The Middle School Experience: Effects on the Math and Science Achievement of Adolescents with LD

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Abstract

The present study examined the relation between middle school transitions and achievement gaps in math and science between adolescents with and without learning disabilities (LD). An abundance of research indicates that motivation and achievement decline during the early adolescent years, and that this decline is often attributable to the transition from elementary to middle grade schools during early adolescence. Using data from the National Education Longitudinal Study, it was found that, on average, there was a strong gap in achievement between the two groups of early adolescents. Hierarchical linear modeling was used to examine school effects on these achievement gaps. Results indicated that although there were achievement gaps in math and science between adolescents with LD and non-LD adolescents, this gap was greatly reduced for adolescents who did not make a school transition until at least the ninth grade. It is proposed that the policies and practices of typical middle-grade schools are particularly incompatible with the educational and psychological needs of young adolescents with LD.

There has been little research involving the math and science achievement of students with learning disabilities (LD) during early adolescence. This is unfortunate, because early adolescence marks a time when students make important life and career choices; a negative experience in math or science at this early age can keep an adolescent from making future life choices that involve work in a particular domain. The present article examines the effects of school experiences during early adolescence on achievement gaps in mathematics and science between students with LD and non-LD students.

Math and Science Achievement of Students with LD

The research that has been done on the mathematics and science achievement of these students indicates that, in general, they do not achieve as well as their non-LD peers. For example, Wigle, White, and Parish (1988) compared the reading, math, and writing achievement of both low- and high-IQ students with LD during late childhood and early adolescence. They found that mean IQ declined over time, as did math achievement scores, while reading and writing scores remained stable. Other studies have also documented the gap in math achievement between students with LD and non-LD students (e.g., Kavale & Reese, 1992), but few have specifically examined such gaps for science achievement.

In a large-scale study of students with LD in the state of Iowa, Cone and his colleagues found that placement into special education services for those students occurred more frequently due to deficiencies in reading and spelling during the early school years, whereas placements due to mathematical problems generally did not occur until the upper elementary years (Cone, Wilson, McDonald Bradley, & Reese, 1985). They also reported that the discrepancy between IQ and achievement for students with LD increased with age. Similar findings involving age were reported in several other large-scale surveys of the characteristics of students with LD (e.g., Ackerman, Anhalt, & Dykman, 1986; Norman & Zigmond, 1980; Sheppard & Smith, 1981).

Research has demonstrated that a number of factors may contribute to the achievement gaps between students with LD and non-LD students. For example, Zentall and Ferkis (1993) suggested that the math difficulties experienced by students with LD were due to a combination of problems with cognitive ability, cognitive style, and inadequate curricular materials. Montague and Applegate (1993) suggested that students with LD approached mathematical problems differently than their nondisabled peers because they lacked certain cognitive strategies that were needed for effective prob-
lem solving. Shepard and Adjogah (1994) found that differences in the language-processing abilities of students with and without LD were related to differences in science achievement. These and other student-specific characteristics were important determinants of students' ability to solve mathematical and scientific problems.

**School-Level Factors That Influence Achievement**

A number of studies, reviews, and reports indicate that the transition from elementary to middle-level school has detrimental effects on the achievement and motivation of early adolescents (Anderman & Maehr, 1994; Anderman & Midgley, 1997; Carnegie Council on Adolescent Development, 1989; Eccles & Midgley, 1989; Eccles et al., 1993; Harter, Whitesell, & Kowalski, 1992; Seidman, Allen, Aber, Mitchell, & Feinman, 1994; Simmons & Blyth, 1987; Wigfield, Eccles, Mahtyer, Reuman, & Midgley, 1991). Nevertheless, studies to date have not specifically examined the effects of this transition on the math and science achievement of early adolescents with LD.

A number of studies show that as students move from elementary to middle-grade schools, achievement, motivation, and attitudes decline. In a large-scale longitudinal study of more than 2,000 young adolescents, Eccles, Midgley, and their colleagues showed that many of the negative changes that occurred over the transition were due to contextual changes in the school environment (Eccles & Midgley, 1989; Wigfield et al., 1991). For example, whereas elementary school is characterized by small classes, stimulating projects, efficacious teachers, and cooperation, the middle school environment often tends to emphasize rote memorization, basic skills, competition, and less creative assignments. In addition, middle school teachers often feel less efficacious than do elementary school teachers (Midgley, Anderman, & Hicks, 1995), and this contributes to changes in student performance and attitude (Midgley, Feldlaufer, & Eccles, 1989). Simmons and her colleagues (e.g., Simmons & Blyth, 1987) have demonstrated that changes in motivation and self-esteem over the transition are directly related to contextual changes in the school environment. For example, one study found that girls who moved into a traditional middle school setting displayed a decline in self-esteem, whereas girls who remained in a kindergarten-through-Grade-8 school and did not make a transition until at least the ninth grade did not experience this decline. In fact, the girls who attended the traditional middle school were still at a significant disadvantage even after entering high school.

These and other studies (e.g., Anderman & Midgley, 1997; Seidman et al., 1994) indicate that the middle school environment is antithetical to the needs of young adolescents. Eccles and Midgley (1989) referred to this as a problem of stage-environment fit—adolescents are at a stage of development when they need to be in an environment where they can experience independence, growth, cooperation, and creativity; however, the typical middle school provides an environment that stresses competition, grades, relative ability, and rote memorization. Although research has demonstrated that this change in environment has detrimental effects on adolescents in general, studies to date have not examined the effects of these transitions on students with LD in particular. Such an examination is crucial, as the transition may exacerbate and contribute to achievement gaps during early adolescence.

The present study examined the relations between school-type and achievement gaps in math and science between adolescents with LD and non-LD adolescents, after controlling for student-level variables that are predictive of achievement. Because prior studies have documented that student-level variables such as gender, grades in school, ethnicity, perceptions of the quality of teaching, and socioeconomic status are predictive of math and science achievement (e.g., Midgley et al., 1989; Young & Fraser, 1993, 1994), those factors were controlled before examining effects of school type on the achievement gap. Specifically, the central hypothesis of the present study was that students with LD who attended kindergarten-through-Grade-8 or kindergarten-through-Grade-12 schools (and thus did not make a school transition until at least the ninth grade) would experience less of an achievement gap than students with LD who attended other types of schools (where a transition to a new school was made prior to the ninth grade), after controlling for student-level variables. The present study utilized a relatively new statistical technique, hierarchical linear modeling (HLM), to examine the organizational effects of school context simultaneously with the effects of student characteristics on math and science achievement. HLM allows for the simultaneous modeling of individual and grouped data; consequently, it allowed for more accurate analyses of students who were nested in schools with different characteristics than would more traditional statistical techniques.

**Method**

**Sample**

Data for the present study came from the base year of the National Education Longitudinal Study (NELS: National Center for Education Statistics, 1988). NELS was a longitudinal study sponsored by the United States Department of Education Office of Educational Research and Improvement. Its purpose was to examine the achievement, progress, and development of eighth graders. After the initial study was conducted in 1988, some of the students were followed up every 2 years through 1994. The present study used a subsample from the NELS data set that included 1,946
eighth-grade students from 78 schools. This sample was formed by including students from all schools that contained at least three students with LD in the NELS sample. Many NELS schools had no participants with LD, or only one or two, and those schools were eliminated, as it would be difficult to obtain useful differentials in achievement between the students with LD and non LD-students.

The number of participants in the schools included in the study ranged from 13 to 34 students per school. Of the selected participants, 296 (15%) were classified as LD and 1,608 (85%) were not LD. Because the study contained many schools from different regions, different criteria were used for LD classification in various schools.

The criteria for inclusion as an LD student in the present study were that the student was classified as LD by the school, and that the student received some special education services during the school day. Specifically, one question in the NELS parent survey asked the parents, "Is your eighth grader currently enrolled in any of the following special programs/services?" One of the specific items then asked parents to indicate if their eighth grader received "special education services for students with learning disabilities." The 296 students with LD included in the present study represented all of the students whose parents indicated that they were enrolled in special education services for students with LD during the eighth grade, and who were also in NELS schools that contained at least three LD students in the NELS sample.

Parents also were asked to indicate if their children experienced any other exceptional conditions. According to the parents of the students included in the present study, 16 (5.4%) of the students with LD and 24 (1.5%) of the non-LD students had a visual handicap; 21 (7%) of the students with LD and 30 (1.8%) of the non-LD students had a hearing problem; 9 (3%) of the students with LD and 2 (0.1%) of the non-LD students were deaf; 28 (9.4%) of the students with LD and 21 (1.3%) of the non-LD students had a speech problem; 5 (1.7%) of the students with LD and 5 (1%) of the non-LD students had an orthopedic problem; 7 (2.3%) of the students with LD and 23 (1.4%) of the non-LD students experienced other physical disabilities; 38 (12.8%) of the students with LD and 55 (3.4%) of the non-LD students had emotional problems; 9 (3%) of the students with LD and 49 (3%) of the non-LD students were enrolled in bilingual or bicultural education services; and 8 (2.7%) of the students with LD and 12 (0.7%) of the non-LD students were enrolled in English as a Second Language programs. Because the subsequent hierarchical analyses required a minimum number of students per school (see Bryk & Raudenbush, 1992), students with various other disabilities were included in the LD and non-LD samples.

The full sample of students with LD and non-LD was divided almost evenly by gender (51% male, 49% female). Ninety-six percent of the students attended public schools, with the remaining 4% attending private or religious schools. Schools varied in type, from kindergarten through Grade 8 (7%); kindergarten through Grade 12 (3%); Grades 6, 7, or 8 through 12 (12%); Grades 3, 4, or 5 through 8 (14%); Grades 6 through 8 or 7 through 8 (44%); and Grades 7 through 9 or 8 through 9 (16%). The full size of the eighth-grade enrollment varied greatly, ranging from small eighth-grade enrollment (18% of the sample had only 1 to 49 students in their class) to large enrollment (10% of the sample were in classes with more than 400 students). Most students were in medium-sized eighth-grade classes (30% had class sizes of between 100 and 199 students). Twenty percent of the students attended urban schools, 44% attended suburban schools, and 36% attended rural schools. Twenty-one percent of the students belonged to minority groups (primarily African American, Hispanic/ Latino American, and Native American).

The students in the sample came from varied backgrounds. Family income for students in this sample varied, with income ranging from about $20,000 to $35,000. The mean family size was 4.5 individuals per household. Seventy-five percent of the eighth graders indicated currently having some college plans.

In terms of ability grouping, 23% were not ability grouped for math instruction, whereas 77% were grouped by ability. In science, 37% were not ability grouped and 64% were ability grouped.

**Construction of Student-Level Predictor Variables**

Below is a description of the development of each of the student-level predictor variables. A plethora of variables can be used in studies predicting effects on academic achievement. The student-level variables chosen for the present study represented only the major demographic individual characteristics that prior research had identified as being important in studies of the achievement of students with LD (e.g., gender, socioeconomic status, minority status, grades in school, plans for the future—see Ackerman et al., 1986; Cone et al., 1985; Norman & Zigmond, 1980; Sheppard & Smith, 1981; Wigle et al., 1988). In this study, a measure of locus of control also was included, as well as a measure of students’ perceptions of the quality of teaching in their schools. The justification for the inclusion of these variables is presented below. The items used to calculate all scales are presented in the Appendix.

**Grades.** Students indicated on a 5-point scale their average grades in math, science, English, and history since the sixth grade. The measure was calculated from the mean of these four variables, in z-score format (Cronbach’s alpha = .76).
Gender, LD, College, and Minority Status. Dummy variables representing gender (1 = female, 0 = male), college plans (1 = yes, 0 = no), and LD status (1 = LD, 0 = non LD) were created. The study also included a dummy variable for minority status, whereby students who were African American, Hispanic/Latino American, or Native American were classified as minorities and students who were Caucasian or of Asian/Pacific Island decent were classified as nonminority (minority = 1, nonminority = 0). In subsequent hierarchical analyses, these variables should be interpreted as the relation between either having or not having a particular characteristic (e.g., being classified as LD or non-LD) on math or science achievement.

Perceptions of Quality of Teaching. A measure of students’ perceptions of the quality of teaching in their school was included, because research suggests that students’ perceptions of teacher expectations, beliefs, and behaviors have a strong impact on motivation and achievement, particularly during late childhood and early adolescence (e.g., Anderman & Young, 1994; Graham, 1984; Midgley et al., 1989; Weinstein, Marshall, Sharp, & Botkin, 1987). In addition, recent school reform efforts specifically aimed at making learning environments more developmentally appropriate for early adolescents have emphasized the importance of students’ perceptions of various aspects of teaching (Anderman & Maehr, 1994; Maehr & Midgley, 1996). Students responded on a 4-point scale, indicating how much they agreed or disagreed with various statements about their perceptions of teaching in their school. Using a principal-components analysis, a five-item composite was created from the z score of the mean on the five items (“The teaching is good,” “Teachers are interested in students,” “Teachers praise my effort,” “I feel put down by teachers,” “Teachers really listen to what I have to say”). The final scale exhibited good reliability (Cronbach’s alpha = .78).

Socioeconomic Status. This variable was constructed from parental data and was a composite of mother’s and father’s educational levels, occupations, and family income. The final variable was standardized (see National Center for Education Statistics [NCES], 1994, for full details on the construction of this variable).

Locus of Control. A measure of locus of control was included because research on students’ causal attributions suggests that students with LD (and BD) often adopt an external locus of control, and that locus of control is an important predictor of academic achievement, particularly in LD populations (Aponik & Dembo, 1983; Foley & Epstein, 1982; Tur-Kaspa & Bryan, 1993). This factor was calculated to be as similar as possible to the measure of locus of control used in the High School and Beyond study (NCES, 1994). The final measure was a z score, where a low score was indicative of low levels of control and a high score indicated high perceptions of control over one’s life.

Dependent Variables

Student-Level Dependent Variables. Students’ scores on standardized mathematics and science achievement tests were used as the dependent variables in the student-level analyses (see NCES, 1994, for full descriptions of these tests).

School-Level Dependent Variables. For the school-level analyses, three separate dependent variables were used: the average math and science achievement, the average achievement gap between students with LD and non-LD students, and the average perceptions of the quality of instruction. For the school-level hierarchical linear models, school-level characteristic variables (e.g., time of transition, school safety, etc.) were used as predictors for each of these three dependent school-level variables. The dependent school-level variables in the hierarchical analyses should be interpreted in terms of their effects on the average student-level variables for each school. In HLM analyses, school-level characteristics can be used as predictors of both the intercept (e.g.,
average school math achievement) and the relation between a student-level predictor variable (e.g., being classified as LD) and the student-level dependent variable (e.g., math achievement). For example, when the LD/ non-LD achievement gap is used as a dependent variable in school-level analyses, coefficients should be interpreted as the effects of school-level factors (e.g., time of transition, school safety, etc.) on the relationship between LD classification and math or science achievement within a given school (see Bryk & Raudenbush, 1992, and Lee & Smith, 1990, for further examples).

**Results**

Means and standard deviations for students with LD and non-LD students are presented in Table 1. Results of a one-way analysis of variance testing for differences between non-LD students and students with LD also are included. Table 2 contains correlations between individual (student-level) predictors. The students with LD exhibited lower math and science achievement and lower overall grades. They also reported lower levels of locus of control and did not aspire to attend college as much as the non-LD students. The students with LD in the sample came from somewhat lower SES backgrounds.

**Hierarchical Linear Models**

Although numerous studies have documented achievement differences between students with LD and non-LD students (e.g., Cone et al., 1985; Kavale & Reese, 1992), most of those studies included only individual characteristics of students as predictors of achievement. It is plausible that those differences in achievement vary across schools—students with LD in one school environment may outperform students with LD in other schools, once individual differences have been controlled.

In this study, HLM was used to separate the within-school variation in achievement of students with LD from the between-school variance in achievement. By using HLM, one can model both individual student characteristics and school-level characteristics into a more comprehensive model. The model takes both student and school-level variables into account.

**TABLE 1**

<table>
<thead>
<tr>
<th>Variable</th>
<th>LD</th>
<th>Non-LD</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math achievement</td>
<td>-0.76</td>
<td>0.15</td>
<td>230.44*</td>
</tr>
<tr>
<td></td>
<td>(0.62)</td>
<td>(0.99)</td>
<td></td>
</tr>
<tr>
<td>Science achievement</td>
<td>-0.68</td>
<td>0.13</td>
<td>181.00*</td>
</tr>
<tr>
<td></td>
<td>(0.76)</td>
<td>(0.99)</td>
<td></td>
</tr>
<tr>
<td>Grades</td>
<td>-0.56</td>
<td>0.11</td>
<td>112.03*</td>
</tr>
<tr>
<td></td>
<td>(0.92)</td>
<td>(0.88)</td>
<td></td>
</tr>
<tr>
<td>Locus of control</td>
<td>-0.34</td>
<td>0.04</td>
<td>63.99*</td>
</tr>
<tr>
<td></td>
<td>(0.84)</td>
<td>(0.71)</td>
<td></td>
</tr>
<tr>
<td>Perceptions of good teaching</td>
<td>0.01</td>
<td>-0.00</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(1.06)</td>
<td>(1.00)</td>
<td></td>
</tr>
<tr>
<td>College plans</td>
<td>0.58</td>
<td>0.78</td>
<td>58.17*</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
<td>(0.41)</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>-0.33</td>
<td>-0.11</td>
<td>24.85*</td>
</tr>
<tr>
<td></td>
<td>(0.78)</td>
<td>(0.72)</td>
<td></td>
</tr>
</tbody>
</table>

Note. All coefficients presented are standardized (effect sizes). For college plans, 1 = does plan to attend college, 0 = does not plan to attend college.

*P < .001.
as HLM calculate standard errors of the estimates more appropriately than do more common ordinary-least-squares (OLS) approaches (Patterson, 1991). When researchers use OLS techniques with nested data, the standard errors often are calculated as too small. Therefore, confidence intervals are also calculated as too small.

**How Much Does Achievement Vary Among Schools?**

First, an unconditional HLM model was calculated, examining the amount of variance in math and science achievement that occurred between schools for both students with LD and non-LD students. Because one of the major purposes of the present study was to examine school-level effects on math and science achievement of LD students, it was important to examine the amount of variance in these variables among schools, for all students, before controlling for individual and school-level variables that might explain the lower achievement of students with LD (cf. Bryk & Raudenbush, 1992). The variance that occurred among schools (intraclass correlation) was 0.21 for mathematics and 0.15 for science. This means that in mathematics, 21% of the variance in math achievement occurred among schools, and this variance can be explained by school-level variables. All reported intraclass correlations have been adjusted for the reliability of the measures.

**The Student-Level Model**

The first HLM model was a Level 1 model, which used student-level data as predictors of math and science achievement. The within-school, or student, model is represented by the following equation:

\[
\text{Achievement} = \beta_{0j} + \beta_{1j} (LD/Non-LD) + \beta_{2j} (Quality of Teaching) + \beta_{3j} (Locus of Control) + \beta_{4j} (College Plans) + \beta_{5j} (Gender) + \beta_{6j} (SES) + \beta_{7j} (Grades) + \beta_{8j} (Minority Status) + \epsilon_{ij}
\]

where

\[
\begin{align*}
\beta_{0j} &= \text{mean math/science achievement for students in school } j; \\
\beta_{1j} &= \text{relation of achievement to being classified as LD in school } j; \\
\beta_{2j} &= \text{relation of achievement to quality of teaching in school } j;
\end{align*}
\]

\[
\beta_{3j} = \text{relation of achievement to locus of control in school } j; \\
\beta_{4j} = \text{relation of achievement to college plans in school } j; \\
\beta_{5j} = \text{relation of achievement to student’s gender in school } j; \\
\beta_{6j} = \text{relation of achievement to SES in school } j; \\
\beta_{7j} = \text{relation of achievement to grades in school } j; \text{ and} \\
\beta_{8j} = \text{relation of achievement to minority status in school } j.
\]

The dependent variables in these analyses were the students’ scores on the math and science achievement tests. The LD/non-LD variable represented whether or not the student was classified as LD (value = 1) or non-LD (value = 0). In the student-level model (prior to adding school-level predictors to the model), this variable should be interpreted as the effect of being classified as LD on achievement, after controlling for other student-level variables, in school j. This procedure has been used by other researchers in HLM studies involving differences between two groups of individuals (e.g., Lee & Smith, 1990). The measure of perceptions of the quality of teaching was eliminated from the science achievement model because it was not a sig-

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**TABLE 2**  
Zero-Order Correlations Among Student-Level Predictors

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Locus of control</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. LD</td>
<td>-.18**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. College plans</td>
<td>.23**</td>
<td>-.18**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Gender</td>
<td>.05*</td>
<td>-.10**</td>
<td>.09**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. SES</td>
<td>.19**</td>
<td>-.11**</td>
<td>.33**</td>
<td>.01</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Grades</td>
<td>.31**</td>
<td>-.24**</td>
<td>.38**</td>
<td>.12**</td>
<td>.31**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Minority status</td>
<td>-.08**</td>
<td>.02</td>
<td>-.03</td>
<td>-.03</td>
<td>-.21**</td>
<td>-.13**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Teaching climate</td>
<td>-.23**</td>
<td>.01</td>
<td>-.09**</td>
<td>-.05</td>
<td>-.08**</td>
<td>-.24**</td>
<td>-.01</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Math achvt.</td>
<td>.26**</td>
<td>-.31**</td>
<td>.29**</td>
<td>-.01</td>
<td>.39**</td>
<td>.49**</td>
<td>-.21**</td>
<td>-.07**</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>10. Science achvt.</td>
<td>.26**</td>
<td>-.29**</td>
<td>.25**</td>
<td>-.03</td>
<td>.35**</td>
<td>.42**</td>
<td>-.18**</td>
<td>-.06*</td>
<td>.70**</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Note. All coefficients presented are standardized (effect sizes). For LD, 1 = LD, 0 = non-LD; for gender, 1 = female, 0 = male; for minority status, 1 = minority, 0 = nonminority; for plans to attend college, 1 = does plan to attend, 0 = does not plan to attend; all school-level transition variables are coded, 1 = student had this transition, 0 = did not have this transition.*

*"p < .05. **p < .01.}
significant predictor of science achievement.

The Full Model

The student-level model is similar to a more typical OLS regression model. However, the advantage of using HLM is that one also may add in school-level predictors and examine the ways in which these predictors influence the intercept and the slopes of various predictors. For math and science, the effects of several school-level variables on mean differences in achievement \( (\beta_{i,j}) \) and on the LD/non-LD differential \( (\beta_{ij}) \) were modeled. This means that school-level variables were used to explain differences in math and science achievement (after controlling for characteristics of individual students) for all students, and for achievement differences between students with LD and non-LD students. Thus, those parameters were allowed to vary among schools, whereas the other student-level variables were fixed—in this way, they were controlled for at the student level but not modeled as effects among schools (see Bryk & Raudenbush, 1992, for a full explanation).

The between-school model examining between-school differences in math and science achievement can be expressed by the equation:

\[
\beta_{ij} = \theta_{00} + \theta_{01} \text{ (Attendance Rate)} + \theta_{02} \text{ (School Is Unsafe)} + u_{ij}
\]

where \( \theta_{00} = \) the intercept term for achievement, controlling for other school-level variables; \( \theta_{01} = \) the effect of school attendance rate within a given school on students’ achievement; and \( \theta_{02} = \) the effect of the level of safety in a given school on students’ achievement in math or science. In this model, the dependent variable is the average math or science achievement in each school. The independent variables are the school-level variables that are related to average achievement within a given school.

The between-school equation examining variation in the effect of being classified as LD is expressed by the following equation:

\[
\beta_{ij} = \theta_{10} + \theta_{11} \text{ (School Is Unsafe)} + \theta_{12} \text{ (No Transition Until at Least 9th Grade)} + u_{ij}
\]

where \( \theta_{10} = \) the intercept term for the LD/non-LD slope (the average LD/non-LD gap across all schools, adjusted for other school variables); \( \theta_{11} = \) the effect of school safety within a given school on the relationship between the LD/non-LD slope and achievement; and \( \theta_{12} = \) the effect of experiencing no transition until at least the ninth grade on the relationship between the LD/non-LD slope and achievement. The measure of school safety was eliminated from the HLM model for science because it was not statistically significant.

In this equation, the dependent variable represents the relation between the LD/non-LD differential and achievement in a given school. Recall that the major research question in the present study concerned the effect of school environment during early adolescence on the math and science achievement of students with LD. Thus, this dependent variable is extremely important in the present study. Specifically, this model represents the effects of school characteristics (e.g., time of school transition, school safety, etc.) on the relation between the LD/non-LD achievement gap and overall achievement in a given school. Thus, significant values for predictor variables in this model are indicative of school-level variables that are related to differences in achievement between students with LD and non-LD students in a given school.

The results of the full HLM model, including student- and school-level variables, are presented in Table 3. All nondummy coded variables have been standardized using \( z \) scores, with a mean of 0 and a standard deviation of 1; therefore, all reported coefficients are represented in terms of effect sizes. The school-level NELS design weights were used in the HLM analyses. Design weights were utilized because the original NELS design oversampled for certain populations of students (see NCES, 1988, for a full description of the weighting variables and procedures). The design weights were adjusted for the sample size by dividing the design weight for each school by the mean design weight for the 78 schools in the sample.

Most of the fixed effects were significant predictors of math and science achievement. Higher achieving eighth-grade students reported higher levels of locus of control, were male, were of high-SES backgrounds, had higher grades, and tended not to be members of minority groups.

The advantage of using HLM, as opposed to OLS techniques, is that one also can model school-level variables on the intercept (mean achievement) and the LD/non-LD slope. The gamma coefficients should be interpreted as additive effects, just as they would be interpreted in a more traditional multiple regression model. The top section of Table 3 indicates that math achievement was higher in schools with higher attendance rates, and that both math and science achievement were lower in schools where safety was a problem.

Recall that in the present study, rather than examining the difference between the expected and actual achievement of students with LD, the HLM model allowed for a comparison of the differences within each school between the actual performances of students with LD and non-LD students. This is an important distinction. The use of HLM specifically allowed for the examination of the relations between school-level variables and the differences in math and science performance between students with LD and non-LD students. Thus, the results may indicate school-level variables that explain why students with LD do not do as well in math...
and science as non-LD students in some schools but not in others.

The results indicated that, on average, students with LD scored 0.62 SD lower in math and 0.56 SD lower in science than non-LD students across schools. However, in math, when students did not experience a transition until at least the ninth grade, the difference in achievement between students with LD and non-LD students was virtually zero (the value of 0.65 SD for no transition until at least Grade 9 and the value of −0.62 SD for the average LD achievement difference virtually canceled each other out, because they added up to 0.03 SD); for science, the students with LD still did not do as well as the non-LD students. After controlling for other variables, the difference in science achievement between students with LD and non-LD students was lowered from 0.56 SD to only 0.06 SD for students who did not make a transition until at least the ninth grade. This was determined by adding the average LD achievement difference (−0.56 SD) to the effect for not having a transition until at least Grade 9 (0.50 SD).

### Explained Variance

The present HLM models did not include an exhaustive set of variables that might have accounted for between-school variance in achievement. Rather, the purpose of the present study was to examine the hypothesis that achievement differentials between students with LD and non-LD students varied by school type. Nevertheless, it was possible to calculate the percentage of variance explained in the various random parameters in each HLM model. By comparing variances from the unconditional HLM models (with no predictors) to the final models, it was determined that the full models explained 46.31% of the variance that occurred among schools in math and 26.32% of the variance that occurred among schools in science. The proportion of variance explained in the dependent variables was determined by subtracting the variance component of the full model from the variance of the fully unconditional model, and then dividing by the variance of the unconditional model (see Bryk & Raudenbush, 1992, for full details on these procedures).

### Discussion

Although research clearly has identified the transition from elementary to middle-level school as a tumultuous and difficult period in the lives of young adolescents ( Eccles & Midgley, 1989), studies have failed to examine the relation between school-type and academic achievement for students with LD during adolescence. The results of the present study demonstrate that achievement differences in math and science between eighth-grade adolescents with and without LD are much smaller in schools where students do not experience a transition until at least the ninth grade.

#### Why Do Students with LD Do Better in Nontransition Schools?

There are a number of reasons why students with LD may do better in school when they do not experience a transition during early adolescence. Research conducted during the past decade clearly indicates that the middle school transition is often a

### TABLE 3

<table>
<thead>
<tr>
<th>Random effects</th>
<th>Gamma coefficient for math</th>
<th>Gamma coefficient for science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean achievement</td>
<td>.08</td>
<td>.05</td>
</tr>
<tr>
<td>School attendance rate</td>
<td>.13***</td>
<td>.07</td>
</tr>
<tr>
<td>School is unsafe</td>
<td>−.10**</td>
<td>−.08*</td>
</tr>
<tr>
<td>Average LD Achievement Difference</td>
<td>−.62***</td>
<td>−.56***</td>
</tr>
<tr>
<td>School is unsafe</td>
<td>.13*</td>
<td></td>
</tr>
<tr>
<td>No transition</td>
<td>.65***</td>
<td>.50***</td>
</tr>
<tr>
<td>Fixed effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locus of control</td>
<td>.09***</td>
<td>.09**</td>
</tr>
<tr>
<td>Plans to attend college</td>
<td>.07</td>
<td>.14**</td>
</tr>
<tr>
<td>Gender</td>
<td>−.15***</td>
<td>−.19***</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>.21***</td>
<td>.24***</td>
</tr>
<tr>
<td>Grades</td>
<td>.38***</td>
<td>.29***</td>
</tr>
<tr>
<td>Minority status</td>
<td>−.15**</td>
<td>−.11*</td>
</tr>
<tr>
<td>Perceptions of quality of teaching</td>
<td>.04*</td>
<td></td>
</tr>
</tbody>
</table>

*Note. All coefficients presented are standardized (effect sizes). For LD, 1 = LD, 0 = non-LD; for gender, 1 = female, 0 = male; for minority status, 1 = minority, 0 = nonminority; for plans to attend college, 1 = does plan to attend, 0 = does not plan to attend; all school-level transition variables are coded, 1 = student had this transition, 0 = did not have this transition. HLM = hierarchical linear modeling.  
*p < .05. **p < .01. ***p < .001.
troublesome time for adolescents, having enduring negative effects on achievement, motivation, and aspirations (Anderman & Maehr, 1994; Anderman & Midgley, 1997; Eccles & Midgley, 1989; Midgley et al., 1995; Simmons & Blyth, 1987). The range of psychological, social, and academic problems that students with LD have to contend with during this stage of development may make them even more vulnerable to such transition effects (e.g., Deci & Chandler, 1986; Swanson, 1987). Consequently, when the young adolescent has to manage both a difficult school transition and a learning disability, he or she may suffer more extensive achievement decrements.

In contrast, when students with LD do not have a school transition until at least the ninth grade, they do not have to contend with that added pressure. As other researchers have found (e.g., Simmons & Blyth, 1987), the absence of a school transition may be tied to higher levels of motivation and achievement. Results of the present study corroborate this finding for math and science achievement.

It is important to note that there is nothing magical about the time when the middle school transition occurs; rather, research has shown that schools structured as Grades 5 through 7, 6 through 8, or 7 through 9 in particular often engage in practices that are highly antithetical to the psychological needs of young adolescents (Eccles & Midgley, 1989). For example, those schools tend to have highly structured environments; to use a lot of between-class ability grouping; and to offer students few opportunities to undertake creative, challenging, and meaningful academic tasks (Anderman & Maehr, 1994; Eccles & Midgley, 1989). Adolescents experience these changes in school environments at a crucial developmental period—just when they need to experience autonomy, independence, creativity, and a sense of belonging (Eccles et al., 1993). The transition from the elementary school environment to the more impersonal middle school is difficult for all adolescents; however, results of the present study suggest that it may be a particularly difficult period for students who also experience learning disabilities.

Subsequent studies should identify the specific school practices that lead to higher levels of achievement for students with LD in school districts where there is no school transition. In addition, researchers need to identify larger samples of these students than was possible in the present study.

Judging the Effects

The reported effect sizes for the LD/ non-LD differential in achievement were strong. By using the effect size metric, it is possible to compare the effect sizes in one study to those in another. When one examines various meta-analyses, it is evident that effect sizes of 0.65 for math and 0.50 for science (for students with LD in schools with no transition until at least the ninth grade) found in the present study are quite strong. For example, Weinstein and his colleagues (Weinstein, Boulanger, & Walberg, 1982) reviewed innovative science curricula and described an overall effect size of 0.31 as a moderate effect. Shymansky and his colleagues (Shymansky, Kyle, & Alport, 1983) also reviewed science curricula and described an effect size of 0.43 as a valued effect. In comparisons of modern and traditional math curricula, Athappilly, Smidtchens, and Kofel (1983) interpreted an overall effect size of 0.24 as beneficial. However, it should be noted that those studies examined curricula, rather than school transitions.

The Use of HLM

The use of multilevel techniques such as HLM has been absent from the LD literature. Although other studies have documented the lower achievement of students with LD, studies to date have not controlled for student-level characteristics, such as gender, grades, and SES, while simultaneously examining the effects of contextual variables on these students' achievement.

There are, of course, certain limitations to HLM. For example, it is difficult to use HLM with small samples of students. In addition, the results of the present study do not indicate the specific mechanisms involved in producing these achievement differences. Indeed, the purpose of the present study was not to specifically identify practices that lead to higher achievement. Nevertheless, results of the present study do indicate that the "problem" of students with LD not performing as well in math and science during adolescence may not be universal: Different school experiences during early adolescence may lead to better achievement for some students with LD.

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AUTHOR'S NOTES

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2. Thanks for comments on earlier drafts of this article to Lynley Hicks Anderman and Doris Stidwell, and thanks to Julia Smith for statistical consultation.

REFERENCES


## APPENDIX

### Items Used to Compute Scales

<table>
<thead>
<tr>
<th>Measure</th>
<th>Items</th>
<th>Response scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locus of control</td>
<td>I don't have enough control over the direction my life is taking.</td>
<td>1 = strongly agree</td>
</tr>
<tr>
<td></td>
<td>In my life, good luck is more important than hard work for success.</td>
<td>2 = agree</td>
</tr>
<tr>
<td></td>
<td>Every time I try to get ahead, something or somebody stops me.</td>
<td>3 = disagree</td>
</tr>
<tr>
<td></td>
<td>My plans hardly ever work out, so planning only makes me unhappy.</td>
<td>4 = strongly disagree</td>
</tr>
<tr>
<td></td>
<td>When I make plans, I am almost certain I can make them work.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chance and luck are very important for what happens in my life.</td>
<td></td>
</tr>
<tr>
<td>Quality of teaching</td>
<td>Teachers are interested in students.</td>
<td>1 = strongly agree</td>
</tr>
<tr>
<td></td>
<td>Most of my teachers listen to what I say.</td>
<td>2 = agree</td>
</tr>
<tr>
<td></td>
<td>The teaching is good.</td>
<td>3 = disagree</td>
</tr>
<tr>
<td></td>
<td>Teachers praise my effort.</td>
<td>4 = strongly disagree</td>
</tr>
<tr>
<td></td>
<td>In class, I feel put down by my teachers.</td>
<td></td>
</tr>
<tr>
<td>Grades</td>
<td>For each of the school subjects listed below, mark the statement that best describes your grades from sixth grade up until now:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>English</td>
<td>1 = Mostly A's</td>
</tr>
<tr>
<td></td>
<td>Math</td>
<td>2 = Mostly B's</td>
</tr>
<tr>
<td></td>
<td>Science</td>
<td>3 = Mostly C's</td>
</tr>
<tr>
<td></td>
<td>Social studies</td>
<td>4 = Mostly D's</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 = Mostly below D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 = Not graded</td>
</tr>
<tr>
<td>School safety</td>
<td>Indicate the degree to which each of the following is a problem in your school:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>physical conflicts among students</td>
<td>1 = serious</td>
</tr>
<tr>
<td></td>
<td>robbery or theft</td>
<td>2 = moderate</td>
</tr>
<tr>
<td></td>
<td>vandalism of school property</td>
<td>3 = minor</td>
</tr>
<tr>
<td></td>
<td>student possession of weapons</td>
<td>4 = not a problem</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>This variable is a standardized (z-score) variable precomputed by NELS personnel. The variable is composed of measures of mother's occupation, father's occupation, mother's education, father's education, and family income.</td>
<td></td>
</tr>
</tbody>
</table>

*Note. All scales were computed from student NELS data, except the school safety scale, which was developed using administrators' responses to the school-level administrator survey. Therefore, responses to the school safety scale represent the responses for one administrator from each school. In computing the grades scale, classes that were not graded were treated as missing data.*