed into 52 high schools randomly selected on the basis of geographical region and community type. Sixty 7th grade students were randomly selected in each school to be included in the study, except in cases where the enrollment of the class was fewer than 60. In these cases, all students in the class were selected for participation. Survey instruments were completed annually by the sampled students, their teachers, their principals, and their parents. In addition, achievement tests focused on mathematics and science were administered in the fall of each year of the study.

Identifying the transition. The LSAY is a longitudinal data set studying students as they progress from the 7th through the 11th grades. Consequently, all students who remain in the sample throughout the duration of the study make a transition from the middle to high school level of education. While it is reasonable to suspect that all students experience a

[3] Cohort 1 is not used in this study because the base year sample is composed of students who were in the 10th grade in the fall of 1987.

cluster of institutional changes as they move through the transition, these changes can only be observed and measured in the LSAY for students who change schools. Consequently, this study used only the sub-sample of students who changed schools as they passed through the transition. In addition, since the focus here is on systemic transitions, students who moved schools more than once and/or to a school other than the appropriate receiving high school during the sampled period were not included in the sample studied since these are not considered systemic transitions.

Student identification codes served as the sole indicator of a systemic transition in a student's record. In the initial year of data collection, each student in the LSAY was assigned a six-digit identification number. The first three digits of this number represent the school he/she attends; as students progressed through grades, these digits were subject to change if/when the student changed schools. Middle schools were selected by virtue of being feeder school to the previously randomly selected high schools, and matching school codes differ by only one number (e.g., middle school 101 is the feeder school for high school 201). Consequently, if a student's identification number changed by one digit only once during the LSAY study--e.g., 101024 (the 24th student in middle school 101) to 201024 (the 24th student in high school 201)--this was evidence of a systemic transition from a middle school to a high school. Students who made the systemic transition between schools could be matched with two sets of school level data--one from middle school and the other from high school.

Measures of student achievement. The achievement tests utilize items developed by the National Assessment of Educational Progress (NAEP). The NAEP items permit an assessment of student capabilities along several dimensions of cognitive achievement. The focus in this study is on composite measures of student performance in mathematics and science. Both mathematics and science composite scores were estimated using item response methods which recognize that some items on a testing instrument are more difficult than others. Students' response patterns were adjusted in light of these variable difficulty levels. The 1992 and 1993 releases offer a series of scores that include imputed values for students who missed a portion of the testing sequence. Previous work experimenting with different reported scores found few substantive differences (Monk 1994; Monk and King 1993). The present study uses the imputed scores to maximize the sample size.

Predictor variables. Appendix 1 summarizes the sources of the predictor variables included in the model. In general, these variables were drawn from the student, parent, teacher,[4] and principal files. Many are composites provided by the LSAY. Others are composites constructed for this study from several LSAY variables. Of interest in this study is the change in these school level variables as students progress from middle to high school. In general, the discontinuity variables used in the analyses were the result of taking simple difference scores of variables from paired middle and high schools to measure the magnitude and sign of the change across the transition.[5] Descriptive statistics for the student background and school discontinuity variables included in the study are provided in Appendix 2.

[4] Responses of teachers were aggregated within each school to get school level variables. In cases where several teacher variables were used to create a composite, the mean of the teacher responses in the school was taken for each variable, and then the variables were combined as indicated in Appendix 1.

[5] Scales were reversed when necessary to reflect the most common occurrence as a student moves from middle to high school. For instance, size tends to get larger, while safety tends to decrease.

Methodology

Two types of analyses were used to explore the effect of school discontinuities and support structures on the impact of the transition from middle to high school on student academic progress. Preliminary analyses focused on changes in the annual achievement gain scores before and after the transition. Independent variables -- school discontinuity and student background variables -- were regressed on the change in achievement gain across the transition. The outcome variable of interest is the difference between the gain score immediately prior to and the gain score immediately following the transition. Accelerated progress is associated with a positive number. Steady progress translates into a value of zero. Decelerated academic progress across the transition is associated with a negative value. Since students vary in the point at which they make the transition (i.e., between 7th and 8th grades, 8th and 9th grades, or 9th and 10th grades),[6] students were aligned at the point of transition, t.

Rather than only use the data immediately before and after the transition, the second type of analysis drew upon the full set of longitudinal data provided by the LSAY. A three-level hierarchical model was used to model the growth trajectory of students from 7th through the 10th grades using discontinuity and background variables (see Bryk and Raudenbush 1992). Level 1 models the growth trajectory of each individual in the sample. Level 2 uses person-level variables (measures of parental support) to predict the individual growth parameters in level 1. Finally, level 3 addresses the variation in growth among schools and provides an outlet to explain that variation using institutional or school level variables. This

[6] Two students made the transition between the 7th and 8th grades, 1249 made the transition between the 8th and 9th grades, and 253 made the transition between the 9th and 10th grades.

portion of the study used only the sub-sample of students making the transition from 8th to 9th grade, since this was the most common point of transition. Because of the complexity of the three-level hierarchical model and the large size of the repeated-observations data set, it was not always possible to use hierarchical models.[7] One solution was to exclude several of the variables consistently found to be insignificant in earlier models from this portion of the analysis. Another was to fix the effects of all variables, except those of direct interest in this study (i.e., those pertaining to the transition). See Appendix 3 for the hierarchical models tested.

Findings: The Effects of School and Family Attributes on the Impact of the Transition

Table 2 presents the effect of student background variables and prior achievement on academic progress across the transition. Results show a strong and consistent negative relationship between 7th grade gain score and academic progress across the transition for both mathematics and science. Students who make good progress in the 7th grade seem to stumble academically as they traverse through the transition, relative to students with lower 7th grade gain scores. Other significant effects on mathematics achievement across the transition are the positive impact of the level of education of the student's mother and the negative effect of being from a single parent family. In addition, the degree to which parents and students participate in activities together, a measure of parents' willingness to participate, is a positive

[7] The more complex specifications of the model led to problems with convergence of the data.

predictor of student progress across the transition. All of these results are quite robust and are consistent with hypotheses.

INSERT TABLE 2 HERE

No significant effects were associated with other variables entered into the model: SES, number of educational resources in the home, level of parent participation in school activities, degree to which parents talk about school with their children, and the general background characteristics of student gender and number of siblings.

What is most puzzling, however, is why the variables found to be significant for mathematics are not similarly significant for science. Seventh grade gain score is the only variable that enters significantly into the model for science. Again, this has a strong negative sign suggesting that students who excel in the 7th grade have more trouble negotiating the transition.

Table 3 reveals the effects of the various measures of school discontinuity on the difference in gain scores before and after the transition. Here the results are strikingly consistent across the two subjects. The strong negative effect of 7th grade gain score remains present in both the mathematics and the science models. In addition, there is evidence of a negative effect of a decline in safety from middle to high school on achievement growth in both subjects,[8] which is particularly strong for science. There appears to be a negative effect of a decrease in the quality of the academic environment in both subjects, and this is

[8] The effect of a decline in safety on achievement in mathematics was found in a less comprehensive specification of the model not presented here.

particularly strong for mathematics. These results are consistent with hypotheses.

INSERT TABLE 3 HERE

The next significant result in Table 4, again consistent in both mathematics and science, is the positive effect of a decrease in the degree to which teachers push students to achieve. This result seems counter-intuitive, but it may be the case that an increase in push adds to the stress of the transition, at least in the short-term. A decrease in the pressure may translate into a more comfortable and supportive learning environment. It is more likely, however, that this result is due to endogeneity problems: teachers push those students who need the most help.

The final variable which enters significantly into the models for both mathematics and science is a change in the autonomy with which students are granted to select courses. This source of discontinuity enters negatively for both mathematics and science suggesting that as students and their parents are given more freedom to choose courses, the achievement growth trajectories of the students show negative effects. There are three possible explanations for this. First, it could be the case that more freedom is coupled with less formal guidance yielding poor course-taking decisions, which, in turn, translate into lower gain scores than might otherwise be the case. Second, more freedom to choose may be a source of stress, taking time and energy away from academics. Finally, freedom to choose courses may give students the ability to take classes with friends, a situation which may not be the most conducive to productivity. It would be interesting to study the decision-making process associated with an increase in freedom to choose courses. At any rate, increasing student autonomy as students move through the educational process is a widespread practice which apparently has adverse short-term effects on student achievement growth trajectories.

Table 4 presents the findings of the HLM analyses. I provide three specifications of the model for each subject. The first includes only the student background characteristics as predictors of the impact of the transition. The second includes only the school discontinuity variables to predict the effect of the transition. The third includes all the variables together.

INSERT TABLE 4 HERE

Level 1 is the repeated observations level, which models each individual's achievement growth trajectory over time. Two variables were entered into this model. First, age is a variable measuring the number of months which have passed since the initial test date (where age=0).[9] The second variable included in the level 1 model is a dummy variable indicating each year that the student is post-transition. This allows for a piecewise linear regression model of achievement growth over time. Rather than simply assume that this is the natural point of the break in achievement growth I tested different as well as multiple points for the piecewise analysis. The dummy variable indicating post-transition (in this sub-sample, 9th grade and beyond) offered the best fit model for both mathematics and science.

[9] One concern with using the LSAY data to study growth over time is that students were not always tested at the same point in time each year. For instance, each year the majority of the students were tested in October or November. However, due to logistical circumstances (e.g., absences) some students were unable to take the test with the rest of their classmates. Rather than lose those data, make-up test were administered, often times well after the regular test date. Since these make-up tests were taken as late as August of the following year, it would be misleading to compare annual gain scores without considering the date of the testing. HLM is capable of dealing with different data collection points for each individual in the sample, while previous analyses assume the data collection points to be universal throughout the sample (e.g. time 1 or grade 7).

For both subjects, there is a significant and positive relationship between age and achievement growth. This is not surprising--the achievement tests administered by LSAY are designed so that as students progress through school, they make gains on the tests (rather than hold steady at a particular status). These results suggest that for every month that passes, on average, students score an additional .25 to .27 of a point on the test.

The post-transition variable is also significant across all specifications of the models for both mathematics and science. This variable has a negative effect on performance over time, and the magnitude of this effect is stronger for science than for mathematics. It is important to note that since the sub-sample included in these analyses are those students who make the transition between 8th and 9th grade, the post-transition indicator variable coincides with students' experiences as they progress through the 9th grade, regardless of a transition between schools.

Level 2 introduces student-level covariates which may explain the variance in the level 1 growth trajectories. The effects of the intercept and of age are fixed at this level, leaving only the post-transition indicator as random at level 2. Further, to keep the model as simple as possible, the level 2 variables are entered only as predictors of the post-transition coefficient of the level 1 model.[10] In other words, I tested the degree to which level 2 predictors explain the variance in the level 1 coefficient of being post-transition. This model includes the 7th grade gain score as the pre-test, as well as various measures of student background. Two such

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[10] Although it is reasonable to hypothesize that these variables also have an effect on the starting point (intercept) and on progress over time (age), entering the level 2 variables as predictors of intercept and age made the model too complex, resulting in data convergence problems.

variables which were included in other previous models, but were excluded here are the degree to which parents talk about school, and the degree to which parents participate in the educational experiences of their children.

Few of the level 2 variables are significant in the hierarchical model. The variable representing the degree to which parents and students participate together in non-school activities is consistently significant in the models for mathematics achievement. This variable has a positive effect on student progress after the transition. In addition, several background variables enter as significant predictors, but are weak and not robust. SES is a significant negative predictor in the full model for mathematics. In addition, mother's level of education and single parent family have weak, but significant positive effects on student progress in science after the transition. Again, these effects appear in only one specification of the model.

Level 3 variables were also entered as predictors of the level 1 coefficient for the post-transition indictor variable. In other words, I was interested here in the degree to which the impact of the transition is dependent upon school level discontinuities. For all specifications in both mathematics and science, a decrease in the quality of the learning environment has a negative impact on academic progress across the transition. This effect is strongest for mathematics: an average high school faculty response of one point lower than was the case for the collective middle school faculty translates into the loss of over one point in mathematics.

The only other school level discontinuity variable which is significant in the mathematics model is the positive effect of an increase in student autonomy which appears only in the full model. In contrast, an increase in student autonomy has a strong and robust negative effect on student progress in science across the transition; one additional unit of student autonomy translates into close to a 2-point loss in science achievement. A case can be made to suggest that these findings support the notion of a curricular transition occurring in science at the 9th grade. Since mathematics courses are presumably sequentially related, it should be relatively easy for students to choose new courses based on past performance. In contrast, if a curricular discontinuity does in fact exist for 9th grade science, ONE would expect to see a negative impact of increased autonomy to choose courses on student performance since the students' past experiences presumably offer little guidance about future success given the unrelated nature of new courses to past ones. For instance, it is not evident that a student who excelled in a life science like biology will perform equally well in a physical science like chemistry.

Finally, there is some evidence that a decrease in the degree to which students work to their ability levels and a decrease in school standards have a positive effect on science achievement after the transition.

Conclusions and Policy Implications

The results found in the study confirmed hypotheses. Students from more stable and supportive home environments tend to evidence less academic difficulty as they progress through the transition. I constructed two categories of parental support for consideration. First, I studied student background characteristics indicating the ability of parents to support the educational experiences of their children. In general, these variables measured at-risk status of students. I found that students who are not at-risk, according to several of the variables used in this study (mother's education level, single parent families), tend to have less difficulty negotiating the transition. These effects were more pronounced in the analyses focused on mathematics than in those examining science achievement.

Second, the variables measuring parents' willingness to support revealed some interesting results. Those which were directly related to support of the educational system--parent participation in educational experiences (homework, school activities), and the frequency that parents talk about school--had no apparent effect on student academic progress across the transition. Conversely, the variable measuring the degree to which parents and their children participate in non-school activities together (e.g., cultural or sporting events, projects around the house) surfaced as one of the more powerful student background variables in the models tested. This variable showed positive effects on student achievement across the transition for mathematics. It may be the case that this variable is a more accurate indicator of the quality of parent-student relationships, from which students can draw support during times of need.

In addition, the study demonstrated that specific school discontinuities can be identified as sources of problems for students as they pass through the transition from middle to high school. In particular, decreases in safety and the quality of the learning environment had significant negative effects on achievement across the transition for both mathematics and science. A decrease in the degree to which teachers push students to achieve had a positive effect on student progress, and an increase in the level of autonomy granted to students and their parents to choose courses had a negative effect on student performance in both subjects across the transition.

Given these findings, several policy interventions warrant consideration. For instance, school policy that could stabilize specific discontinuities identified as problematic for students could be expected to decrease the negative effect of the transition on student academic performance. In particular, decreases in school safety and academic environment were found to magnify the negative effects of the transition on student performance. Identifying ways to lessen the magnitude of these changes across the transition (and possibly even create more positive situations) could be expected to ease the difficulty of the transition for students.

In addition, analyses revealed a significant positive effect of a decrease in teacher push on student achievement across the transition. This variable warrants additional consideration. It may be that students benefit from a short-term hiatus from overwhelming academic pressure while they adjust to the new school environment. It would be interesting to see if the positive effect of this variable decreases as the students adjust to the transition.

Another transitional discontinuity variable shown to be a significant predictor of student achievement across the transition is an increase in autonomy granted to students and their parents to select courses. This variable was found to have a negative effect on student academic progress, particularly in science. This finding is most interesting because of its policy manipulability. It may not necessarily be the increase in autonomy that is problematic, but rather the quality of the guidance that students receive as they exercise their freedom to choose courses. Finding ways to improve the quality of the guidance structures or to decrease the difficulties associated with this increase in autonomy are important issues to consider.

In addition to the transitional discontinuities found to be significant predictors of a student's academic performance across the transition, this study offers evidence that different types of students are affected differently by the transition. More specifically, students from relatively supportive home environments tend to experience less academic difficulty as they progress across the transition than do their more at-risk counterparts. The differences among students that are apparent in the findings of this study should be recognized in the nature of the policy interventions. Students lacking support in the home environment could benefit from supplemental support as they make the transition from the middle to high school level of education. This study identifies yet another point in the educational process where at-risk students are particularly vulnerable to disproportionate failure, and can benefit from additional resources and attention. Just as programs for at-risk students exist for the pre-school and the school-to-work transitions, there appears to be a need for supplemental programming during the transition between middle and high school levels of education. Further, this finding could be used to guide existing programs geared toward meeting the needs of at-risk youth in their middle and high school years to a critical point in their academic development. This has the potential to result in more productive and efficient use of limited resources.

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Table 1
Discontinuity Variables and Their
Hypothesized Direction of Change and Effect on Student Progress

School Discontinuities	Hypothesized Direction	Hypothesized Effect on Student Performance
Environmental		
School size	Increase	?
Safety	Decrease	Negative
Learning environment	?	?
Students who work to ability level	?	Positive or Negative
School Standards	Increase	Positive or Negative
Teacher academic push	Increase	Positive or Negative
Student Autonomy	Increase	Negative
Social Structures		
Diversity	Increase	Negative

Table 2
The Effects of Student Background Characteristics on Student Achievement Gains in Mathematics and Science Across the Transition from Middle to High School[1]
(Ordinary Least Squares Regression Coefficients and Standard Errors)

	Math[2]			Science		
Intercept	2.45 ** (0.85)	4.46 ** (1.65)	2.51 (2.04)	1.78 ** (0.86)	4.53 ** (1.65)	4.51 ** (2.07)
Subject-specific 7th grade gain	-1.38 ** (0.03)	-1.37 ** (0.03)	-1.38 *** (0.03)	-1.46 ** (0.03)	-1.47 ** (0.03)	-1.46 ** (0.03)
SES	-0.25 (0.41)		-0.35 (0.42)	0.45 (0.42)		0.43 (0.43)
Mother's education	0.51 ** (0.26)		0.5 * (0.26)	0.12 (0.26)		0.05 (0.26)
Single parent	-1.06 * (0.58)		-1.12 * (0.6)	0.19 (0.59)		0.28 (0.6)
Home resources	0.19 (0.15)		0.19 (0.16)	0.04 (0.16)		0.01 (0.16)
Parent participation in education		0.29 (0.9)	0.32 (0.96)		1.36 (0.9)	-1.1 (0.97)
Activities with parents		0.05 ** (0.02)	0.05 ** (0.02)		0.01 (0.02)	0.01 (0.02)
Parents talk about school		-0.15 (0.16)	-0.17 (0.16)		-0.11 (0.16)	-0.14 (0.16)
Female			0.29 (0.43)			-0.46 (0.44)
Number of siblings			-0.16 (0.16)			-0.06 (0.16)
n	1254	1296	1252	1254	1296	1252
R^2 (adj)	0.57	0.58	0.57	0.63	0.63	0.63

*** p<.01 ** p<.05 * p<.10

[1]These analyses utilize the aligned configuration of data, including only those students in the sample who made a school level transition.

[2]The outcome variable used here measures the difference between the gain score made during the year immediately before the transition and that made in the year immediately following the transition.

Table 3
The Effects of School Level Discontinuity Variables on Student Achievement Gains in Mathematics and Science Across the Transition from Middle to High School[1]
(Ordinary Least Squares Regression Coefficients and Standard Errors)

	Math[2]	Science
Intercept	5.16 *** (0.57)	3.23 *** (0.57)
Subject-specific 7th grade gain	-1.36 *** (0.04)	-1.51 *** (0.04)
Increase in size	0.0 (0.0)	0.0 (0.0)
Decrease in safety	-1.7 (1.15)	-4.08 *** (1.17)
Decrease in quality of learning environment	-1.45 *** (0.44)	-0.75 * (0.46)
Decrease in students who work to ability	-0.21 (0.68)	0.21 (0.7)
Decrease in standards	0.1 (0.48)	0.37 (0.49)
Decrease in teacher academic push	0.88 ** (0.41)	0.86 ** (0.43)
Increase in student autonomy	-1.85 ** (0.73)	-1.65 ** (0.75)
Increase in diversity	0.03 (0.02)	0.01 (0.03)
n	1077	1077
R^2 (adj)	0.56	0.62

*** $p < .01$ ** $p < .05$ * $p < .10$

[1]These analyses utilize the aligned configuration of data, including only those students in the sample who made a school level transition.

[2]The outcome variable used here measures the difference between the gain score made during the year immediately before the transition and that made in the year immediately following the transition.

Table 4
Hierarchical Linear Model Testing the Effects of Student Background Characteristics and School Discontinuity Variables on Student Achievement in Mathematics and Science Across the Transition from Middle to High School[1]
(Regression Coefficients and Standard Errors)

	Math			Science		
Intercept	52.15 *** (0.34)	57.5 *** (0.34)	57.5 *** (0.34)	56.6 *** (0.32)	56.6 *** (.32)	56.6 *** (0.32)
Repeated Obs. (L1)						
Age[2]	0.27 *** (0.01)	0.27 *** (0.01)	0.27 *** (0.01)	0.25 *** (0.01)	0.25 *** (0.01)	0.25 *** (0.01)
Post-transition[3]	-0.85 *** (0.36)	-0.6 * (0.44)	-0.89 ** (0.48)	-2.11 *** (0.29)	-2.17 *** (0.4)	-2.12 *** (0.41)
Individual level (L2)[4]						
Subject-specific 7th grade gain	-0.01 (0.03)		-0.02 (0.02)	0.01 (0.02)		0.01 (0.02)
SES	-0.05 (0.27)		-0.33 * (0.25)	0.08 (0.24)		0.07 (0.23)
Mother's education	-0.04 (0.19)		-0.18 (0.17)	0.23 * (0.17)		0.2 (0.17)
Single parent	0.33 (0.4)		0.34 (0.36)	0.5 * (0.33)		0.37 (0.34)
Home resources	0.11 (0.1)		-0.04 (0.09)	0.01 (0.09)		-0.03 (0.09)
Activities with parents	0.05 *** (0.01)		0.04 *** (0.01)	0.01 (0.01)		0.01 (0.01)
School level (L3)						
Decrease in safety		-0.15 (1.09)	0.3 (1.19)		-0.15 (0.95)	-0.07 (0.95)
Decrease in quality of learning environment		-1.25 *** (0.37)	-1.22 *** (0.4)		-0.87 *** (0.33)	-0.77 *** (0.32)
Decrease in students who work to ability		0.13 (0.53)	0.2 (0.57)		0.62 * (0.46)	0.5 (0.46)
Decrease in standards		-0.17 (0.46)	-0.42 (0.49)		0.47 (0.39)	0.52 * (0.37)
Decrease in teacher academic push		-0.31 (0.36)	-0.33 (0.4)		0.15 (0.31)	0.07 (0.31)
Increase in student autonomy		1.16 (0.95)	1.67 * (1.03)		-1.9 ** (0.84)	-1.65 ** (0.83)
n -- Level 1	3931	3931	3931	3931	3931	3931
n -- Level 2	845	845	845	845	845	845
n -- Level 3	29	29	29	29	29	29

*** $p < .01$ ** $p < .05$ * $p < .10$

[1]These analyses are based on the sub-sample of students who made the transition between the 8th and 9th grades.
[2]Age measures the number of months since the first administration of the test.
[3]Post-transition is a dummy variable indicating each year after the transition.
[4]Level 2 and level 3 predictor variables model the level 1 coefficient of post-transition. Other level 2 effects are fixed.

Appendix 1
LSAY Variables Included in the Study

Description	LSAY File	LSAY Variable(s)
Test scores		
Mathematics	Student	amthimp, cmthimp, emthimp, gmthimp, imthimp
Science	Student	asciimp, csciimp, esciimp, gsciimp, isciimp
Student Background		
SES	Composite	ses3
Mother's education	Composite	mothed
Single parent family	Parent	bh34
Home resources	Composite	hscre1
Parent participation in education[1]	Parent	bh65, 67, 73, 75, 95, 96, 97, 98, 104, 105, 106
Activities with parents[2]	Parent	bh155 - bh161
Parents talk about school	Composite	psctk1
Female	Parent	bh7
Number of siblings	Parent	bh5
School Discontinuities		
Size	Principal	ek2a
Safety[3]	Teacher	be52, 53, 54, 55, 56
Quality of learning environment	Teacher	be16
Students work to ability levels	Teacher	be30
Standards	Teacher	be25
Teacher academic push	Teacher	be31
Diversity[4]	Principal	ek2a, ek2b, ek2c, ek2d
Student autonomy to choose courses	Principal	ek13a1, ek13f1

1. Parent participation=Mean (visit school, volunteer work at school, attendance at school events, help with homework and school projects)
2. Activities with parents=Mean (attend play, attend sporting event, work on projects, engage in cultural activities, spend recreational time, play music, attend religious service)
3. Safety=Mean(theft/vandalism, drugs/alcohol, fighting, verbal abuse, racial relations)
4. Diversity= - (|25-#Black| + |25-#Asian| + |25-#Hispanic| + |25-#Other|)

Appendix 2
Descriptive Statistics for Variables included in the Study

Variables	N	Mean	Standard Deviation
Achievement Test Scores			
7th grade math score	2000	52.21	9.77
8th grade math score	2000	54.63	10.28
9th grade math score	2000	58.32	11.59
10th grade math score	1999	61.17	13.18
11th grade math score	1992	62.66	14.92
7th grade science score	2000	52.09	9.76
8th grade science score	2000	55.04	10.35
9th grade science score	2000	58.05	10.46
10th grade science score	1999	58.55	11.79
11th grade science score	1991	60.60	12.90
7th grade math gain (pre-gain)	2000	52.21	9.77
7th grade science gain (pre-gain)	2000	52.09	9.76
Student Background			
SES	2000	.15	3.22
mother's education	1952	2.40	1.03
single parent	1715	.18	.38
home resources	1932	3.27	1.65
parent participation in education	1715	1.38	.24
activities with parents	1714	16.48	10.39
parents talk about school	1715	5.53	1.37
female	2000	.49	.50
number of siblings	1714	2.88	1.47
School Discontinuities			
increase in size	1162	607.06	414.38
decrease in safety	1341	.32	.25
decrease in learning environment	1487	.37	.76
decrease in students who work to ability	1487	.39	.57
decrease in standards	1487	.14	.59
decrease in teacher academic push	1341	.16	.63
increase in student autonomy	2000	-.04	.36
increase in diversity	1162	.95	10.94

Appendix 3
Hierarchical Linear Models Used in the Study

Level 1 model:

Achievement = P0 + P1(age) + P2(post-tran) + E

Level 2 model:

P0 = B00 + R0
P1 = B10
P2 = B20 + B21(mthgain) + B22(SES) + B23(mothed) + B24(singlpar) + B25(homeres) + B26(paract) + R2

Level 3 model:

B00 = G000
B10 = G100
B20 = G200 + G201(cgsafety) + G202(cgenvir) + G203(cgabilty) + G204 (cgstd) + G205(cgpush) + G206(cgatmy) + U0
B21 = G210
B22 = G220
B23 = G230
B24 = G240
B25 = G250
B26 = G260

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