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AUTHOR Earthman, Glen I.; Lemasters, Linda K.

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ABSTRACT

Research on educational facilities is important to help industry and school districts make decisions on funding and maintaining good educational environments for their students. This paper presents findings from three syntheses of 232 studies on educational facilities and funding decisions, followed by discussions of practical solutions designed to help decision makers improve educational facilities. The research reveals that student achievement scores were higher when windows, floors, heat, roofs, locker conditions, ceilings, laboratory conditions, age of the facility, lighting, interior paint, and cosmetic conditions of the school were generally rated above standard by school staffs. Also examined are research findings on how facility conditions affected student attitudes, behaviors, and achievement. Lists of measurements of dependent variables and research summary notations for educators and architects concerning the facility/student relationship conclude the paper. (Contains 79 references.) (GR)

CAN RESEARCH FINDINGS HELP SCHOOL SYSTEMS OBTAIN THE MOST BANG FROM THE CONSTRUCTION BUCKS?

Glen I. Earthman
Director
National Clearinghouse on Ed Facilities
1750 Kraft Dr., #2200
Blacksburg, VA 24060
(540) 231-9707
earthman@vt.edu

and

Linda K. Lemasters
Assistant Superintendent for Admin Services
Gloucester County Public Schools
6385 Main Street
Gloucester, Virginia 23061
(804) 693-5304
lemaster@admin.sbo.gc.k12.va.us

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INTRODUCTION

The Council of Educational Facilities Planners, International has had a continuing interest in the area of research on educational facilities. The research interest of the organization and its members has been very long-standing, perhaps since the first days of the organization and its predecessor, the National Council on Schoolhouse Construction. The research interest also has been rather broad in application and extends from one end of the continuum to the other. The broad interest simply reflects the many different disciplines, trades, and professions that are involved in the general area of providing adequate housing for students. The range of interests extend from planning and financing to designing and building, as well as all of the other areas of interest in-between.

The need for research in all areas of interest on educational facilities is very great, because only by investigating the many questions and problems associated with the physical environment

can the industry do a better job of providing good housing for students. The practitioners, professionals, and trades people who work in this field all benefit from the work of researchers, be they educators, architects, engineers, contractors, financiers, or planners. This inextricable partnership between researcher and users of research findings has enabled children to go to school in improved surroundings over the years.

We would be remiss, however, to assume that all students in the country enjoy the benefits of application of recent research findings on the physical environment. Such is simply not the case. In the United States we have students attending some of the most advanced school buildings possible. On the other end of the continuum, there are some students who are housed in some of the most unbearable and unsafe buildings one can imagine. None of us would have to go too far from our individual homes to see examples of these conditions. The inequity of school facilities is ever present.

Granted, there are some school systems that have excellent buildings throughout the system. Next door to that school system,

however, there may be students attending schools in marginal buildings. This situation is not new or revealing to anyone. This is common knowledge; we all know this for a fact. Yet the inequity never seems to abate to any measurable degree.

There are many reasons why these conditions exist in local school systems. The most evident is lack of sufficient resources to improve all school buildings. This is coupled with a political agenda which states either that the local school system can not afford to raise taxes to improve school buildings or that the buildings were good enough for me when I attended school in them and look where it got me. This is not a mean-spirited commentary. This answer happens too often to be coincidental or unique. The politics of this situation are well known by everyone who works in the field of educational facilities.

There is also competition for the tax dollar between the various segments of the local scene. Local governments must provide for all of the infrastructure services of the community. As such, the school system must compete with the needs of the community for an improvement in the water and sewer system as

well as new fire stations, and recreation facilities. There is a certain amount of truth to the statement that the school children are the most precious resource a community has and as a result good school buildings must be available to them, but the other community services are also extremely important to the total well being of the community. Local communities, however, should not be placed into the situation where the decision makers must chose between the needs of the school children and the needs for other community services. The resources of the country are sufficient to take care of the needs of the community. The problem, though, is that the resources are not evenly distributed throughout the nation and as a result, we see disparity between school systems within a state, and even between states.

Nevertheless, there is some truth to the observation that many school systems across the country simply do not have the necessary local resources to improve all of the school buildings in the jurisdiction. This condition, however, is sometimes the excuse given for not doing anything about improving the buildings. What is clear, however, is that local school systems are not equally equipped

or have the necessary resources to address the problem of school building disrepair.

In addition to the problem of housing students in unsafe buildings, there is the problem of housing them in physical environments that are not conducive to effective learning. To simply state that school buildings must be safe and clean for students is not enough. If we truly believe buildings have an influence upon the user, then it is important that buildings reflect the need of the educational program. There are some esoteric needs of the educational program in terms of the physical surroundings, but there are also some basic building needs which impinge upon the learning of students in a school building. These needs and conditions are normally in existence in new, modern buildings. They are not, however, prevalent in the present stock of existing buildings.

This fact have been documented for the past fifteen years, since the AASA study in 1983 on school maintenance. The documentation has been carried down through the years by various sources. The AASA produced a report entitled Schoolhouse in the Red in 1989. Then again, the Educational Writers Association in

1989 published the report Wolves at the Schoolhouse Door. The latest report on the condition of the public school buildings was that of the General Accounting Office (1996). In addition to the national reports, the department of education in many states regularly reports on facility needs. In all cases, whether on a state or national level, the story is the same. There are many school buildings that are non-functional and present a hazard to the health of the student attending school. The GAO report stated that perhaps as many as 14 million students are housed in unsafe buildings which are hazardous to their health. Imagine if one of those children were your child. That would simply be intolerable. Unfortunately, the vast majority of these 14 million children are from the lower scale of income and are from families that have the least political clout in the local community to do anything about the situation.

On one side of the equation we have the buildings that actually present a hazard to the health of students. On the other side there is the mounting evidence that there is a relationship between the condition of buildings and the achievement of students. Four finely crafted studies investigated the relationship between the building

condition and the achievement of students. The findings of these studies were very consistent. In each separate case, the researchers found a positive relationship between these two variables. The difference in achievement scores of the students in sub-standard buildings and those in above standard buildings is not large, but the difference is there. These differences ranged from 5 to 11 percentile points, depending upon the sub-scales being used for the comparison. Five percentile points may not seem like much difference, but compared with the amount of influence public schools do have over the learning of a student, it may be significant. More importantly, the condition of the school building is something for which the community, school boards, and educators can take direct responsibility. A leaking roof can be repaired, as well as all of the other building conditions needed for effective learning. Whether or not this takes place is a matter of concern. Whether or not we place our resources in the condition of the school building is really the question.

The Federal Government and Congress has shown concern for the condition of the public schools. There have been several

initiatives within the past three years to assist local school systems in addressing the state of disrepair of buildings. One of the first efforts was through Senator Carol Mosley-Braun who sponsored a congressional bill to allocate $100 million in federal funds to assist in bringing the school building up to standard. This bill was passed, but there was no moneys appropriated to fund the provisions of the act. Earlier this year, the president sent to Congress proposed legislation to help local communities and states rebuild schools. The "Partnership to Rebuild America's Schools Act of 1997" would allocate $5 billion over the next four years to upgrade school buildings. The proposed legislation would encourage $20 billion in investments for school modernization by states, localities, and the private sector. This legislation has not been acted upon as yet. Again, through the "Taxpayer Relief Act of 1997" there are provisions for tax credits for individuals and institutions that hold what are called "qualified zone academy bonds." These bonds are defined as any bond issued by a State or local government provided that 95 percent of the proceeds are used for the purpose of improving school buildings. This legislation calls for a total of

$800 million issued over two years that can qualify for these favorable tax credits. Such academy bonds will be allocated to the States according to their respective populations of individuals below the poverty line. Qualified zone academies are defined as public schools that have special academic programs and that are in an enterprise community or expect 35 percent of the students to come from low income families.

Although there is not a great deal of federal funding available to local school systems to improve buildings as yet, it seems reasonable to expect there will be greater interest in the problem with a resultant increase in federal funding. Of course, no matter what the level of funding that comes about, the amount of funding will not take care of the need as expressed by the reports on building conditions. The GAO Report indicated it would take $112 billion to bring the schools up to standard. As in most situations, the need is far greater than the available funding, however, there does seem to be an effort to begin providing funds.

If it is correct to assume there will be an increased level of funding for building improvement, then it behooves school boards and

educators to determine how they can get the greatest good from the funds they might receive. There are some guidelines that can be used to determine how such funds may be expeditiously expended. These guidelines are driven by research findings that will insure the wise expenditure of funds.

THE RESEARCH

Often during budget time, school boards are faced with the dilemma of whether to designate funds for teachers and teaching materials or buses and buildings. Indeed, the interpretation is that buses, budgets, and buildings consume more than their "fair" share. This interpretation, however, is based on an assumption that these support areas, in particular the facility, do not affect the learner.

Research on facilities and student achievement, performance, and attitudes, which was reviewed by Weinstein in 1979 and McGuffey in 1982, disputes that interpretation. These researchers provided syntheses of 232 studies (Earthman, 1996). There have been many studies completed since Weinstein's and McGuffey's reviews in 1979 and 1982; therefore, Lemasters' (1997) synthesis

was conducted for the ensuing years. This compilation of the research was needed to ascertain the most recent conclusions drawn by researchers and to make this information known and accessible to planners and designers of facilities.

The findings from the three syntheses indicated that when school boards put funds in line items other than teachers and instructional materials, they continue indirectly to contribute to improved instruction.

FINDINGS FROM THE RESEARCH

In looking at the research concerning facilities, one must make conclusions that weigh the difficulties of control in educational research. It is difficult in the educational setting to randomly assign teachers and students and to have the funding to randomly change the physical settings. There are grave problems in education in trying to match teaching methods, student abilities, and physical learning climates while conducting research. Indeed, there may be moral questions as to the appropriateness of doing such and making the research public, as well as legal questions of privacy.

However, the conclusions that are drawn from the research are important not only for the information that they provide the educator and the building designer, but also for how they substantiate or disagree with the two previous syntheses by McGuffey (1982) and Weinstein (1979). Therefore, conclusions from the three syntheses will be included in this discussion. (Findings for the Lemasters' study are in italics.)

1. *The most recent synthesis concluded that school facilities which are well-maintained have a positive impact on student achievement.* This statement was supported in the work of McGuffey (1982), who concluded that obsolete learning environments detract from the learning process. On the other hand, Weinstein (1979) was unable to state conclusive statistical data that the physical environment had impact on achievement. Her study did concede that the physical environment affected attitudes, and positive attitudes may result in improved achievement.

2. *Lemasters, also, found support in the research that school facilities which are maintained well positively influence student*

behavior. This was supported in McGuffey's study, and was not disputed in the work of Weinstein.

3. *According to the most recent studies, students will seek areas of privacy in the classroom, even if they must create the structure themselves, as classrooms with areas for privacy reduce student anxiety and stress.* Although this was not a variable addressed by McGuffey, Weinstein saw privacy as a variable that needed additional study.

4. *Full-spectrum fluorescent lighting with trace amounts of ultraviolet content has a positive effect on student health.* Although neither McGuffey nor Weinstein addressed this variable as the Lemasters' (1997) synthesis did, McGuffey concluded that the studies he reviewed indicated seeing factors had a significant effect on visual performance. However, he stated that natural light had little or no effect on classroom performance.

5. *The 1997 synthesis found support in the research that non-instruction noise has an adverse effect on the student learner.* McGuffey reviewed studies that concluded that noise could create enough interference with instruction that learning would be

hindered. Weinstein could find no conclusive evidence in the studies she reviewed that noise affected achievement, but did state that classroom noise levels should be realistic.

Thus, there are many variables that influence student achievement, student attitudes, student behavior, and how students learn. The problem for all of the studies in this synthesis was determining the degree to which the school facility actually was the cause of student behavior and achievement.

But even when the variance of achievement test scores resulting from the building environment is minimal, it is a portion of the elements affecting behavior and achievement that can be controlled through the efforts of educators and design professionals. In addition, the condition of school buildings is a very visible demonstration or value statement made to the student of the importance that society or the community places on education.

As stated by Edwards (1991) in her study:

> Good infrastructure is truly at the base of a quality education. For a society searching for ways to address the educational needs of the future, the building itself is a good place to start (p. 47).

After reviewing over fifty-three studies and reading the U. S. General Accounting Offices' facilities report (1995), one could hardly disagree with Edwards.

PRACTICAL CONCLUSIONS

As was stated in the introduction, the General Accounting Office (GAO) suggested fourteen million students attend schools needing extensive repair or replacement. According to Senator Moseley-Braun (press release, June 21, 1996),

> Crumbling schools is not just an inner city problem. It is not a problem for poor children, or for minority children. . . .It is an American problem--and it relates directly to our future. . . . America can't compete if our students can't learn; and our students can't learn if their schools are falling down.

From state and federal documents presented in the GAO study and from the available research on how the facility affects student achievement and behavior, it is illogical that resources are not available to address maintenance, renovation, and construction needs. In the State of Virginia, for example, the allocation for maintenance of facilities is very small. The funding is dynamic, as the legislature often lowers the allocation when the budget is tight.

As for the construction of new facilities, the Commonwealth provides only funds for loans. There are many problems contributing to this lack of action.

However, Virginia is not the only state that responds to facility needs in such a manner. There are approximately thirty-three more who follow such a funding pattern, leaving the place where the student learns as a less than high priority item in state budgets. Perhaps the proposed initiatives of President Clinton for improving the school buildings of the country will move the states toward action.

With this possibility of increased fund, designers and educators need to become knowledgeable about the data from the research. Thus, when the funds become available, designers can incorporate the available research into their designs and school boards will make researched based decisions at budget time.

The following provides an important, although incomplete, list of suggestions from the studies that may be useful to school boards and the professionals who plan, build, maintain, and remodel school facilities.

Age of the Facility

- Students had higher achievement scores in newer facilities. Indeed, as the age of the facilities decreased, there was a corresponding increase in scores in mathematics, reading, and composition.
- There were fewer discipline incidents in newer facilities.
- Attendance records were better in the new facilities.
- Social climate factors perceived by students were considerably more favorable in a new school.

Condition of the Facility

- As the condition of the facility improved, achievement scores improved.
- Stimulating environments promoted positive attitudes in students.
- Higher student achievement was associated with schools with better science laboratories. Furthermore, attitudes toward the science classroom predicted science achievement.
- Higher student achievement was associated with well-maintained schools.

- There was a consistent pattern of higher achievement in air conditioned schools.
- Achievement was greater in facilities that allowed for individual preferences for heat.

Color of the Indoor Facilities

- Higher student achievement was associated with schools with pastel painted walls.
- There seemed to be a cause-effect relationship between the variables of color and light and students' blood pressures.
- Relaxing shades of blue significantly reduce systolic diastolic blood pressure.

Unrelated Noise on the Outside of the Building

- Higher student achievement was associated with schools with less external noise.
- Outside noise caused students to be dissatisfied with their classrooms.
- Excessive temperatures and noise caused stress in students.

Light inside Facilities

- There seemed to be a cause-effect relationship between the variables of color and light and students' blood pressures.
- Under some conditions, classrooms having fluorescent lighting without an ultra-violet component had higher absence rates. Classrooms with full-spectrum lighting with ultra violet content had a significant positive effect on attendance. In general, light with ultra-violet content appeared to improve student health.
- Light in the classroom seemed to have a positive effect on attendance rates.
- Light had a positive effect on achievement.
- Daylight in the classroom seemed to foster higher achievement.

Density in the Classroom

- Students seek areas of privacy in the classroom. Students were most often not comfortable in low privacy areas.
- Open-plan classrooms had higher levels of off-task behavior. Students spent their time in less educationally valuable ways in more open classroom units.
- Students experienced more anxiety in the open-plan classrooms.

- Density was a significant predictor of task inattention.
- Overcrowding had a negative impact on student achievement in poorer school districts.
- Openness of the classroom perimeter explained a significant proportion of the variance in absenteeism, task inattention, and fidgeting.

SUMMARY

In summary, student achievement scores were higher when windows, floors, heat, roofs, locker conditions, ceilings, laboratory conditions, age of the facility, lighting, interior paint, cosmetic conditions in general were rated above standard by school staffs. Studies suggested that the facility often affected attitudes and behaviors as well.

With all of the many elements within the educational process that are outside the control of the educator, it is possible to provide a school building that exemplifies to the student the importance that the community, the state, or the nation places on education. The place where students learn can encourage good student behaviors and optimal student achievement.

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MEASUREMENT OF DEPENDENT VARIABLES

RESEARCHER	ACHIEVEMENT	BEHAVIOR
Ahrentzen	-	Student satisfaction with classroom
Edwards	Comprehensive Test of Basic Skills	-
Bowers	Scores in reading, listening, language, and math	Attendance; discipline incidents; Piers-Harris Self-Concept Scale
Bross	-	Errors on a mirror tracing
Burgess	-	Free-play behaviors
Burkhalter	-	Career Maturity Inventory Attitude Scale
Cash	Test of Academic Proficiency	Number of disciplinary incidents
Chan (80)	Iowa Test of Basic Skills	-
Chan (82)	-	Our School Building Attitude Inventory
Cheng	-	Researcher developed instrument to measure attitudes
Christie	Standard Progressive Matrix (60 subtests)	-
Cohen (80)	-	Blood pressure; attention strategies; feelings of helplessness
Cohen (90)	-	Preference paradigm was developed by student
Cotterell	-	Student behavior; anxiety; peer interaction
Earthman	Comprehensive Test of Basic Skills	Number of disciplinary incidents
Garrett	Test of Academic Progress	-
Grangaard	-	Blood pressure; off-task behavior
Harting	-	Attendance
Hathaway	Canadian Test of Basic Skills	Attendance; vision changes; growth and development rates
Heubach	-	Questionnaire evaluating privacy perceptions
Hines	Test of Academic Proficiency	Number of disciplinary incidents
Hood-Smith	-	Disciplinary incidents; social behavior
Hyatt	California Test of Basic Skills; California Achievement Tests	Opinion questionnaire developed by Port of Seattle to measure attitudes
Ingraham	-	Measured inattention, off-task or disruptive behavior
Javor	Biology class averages and test scores	-
Jue	-	Task inattention; attendance; restlessness
Karst	-	Attitude inventories
Kaufman	-	Stress
Knight	Grades and tests in reading, math, language	-
Krawitz	Iowa Test of Basic Skills	-
Krimsky	Gates-MacGinitie Reading Tests	-
London	-	Attendance
Murrain	Word recognition scores	-
Mwamwenda	National exams in math, English, science, social science, Setswana	-
Nash	-	Measured student choices of activities
Navarro	Peabody Individual Achievement Test	-
Neill	-	Span of attention; disruptive behavior; aggressive behavior
Nicklas	California Achievement Tests and End-of-Grade testing	-
Peatross	-	Student circulation and interaction
Pizzo	Gates-MacGinitie Reading Tests	-
Pritchard	California Test of Basic Skills	Measured attitudes of students in new school
Rivera-Batiz	NY City Bd. of Ed. school profile data	Opinions and perceptions were measured
Scagliotta	-	Negative behavior
Shea	Metrooolitan Achiev. Test (reading subtest)	-
Sommer	-	Student participation
Stires	Course grades	Attitudes toward the course; attendance
Stueck	-	Social interaction; student self-motivation
Sydoriak	Iowa Test of Basic Skills	Blood pressure; growth rates
Talton	Teacher reported semester grades	Simoson and Troost (measures attitudes)
Wohlfarth	Standardized tests	Disciplinary incidents; attendance; blood pressure; School Subjects Attitude Scale; Preadolescent Mood Scale
Yielding	-	Student movement; student perceived learning climate
Zentall (80)	Test of Written Language	Measured neatness and errors
Zentall (88)	Test of Written Language	Conners Abbreviated Teacher Rating Scale

NOTES FOR EDUCATORS AND ARCHITECTS

Ahrentzen	√Students wishing to be alone seek areas of privacy
	√Outside noise causes students to be dissatisfied with their classrooms
Edwards	√School age was found to be a predictor of building condition
	√Parental involvement is positively related to the school building's condition
	√As the condition of the facility improved, achievement scores improved
Bowers	√Students had higher achievement scores in newer facilities
	√There were fewer discipline incidents in newer facilities
	√Attendance records were better in the new facilities
Burgess	√Pre-school students may need more spacious classrooms
Burkhalter	√Stimulating environments promote positive attitudes
Cash	√Higher student achievement was associated with schools with air conditioning, better science laboratories, pastel painted walls, less external noise, and well-maintained schools
Chan	√There was a consistent pattern of higher achievement in air-conditioned schools
Cheng	√Effective classrooms were perceived as being equipped with appropriate physical facilities, having enough space, and being neat, clean, and free of pollution

Cotterell	√Open-plan classrooms had higher levels of off-task behavior
	√Students experienced more anxiety in the open-plan classrooms
Earthman	√Student achievement scores were higher when the following building conditions were rated above standard: windows, floors, heat, roofs, locker conditions, ceilings, laboratory age, lighting, interior paint, mopped floors, cosmetic opinions, density
Garrett	√As the age of the facilities decreased, there was a corresponding increase in scores in mathematics, reading, and composition
Grangaard	√There seemed to be a cause-effect relationship between the variables of color and light and the students' blood pressures
Harting	√The rate of student absenteeism was significantly higher in the windowless school
	√Under some conditions, classrooms having fluorescent lighting without an ultra-violet component have higher absence rates
Hathaway	√Light had an effect on attendance rates
	√Light had an effect on achievement
	√Light with ultra-violet content appeared to improve student health
Heubach	√Students are not comfortable being in low privacy areas
Hines	√Higher achievement scores were associated with newer buildings, more windows, air conditioning, good maintenance, and individually heated instructional areas
Hyatt	√Student attitudes toward the classroom environment will affect achievement

	√Noise outside of the classroom negatively affects classroom achievement
Ingraham	√There was a possible cause-effect relationship between electromagnetic radiation and students' off-task behaviors
Jue	√Density is a significant predictor of task inattention
	√Openness of the classroom perimeter explained a significant proportion of the variance in absenteeism, task inattention, and fidgeting
Kaufman	√Excessive temperatures and noise may cause stress in students
London	√FSF lighting improved attendance
Murrain	√Achievement is greater in facilities that allow for individual preferences for heat
Neill	√Children spend their time in less educationally valuable ways in more open classroom units
Nicklas	√Daylight in the classroom fosters higher achievement
Peatross	√Students will create their own privacy areas
Pritchard	√Social climate factors perceived by students were considerably more favorable in a new school
Rivera-Batiz	√Overcrowding has a negative impact on student achievement in poorer school districts
Sydoriak	√Relaxing shades of blue significantly reduce systolic diastolic blood pressure
Talton	√Attitudes toward the science classroom predict science achievement
Wohlfarth	√Classroom with full-spectrum lighting with ultra violet content has a significant effect on attendance

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