Journal of Environmental Psychology 30 (2010) 239–244

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep

The ecological context of student achievement: School building quality effects are exacerbated by high levels of student mobility

Gary W. Evans*, Min Jun Yoo, John Sipple

Cornell University, NY, United States

ARTICLE INFO

Article history:
Available online 18 January 2010

Keywords:
School facilities
Student mobility
Academic performance

ABSTRACT

National reports along with numerous statewide studies indicate that the physical infrastructure of American schools is crumbling. At the same time there is emerging evidence that school building quality matters for children's academic achievement. We integrate two separate literatures that have demonstrated that low school building quality as well as high rates of student mobility each contribute to reduced academic achievement by showing that these two variables statistically interact. Elementary school children in 511 New York City public schools have lower achievement scores if they attend schools of poor structural quality and with high rates of student mobility. The significant main and interactive effects of school building quality and student mobility on standardized test scores occur independently of socioeconomic and racial composition of the school.

Notably absent from discourse about educational quality and American school children's academic achievement is mention of school buildings. This is remarkable for at least two reasons. One, an emerging body of literature shows that where learning occurs matters and two, American school buildings are literally falling apart. A decade ago the United States government completed the most comprehensive analysis to date of the status of the physical plants of American public schools (NCES, 2000). The report reached some startling and alarming conclusions. For example, the average age of public school building plants in 1999 was close to 40 years. At that time, more than half of American school children attended a school with at least one serious physical defect in the building. Moreover, these average statistics mask the unequal distribution of school building quality in American schools in terms of socioeconomic status (SES). For example, the greater the proportion of children eligible for government school meal subsidies, the worse the building quality (NCES, 2000). Given the documented linkages between school building quality and student performance outlined below, this means that American children most in need of a satisfactory learning environment are not getting it.

New York City, America's largest school district, operates over 1500 facilities, serving more than one million children (CFE, 1999). Nearly 60% of those facilities were constructed before 1940; those constructed more recently were often built with cheap materials, and many suffer from structural or system defects (Buresh & Hayden, 1996; McCall, 1997). Consequently, by 1996 over four-fifths of New York City's schools were in need of repair (Buresh & Hayden, 1996). Moreover, 61% of the City's elementary schools operate at or above capacity (CFE, 1999), due to continuous enrollment growth (Buresh & Hayden, 1996; McCall, 1997). In some of these overcrowded buildings, the state of deterioration is so grave that if repairs or renovations are not undertaken immediately, the facilities will be condemned (CFE, 2004). We examine inter-relations among school building quality and student mobility in New York City elementary school children as they influence standardized test scores.

There is a small but growing literature on school building quality and children's academic performance. Although these studies vary widely in quality, they converge in demonstrating that independent of SES, children who attend schools lower in physical quality, perform worse on standard measures of performance, typically statewide English and Math achievement tests. This has been shown in studies relying upon teachers' or school administrators' evaluations of building quality (Cash, Earthman, & Hines, 1997; Earthman, 1998; O'Neill & Oates, 2001; Schneider, 2002a), as well as on expert rater evaluations of building facilities (Branham, 2004; Duran-Narucki, 2008; Edwards, 1992; Lewis, 2001). Although most studies have utilized cross-sectional comparisons with statistical controls for SES, similar if not stronger results have been found when investigators assessed student cohorts in the same school

* Corresponding author. Cornell University, Departments of Design and Environmental Analysis and of Human Development, Ithaca, NY 14853-4401, United States. Tel.: +1 607 255 2144; fax: +1 607 255 0305.
E-mail address: gwe1@cornell.edu (G.W. Evans).

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doi:10.1016/j.jenvp.2010.01.001

districts before and after building improvements or replacements (Berry, 2002; Bowers & Burkett, 1988; Christopher, 1988, 1991; Phillips, 1997). Not surprisingly, school building quality is noticed by children and teachers, and they find low quality school buildings demoralizing (Fine, Burns, Payne, & Torre, 2004; Schneider, 2002b; Simon, Evans, & Maxwell, 2007).

There is clearly a need for better studies on school building quality and academic achievement. Some of the improvements needed in research on school building quality and achievement include larger samples, more reliance on psychometrically sound indicators of building quality, and use of prospective longitudinal samples. Another feature of the school building quality and achievement literature is the primary motivation for the present study. With the exception of a recent publication, the school building quality literature has left unanswered a critical question: how is it that school buildings affect academic achievement? Duran-Narucki (2008) reasoned that one reason why school building quality could influence academic achievement is because of attendance. School attendance is inversely related to academic achievement. She found that expert ratings of school building quality on a standardized index were significantly related to elementary students' standardized test scores. Of particular interest, this effect was largely due to pupil attendance. Independent of school socioeconomic profiles, children in poorer quality school buildings were absent more often. These elevated absenteeism rates, in turn, explained most of the covariance between school building quality and elementary school children's standardized test scores. In the present study we build upon Duran-Narucki's important study and other prior work on school building quality and student performance by asking a related question. Does the adverse impact of school building quality on student standardized test scores vary across different schools? In particular, we were interested in whether higher rates of student mobility might exacerbate the harmful impacts of poor building quality on student achievement.

We reasoned that the combination of lower building quality and higher student mobility would interact to accentuate the harmful impacts of poor quality building conditions on students' academic achievement. This hypothesis is grounded both in theory and on analytical evidence. Theoretically, Duran-Narucki found that absenteeism was a major pathway through which poor school building quality was operating. Children don't learn as much if they spend less time in school. Similarly, children achieve less if they have to transfer from one school to another. Both student absenteeism and student mobility disrupt the continuity of the classroom learning experience, and like poor building quality, hurt standardized test scores (GAO, 1994; Heinlin & Shinn, 2000; Kohen, Hertzman, & Wiens, 1998; Rumberger & Thomas, 2000). Approaching our hypothesis from an analytical perspective, children's exposure to cumulative risk factors has a significantly greater adverse impact on their cognitive development than exposure to any one risk factor (Ackerman & Brown, 2006, 2010; Gutman, Sameroff, & Cole, 2003; Sameroff, Bartko, Baldwin, Baldwin, & Seifer, 1998; Sameroff, Gutman, & Peck, 2003; Sameroff, Seifer, & McDonough, 2004). Whereas exposure to one risk factor typically only slightly elevates adverse cognitive outcomes among children, as exposure to multiple risk factors accumulates, adverse cognitive impacts rise dramatically. Therefore schools with high rates of student mobility in conjunction with poorer building quality should be particularly damaging to academic achievement. Readers will note that this is a statistical interaction prediction. We hypothesize that the slope of the line between building quality and student test scores will be significantly different from zero (i.e., a main effect of building quality on test scores). However the expected positive slope of the line will be conditional on student mobility with a flatter slope predicted for schools with greater levels of stability.

An alternative theoretical formulation that can also be empirically tested is that instead of student mobility moderating the effects of school building quality, student mobility could mediate the effects of building quality on test scores. Recall that Duran-Narucki (2008) found that an underlying mechanism explaining the link between building quality and standardized test scores was attendance. That is, the covariation between school building quality and academic performance was largely attributable to school attendance. Thus instead of mobility moderating school building quality as we hypothesize, an alternative is that student mobility mediates its effects on student test scores. We favor the moderating hypothesis because whereas attendance on a day to day basis might be influence by both student and perhaps parent motivation to attend school, it seems less likely that family mobility would be driven by poor school building quality. Nonetheless there is value in examining both hypotheses. Thus we test whether student mobility functions as a mediator or a moderator of the effects of school building quality on student standardized test scores.

1. Method

1.1. Sample

Of the 609 public, elementary school buildings in the New York City school system, complete data on building physical conditions and student achievement data were available for 511 elementary public school buildings. The sample we were able to construct from two different data archives appears to be unbiased. There are no statistically significant differences between our sample of schools and the entire population of elementary schools in percentage eligible for government subsidized meals (70% vs. 70%), percent white (16% vs. 13%), percent English as a second language (16% vs. 14%), or student mobility (9% vs. 9%).

1.2. Procedure

Data on school building facility quality are available on the web (http://www.nycenet.edu/school_facilities/dlist.htm) from the New York City Department of Education. These surveys were conducted in 2005 by architects and construction engineers employed as external consultants. Building ratings consist of 1 (poor) – 5 (good) evaluations of architectural (e.g., ceiling, floors, windows, roof), mechanical (e.g., drinking fountains, air conditioning, heating), and electrical (e.g., lighting, wiring) conditions based on walk through inspections. Principal components analysis of the 46 original building rating items yielded a single factor solution with 36 items that has high internal consistency (Cronbach $\alpha = .80$).

Data on academic achievement and background information on each school were obtained from New York City Annual School Reports available from the New York City Department of Education website (http://schools.nyc.gov). Student academic achievement data include standardized mathematics and reading achievement test scores from all 3rd and 5th graders in 2006. These examinations are identical to those the State of New York uses to test students across the state. We used the subject-specific, grade-level mean scores for mathematics and English-Language Arts. Mean scale scores are not available for individual students but reported at the level of school only. These tests have undergone extensive psychometric development (http://www.emsc.nysed.gov/osa/ei/gr3-8guide10.pdf).

The Annual School Reports also provide various types of sociodemographic data for each public school including an index of student mobility, termed student stability. Student stability is