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Academic Achievement for Fifth-Grade Students in Elementary and Intermediate School Settings: Grade Span Configurations

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Abstract

Few researchers have addressed student achievement outcomes as a function of grade span configurations for older elementary-aged students. Thus, this study was designed to determine differences between students' Grade 5 reading and mathematics achievement in elementary schools (K–5) as compared to intermediate schools (Grade 5, 5–6) for 5 academic years. Using archival statewide data, researchers used a rigorous five-step distance-based formula to match elementary schools to intermediate schools on four demographic/school characteristic variables.

Students in K-5 settings attained statistically significantly higher levels of reading and mathematics achievement than did their counterparts, with moderate mean effect sizes of 0.37 and 0.47, respectively.

Keywords: achievement, grade configuration, elementary schools, grade span, middle schools, intermediate schools, school settings

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Academic Achievement for Fifth-Grade Students in Elementary & Intermediate School Settings: Grade Span Configurations

Schools for students in Grades Kindergarten (K) through high school (Grade 12) are organized in a variety of sizes and grade configurations or grade spans (Combs, Moore, Edmonson, & Clark, 2008). Grade configurations or grade spans refer to the ranges of grade levels (e.g., K-5, K-6, 9-12, 10-12). Although numerous researchers have studied school size in relation to achievement and cost-effectiveness (see Leithwood & Jantzi, 2009), fewer studies have been conducted in which the effect of grade span configurations on student achievement has been examined (Coladarci & Hancock, 2002; Renchler, 2002). A common sentiment about the lack of evidence concerning grade configurations—also known as grade span—was expressed more than 10 years ago and remains true today: "Research has not provided definitive answers to the myriad possible questions about grade span, but the questions have never gone away" (Paglin & Fager, 1997, p. 1).

Of particular interest are students in upper elementary or early middle school grades. These students, ages 11 to 13, are in a "developmental period in which prevention and intervention efforts can be particularly effective in deterring negative trajectories or outcomes" (Coyl, 2009, p. 407). Interestingly, students in Grade 5 are educated in a variety of grade configurations, whereby fifth-grade students could be the oldest students in an elementary setting (e.g., K-5) or the youngest students in an intermediate or middle school setting (e.g., 5-6, 5-8). The most common grade span configuration for fifth graders in the United States in 2005 was the various combinations of Pre-Kindergarten, Kindergarten, and/or Grade 1 to Grade 5 (n = 24,060 schools, 36.9%) or to Grade 6 (n = 12,569, 19.3%) school (National Center for Education Statistics, 2005). The next most common arrangement with 12,545 schools or 19.2% was the intermediate or middle school setting housing various combinations of grades through Grade 8. A less frequent but currently debated (Coladarci & Hancock, 2002) arrangement for fifth graders are Grades K-8 schools—also known as *elemiddle* schools (Hough, 2005)—which was the configuration for 5,595 or 8.6% of U.S. schools.

Although K-5 and K-6 schools have been the most frequently occurring elementary arrangement for some time, an increasing number of school districts are moving upper elementary students into intermediate and middle school settings (McEntire, 2005; Stevenson, 2007) to be more responsive to the needs of students (Cook, MacCoun, Muschkin, & Vigdor, 2008; Paglin & Fager, 1997). One rationale for this trend has been that teachers in Grades 4-6 can become subject-matter specialists. Moreover, the middle school movement, particularly since the 1980s, has brought greater attention to the social-emotional needs of young adolescents (Elovitz, 2007) as educators have applied teaching strategies and school organizational models (e.g., teaming, departmentalization) with these students in the fifth and sixth grades (see Finnan, 2009).

Although educational setting structures (e.g., facilities, school size, grade spans) are considered important variables by researchers examining student achievement, few studies exist that examine the relationship between grade span configuration and student achievement (Educational Research Service, 2004). Moreover, although some students in Grades 5 and 6 are being educated in intermediate school settings separate from younger elementary students and from older middle school students, even fewer studies were located wherein intermediate schools were examined. Most of the studies conducted focused on the comparisons of students in middle schools (i.e., 5-8, 6-8) to students in K-8 schools. These studies can provide evidence concerning student achievement in two types of school settings—those with large grade span configurations and those with small grade span configurations, which is ultimately the focus of the current investigation.

Grade Span and Student Achievement

Connolly, Yakimowski-Srebnick, and Russo (2002) examined 2,871 students from Baltimore, Maryland in grade span configurations of K-5, 6-8, and K-8, and reported that students in K-8 settings had statistically significantly higher performance on standardized tests in the areas of mathematics, writing, and reading than did students in K-5 and 6-8 settings. In Maine, Wihry, Coladarci, and Meadow (1992) documented that eighth-grade students in elementary grade span configurations (K-8, 3-8, K-9) performed better on standardized tests than did eighth graders in junior high or high school configurations of Grades 6-12, 7-12, and 8-12, particularly in the subject area of reading. Similar results were reported for sixth graders. In Connecticut, Tucker and Andrada (1997) studied academic achievement of sixth graders and discovered that students who were at the upper end of an elementary grade span configuration (e.g., sixth graders in a K-6 setting) performed better on the Connecticut Mastery Test (CMT) than did students in the lower grade of a secondary configuration (e.g., sixth graders in a 6-8 setting).

Three studies using longitudinal data were conducted in Philadelphia schools (i.e., Byrnes & Ruby, 2007; Offenberg, 2001; Weiss & Kipnes, 2006). Specifically, Offenberg (2001) examined ninth-grade achievement data to compare K-8 graduates and middle school graduates and reported that students from the K-8 schools had statistically significantly higher levels of achievement in reading, mathematics, and science than did students from middle schools, even when controlling for socioeconomic status and school size. Moreover, these K-8 students achieved higher grade point averages and earned a larger number of credits than did students in the middle school settings. Byrnes and Ruby (2007) compared student achievement data of pre-existing K-8 schools, emerging K-8 schools, and the 6-8 middle schools in Philadelphia. They studied student data over 5 years for 95 schools and noted that students in the more established K-8 schools demonstrated higher levels of achievement than did those in middle schools. Weiss and Kipnes (2006) also analyzed longitudinal data from Philadelphia Public Schools, a district with both 6-8 and K-8 schools. In contrast to the findings of other researchers (Byrnes & Ruby, 2007; Connolly et al.,2002; Offenburg, 2001; Tucker & Andrada,1997; Wihry et al., 1992), little evidence was found to indicate higher student achievement occurred in K-8 schools as compared to 6-8 schools.

Interested in Grades 5-6 students in middle schools, Jenkins and McEwin (1992) studied instructional practices in three grade span configurations: K-6, K-8, and 5-8. They reported similarities among all three settings regarding the levels and amounts of instruction in mathematics, language arts, science, social studies, and physical education. However, they believed that programs at K-6 schools tended to be more developmentally appropriate for younger children rather than for adolescents in Grades 4-6. In fact, Jenkins and McEwin (1992) recommended that fifth-grade students would be better served in middle schools than in other types of grade span configurations. Only one study was located wherein researchers compared the large and small grade spans in elementary (K-5) and intermediate (5-6) settings using a science achievement measure—a subject that was assessed for the first time in Grade 5. Combs et al. (2008) noted that Grade 5 students in elementary settings outperformed students in intermediate settings in science achievement and reported a medium effect size (d = 0.40) based on Cohen's (1988) criteria.

Although researchers have recently focused on K-8 grade span configurations (e.g., Byrnes & Ruby, 2007; Connolly et al., 2002; Offenberg, 2001; Pardini, 2002; Weiss & Kipnes, 2006; Yecke, 2006), many researchers (e.g., Byrnes & Ruby, 2007; Cook et al., 2008; Connolly et al., 2002; Mizell, 2005) have suggested a need for additional studies to confirm achievement differences for students in other grade span configurations. Even though much of the evidence favors schools with larger grade spans (K-6 and K-8), limitations remain in all of these studies. Indeed, Cook et al. (2008) recognized such limitations by stating, “the results . . . are not based on random assignment, which leaves open the possibility that the true causal process has not been adequately identified” (p. 118), and the associated benefits of grade configurations for older and younger children remain an “open empirical question” (p. 119).

Theoretical Frameworks: Transitions and Communities of Practice

In an attempt to understand why achievement differences might exist in schools of various grade span configurations, we utilized two theoretical frameworks. Students changing from one school to another (i.e., transitions) has been one common explanation for achievement declines. Further, based on a systems-perspective and our experience in schools, it is possible that interactions among educators might be related to the organizational structures (e.g., physical layout, size, grade configurations) of the school. Thus, the communities of practice theory is presented.

Transitions

When reviewing grade span configurations, researchers have focused on the transitions required of students as they progress in U.S. schools (e.g., Alspaugh & Harting, 1995). Transitions are the changes students make when changing from grade to grade and teacher to teacher; however, the transitions among levels or different school settings appear to be more problematic for students (Anderman & Midgley, 1997). As such, grade configurations are "inextricably linked" to transitions "because grade span dictates to a large degree when children will move between schools" (Burkam, Michaels, & Lee, 2007, p. 290). Students who leave an elementary (K-5) setting to enter a middle school (6-8) setting experience many changes, including a new building, a new faculty, a new schedule, and a new routine. Furthermore, students move from a setting where they are the oldest to a setting where they are the youngest. Moreover, Alspaugh and Harting (1995) provided evidence of these transition effects occurring in every grade span configuration regardless of students' ages. For some students, possible negative effects such as lower self-esteem or increased behavioral problems have been noted (Anderman & Midgley, 1997; Arcia, 2007; Bergquist, Bigbie, Groves, & Richardson, 2004; Cook et al., 2008; Cromwell, 1999; Kennedy, 1993; Malaspina & Rimm-Kaufman, 2008; Mendez & Knoff, 2003; Simmons, Black, & Zhou, 1991; Weiss & Kipnes, 2006). In addition, students might experience decreased academic performance during transitions to another school or setting (Alspaugh & Harting, 1995; Byrnes & Ruby, 2007; Mizell, 2005). As such, Whitley, Lupart, and Beran (2007) concluded that the transition from elementary school to junior high school has "long been associated with a decline in academic performance" (p. 650).

Some researchers have offered explanations for the decline in achievement for early adolescents as they transition from an elementary school setting to a middle school or junior high school setting (Eccles, Lord, & Midgley, 1991; Simmons & Blyth, 1987). Simmons and Blyth (1987) suggested that a decline in achievement, in addition to motivation and self-esteem, might occur because these early adolescents are facing two major transitions—puberty and a change in schools. These researchers argued that students who remain in a setting without transitions (e.g., K-8) have to adjust to only one major transition—puberty.

Communities of practice

Another framework that might be useful in understanding achievement differences that might occur in schools with various grade spans is communities of practice. Wenger's (1998) communities of practice theory has been applied by businesses to understand organizational behavior and by educators to understand learning processes (Wenger & Snyder, 2000). Communities of practice are "groups of people who share a concern or passion for something they do and learn how to do it better as they interact regularly" (Wenger, 2008, p. 2). Not all groups or communities are actual communities of practice. A community of practice has three characteristics: domain (i.e., members are committed to a shared domain of interest), community (i.e., members interact and learn from each other), and practice (members are practitioners who share a practice) (Wenger, 2008). Members in the group develop relationships, share ideas, and help each other and, as a result, acquire new learning and new ways to solve problems (Wenger & Snyder, 2000). The groups can be recognized and structured by an organization, or the groups can be created informally through social networks (e.g., teachers who share the same lunch period or hallway in a building).

The structural components of a school (e.g., grade span configuration, school size, facility design) can affect the forming of communities of practice. For example, McPartland, Coldiron, and Braddock (1987) reported that teachers who worked in schools with more grade levels in the same school provided a more continuous program than did teachers in schools with fewer grade levels. It is possible that teachers who work in schools with larger grade spans (e.g., Grades K-5, K-8) form communities of practice that learn and work to solve problems associated with student achievement through formal and informal discussions about teaching strategies and curricular issues. Although communities of practice also would be present in schools with smaller grade spans (e.g., Grades 5-6, 6-8), teachers in these intermediate or middle schools would not have the benefit of engaging in discussions with Grades K-4 colleagues in the same building on a regular basis. Interestingly, these cross-grade-level discussions have been formalized in school districts as a way to improve curriculum and instruction (Texas Leadership Center, 1998); such structures have been termed *vertical alignment teams*, defined as "a small number of people from different levels within an organization who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable" (p. 18). Vertical alignment teams could function as communities of practice, although vertical alignment teams and communities of practice are not identical concepts. In practice, vertical alignment teams (e.g., all mathematics teachers in Grades K-6 from all campuses in a school district) are often presented as formal structures organized by district leaders and result in limited interaction among teachers and limited changes in instruction, based in part on a faulty social infrastructure (Duffy, 2006). Conversely, communities of practice offer regular interaction, interdependence, and member-initiated accountability (Wenger, 2008). Thus, communities of practice appear to be a viable structure for school improvement (Rogoff, Turkanis, & Bartlett, 2001) and useful in understanding the informal interactions that can occur among teachers that impact student achievement.

Purpose of Study

Although school district decision-makers have claimed that consideration of student achievement is important when planning new school facilities, attendance zones, and grade spans (Educational Research Service, 2004), researchers have claimed that a lack of empirical studies exists in which these relationships have been examined (Byrnes & Ruby, 2007; Cook et al., 2008; Wihry et al., 1992). As district administrators and school board members face increasing and/or decreasing student enrollments, they need information to plan and to guide the design of district facilities. In addition, very few studies were located in which fifth graders were the focus of the studies. Jenkins and McEwin (1992) noted that the placement of fifth graders is "too often made with little regard for which grade organization best serves these youths" (p. 8).

Therefore, in the present study, the differences in reading and mathematics achievement were examined as a function of grade span configuration. Specially, Grade 5 students' scores in K-5 elementary schools were compared to students in Grades 5 and/or 6 intermediate schools. The grade span configurations (i.e., K-5, 5-6) were selected for this study because they represented the largest configurations for schools in Texas containing fifth-grade students, and they provided a basis for comparing schools with large grade spans to those with smaller grade spans, as shown in Table 1. K-8 schools were not selected because they had smaller student enrollments and were located in mostly rural areas. Several variables that have been shown to impact school achievement were controlled through a rigorous matching technique (i.e., school size [Leithwood & Jantzi, 2009], economic disadvantage [Sirin, 2005], student mobility [Kerbow, 1996], and limited English proficiency [Contreras, 2005]).

Table 1

Number of Texas Elementary and Middle Schools by Grade Span Configurations serving Grade 5 in Texas 2003–2008

Grade Span	School Classification	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	Total
K-5	**Elementary**	**1,984**	**2,015**	**2,096**	**2,270**	**2,407**	**10,772**
K-6	Elementary	740	730	713	616	557	3,356
K-8	Elementary	95	98	102	115	115	525
3-5	Elementary	81	84	79	70	84	398
4-6	Elementary	69	67	71	54	51	312
4-5	Elementary	52	54	50	63	64	283
1-5	Elementary	42	38	43	48	47	218
2-5	Elementary	22	25	22	22	22	113
1-6	Elementary	19	23	22	16	21	101
K-7	Elementary	18	21	15	11	16	81
3-6	Elementary	12	5	8	13	9	47
5	Elementary	8	6	5	11	12	42
2-6	Elementary	8	5	3	4	4	24
1-8	Elementary	1	4	3	2	1	11
3-7	Elementary	1	2	3	1	1	8
3-8	Elementary	1	2		2	3	8
2-8	Elementary	1	3	1	1	1	7
1-7	Elementary		1		1	1	3
2-7	Elementary	2					2
5-6	**Middle**	**136**	**142**	**137**	**135**	**137**	**687**
5-8	Middle	74	74	82	72	78	380
5-7	Middle	6	4	7	4	3	24
5-9	Middle	4	3	3	3	3	16
4-8	Middle	4	3	1	2	3	13
4-7	Middle	2	1	1	2	1	7

Note. The two configurations in bold typeface represent the population from which matched pairs were selected for the present study. These two groups represented the most schools identified as elementary and middle schools containing fifth-grade students.

The present study was conducted in Texas for several reasons. Following California, Texas is the most populous state in the nation (U.S. Census Bureau, 2005) and thus a large sample could be obtained. Second, Texas has had a stable accountability system and has used the same criteria-referenced achievement measure since 2003 for Grades 3 to 8, the Texas

Assessment of Knowledge and Skills (TAKS) (Texas Education Agency [TEA], 2009). This stability in assessment allowed the researchers to include multiple years in the study, and this multi-year analyses were rare in other grade configuration studies. Third, as noted earlier, many studies on grade span have been conducted in the northeastern U.S. and relatively few studies have been conducted in the southwest. Finally, Howley (2002) called for future research on grade span configurations focused at the state level rather than those analyses focused at the national level because most policy decisions that influence schools are made at the state and local governance levels.

Research Questions

The following research questions were used to guide this investigation:

1. What is the difference in Grade 5 students' levels of reading achievement between elementary campuses and intermediate campuses for 5 academic years, 2003-2008?

2. What is the difference in Grade 5 students' levels of mathematics achievement between elementary campuses and intermediate campuses for 5 academic years, 2003-2008?

Based on the research concerning the effects of school transitions on student achievement and the framework of communities of practice presented, it was hypothesized that fifth-grade students perform at higher levels in reading and mathematics in the K-5 elementary schools as compared to those in 5-6 intermediate schools.

Method

Participants

Participants in this study consisted of 1,356 Texas schools comprising 678 elementary schools (Grades K-5) and 678 intermediate schools (Grades 5 or Grades 5-6), drawn from 5 academic years, 2003–2008.[1] To conduct dependent statistical analyses on student achievement data for the campuses, intermediate schools were matched to elementary schools using a rigorous distance-based formula developed by Clark (2009). This distance-based formula accounted for school size, percent of students with low socioeconomic (SES) status students, campus mobility rates, and percent of students with limited English proficiency (LEP).[2-3] As a result, campus compositions were very similar for the two groups. For example, elementary schools in this study were represented by the following mean student demographics: an average student count of 593 students, 49.8% low SES, 15.6% mobility rate, 9.9% African American, 44.3% Hispanic, 40.6% White, and 23.3% LEP. Intermediate schools were represented by the following mean student demographics: an average student count of 640 students, 48.6% low SES, 15.4% mobility rate, 16.2% African American, 32.7% Hispanic, 48.5% White, and 7.5% LEP.

Instrumentation

The TAKS reading and mathematics examinations, which are comprehensive statewide assessments, were used to measure the dependent variable in this study. The scores have a possible range of 0 to 100 and represent the percentage of students who met the minimum requirements on the examination. The score reliability of the TAKS examinations are based on internal consistency measures (TEA, 2007). Specifically, the Kuder-Richardson 20 (KR-20) was calculated for each examination year from 2003-2008, with alphas ranging from 0.81 to 0.93 (TEA, 2007).

The TAKS examinations are based on the state curriculum, the Texas Essential Knowledge and Skills (TEKS). The TAKS mathematics examination contains 44 multiple-choice items and assesses six strands of mathematical concepts, which are (a) numbers, operations, and quantitative reasoning; (b) pattern relationships and algebraic reasoning; (c) geometry and spatial reasoning; (d) measurement; (e) probability and statistics; and (f) mathematical processes and tools (TEA, 2008a). In the subject area of reading, four objectives are assessed using 42 multiple-choice items, which are (a) the understanding of culturally varied written texts, (b) the application of knowledge of literary elements, (c) the use of strategies to analyze texts, and (d) the application of critical thinking skills (TEA, 2008b).

Assessment and campus data were accessed from the state's Academic Excellence Indicator System (AEIS) database. The AEIS was shared with the public beginning in the 1990-1991 school year, but it originated in 1984 with the passage of House Bill 72. Data for the AEIS originate from a variety of sources, including the Public Education Information Management System (PEIMS), an extensive data reporting system required of all public schools in Texas. Additional data are derived from the TAKS examination results, compiled by independent testing contractors (TEA, 2008c). Collectively, this information comprises one of the most extensive data sets on public schools available.

Procedures

For the purpose of this study, elementary schools were classified as those schools that contained grade levels comprising Kindergarten and/or Pre-Kindergarten through Grade 5. Intermediate schools were defined as campuses only serving students in Grade 5 or Grades 5 and 6. Campuses that did not fall into these classifications were excluded from the study.

Datasets for each school in one of the two classifications coded by TEA (i.e., elementary, middle) were formed from the AEIS for each of 5 academic years, 2003–2008. All elementary and middle school campuses were renamed according to their grade span configurations, and researchers apportioned elementary schools (K–5) and intermediate schools (Grade 5, 5–6) into a dataset. Schools with fewer than 30 students in Grade 5 were excluded from the study because such schools would not be held accountable for meeting passing standards established for Grade

5, as explained in the state agency's guidelines (TEA, 2005). Additionally, schools classified as charter schools also were excluded.

In an attempt to isolate the effect of grade span organizational patterns on student achievement, all intermediate schools for the 5 years examined were matched to an elementary school using Clark's (2009) distance-based formula. This technique involves matching each target school to a school in a comparison pool by calculating the distance (i.e., difference) between the target school and all schools in the pool with respect to one or more matching variables, and then selecting the school that yields the smallest distance to serve as a match. As such, the technique is repeated until all target schools are matched (Clark, 2009). This technique was validated and adopted by Pearson's[4] Educational Assessment group in 2009 for use in matching campuses and resulted in two commercial products: *Districts Like Us* (Clark, 2008a) and *Schools Like Us* (Clark, 2008b). These products are used by school districts for evaluation and improvement purposes.

Clark's (2009) distance-based procedure contains the following five steps: (a) select the matching variables, (b) identify and account for any missing data, (c) standardize the matching variables; (d) find optimal matches for each target school, and (e) validate the matching procedure. Each of these steps is described in the following sections as it was operationalized in the current study.

Step 1: Select the matching variables. According to Clark (2009), schools can be matched on as few as one variable. However, as the number of matching variables increases, so does the sensitivity of the matching procedure until diminishing (marginal) returns prevail (Clark, 2009). In the present study, schools were matched to one another based on the following four campus characteristics: (a) school size, (b) low SES (i.e., percent of students identified as economically disadvantaged on the campus), (c) mobility (i.e., percent of students who had completed less than 83% of the school year on their identified campus) (TEA, 2008c), and (d) LEP (i.e., percent of students identified as LEP).

These four criteria were selected by the researchers as a foundation for school matching based on the current Texas and previous California statewide models for creating campus comparison groups (California Department of Education, 1994; Cronbach, Bradburn, & Horvitz, 1994; TEA, 2005). For both states, low SES, mobility, and LEP were key demographics in determining useful campus comparisons because of their impact on students' achievement (California Department of Education, 1994; TEA, 2005). However, of the two states, only California's method took school size into account, and unlike both models, which were designed to create a group of comparison campuses for a school within its grade classification (e.g., an elementary comparison group for an elementary campus), the researchers in this study attempted to match an intermediate school to its closest comparison campus at the elementary level.

Step 2: Identify and account for any missing data. To utilize a distance-based formula for school matching, complete data for each of the variables were needed for every school. Although school size, SES, and LEP data sets were complete in the AEIS system, mobility rates were not present for 3% of the schools extracted (i.e., 398 of 10,928). As noted by Clark (2009), various ways of dealing with missing data include listwise deletion (i.e., deleting schools that have missing values on any of the selected matching variable), pairwise deletion (i.e., deleting the specific missing matching values from the analysis [not the entire school]), and imputation (i.e., replace the missing matching values with the predicted values). With respect to imputation, researchers can utilize either single imputation procedures (e.g., group means, medians, or modes; regression imputation; stochastic regression imputation; expectation-maximization [EM] algorithm) or multiple imputation procedures (e.g., frequentist multiple imputation, Bayesian multiple imputation) (cf. Shafer & Graham, 2002). Single imputation involves substituting each missing matching value with a single value, whereas multiple imputation involves "replac[ing] each missing value with a set of plausible values that represent the uncertainty about the right value to impute" (Yuan, 2000, p. 1). In the present study, the researchers used a multiple regression analysis (i.e., regression imputation) to impute predicted values for missing mobility rate data using school size, percent of low-SES students, and percent of LEP students as the independent variables (Allison, 2001; California Department of Education, 1994). Although the regression imputation has limitations—as do all other imputation techniques—this technique has been found to produce estimates with little bias (Musil, Warner, Yobas, & Jones, 2002; see also, Allison, 2001).

Step 3: Standardize the matching variables. An important obstacle that had to be addressed prior to computing the shortest distance between intermediate and elementary schools were the variations in the data pertaining to the school size and LEP variables. The average size of the Grade 5 cohorts at the intermediate campuses ($M = 323.34$, $SD = 132.40$, $n = 678$) was statistically significantly larger (Mann-Whitney's $U = 225558.50$, $p < .0001$) than was the average size of the Grade 5 cohorts at the elementary campuses ($M = 90.53$, $SD = 33.42$, $n = 10{,}249$), yielding an extremely large effect size ($d = 5.04$; Cohen, 1988). In addition, average LEP rates were statistically significantly lower (Mann-Whitney's $U = 1945827.50$, $p < .0001$) at an intermediate campus ($M = 7.47\%$, $SD = 8.84$, $n = 678$) than at an elementary campus ($M = 25.31\%$, $SD = 22.96$, $n = 10{,}249$), yielding a very large effect size ($d = 0.80$; Cohen, 1988).

To overcome these variations and account for school size and LEP rates in the matching process, the researchers converted school size and LEP data into *z*-scores exclusive to school classification. By performing this calculation, intermediate campuses could be compared to elementary campuses relative to school size and LEP rates (i.e., large intermediate campuses would be paired with large elementary campuses, and well-matched schools would adhere closely to the ratio established by compared means). Finally, to standardize the remaining data, SES and mobility rates were converted into *z*-scores relative to the entire group. This conversion was conducted at the group level as opposed to the school level because significant differences in the variations were not present in the remaining data (i.e., *SD* = 24.11 vs. 29.96 for intermediate SES vs. elementary SES; *SD* = 4.94 vs. 7.48 for intermediate mobility vs. elementary mobility) as were present in school size and LEP averages.

Step 4: Find optimal matches for each target school. Once missing variables were accounted for and the data converted to *z*-scores relative to either school classification or whole group, schools were matched to each other by calculating the lowest average *z*-score difference between a target intermediate campus and all elementary campuses within an academic year across all four selected variables. In the pairing process, no schools were used more than once for each academic year (i.e., matching without replacement). In addition, if one elementary school was determined to have the lowest *z*-score difference in relation to two intermediate schools, then the pairing that produced the lowest rate of difference for the entire set of schools for that specific academic year was selected.

Specifically, a four-dimensional Pythagorean distance formula was utilized—with school size (SS) and LEP rates for each school converted into *z*-scores relative to school classification (i.e., K-5, 5/5-6), and SES and mobility rates (M) for each school converted into *z*-scores relative to the entire data set (i.e., all K-5 and all 5/5-6 schools in the state). The distance formula was as follows. Assume *t* is the demographic variable for the target school (i.e., intermediate school), and *k* is the demographic variable for the *k*-th school (elementary school). Then, for the 5 years, the number of elementary schools that had each of the four demographic variables for each year was as follows:

2003-2004 k-th school = $k_1, k_2, \ldots, k_{1889}$

2004-2005 k-th school =. $k_1, k_2, \ldots, k_{1919}$

2005-2006 k-th school = $k_1, k_2, \ldots, k_{1997}$

2006-2007 k-th school = $k_1, k_2, \ldots, k_{2161}$

2007-2008 k-th school = $k_1, k_2, \ldots, k_{2283}$

Further, the overall Euclidean distance between Intermediate School *t* and Elementary School *k* was given by:

$$d_{t,k} = \sqrt{(zSS_t - zSS_k)^2 + (zSES_t - zSES_k)^2 + (zM_t - zM_k)^2 + (zLEP_t - zLEP_k)^2},$$

where zSS_t and zSS_k represented the z-scores of the school size variable for Intermediate School *t* and Elementary School *k*, $zSES_t$ and $zSES_k$ represented the z-scores of the SES variable for Intermediate School *t* and Elementary School *k*, zM_t and zM_k represented the z-scores of the mobility variable for Intermediate School *t* and Elementary School *k*, and $zLEP_t$ and $zLEP_k$ represented the z-scores of the LEP variables for Intermediate School *t* and Elementary School *k*. Thus, Intermediate School *t* had *k* Euclidean distance scores. That is, each elementary school had *k* Euclidean distance scores. The elementary school then that was matched with Intermediate School *t* was the school that had the smallest Euclidean distance (Ed) score, as follows:

$$Ed_{t,k} = \min (d\,[t, k]),$$

where Ed_{tk} represents the elementary school with the smallest Euclidean distance. For example, Intermediate School 1 was paired with the elementary school that had the smallest Euclidean distance:

$$Ed_{1,k} = \min (d\ [1, k]).$$

However, if this elementary school already had been matched to another intermediate school because the Euclidean distance associated with this other school was even smaller, then Ed_{tk} represented the next smallest Euclidean distance,

$$Ed_{1,k+1} = \min (d\ [1, k+1]),$$

or the third smallest Euclidean distance was identified if this second-choice elementary school already had been matched, and so forth, until the unmatched elementary school with the smallest Euclidean distance was identified. Thus, elementary school matching was undertaken without replacement such that an elementary school could not be paired with more than one intermediate school. Ultimately, the goal of the distance-based procedure was to obtain a solution in which the mean Euclidean distance across all *t* intermediate schools was minimized—a form of least squares minimization. Using these aforementioned techniques, the researchers were able to match schools with different grade span configurations in an optimal way. Moreover, no studies were located in the literature that used such extensive matching techniques. The participating schools and their demographic compositions for each of the years studied are shown in Table 2.

Table 2

Demographic Compositions (%) of Elementary and Intermediate Campuses Studied

	School Size *M*	Low SES *M*	Mobility *M*	LEP *M*	African American *M*	Hispanic *M*	White *M*
			2003-2004 School Year				
Elementary (*n* = 130)	590.66	48.97	15.45	21.75	9.73	43.78	41.94
Intermediate (*n* = 130)	659.77	47.59	15.32	6.41	18.07	29.88	49.84
			2004-2005 School Year				
Elementary (*n* = 140)	589.18	48.42	15.69	23.06	9.22	43.14	41.76
Intermediate (*n* = 140)	648.57	46.94	15.31	7.04	15.21	30.65	51.76
			2005-2006 School Year				
Elementary (*n* = 137)	599.82	50.69	15.33	23.61	9.82	43.70	41.51
Intermediate (*n* = 137)	630.40	49.31	15.25	7.50	16.12	33.23	48.25
			2006-2007 School Year				
Elementary (*n* = 135)	590.14	50.38	16.53	23.14	9.39	45.13	40.53
Intermediate (*n* = 135)	635.78	49.50	16.59	7.65	16.87	33.25	47.21
			2007-2008 School Year				
Elementary (*n* = 136)	596.85	50.59	14.77	24.63	11.28	45.85	37.13
Intermediate (*n* = 136)	627.30	49.86	14.74	8.74	14.92	36.64	45.57

Note. Schools were matched based on the following four variables: school size, SES, mobility, and LEP.

Step 5: Validate the matching procedure. After all target schools had been matched, a Pearson's correlation matrix was conducted for each academic year to determine the extent of the relationship between the schools' matched variables, with the assumption that the higher the correlation, the better the match. Bonferroni's adjustment was used to control the familywise error rate (Chandler, 1995; Ho, 2006; Manly, 2004; Vogt, 2005). Specifically, for each school year (i.e., family), the nominal alpha value of .05 was divided by the number of correlations involved (i.e., 16), which yielded an adjusted alpha value of .003 (i.e., .05/16). Results from the Pearson's correlation matrix, as depicted in Table 3, indicated statistically significant correlations for 63 of the 80 demographics combinations at the $p < .001$ level. Moreover, with respect to the effect size, 41 of the 80 correlation coefficients were large (i.e., > 0.50; Cohen,1988) and 19 correlation coefficients were in the moderate range (i.e., $.30 \leq r < .50$; Cohen,1988). Thus, 60 of the 80 (75.0%) of the correlations represented at least a moderate effect size, which indicated that the matching was successful. This additional step was taken to demonstrate the similarities in the matching variables of the matched schools.

Table 3

Pearson Correlation Matrix for Matched Variables for 2003-2008

	2003-2004 School Year			
	Intermediate Schools			
Elementary Schools	School Size	Low SES	Mobility	LEP
School Size	.90*	.21	.19	.50*
Low SES	.13	.97*	.58*	.67*
Mobility	.11	.58*	.96*	.44*
LEP	.43*	.65*	.43*	.96*

	2004-2005 School Year			
	Intermediate Schools			
Elementary Schools	School Size	Low SES	Mobility	LEP
School Size	.81*	.22*	.19	.54*
Low SES	.16	.97*	.56*	.69*
Mobility	.02	.55*	.96*	.40*
LEP	.40*	.67*	.44*	.96*

	2005-2006 School Year			
	Intermediate Schools			
Elementary Schools	School Size	Low SES	Mobility	LEP
School Size	.86*	.20	.22*	.50*
Low SES	.05	.97*	.55*	.72*
Mobility	-.02	.54*	.96*	.36*
LEP	.34*	.68*	.38*	.97*

2006-2007 School Year

	Intermediate Schools			
Elementary Schools	School Size	Low SES	Mobility	LEP
School Size	.91*	.12	.21	.49*
Low SES	.05	.97*	.49*	.68*
Mobility	.12	.48*	.96*	.41*
LEP	.41*	.65*	.36*	.97*

2007-2008 School Year

	Intermediate Schools			
Elementary Schools	School Size	Low SES	Mobility	LEP
School Size	.83*	.14	.25*	.49*
Low SES	-.02	.97*	.58*	.71*
Mobility	.07	.59*	.96*	.47*
LEP	.30*	.65*	.45**	.98*

*p < .003 (i.e., the Bonferroni-adjusted alpha value = .05/16 = .003 for each school year)

Results

Prior to conducting inferential statistical tests, the dependent variables (i.e., TAKS reading and mathematics examination scores) were examined to determine if the skewness and kurtosis values were within normal limits. The standardized skewness coefficients (i.e., skewness divided by its standard error) and standardized kurtosis coefficients (i.e., kurtosis divided by its standard error) were calculated and compared to ±3, which represents the cutpoint suggested by Onwuegbuzie and Daniel (2002) for deeming a standardized skewness and a standardized kurtosis coefficient to be relatively large and thus represent a departure from normality. Of the 40 standardized skewness and kurtosis coefficients, 25 (63%) were outside the range of normality. More specifically, 40% and 10% of the intermediate schools yielded standardized skewness coefficients and standardized kurtosis coefficients, respectively, that were large, with these schools yielding *non-normal* test scores that were characterized by negative skew and a leptokurtic distribution (i.e., a distributional shape that was more peaked than the normal distribution). Even more notably, 100% of the elementary schools yielded standardized skewness coefficients and standardized kurtosis coefficients that were large, with these schools also yielding *non-normal* test scores that were characterized by negative skew and a leptokurtic distribution. Consequently, non-parametric dependent samples inferential procedures were conducted (i.e., Wilcoxon's matched-pairs signed-ranked test). This inferential test can be used to test differences between two samples when using a matched-subjects design (Howell, 2007; Sprinthall, 2003). Because five inferential tests were computed for reading and mathematics scores for each of 5 academic years, the Bonferroni adjustment was applied such that the total familywise error rate did not exceed .05. Thus, the adjusted level of statistical significance was .01 (i.e., .05/5).

Mathematics

For mathematics, five individual Wilcoxon's matched-pairs signed-ranked tests were conducted comprehensively to measure student achievement between the matched schools over a 5-year period. Fifth-grade students attending an elementary school had statistically significantly higher scores in mathematics than did fifth-grade students in intermediate campuses for all 5 academic years (2003-2004, $z[130] = -5.05$, $p = .0001$, $d = 0.53$; 2004-2005, $z[140] = -3.51$, $p = .0001$, $d = .33$; 2005-2006, $z[137] = -5.15$, $p = .0001$, $d = .56$; 2006-2007, $z[135] = -4.91$, $p = .0001$, $d = .42$; 2007-2008, $z[136] = -5.19$, $p = .0001$, $d = .49$). Effect sizes ranged from .33 to .56 and, on average ($M = 0.47$, $SD = 0.10$), were moderate, based on Cohen's (1988) criteria. Descriptive statistics for these schools for each of the 5 years of data analyzed are depicted in Table 4.

Table 4

Grade 5 Mathematics Scores for Matched Groups of Elementary and Intermediate Campuses, 2003-2008

	Elementary (K-5)			*Intermediate (5-6)*					
School Year	*n*	*M*	*SD*	*n*	*M*	*SD*	Wilcoxon Z	*p*	Cohen's *d*
2003-2004	130	78.69	13.91	130	71.27	14.30	-5.05	.0001*	0.53
2004-2005	140	82.81	13.52	140	78.69	11.40	-3.51	.0001*	0.33
2005-2006	137	86.48	10.35	137	80.31	11.68	-5.15	.0001*	0.56
2006-2007	135	88.82	10.04	135	84.68	9.47	-4.91	.0001*	0.42
2007-2008	136	88.93	9.09	136	84.29	9.90	-5.19	.0001*	0.49

*$p < .01$ (i.e., the Bonferroni-adjusted alpha value = .05/5 = .01)

Reading

For reading, five individual Wilcoxon's tests were conducted to measure, in a comprehensive manner, student achievement between the matched schools over a 5-year period. Grade 5 students attending an elementary school had statistically significantly higher scores in reading than did Grade 5 students in intermediate campuses for all 5 academic years (2003-2004, $z[130] = -5.18$, $p = .0001$, $d = 0.49$; 2004-2005, $z[140] = -3.79$, $p = 0001$, $d = .25$; 2005-2006, $z[137] = -4.03$, $p = 0001$, $d = .35$; 2006-2007, $z[135] = -4.87$, $p = 0001$, $d = .38$; 2007-2008, $z[136] = -4.61$, $p = 0001$, $d = .36$). Effect sizes ranged from 0.25 to 0.49 and were, on average ($M = 0.37$, $SD = 0.08$), small to moderate, based on Cohen's (1988) criteria. Descriptive statistics for the TAKS reading measure for each year appear in Table 5.

Table 5

Grade 5 Reading Scores for Matched Groups of Elementary and Intermediate Campuses, 2003-2008

	Elementary (K-5)			*Intermediate (5-6)*					
School Year	*n*	*M*	*SD*	*n*	*M*	*SD*	Wilcoxon Z	*p*	Cohen's *d*
2003-2004	130	79.59	13.69	130	73.13	12.76	-5.81	.0001*	0.49
2004-2005	140	79.14	14.61	140	75.76	12.06	-3.79	.0001*	0.25
2005-2006	137	84.05	11.89	137	80.05	11.29	-4.03	.0001*	0.35
2006-2007	135	85.75	11.24	135	81.93	9.09	-4.87	.0001*	0.38
2007-2008	136	88.24	9.24	136	84.94	8.87	-4.61	.0001*	0.36

*$p < .01$ (i.e., the Bonferroni-adjusted alpha value = .05/5 = .01)

Discussion

In this study, reading and mathematics scores of Grade 5 students who attended elementary schools were compared with the reading and mathematics scores of Grade 5 students who attended intermediate schools. Grade 5 students attending elementary settings scored statistically significantly higher in each of the 5 years of analyses, with effect sizes ranging from 0.25 to 0.56. Special attention was given to the matching procedures for each pair of schools so that the following variables could be controlled: school size (Leithwood & Jantzi, 2009), economic disadvantage (Sirin, 2005), student mobility (Kerbow, 1996), and limited English proficiency (Contreras, 2005). Interestingly, the mean achievement difference between the fifth-grade students who attended elementary settings and those who attended intermediate settings was one tenth of a standard deviation larger for mathematics achievement than for reading achievement (0.47 vs. 0.37, respectively). This suggests that fifth-grade students who attend intermediate settings in Texas might be at a greater disadvantage relative to their fifth-grade counterparts who attend elementary schools, particularly in mathematics.

Although some researchers have documented that students perform better in settings with larger grade spans (e.g., K-8), and in settings including younger students (e.g., Arcia, 2007; Byrnes & Ruby, 2007; Cook et al., 2008; Offenberg, 2001), few studies were located in which the performance of fifth graders in an intermediate setting having only one or two grades in the school was examined. One exception is a study where researchers examined the science performance of Texas fifth graders in elementary and intermediate settings and reported statistically significant differences favoring elementary settings (Combs et al., 2008). Additional studies should be replicated to determine if these findings are present in other states.

Interpretation of Results Using Theoretical Framework of Transitions

The intermediate schools in this study contained either Grades 5 and 6 or Grade 5, thus having only one or two grade levels in the school. Such settings would require students to make an additional transition after Grade 5 or 6. In previous studies, achievement losses associated with transitions have been noted (Alspaugh & Harting,1995; Howley, 2002). Although students with achievement losses were able to regain prior levels, Alspaugh and Harting (1995) reasoned that fewer transitions would result in fewer performance concerns. Based on the work of Simmons and Blyth (1987), it is possible that achievement differences were present in part because of the negative effects students might have experienced in the transition to an intermediate setting while also experiencing the changes taking place during puberty (Simmons & Blyth, 1987). One possible explanation for lower scores at the intermediate schools could be that Grade 5 intermediate students were adjusting to their new settings in terms of different school structures, unfamiliar teachers, and peer interactions. Although transitions have been related to decreased achievement and increased behavior infractions (e.g., Arcia, 2007; Byrnes & Ruby, 2007; Weiss & Kipnes, 2006), this study was not designed to determine why differences may have occurred. Moreover, because multiple variables affect student achievement, the researchers, in the design stage of the study, addressed variables that have been found to be related to achievement differences in previous research (e.g., school size [Leithwood & Jantzi, 2009], economic disadvantage [Sirin, 2005], student mobility [Kerbow, 1996], and students with limited English proficiency [Contreras, 2005]). However, there are other variables also known to impact student achievement such as teacher quality (see Hanushek, Kain, O'Brien, & Rivkin, 2005), which could be investigated in future studies.

Interpretation of Results Using Theoretical Framework of Communities of Practice

Another possible explanation, based on Wenger's (1998) communities of practice theory, is that the interaction of the adults in the elementary schools might differ from the interactions present in intermediate schools structured with fewer grade levels. Grade 5 teachers in schools with larger grade spans (e.g., K-5) likely have more opportunities to interact with teachers in younger grade levels in ways that might influence student achievement (e.g., sharing strategies and resources). Providing continuity in curricula and instruction has been noted in schools experiencing success (McPartland et al., 1987). In fact, the interaction of teachers among various grade levels has been formalized into a practice used to improve instruction (i.e., vertical alignment teams; Duffy, 2006; Texas Leadership Center, 1998). Communities of practice may be useful in understanding why an infrastructure with several grades included in one building might be more beneficial to improving student performance. Future studies should be conducted to explore communities of practice and qualitative research might be helpful in understanding the variations among the communities of practice in various grade span configurations.

Limitations

One limitation of this study is that it is nonexperimental; therefore, the cause of the differences in scores between the two settings cannot be determined. As such, the findings are best considered collectively with other studies (Cook et al., 2008; Tucker & Andrada, 1997; Wihry et al., 1992). Another limitation stems from the inability to model the potential nested structure of the data, namely, mathematics and reading achievement (e.g., students within classes, classes within schools, schools within school districts). Unfortunately, the researchers did not have access to student-level (i.e., Level 1) data, which prevented the use of hierarchical modeling techniques (HLM; Raudenbush & Bryk, 2002). Nor could classes be used as the Level-

1 unit of analysis because this level of data also was not available. It is possible that the intra-class correlation is large enough to indicate within-school dependency among the achievement scores; thus, the inability to model this situation using HLM techniques represents a limitation to the study. Thus, replications of this study are needed using HLM procedures.

Strengths of Current Study and Need for Additional Research

Notwithstanding, the present study makes an important contribution to the literature about grade span configurations for early adolescents. Although the optimum method for examining causality would have been to randomly assign schools to configurations, this is a practical impossibility. However, the researchers were able to undertake the next best design, namely to identify rigorously the closest match for every existing intermediate school in Texas. This matching technique reduced threats to the internal validity of the findings (e.g., differential selection of participants, mortality; [Johnson & Christensen, 2010]) by controlling for variables known to predict achievement (i.e., school size, SES, mobility, and LEP). Researchers were able to examine achievement differences across 5 years, and this is an additional strength of the study. Additional longitudinal studies are needed to examine other transition points for students, such as students in primary schools, ninth-grade centers, and single grade schools. Qualitative research could help to uncover some of the issues related to transitions for various ages of students.

The present findings point to the need for continued research on grade span, particularly focused on the aspects that might be related to grade span (e.g., curricula continuity, teacher interaction). In addition, based on the findings, the researchers challenge the notion that isolating young adolescents into a separate facility with a small grade span is superior to educating these students in elementary settings with larger grade spans (see Beane & Lipka, 2006; Paglin & Fager, 1997). On the other hand, few grade span configurations studies were identified that examined the performance effects on younger children (e.g., first, second, third graders) being educated with adolescents (see Burkam et al., 2007), although some anecdotal evidence describes the negative social effects for younger students in K-8 schools (see Connolly et al., 2002; Cook et al., 2008). In conclusion, more studies are needed to understand the reasons that Grade 5 students performed higher in schools with large grade span configurations.

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Footnotes

[1] There was a total of 130 elementary schools matched with 130 intermediate schools in the 2003-2004 school year, 140 elementary schools matched with 140 intermediate schools in the 2004-2005 school year, 137 elementary schools matched with 137 intermediate schools in the 2005-2006 school year, 135 elementary schools matched with 135 intermediate schools in the 2006-2007 school year, and 136 elementary schools matched with 136 intermediate schools in the 2007-2008 school year. This yielded a total of 678 elementary schools matched with 678 intermediate schools across the 5 academic years, and a total of 1,356 schools.

[2] The distance-based matching formula converts campus demographics into standardized measures so that campuses with dissimilar school classification can be compared. Using standardized measures, and accounting for the distance between those measures, allows researchers to compare "large" elementary schools with "large" middle schools, regardless of the actual student counts.

[3] Limited English Proficient status for students is concentrated at the lowest grade levels, and gradually diminishes as students move up and are exited from the program. For this reason, LEP percents are much higher in the elementary campuses when compared to middle schools. However, using the distance-based matching formula in relation to standardized measures, the researchers were able to compare and to examine elementary schools with a "high" percent of LEP students to middle schools with a "high" percent of LEP students.

[4] According to their website,

> Since September 2000, [Pearson has been]…the leading provider of assessment and education data management services in North America. Together with [their] sister companies (Edexcel, Pearson Language Testing, and Pearson VUE), Pearson is the

leading and most innovative provider of assessment and education data management services in the world. (Pearson, 2010, ¶ 1)

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