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The walls speak: the interplay of quality facilities, school climate, and student achievement

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Received November 2006
Revised July 2007
Accepted August 2007

Abstract

Purpose – A growing body of research connecting the quality of school facilities to student performance accompanies recent efforts to improve the state of the educational infrastructure in the USA. Less is known about the mechanisms of these relationships. This paper seeks to examine the proposition that part of the explanation may be the mediating influence of school climate.

Design/methodology/approach – Teachers from 80 Virginia middle schools were surveyed employing measures including the School Climate Index, a seven-item quality of school facilities scale, as well as three resource support items. Data on student SES and achievement were also gathered. Bivariate correlational analysis was used to explore the relationships between the quality of facilities, resource support, school climate, student SES, and student achievement. In addition, multiple regression was used to test school climate as a mediating variable between the quality of facilities and student achievement.

Findings – Results confirmed a link between the quality of school facilities and student achievement in English and mathematics. As well, quality facilities were significantly positively related to three school climate variables. Finally, results confirmed the hypothesis that school climate plays a mediating role in the relationship between facility quality and student achievement.

Originality/value – As we face fundamental issues of equity across schools and districts, leaders struggle to convince taxpayers of the need to invest in replacing and/or renovating inadequate facilities. Deeper understandings of the complicated interplay between the physical and social environments of school, and how these dynamics influence student outcomes, may help educators build a compelling case.

Keywords School buildings, Facilities, Quality, Schools, Students, United States of America

Paper type Research paper

The state of school buildings in the USA has entered into public discourse recently through Bill Moyer's 1996 television special, Children in America's Schools, and before this through Jonathon Kozol's, Savage Inequalities, an exposé on the conditions under which many low-income students are educated (Hayden and Cauthen, 1996; Kozol, 1991). The American Society of Civil Engineers' (ASCE) 2005 Report Card for America's Infrastructure assigns US schools a disappointing D. Although up from a failing grade assigned in 1998 and a more recent D- in 2003, the ASCE's most current assessment underscores local school districts' struggles to keep pace with an ever-growing need in the face of burgeoning construction costs, increasing student enrollments, and the press for smaller class sizes.

As we confront the challenges of educational accountability and standards-based reform, assuming responsibility for educating all students to high levels of

Journal of Educational Administration
Vol. 46 No. 1, 2008
pp. 55-73

0957-8234
DOI 10.1108/09578230810849817

achievement, we face fundamental issues of equity across schools and school districts. In our efforts to ensure that all students have access to a rigorous curriculum and highly-qualified teachers, we must also face the condition of the physical environment within which teachers teach and students learn. A growing body of research provides evidence of a link between school building quality and student achievement. Less is known, however, about the mechanisms of this relationship. One unexamined link between school facilities and student achievement is school climate.

In this study, we examined the proposition that at least part of the explanation for the link between school building quality and student outcomes is the mediating influence of school climate. School climate may explain, at least in part, the deleterious impact that poor school facilities has on learning. It may be that dilapidated, crowded, or uncomfortable school buildings lead to low morale and reduced effort on the part of teachers and students alike, to reduced community engagement with a school and even to less positive forms of school leadership. Thus, poor school climate may play a contributing role in low achievement when school facilities are inadequate. We begin with a review of the current research on the link between building quality and student achievement and behavior, as well as teacher attitudes and performance. We then discuss the method of the current study and the findings. Placing the study within the context of identified need and industry response, we then discuss the implications for future research and for current practice.

School physical environment and student achievement

A growing body of research connecting the quality of school facilities to student outcomes, including both achievement and attitude, as well as teacher attitude and behavior, has accompanied the recent concern for the quality of the educational infrastructure in the USA.

Building condition

McGuffey (1982) laid a foundation for the link between a school's physical environment and student achievement, synthesizing findings across a number of studies that demonstrated a relationship between student achievement and building quality, newer buildings, improved lighting, thermal comfort and indoor air quality, as well as specific building features such as science laboratories and libraries. These studies primarily utilized correlational analyses and multiple regression analyses to examine the relationship between building condition and student performance on standardized tests.

More recent research examining student achievement scores with school facilities' quality ratings, and using the percentage of students in free and reduced-price lunch programs as a means to control for SES, has revealed differences of between five and 17 percentile points in achievement scores of students in functional buildings when compared with scores of students in poor buildings, after controlling for socioeconomic status. One study in this line of research examined Washington, DC public schools and found that the physical state of a school was a predictor of student achievement. A committee of experts including engineers, architects, and maintenance staff evaluated roofs, ceilings and walls, heating and electrical systems, and bathroom facilities and rated buildings poor, fair, or excellent according to their overall physical condition. Data suggested that as schools move from poor to fair, average achievement scores

increased by 5.46 points, while improvement from poor to excellent was associated with a 10.9 point increase (Berner, 1993). Several extensive studies of school building condition and student achievement in Virginia all found significant links. These studies employed a researcher-developed assessment instrument to measure the condition of school buildings. Student achievement scores were higher in schools with higher quality ratings. In schools that were well maintained, that were swept and mopped more frequently, and where graffiti was removed more expediently, achievement scores were higher. Where lockers were kept in good repair and classroom furniture was of higher quality, achievement improved (Cash, 1993; Earthman, 2004; Hines, 1996; Lanham, 1999).

These findings have been repeated in studies throughout the USA. A district-wide study of 139 Milwaukee schools, utilizing a comprehensive facility assessment, documented that while controlling for variables including student motivation, socio-economic status and race/ethnicity, good facilities had a significant impact on reading achievement (Lewis, 2000). Researchers investigating the impact of school facility condition on student learning and behavior, as well as teacher turnover, in Texas middle schools reported a positive relationship between facility condition and student achievement (O'Neill and Oates, 2001). Likewise, the degree to which schools in the Los Angeles Unified School District (LAUSD) complied with health and safety regulations, as measured by the "Overall Compliance Rating" (OCR), was found to clearly influence student academic performance in these schools (Buckley *et al.*, 2004). In fact, when controlling for the composition of the student body, the size of the school, and its level (elementary, middle, or high), the research model predicted that LAUSD could realize an average increase of 36 points on the API[1] by improving a school's condition from the worst to the best. An increase of one standard deviation in the OCR (about 0.46) predicted an API increase of 5.6 points. The researchers admittedly lacked the data to identify "the specific mechanisms by which compliance is linked to educational outcomes". Nonetheless, their findings suggested "that school buildings in poor shape lead to reduced learning . . .[and] poorly managed schools lead to poor achievement" (Buckley *et al.*, 2004, p. 3).

Building features

Several recent reviews document relationships between various school building design features and academic outcomes (Earthman, 2004; Earthman and Lemasters, 1996, 1998; Higgins *et al.*, 2005; Lemasters, 1997; Schneider, 2002). Specific building features related to human comfort have been shown to be related to student achievement. These include building age, climate control, indoor air quality, lighting, acoustical control, design classifications, and overall impression.

Building age. Scholars have studied building age and upkeep and how these influence student achievement, attitude, and behavior. Many older buildings become obsolete, with limited capacity to accommodate innovations in curriculum development, instructional strategies and content development (Chan, 1996). In two studies in Georgia school districts, researchers found that students in non-modernized buildings scored lower on basic skills assessments than those students in modernized or new buildings (McGuffey and Brown, 1978; Plumley, 1978). Building age accounted for as much as 3.3 percent of the variance in students' scores on the Iowa Test of Basic Skills (McGuffey and Brown, 1978). Scholars in other settings have found similar

results; students who are housed in new or modernized buildings were found to score consistently higher on a range of standardized tests (Chan, 1979; Earthman and Lemasters, 1996; O'Neill, 2000; Phillips, 1997). A before-and-after study of renovated schools in Syracuse, New York found improvement in achievement among students in the refurbished buildings (Maxwell, 1999). In a study of two rural Tennessee elementary schools, Bowers and Burkett (1988) compared groups of students at the newest and the oldest buildings in the district. Both student groups were determined to be from similar socio-economic levels based on the percentage qualifying for free and reduced lunch, while teachers and administrators were comparable in terms of certification level, age and experience. The new school was described as well-equipped, with attention to acoustics, color schemes and furniture selection, while no such efforts were visible in the old building. Data revealed that students attending the new school out-performed their peers in the older school on all available measures of achievement.

Questions related to school building age and upkeep focus attention beyond initial capital investments to long-term maintenance and operations (M and O) costs. These necessary functions are often the first to suffer when school districts face budget shortfalls. In fact, recent data reflect a continuing downward trend in school district expenditures, with the median district spending only 7.5 percent of the total district expenditures on maintenance and operations for the 2004-2005 school year ("a percentage hovering close to the all-time-low 7.43 percent allocation in 2003" (Argon, 2005, p. 46)). Thus, building quality may be less about age and more about budget, when a lack of maintenance contributes to the deterioration of an otherwise high-quality, older building and funding limitations result in a brand-new building of inferior quality (Schneider, 2002).

Air temperature and quality. The two most important individual building elements found to affect student achievement were temperature control and air quality (Earthman, 2004). Climate control (including the presence of air conditioning) had demonstrable impact on student learning outcomes (Cash, 1993; Earthman, 2004; Hines, 1996; Lanham, 1999). In fact, air conditioning accounted for 1.6 percent of the total variance in 3rd Grade English, 2.8 percent for 5th Grade English, and 4.8 percent for 5th Grade technology (Lanham, 1999).

Lighting. Lighting ranked next in order of criteria influencing student outcomes, with daylight offering the most positive effect (Heschong Mahone Group, 1999). Daylight offers a more positive effect on student outcomes than other forms of lighting, potentially due to its biological effects on the human body (Heschong Mahone Group, 1999; Wurtman, 1975).

Acoustical control. Acoustics have also been shown to have an impact on student learning (Cash, 1993; Earthman, 2004; Hines, 1996; Lanham, 1999). Acoustical control matters such as chronic noise exposure have been shown to hinder cognitive functioning and to impair pre-reading and reading skills (Haines *et al.*, 2001; Evans and Maxwell, 1997, Maxwell and Evans, 2000).

School design classifications and features. Specific design classifications that have been related to student achievement on the Iowa Test of Basic Skills (ITBS) include pathways encouraging ease of movement, positive outdoor spaces, large-group meeting spaces, instructional neighborhoods, ample egress, natural light and views, the presence of technology for teachers, and pleasing or appropriate color, defined as age-and activity-appropriate color choices (Tanner, 2000; Tanner and Lackney, 2006).

One additional design feature that has been found across a number of studies is the availability of high quality science laboratory in secondary schools (Cash, 1993; Earthman, 2004; Hines, 1996; Lanham, 1999).

Overall impression. The aesthetic features of a school can foster a strong sense of belonging that, in turn, can generate an enthusiasm for learning (Jarman *et al.*, 2004). The overall impression of the learning environment is a reflection of the personality of a place. "An overall positive impression . . . implies the presence of friendly student and teacher learning environments" (Tanner, 2000, p. 327). Improved cosmetic features, such as exterior painting, careful maintenance and/or replacement of lockers and classroom furniture, carpeting, and the absence of graffiti have been associated with increased mean scale scores on every subtest of the Virginia Test of Academic Proficiency (Cash, 1993; Earthman, 2004; Hines, 1996; Lanham, 1999). These cosmetic features and comfort factors appeared to have more of an effect on student achievement than did structural factors (Cash, 1993), although structural factors also influenced achievement on every subtest but one (Hines, 1996).

A recent meta-analysis of the literature considered published studies examining the effects of physical school environments (i.e. ambient conditions) on student and teacher attitudes, behaviors, and outcomes. The outcomes from this extensive review of scholarship, across education, architecture, environmental psychology and physiology, underscore the limitations of the research to date (Bosch, 2006). A growing body of evidence from correlational studies links the physical environment of schools to the attitudes, behavior and outcomes of building occupants. In most cases, causal relationships have yet to be established. Further, important questions surrounding school facilities effects remain unanswered, including how . . . school facilities enhance or detract from the learning process and what constitute mediating variables. In fact, of the studies analyzed by Bosch, only one tested the role of mediating factors.

School social environment and student achievement

As a growing body of evidence establishes the linkages between discrete physical features of school facilities and student achievement, it is important to acknowledge that while some influences are clearly physiological, others are related to social factors. These social influences are generally reciprocal and interactive, and thus, somewhat more difficult to define and quantify (Lackney, 1996). These qualities of the built learning environment are what create feelings of ease and comfort or alternately, put inhabitants on edge. Thus, empirical research must be responsive to the complex dynamic of how physical features may influence attitudes and behaviors. The idea that the quality of interpersonal relationships and dynamics in a school can influence student learning is not new. School climate is an assessment of the social dynamics in a school; and more than four decades of research provides a well-established link between school climate and student achievement (Anderson, 1982; Brookover *et al.*, 1978; Hoy and Feldman, 1987; Hoy and Hannum, 1997; Hoy *et al.*, 1998; Hoy and Sabo, 1998; Hoy *et al.*, 1991). This current study examines the linkage between the physical environment and the social environment in schools.

Learning climate

Teachers perceive that cleanliness, orderliness, and the general character of a school building influences student behavior (Lackney, 1996). In a study of the relationship

between building condition and learning climate in three Texas elementary schools, learning climate was perceived to be related to overall building condition, size and organization of instructional spaces, and ongoing maintenance (Lowe, 1990). Learning climate was defined in terms of teacher, student, and parent perceptions about self, student achievement, organizational rules and policies, and the facility itself. Teacher perceptions about building condition and its effect on performance were captured using a researcher-designed questionnaire. The quality of school buildings has also been related to student attitudes and behavior, including vandalism, absenteeism, suspensions, disciplinary incidents, violence, and smoking (Schneider, 2002).

As a construct, academic press describes more specific aspects of the learning climate. Schools with a high level of academic press are serious and orderly places, driven by a quest for excellence. In these schools, students who do well academically are respected by their peers and honored by the school community. Teachers set high goals and the principal assists in achieving these goals. Students respond positively to the challenge of these goals and they work hard to achieve them. Academic press has repeatedly been demonstrated to be strongly related to student achievement (Hoy *et al.*, 1998; Hoy and Sabo, 1998; Hoy *et al.*, 1991).

Teacher behavior and attitudes

Students are not the only ones affected by poor quality buildings. The nature and quality of the built learning environment also has been shown to affect teacher attitudes, behaviors, and performance (Lowe, 1990; Dawson and Parker, 1998; Schneider, 2003; Buckley *et al.*, 2004). In a study of a large sample of teachers in Chicago and DC schools, researchers found that teacher retention/attrition decisions were significantly related to the quality of school facilities, even when controlling for other factors that might be perceived to impact attrition (Buckley *et al.*, 2004, p. 8). One third of Chicago teachers and more than half of the DC teachers were dissatisfied with their physical working conditions. Factors that most directly affected the quality of teacher work life included indoor air quality (IAQ), thermal controls, noise level and acoustics, adequate classroom lighting, and the amount of natural daylight. Teachers who perceived a detrimental effect on their health due to building conditions, or who were stressed by high noise levels, poor acoustics, and lack of thermal controls were more likely to seek employment elsewhere.

Beyond the physical conditions of a school, social dynamics also affect teacher satisfaction, commitment, and behavior (Anderson, 1982; Brookover *et al.*, 1978; Hoy *et al.*, 1990; Tarter *et al.*, 1995). Teacher attitudes and behaviors have been directly linked to student achievement. Among middle school teachers, teacher affiliation as well as collegial and committed behaviors, were moderately related to student achievement (Hoy and Sabo, 1998). For high school teachers, disengaged and frustrated teacher behaviors were negatively correlated to achievement (Hoy *et al.*, 1991). As a construct, teacher professionalism refers to these attitudes and behaviors, capturing teachers' perceptions of the extent to which their colleagues demonstrate commitment to their students, engagement in the teaching process and willingness to cooperate with one another. Like earlier measures of teachers' attitudes, teacher professionalism has been linked to student achievement (Hoy *et al.*, 1998; Tschannen-Moran *et al.*, 2006).

Principal leadership

Collegial leadership characterizes the relationships between principals and teachers. Collegial leadership refers to principal behaviors perceived as supportive and collegial and not overly directive or restrictive. Principals who employ collegial leadership practices seek to meet faculty needs and school goals. These principals are considerate, helpful, and genuinely concerned about the welfare of teachers. They openly explore all sides of topics and willingly make changes accordingly. They accept divergent opinions and questions without appearing to snub teachers. These principals are careful to take an interest in the classroom issues that are important to teachers. Although principals do not play a direct role in the delivery of instruction, collegial leaders articulate a set of expectations and set the tone for the school. In an extensive review of literature on principal leadership, Hallinger and Heck (1996), found primarily indirect effects of the principal's behavior on student achievement. In contrast, Hoy and his colleagues have found direct effects (Hoy and Sabo, 1998; Hoy *et al.*, 1991). Little is known about the relationship of principal leadership and the quality of school facilities. Do teachers perceive that poor quality buildings result from poor leadership on the part of the building principal, or do they perceive the responsibility lies elsewhere, perhaps with the superintendent or school board? It may be that teachers in poor quality facilities perceive that they, along with their principals, are put in positions having to make do.

Community ties

Community engagement is the extent to which the school has fostered a constructive relationship with its community. This construct describes the degree to which the school can count on involvement and support from parents and community members, and the extent to which the school provides the community with information about its accomplishments. A school with strong community engagement responds to the needs and concerns of parents and community members, and as a result should be able to marshal community support when needed. A school's ability to productively engage its community has been found to be related to student achievement (DiPaola, 2005). When a school's relationship to the community was examined as the schools' ability to fend off influence from parents and the community, researchers consistently found that a school's success at buffering was negatively related to student achievement (Hoy and Sabo, 1998; Hoy *et al.*, 1991). These results suggest that the more schools were successful at keeping parents out, the lower student achievement was likely to be.

The relationship between the quality of a school facility and that school's engagement with their community presents an important focus for research. Berner (1993) found that parent involvement was related to the condition of school buildings in Washington, DC, with PTA budgets being the most significant of the variables tested. In fact, this is likely to be a complex relationship, involving reciprocal forces, as it is the community that must fund school building projects, renovation, and maintenance. As communities actively engage with their schools, they come to understand the various needs associated with teaching and learning, including physical environments conducive to these primary school functions. Thus, they grow more willing to make the sacrifices necessary to provide for adequate school buildings. Poor-quality school buildings are likely to be perceived by inhabitants and community members alike as a lack of commitment to the aims of schooling (Uline, 1997).

This study considered the interplay between the physical environment and the social environment of schools. As such, it focused on teacher perceptions of the physical environment, not the nuts and bolts of physical properties such as building age or quantitative measures of light or noise. Two hypotheses guided the research. First, we hypothesized that we would find a positive link between teachers' perceptions of the quality of their school facility and student achievement. Our expectation was that teachers' subjective perceptions would have a similar relationship as did the more objective measures used in previous studies. We further hypothesized that this link would be mediated by the influence of various aspects of school climate. Specifically, we examined four factors of school climate: academic press, community engagement, teacher professionalism, and the collegial leadership of the principal.

Method

This exploratory study was undertaken to examine the interdependent relationships between the physical environment and the social environment of schools, as well as the relationship of each to student achievement.

Participants

Data were gathered from surveys completed by teachers in 80 middle schools in Virginia. The schools were selected on the basis of their willingness to participate in the study. The sample was a large and diverse. Schools were diverse in size, socio-economic status and racial composition, as well as setting (urban, suburban, and rural). Although not randomly selected, the schools in the sample were comparable to the schools not included in the sample in terms of school size and the proportion of students receiving subsided meals. With the permission of the principal, researchers administered the surveys during a regularly-scheduled faculty meeting at each school. A member of the research team explained the general purpose of the study, assured the confidentiality of all responses, and asked teachers to complete the questionnaires. Because the unit of analysis was the school, a random group of the teachers in each school was selected to respond to the measures concerning the quality of school facilities and the school climate variables with results aggregated to the school level. The remaining faculty responded to a separate survey that was part of a larger study of organizational properties. No attempt was made to gather data from faculty who were not present at the meeting, but virtually all teachers in attendance returned usable questionnaires. The number of respondents at each school ranged from six to 31, with an average of 14. The total number of teachers who responded to the surveys was approximately 1,134.

Measures

Data concerning teacher perceptions of the quality of school facilities, resource support, and school climate were gathered using surveys and analyzed in conjunction with data on student achievement and socioeconomic status. For the surveys of teacher perception of the quality of school facilities, resource support, and school climate, respondents were asked to assess how frequently they perceived each statement to be true of his or her school, along a five-point scale with anchors at 1 – never, 2 – rarely, 3 – sometimes, 4 – often, 5 – very frequently. Although these responses were

categorical in nature and lack a precise underlying metric, we followed the common practice of analyzing them as numerical data.

(1) *Quality of school facilities.* Teachers were asked to rate the quality of their school facilities by responding to seven items that assessed their perceptions of the degree to which their school building was attractive, had adequate space, and was well maintained. These features tapped elements identified in previous research as potentially related to student achievement. Sample items include:
   - This building is pleasing in appearance.
   - The facilities here are lacking in regular maintenance (reverse-coded).

(2) *Resource support.* Three items examined teacher perceptions of resource support. Teachers were asked to assess the degree to which they had the materials and supplies they needed to accomplish their teaching duties. In addition, they were asked about the availability of technology. Sample items include:
   - Teachers are provided with adequate materials for their classrooms.
   - The availability of technology is adequate to support our learning goals.

(3) *School climate index.* The School Climate Index (SCI) is a 28-item measure of school climate comprised of four subscales: Academic Press (six items), Community Engagement (seven items), Teacher Professionalism (eight items), and Collegial Leadership (seven items) (Tschannen-Moran *et al.*, 2006). Sample items representing each of the respective subscales include:
   - Students respect others who get good grades.
   - Community members are responsive to requests for participation.
   - Teachers are committed to helping students.
   - The principal is friendly and approachable.

(4) *Student achievement and socioeconomic status.* Data on student achievement were drawn from two eighth-grade Virginia Standards of Learning (SOL) tests: English (Reading, Research, and Literature) and Math. Because these two measures were highly correlated ($r = 0.92$), a factor analysis (using maximum likelihood) was conducted. These two measures of student achievement loaded onto one strong factor with an eigenvalue of 1.92 that explained 96 percent of the variance. Consequently, they were combined into one variable for subsequent analyses. Data on the proportion of students receiving free and reduced-price lunches were gathered from the Virginia Department of Education web site.

Data analysis

Because the level of analysis was the school, all measures were aggregated to the school level. The measure of quality of school facilities was examined using descriptive statistics, factor analysis, and reliability analysis. The measure of resource support and the subscales of the School Climate Index were also tested for internal consistency. Bivariate correlational analysis was used to explore the relationships between the quality of school facilities, resource support, school climate, student socioeconomic status, and student achievement. Finally, multiple regression was used to test school

climate as a mediating variable between the quality of school facilities and student achievement.

Results

Our first analysis tested the perceptual measures for internal consistency. Descriptive analysis of the quality of school facilities items revealed means that ranged from 3.32-3.86 on a five-point scale with a standard deviations ranged from 0.49-0.70 (see Table I). A factor analysis using Varimax rotation was conducted, revealing one strong factor with an eigenvalue of 4.6 that explained 66 percent of the variance in perceptions of school facility quality. Six of the seven items loaded well on this factor, with factor loadings ranging from 0.49-0.90. Interestingly, item 60 (This building is neat and clean.) had the highest overall mean and also the highest variability ($m = 3.86, \mathrm{SD} = 0.70$); however, it had low communality with the other items and did not load onto the main factor. Because this item apparently did not vary systematically with the other assessments of building quality, it was removed from subsequent analyses. The remaining six items had a Cronbach's alpha reliability of 0.93. In addition, the three items comprising the resource support scale had a Cronbach's alpha of 0.82.

The internal consistency of the four subscales of the School Climate Index (Tschannen-Moran *et al.*, 2006) was also examined and these demonstrated adequate reliability. The alpha reliability for the six items comprising the academic press subscale of the School Climate Index was 0.92. The seven items of community engagement subscale had an alpha of 0.93. The alpha for the eight items in the teacher professionalism subscale was 0.94. And the seven items of collegial leadership had an alpha of 0.93. Correlational analyses of these subscales in relation to the perceptions of the quality of school facilities and student achievement, however, indicated that the collegial leadership of the principal was unrelated to either of these two variables of interest. Consequently, this subscale was dropped from further analysis. The remaining three school climate variables were significantly positively related to both the quality of school facilities and to student achievement (academic press ($r = 0.52, 0.61$, respectively), teacher professionalism ($r = 0.37, 0.34$, respectively), and community engagement ($r = 0.50, 0.63$, respectively). They were also positively related to one another, ($r = 0.46$ to 0.82). Thus a factor analysis using maximum likelihood was conducted, revealing one strong factor with an eigenvalue of 2.39 that

No.	Item	Mean	SD	Factor 1
57.	The facilities here are adequate to support learning	3.58	0.53	0.90
61.	The building is a comfortable place to be	3.74	0.49	0.79
62.	This building is pleasing in appearance	3.75	0.57	0.75
64.	There is adequate space for teaching and learning here	3.37	0.55	0.73
59.	Classroom equipment and furniture are in disrepair *	3.35	0.53	0.68
58.	The facilities here are lacking in regular maintenance *	3.32	0.51	0.49
60.	This building is neat and clean	3.86	0.70	0.05
		Eigenvalue		4.6
		Percent of variance		0.66

Table I.
Means and standard deviations of the quality of school facilities items

Note: *= reverse coded

explained 80 percent of the variance. This factor, combining these three subscales into a single variable we labeled School Climate Index, was used in subsequent analyses. The collegial leadership of the principal was significantly related to the other three subscales of school climate ($r = 0.37$ to 0.50, $p < 0.01$).

Next, correlational analyses were conducted to examine the relationships between the variables (see Table II). Perceptions of the quality of school facilities were strongly related to assessments of resource support ($r = 0.73, p < 0.01$). These perceptions of building quality however, were uncorrelated to student socioeconomic status. The quality of school facilities was related to the School Climate Index ($r = 0.52, p < 0.01$). The School Climate Index was also related to student achievement ($r = 0.61, p < 0.01$). In concert with the findings of earlier research, perceptions of the quality of school facilities were related to student achievement in English and mathematics ($r = 0.25, p < 0.05$). Similarly, resource support was related to student achievement ($r = 0.31, p < 0.05$). As expected, student SES was strongly related to student achievement ($r = -0.85, p < 0.01$).

A regression analysis was then conducted in which the quality of school facilities and the School Climate Index were regressed on student achievement. The regression equation was significant and explained 39 percent of the variance in student achievement (see Table III). Only the School Climate Index, however, made a significant independent contribution to the equation ($b = 0.70, p < 0.01$). We suspected that school climate was mediating the earlier relationship found between the quality of school facilities and student achievement, thus mediation was tested using the product of coefficients procedure described by Wuensch (2007). The three tests conducted, Sobel, Aroian and Goodman (Preacher and Leonardelli, 2006)

		2.	3.	4.	5.
1. Quality of school facilities	(0.93)	0.73**	0.52**	−0.23	0.25*
2. Resource support		(0.82)	0.62**	−0.23	0.31*
3. School climate index			(0.96)	−0.47**	0.61**
4. Free and reduced-priced meals					−0.85**
5. Student achievement					(0.96)

Notes: * $p < 0.05$;** $p < 0.01$; Cronbach's alphas are reported on the diagonals

Table II.
Correlations between school facilities, climate, and student achievement

	Student achievement		
	Beta	*t*	Sig.
Quality of facilities	−0.16	−01.34	0.19
School climate index	0.70	6.02	0.000**
			$R^2 = 0.39$
			Adjusted $R^2 = 0.37$
			SE = 0.794

Notes: $N = 80$; * $p < 0.05$; ** $p < 0.01$

Table III.
Multiple regression analysis of quality of facilities and school climate on student achievement

demonstrated that school climate mediated the relationship between perceptions of the quality of school facilities and student achievement (see Table IV).

Discussion

Our results confirmed our hypothesis that school climate plays a mediating role in the effects of the quality of school facilities on student achievement. This begins to fill in one piece of the puzzle as we seek to understand the mechanisms through which high-quality facilities support learning and poor-quality facilities are detrimental to student achievement. Our results revealed that when learning is taking place in inadequate facilities, there tends not to be as clear a focus on academics, and the learning environment is less likely to be perceived as orderly and serious. Where school buildings are shabby and inadequate, there is less likely to be the kind of community engagement that supports teaching and learning. Teacher attitudes and behaviors are related as well, as teachers are less likely to show enthusiasm for their jobs and to go the extra mile with students to support their learning when they teach in buildings they judge to be of poor quality.

Interestingly, the quality of school facilities was unrelated to the collegial leadership of the principal. Whether the principal had an open leadership style or tended to be more authoritarian was unrelated to the physical features of the school building. The principal's leadership style was likewise unrelated to student achievement. The leadership of the principal was, however, related to the three other school climate variables and these variables were related to achievement. This would indicate that the principal's leadership style plays an indirect rather than a direct role in fostering student achievement. These findings are in concert with those of Hallinger and Heck (1996) that principals mediate student achievement by setting the tone for a strong emphasis on academics and teacher professionalism. It may also be true that principals who assume leadership of a building where the climate does not support a serious focus on academics are more likely to be perceived as demanding or authoritarian as they seek to make change.

Further, one might expect to find that the quality of the school building would be related to the socioeconomic status of the student body. This was not the case. The perceived quality of facilities was uncorrelated to proportion of students receiving free and reduced-priced meals. An earlier study of rural high schools in Virginia also found a low correlation between building quality and student SES, as measured by free and reduced-price lunch, as well as an absence of correlation to the Local Composite Index of district wealth ($r = 0.136$ and 0.14, respectively, Cash, 1993). In the current study, the perceptions of the quality of facilities were strongly related to resource support. This would indicate that where resources were adequate, facilities also tended to be of higher quality, irrespective of the socioeconomic status of the students served.

Table IV. Tests of mediation

	Test statistic	*p*-value
Sobel test	4.020	0.000
Aronian test	3.990	0.000
Goodman test	4.051	0.000

An unanticipated finding was that the cleanliness and neatness of a building seemed to function somewhat independently of the other indicators of building quality. Whether the building was well kept was not predictive of whether there was likely to be adequate space to support learning, whether the participants rated the space as comfortable or pleasing in appearance, or the other indicators of quality. The mean for this indicator was higher than that for the other items in the scale, indicating that even where participants rated their school buildings as lacking in other respects, they at least were kept clean and neat. But there was also greater variability in this indicator, which combined with the lack of covariance with other indicators of quality would suggest that in some instances higher quality buildings were not as well kept as some of poorer quality.

Several limitations should be considered in interpreting the results of this study. In the first place, the study was exploratory in nature. While the measure of teacher perceptions of school facilities was based on aspects of facilities that have been found to be related to student achievement as they have been rated by more objective means, this measure has not been used nor tested extensively beyond this study. Second, as the interest was in teachers' perceptions of their school buildings, the data were necessarily self-report and subjective in nature. No attempt was made to align these perceptual data with more objective measures of the same buildings. Likewise, the measures of building quality and resource support were a part of the same survey as the school climate variables, which leaves open the possibility of same-source or response-set biases. Finally, these results were primarily correlational in nature, which can be useful in establishing the existence of a relationship, but are limited in their ability to establish a causal link. Because of the difficulty in obtaining permissions to collect data across large numbers of schools and districts, a quasi-experimental method employing matched samples was not considered feasible design for this study.

Implications

The manner in which a school building is designed, managed, and maintained sends a message to its occupants and the community beyond, speaking volumes about the value placed on activities transpiring within its walls. The physical properties of a school building are the tangible context within which teaching and learning take place (Willower, 1988). We have the capacity to influence these properties practically and artfully on behalf of the students and teachers whose performance we wish to support and improve (Uline, 2000).

According to the most recent national estimates, 21 percent of US schools are more than 50 years old and another 50 percent are at least 30 years old, requiring a total of $127 billion dollars in new construction and retro-fitting (Office of Education Research and Improvement, 2000). A National Education Association (NEA) study placed the need at more than double these estimates, bringing the cost of modernizing America's schools to $268 billion. Add to this $52 billion for technology needs and the total surges to $322 billion (National Education Association, 2000). *American School and University's* 31st Annual Official Education Construction Report estimates school districts spent a record total of $29.1 billion on school construction in 2004, with $13.2 billion spent for new construction, $5.6 billion for additions, and $10.3 billion for modernizations (Argon, 2005). School Planning and Management placed the total somewhat more conservatively at $20.2 billion in 2004. In their 2005 report, they

estimate $21.6 billion, estimating $12.8 billion in new structures, just less than $5 billion for additions and $3.9 billion for renovation (Abramson, 2006). The needs of school building construction and repair present a tremendous challenge and, at the same time, an extraordinary opportunity. With the investment of such large expenditures of taxpayer money comes the responsibility to be thoughtful as we approach the issue of school design and construction, in addition to the long-term maintenance of our investment. Cutting corners at the time of initial building or through deferred maintenance may have heretofore unforeseen costs in student outcomes.

Despite the recent increases in school construction, one in four schools continues to "make do" with poor quality buildings (Mead, 2005, p. 1). Even as evidence mounts regarding the detrimental effects these poor conditions have on students and teachers, school district leaders struggle to convince federal policy makers and local taxpayers of the need to invest resources in replacing and/or renovating inadequate school facilities. It appears many remain unconvinced about the seriousness of the problem. And yet, according to leading experts in the field:

> We already know what is needed: clean air, good light, and a quiet, comfortable, and safe learning environment. This can be and generally has been achieved within the limits of existing knowledge, technology, and materials. It simply requires adequate funding and competent design, construction, and maintenance (Schneider, 2002, p. 16).

Evidence that school climate plays a mediating role in the effect that school building quality has on student achievement may suggest that certain building improvements and design features leverage stronger results than others. At the very least, design features that serve to reinforce and enhance the social environment of school should not be underestimated in their importance. At the same time we seek to improve science laboratories and integrate state of the art technology systems, we should also pay particular attention to the ways in which various learning spaces encourage or impede daily interactions between and among students, teachers and parents. If carefully conceived, the separate spaces of a school reinforce each other physically and aesthetically, creating rich environments where interpersonal relationships can flourish (Uline, 2000). Within such spaces, occupants find themselves comfortable enough to take the individual and collective risks requisite to most meaningful interaction and learning.

Design features that make for flexible and responsive environments create a sense of comfort and invite occupants to actively experience school life. When students feel comfortable to move within and beyond their individual classrooms, chances are they will engage more actively in their own, and each others, learning. The particular personality of various spaces within a school may encourage a sense of belonging and foster a collective commitment to share learning goals. A combination of shared and personal spaces for student and teacher work can help to nurture an orderly and serious academic atmosphere. Further, when students, teachers, parents, and community members have access to common areas, they have more opportunity to interact, encouraging an extended sense of engagement with the school's community of learners.

Even the nature of traffic flow through a school building may make a significant difference in school climate. When physical surroundings force the occupants of a school to move against each other in crowded spaces, adults and students are more

likely to violate personal space and put each other on edge. On the other hand, well-designed hallways allow passers-by to move comfortably along to shared destinations (Tanner and Lackney, 2006). Indeed, many of the design features and classifications found to be related to student achievement, including flexible classroom arrangements, clearly defined pathways, positive outdoor spaces, large-group meeting rooms, instructional neighborhoods, and ample egress (Tanner and Lackney, 2006) likely produce "socially configured work spaces" within schools (Giles and Hargreaves, 2006, p. 136). Continued investigation of such features promise deeper insight into the complex dynamics of how social influences impact learning.

This study underscores the importance of perceptions of building quality in fostering school climate that is conducive to student learning. It behooves us to continue exploring measures of perception and orientation, of preference and appreciation (Uline, 2000) along with study of specific design classifications and features and various other discrete physical building conditions.

Conclusion

We are beginning to understand how and when a school's physical structure reinforces the established goals of teaching and learning. We are coming to know why certain spaces work and others do not. As public and policy communities demand hard evidence of these connections, researchers continue to explore the complicated intricacies of how a school building's physical properties influence teaching and learning. A combination of research approaches may best inform. Considering the degree to which school climate mediates this complicated interplay of factors may help to tell a compelling story about how human comfort, pleasing appearance, adequacy of space, functional furniture and equipment, a clean and orderly environment, and regular maintenance affects occupants' sense of well being and thus their capacity to teach and learn.

Note

1. The API is a numeric index based on California's Standardized Testing and Reporting (STAR) program. The index is a weighted average of student performance as measured by the Stanford Achievement Test, Ninth Edition (Stanford 9) and the California Standards Tests (CSTs) in English-language arts, mathematics, and history-social science.

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