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ABSTRACT

Almost every educator would agree that a well-maintained school building is essential for a proper learning environment. This paper presents findings of a study that examined the relationship between student achievement/behavior and school-building condition. A survey sent to all high schools (n=199) in North Dakota elicited responses from 120 principals, a 60 percent response rate. The Comprehensive Test of Basic Skills was used as a measure of student achievement and the numbers of disciplinary incidents as an indicator of student behavior. School-building condition was measured by principals' responses to an evaluative instrument. Findings indicate that a positive relationship existed between student achievement and building condition and between student behavior and school condition. Study results were compared with other studies that used similar methodologies with different populations. The data support the hypothesis that there is a positive relationship between student achievement/behavior and school environment. Three figures and 10 tables are included. (LMI)

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A STATEWIDE STUDY
OF
STUDENT ACHIEVEMENT AND BEHAVIOR
AND
SCHOOL BUILDING CONDITION

by

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Abstract

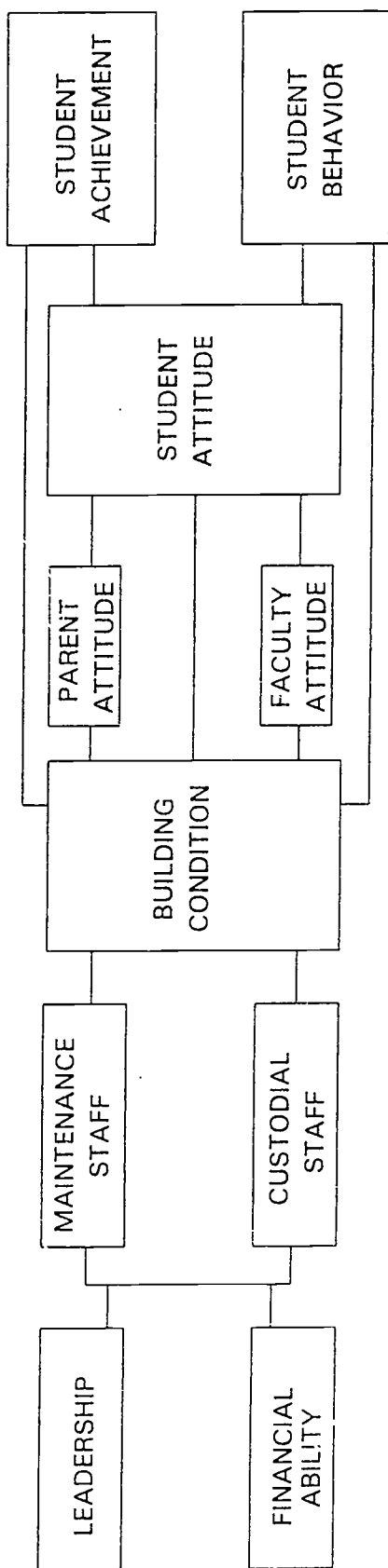
A statewide survey of all high schools in North Dakota was undertaken to examine the relationship between achievement and behavior of students and the condition of the school building. The study used the Comprehensive Test of Basic Skills as a measure of student achievement and the numbers of disciplinary incidents to record the behavior of students. The condition of the school building was determined by using an evaluative instrument used in previous studies. A relationship between the achievement of students and the building condition was found to exist in these schools. A relationship was also found between student behavior and school condition. The results of this study were compared with previous studies using similar methodologies, but different populations. This study supports the growing body of research that suggests there is a positive relationship between achievement of students and the condition of the built environment in which they are housed.

Introduction

Almost every educator will agree that a well maintained school building is essential for a proper learning environment for students. Yet there is not a great deal of research to the effect that there is a direct relationship between the quality of the built environment and the amount of learning completed by students. The difficulty in properly isolating the variables that influence student learning presents some major methodological problems and makes any research effort in this area tenuous at best. Nevertheless, there have been some studies, especially within the last 15 years, that seemed to generate some findings which give promise.

This study addressed the possible relationship between selected student variables and the condition of the school building in which the student is housed. There have been several reported studies concerning this relationship and in all cases, a positive relationship has been found. This research is based upon the theoretical construct that states the condition of the built environment influences how a person works and acts. This translates, as far as an educational organization is concerned, into how students learn and behave in a school building. The exact theoretical construct is contained in Figure 1.

The condition of a school building is the result of efforts on the part of the school maintenance and operations staff. These staffs are funded and supervised as a result of the efforts of the superintendent and school board in both raising sufficient funds and expecting a high level of work on their part. Consequently, the condition of the building rests ultimately upon the financial ability of the school system and the desire of the school board to have buildings in good shape. If the school board and superintendent deem it important to have all school buildings in good shape, then sufficient funds will be raised to properly staff the maintenance and operations department. At the same time, the school board and superintendent



MODEL DESIGN
Figure 1

must expect the staff to do those things necessary to keep the building in the kind of shape they desire. On the other end of the construct, the condition of the school building influences the perceptions of both school staff and parents who in turn influence the behavior and achievement of the student. The condition of the building also directly influences students in how they achieve and behave.

To test this construct, the study looked at both selected student variables, such as academic achievement and behavior, and the reported physical condition of the school building.

Studies as early as 1967 have reported on the relationship between school building condition and student achievement and behavior. The age of the building has been used as a cumulative factor for selected variables concerning the condition of a building. Burkhead, Fox, and Holland (1967) studied a sample of 238 school buildings in large cities. They found that building age was significant in reading score regression. Other studies (Michelson, 1970; Guthrie, 1971; McGuffey and Brown, 1978; Plumley, 1978) reported similar results. Chan (1978) did a follow-up of the McGuffey and Brown study. His findings indicated a statistically significant relationship at the 0.05 level between building age and academic achievement as measured by the composite, mathematics, and vocabulary scores of the Iowa Test of Basic Skills (ITBS). Two recent studies (Edwards, 1992 and Cash, 1993) researched this relationship and found a positive relationship between student achievement and behavior variables and building condition. Both researchers used a similar methodology employing a basic building evaluation and comparing the results with student achievement scores. The population in Edwards' study was the Washington, D. C. public schools. Edwards found that the condition of the school was related to student achievement. The standardized test scores of students in schools rated fair were 5.45 percentage points above those of students in school buildings rated poor. The difference between the scores of students in poor school buildings and students in buildings rated excellent was 10.9 percentage points.

Cash examined rural high schools in Virginia. She compared the student scores on the ITBS and their behavior with the condition of school building. Each building was evaluated on 29 items relating to condition. Each of the building evaluation items came from previous research which indicated a relationship between achievement and that particular item. She found that scores of students in the above standard school buildings were as many as 5 percentage points above the scores of students in buildings rated poor. She also looked at the variables representing student behavior among the three building condition groups. Her results were the reverse of what might be expected. Students in above standard buildings produced more reported incidents of misbehavior than did the students in buildings rated poor. No logical explanation was given for these findings.

Although there is some contention that achievement scores on standardized tests do not reflect the educational program offered in the school, achievement test scores do provide the best uniformity of data and are recognized by educational organizations as a measure of the performance of students.

Methodology

Specifically, the main research question addressed in this study was to determine if there is any relationship between the condition of the school building and selected student variables. The variables in this case were the academic achievement of students and their behavior, as they were in the Cash study. Student achievement was measured by the Comprehensive Test of Basic Skills that was administered to all 11th graders in the state in the spring of the year. Student behavior was measured by the total number of reported disciplinary incidents per pupil for the year.

The state of North Dakota was selected for this study because traditionally students as a whole score among the highest in the nation on the Scholastic Achievement Test. Second, North Dakota has a relatively homogeneous population that is mostly rural. In fact there are only four major metropolitan areas and the largest city has a population of approximately 70,000 residents. The high scoring of students on the Scholastic Achievement Test and the relative homogeneity of the population of the state seemed to make it an excellent site for the logical extension of the Cash research.

There are 199 high schools in the state ranging in size from 65 to 1200 students. This constituted the population of the study. A response was received from 120 school principals. This represented a 60 percent rate of return of the survey instruments. A follow-up study of the non-respondents indicated there was no difference between the respondent and non-respondent schools, according to geographical distribution, size, and age of school building.

Each school was sent an evaluation instrument and the principal was asked to record the presence or absence of selected building conditions. Each item was worded in such a way that the response would be recorded as either present or absent. The quality of each building item was not included. These conditions ranged from the presence of air conditioning and windows in instructional areas to recency of painting and existence of noisy conditions. Table 10 contains a list of all 29 building condition items used in the study. Each of the items identifying the building condition used in the survey instrument was obtained through analysis of research. In every case, at least one research study had shown the items to be positively related to student learning in the classroom. Building principals were asked to record the presence or absence of these conditions. The result of this evaluation was used to identify a school building in one of three rankings: above standard (top 25 percent), standard (middle 50 percent), or below standard

(bottom 25 percent). In addition, each item was categorized into two categories: cosmetic and structural. The cosmetic items related to how the building looked, such as recent painting, presence of graffiti, and cleanliness. The structural conditions related to parts of the building such as air conditioning, presence of windows, lighting, and condition of lockers. All 29 items constituted the total building condition which was used to compare achievement scores. Thus there were three categories used in the analysis: overall building condition, cosmetic condition, and structural condition. Table 1 shows the number of school buildings in each ranking and category.

Table 1

The Range, Count, and Percentage of Scores in Each Category: Building Condition, Cosmetic Condition, and Structural Condition

| | RANGE | N | % |
|-----------------------------|---------------|----|----|
| BUILDING CONDITION | | | |
| Substandard | 1.846 - 2.2 | 29 | 24 |
| Standard | 2.21 - 2.462 | 64 | 53 |
| Above Standard | 2.463 - 2.92 | 27 | 23 |
| COSMETIC CONDITION | | | |
| Substandard | 1.8 - 2.4 | 26 | 22 |
| Standard | 2.41 - 2.8 | 64 | 53 |
| Above Standard | 2.81 - 3.0 | 30 | 25 |
| STRUCTURAL CONDITION | | | |
| Substandard | 1.5 - 2.063 | 25 | 21 |
| Standard | 2.064 - 2.375 | 71 | 59 |
| Above Standard | 2.376 - 2.938 | 24 | 20 |

Note. The scores indicated in the range column were derived from responses to items in the State Assessment of Facilities in Education (SAFE).

These three rankings of quality of building plus the three condition categories were used to then compare the results of the latest student scores on the CTBS in each building and the number of reported disciplinary incidents.

Results

The comparison of achievement scores was done for each of the three building categories according to the three rankings. Tables 2, 3, and 4 show the results of these comparisons. Table 2 shows the comparison of the 13 different test scores with the ranking of the buildings using all 29 condition items. Table 3 demonstrates the results of the comparison of achievement scores

with those building items listed under the cosmetic condition. Table 4 shows the comparison of test scores with those items under the structural building conditions.

Table 2

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Comprehensive Test of Basic Skills for Grade 11 During School Year 1993-94 and Building Condition Ratings

| Achievement | OVERALL BUILDING CONDITION | | | |
|----------------|----------------------------|----|--------------------------|----|
| | SUBSTANDARD N = 20 | | ABOVE STANDARD N = 24 | |
| | \bar{x} | PR | \bar{x} | PR |
| Reading Vocab | 801.8 | 48 | 807.7 | 55 |
| Reading Comp | 787.4 | 51 | 788.3 | 52 |
| Reading Total | 794.9 | 52 | 798.2 | 55 |
| Spelling | 806.8 | 49 | 815.0 | 58 |
| Language Mech | 779.2 | 53 | 784.9 | 59 |
| Language Exp | 788.8 | 58 | 794.4 | 63 |
| Language Total | 784.6 | 59 | 789.5 | 63 |
| Math Comp | 831.7 | 66 | 832.5 | 67 |
| Math Con & App | 812.6 | 66 | 816.3 | 69 |
| Math Total | 822.5 | 67 | 820.6 | 66 |
| Total Battery | 799.7 | 58 | 804.3 | 63 |
| Science | 800.6 | 59 | 809.1 | 66 |
| Social Studies | 797.4 | 65 | 797.1 | 65 |

Note. Scale score means have been adjusted for socioeconomic status. Percentile ranks have been derived from scale score means which have been adjusted for socioeconomic status.

Table 3

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Comprehensive Test of Basic Skills for Grade 11 During School Year 1993-94 and Cosmetic Building Condition Ratings

| Achievement | COSMETIC BUILDING CONDITION | | | |
|----------------|-----------------------------|----|--------------------------|----|
| | SUBSTANDARD N = 19 | | ABOVE STANDARD N = 23 | |
| | \bar{x} | PR | \bar{x} | PR |
| Reading Vocab | 803.9 | 51 | 810.9 | 58 |
| Reading Comp | 788.2 | 52 | 789.4 | 53 |
| Reading Total | 796.2 | 53 | 800.1 | 57 |
| Spelling | 804.7 | 47 | 815.5 | 58 |
| Language Mech | 785.6 | 59 | 785.5 | 59 |
| Language Exp | 791.7 | 59 | 795.3 | 63 |
| Language Total | 786.6 | 59 | 790.0 | 63 |
| Math Comp | 827.8 | 62 | 836.0 | 70 |
| Math Con & App | 811.3 | 65 | 818.7 | 71 |
| Math Total | 819.5 | 64 | 827.1 | 71 |
| Total Battery | 800.5 | 59 | 805.8 | 66 |
| Science | 803.9 | 61 | 811.4 | 69 |
| Social Studies | 793.0 | 61 | 797.1 | 65 |

Note. Scale score means have been adjusted for socioeconomic status. Percentile ranks have been derived from scale score means which have been adjusted for socioeconomic status.

Table 4

A Comparison of Achievement Scale Score Means and Percentile Ranks on the Subtests of the Comprehensive Test of Basic Skills for Grade 11 During School Year 1993-94 and Structural Building Condition Ratings

| Achievement | STRUCTURAL BUILDING CONDITION | | | |
|----------------|-------------------------------|----|--------------------------|----|
| | SUBSTANDARD N = 13 | | ABOVE STANDARD N = 23 | |
| | \bar{x} | PR | \bar{x} | PR |
| Reading Vocab | 799.0 | 46 | 804.6 | 51 |
| Reading Comp | 786.9 | 49 | 786.9 | 49 |
| Reading Total | 793.5 | 49 | 795.6 | 52 |
| Spelling | 804.9 | 47 | 806.7 | 49 |
| Language Mech | 774.6 | 48 | 782.0 | 56 |
| Language Exp | 785.5 | 54 | 791.5 | 59 |
| Language Total | 781.1 | 54 | 786.4 | 59 |
| Math Comp | 835.5 | 69 | 823.5 | 59 |
| Math Con & App | 815.4 | 68 | 811.3 | 65 |
| Math Total | 826.2 | 70 | 812.7 | 58 |
| Total Battery | 798.9 | 57 | 799.5 | 58 |
| Science | 797.4 | 55 | 804.5 | 62 |
| Social Studies | 797.6 | 65 | 792.0 | 60 |

Note. Scale score means have been adjusted for socioeconomic status. Percentile ranks have been derived from scale score means which have been adjusted for socioeconomic status.

Table 2 shows the comparison between the overall building condition and the thirteen components of the CTBS. In eleven cases the percentile ranks scores of students in the above standard schools were higher than the scores of students in the substandard schools. The difference ranged from one percentile point to nine percentile points. In one test, social studies, there was no difference. The percentile ranks of students in the substandard schools were one percentile point (2 scaled score mean points) higher than those in above standard schools on the total mathematics portion of the test.

A similar comparison was made of the cosmetic condition of the building with the CTBS scores. The results of this comparison are contained in Table 3. There were a total of 13 subsets of the achievement test compared. The students in the above standard school buildings scored higher than those in the substandard buildings on twelve of the subtests. The range of difference between the substandard and above standard buildings on these subtests was from plus 1 to 11 percentile points. There was no difference between the percentile ranks between the substandard schools and above standard schools in Language Mechanics.

Using the structural conditions of buildings as a measure of comparison with achievement scores, the results were not the same as for the overall building and the cosmetic

building conditions. In eight of the subtests, the students in the above standard buildings scored above those in the substandard buildings. In four of the subtests, students in the substandard buildings scored higher. Social studies and mathematics were the areas where these differences were found. The range of difference was from 3 to 12 percentage points.

Using the total test battery as a measure of comparison on all three building categories and condition types, the range of difference was from plus 1 to 7 percentile points. Although not as convincing as similar studies, nevertheless, the preponderance of data shows a difference in student achievement scores between those in above standard building and those in substandard buildings.

Part of the building evaluation asked for the quality of the science laboratories in terms of age and availability of science equipment. Data from this evaluation were compared with science test scores and are presented in Tables 5 and 6.

Table 5

A Comparison of Science Lab Equipment Availability and Science Subtest Scale Score Means and Percentile Ranks on the Comprehensive Test of Basic Skills for Grade 11 During School Year 1993-94

(Survey item 10: Please indicate which utilities or equipment are available and in usable condition in the science labs -- gas, water, sinks, electricity)

| Science Achievement | Lacking at Least One N = 3 | Possessing All N = 92 |
|---------------------|-------------------------------|--------------------------|
| Scale Score Means | 803.1 | 807.4 |
| Percentile Rank | 61 | 65 |

Note. Scale score means have been adjusted for socioeconomic status and percentile rank has been derived from scale score means which have been adjusted for socioeconomic status.

Table 6

A Comparison of Science Lab Equipment Age With Science Subtest Scale Score Means and Percentile Ranks on the Comprehensive Test of Basic Skills for Grade 11 During School Year 1993-94

(Survey item 11: How long ago was science equipment updated to current standards)

| Science Achievement | Updated Over 10 Years Ago N = 39 | Updated Between 5 and 10 Years Ago N = 30 | Updated Fewer Than 5 Years Ago N = 26 |
|---------------------|--|---|---|
| Scale Score Means | 804.5 | 808.1 | 810.6 |
| Percentile Rank | 62 | 66 | 68 |

Note. Scale score means have been adjusted for socioeconomic status and percentile rank has been derived from scale score means which have been adjusted for socioeconomic status.

In both cases, comparing age and availability of equipment, students in those school buildings where there was newer science equipment and all three utilities were available scored from 4 to 6 percentile points higher than students in buildings where such equipment was older or not available.

A comparison of student behavior and the three conditions and rankings of the building was made to explore a possible relationship between the two. These data are contained in Tables 7, 8, and 9.

Table 7

A Comparison of Behavior/Student Ratios and Building Condition Ratings

| Behavior | BUILDING CONDITION | |
|---------------------------|-----------------------|--------------------------|
| | SUBSTANDARD N = 23 | ABOVE STANDARD N = 26 |
| In School Suspensions | 0.0854 | 0.0383 |
| Out of School Suspensions | 0.0377 | 0.0255 |
| Overall Suspensions | 0.1231 | 0.0638 |
| Expulsions | 0.0021 | 0.0003 |
| Violence/Substance Abuse | 0.0436 | 0.0364 |

Note. The behavior/student ratios have been adjusted for socioeconomic status.

Table 8

A Comparison of Behavior/Student Ratios for Schools Grouped by Cosmetic Building Condition Ratings

| Behavior | COSMETIC BUILDING CONDITION | |
|---------------------------|-----------------------------|--------------------------|
| | SUBSTANDARD N = 21 | ABOVE STANDARD N = 27 |
| In School Suspensions | 0.1093 | 0.0433 |
| Out of School Suspensions | 0.0335 | 0.0115 |
| Overall Suspensions | 0.1427 | 0.0539 |
| Expulsions | 0.0025 | 0.0018 |
| Violence/Substance Abuse | 0.0439 | 0.0316 |

Note. The behavior/student ratios have been adjusted for socioeconomic status.

The total number of disciplinary incidents per school was very small in all schools throughout the state. In some cases only one disciplinary incident was recorded for all grades for the entire year. As a result, the comparison figures are extremely small and in some cases meaningless. Nevertheless, students in the above standard buildings recorded fewer disciplinary incidents than those in the substandard buildings when comparisons were made on the overall and cosmetic conditions of the building. When the structural building condition was used as a measure of comparison, however, the results were somewhat different. The results of this analysis are contained in Table 9.

Table 9

A Comparison of Behavior/Student Ratios for Schools Grouped by Structural Building Condition Ratings

| Behavior | STRUCTURAL BUILDING CONDITION | |
|---------------------------|-------------------------------|--------------------------|
| | SUBSTANDARD N = 18 | ABOVE STANDARD N = 24 |
| In School Suspensions | 0.0416 | 0.0521 |
| Out of School Suspensions | 0.0306 | 0.0260 |
| Overall Suspensions | 0.0722 | 0.0782 |
| Expulsions | -0.00007 | 0.0009 |
| Violence/Substance Abuse | 0.0132 | 0.0339 |

Note. The behavior/student ratios have been adjusted for socioeconomic status.

There were more reported disciplinary incidents in above standard buildings than in substandard buildings. This occurrence was only when structural building conditions and the total number of incidents were compared and the range of ratios is very small. No explainable reasons were detected for these findings.

A comparison of the total test battery scale score means on the CTBS and the results of the overall building condition data was made. Table 10 contains the results of this analysis.

Table 10

A Comparison of Total Battery Scale Score Means on the Comprehensive Test of Basic Skills for Grade 11 During the 1993-94 School Year and State Assessment of Facilities in Education (SAFE) Responses for Items 1 through 29

| Item on SAFE | N | SUBSTANDARD | N | ABOVE STANDARD |
|-------------------------|----|-------------|----|----------------|
| 1 Building Age | 11 | 800.6 | 10 | 793.7 |
| 2 Windows | 9 | 802.5 | 74 | 804.4 |
| 3 Floors | 4 | 798.6 | 18 | 800.0 |
| 4 Heat | 16 | 799.5 | 62 | 803.9 |
| 5 Air Conditioning | 69 | 805.6 | 5 | 798.0 |
| 6 Roof | 7 | 802.0 | 61 | 805.4 |
| 7 Adjacent Facility | 62 | 804.3 | 17 | 806.9 |
| 8 Locker Condition | 5 | 802.5 | 75 | 804.0 |
| 9 Ceilings | 9 | 799.7 | 43 | 803.9 |
| 10 Lab Equipment | 3 | 802.0 | 0 | --- |
| 11 Lab age | 39 | 804.3 | 26 | 805.0 |
| 12 Lighting | 4 | 802.9 | 58 | 805.3 |
| 13 Wall Color | 0 | --- | 62 | 803.1 |
| 14 Noise | 2 | 809.2 | 86 | 804.7 |
| 15 Interior Paint | 1 | 800.8 | 90 | 804.4 |
| 16 Interior Paint Cycle | 34 | 802.7 | 57 | 805.2 |
| 17 Exterior Paint | 18 | 804.0 | 56 | 801.8 |
| 18 Exterior Paint Cycle | 54 | 803.4 | 31 | 804.9 |
| 19 Swept | 0 | --- | 93 | 804.3 |
| 20 Mopped | 7 | 794.0 | 69 | 804.5 |
| 21 Graffiti | 1 | 805.4 | 67 | 805.7 |
| 22 Graffiti Removal | 0 | --- | 89 | 804.6 |
| 23 Desks | 0 | --- | 44 | 805.4 |
| 24 Grounds | 4 | 791.8 | 39 | 801.8 |
| 25 Cosmetic Opinion | 8 | 802.2 | 55 | 804.9 |
| 26 Structural Opinion | 5 | 799.9 | 50 | 805.4 |
| 27 Overall Opinion | 7 | 799.1 | 54 | 804.6 |
| 28 Gross SP (Density) | 5 | 800.5 | 62 | 805.8 |
| 29 Acreage | 67 | 804.4 | 4 | 802.5 |

Note. Complete questions can be found in Appendix.

In eighteen categories, scores of students in the above standard school buildings were higher than those of students in substandard buildings. In five of the categories, the scores of students in substandard buildings were higher than those in above standard buildings. This analysis does not provide any discernible pattern among those items where the scores of students in the substandard buildings were higher. These scores might well have been simply an anomaly. Those items were: building age, air conditioning, noise, exterior painting, and acreage in the site. Age of building, air conditioning in the classroom, and noise are building conditions that are important to student learning, and in the previous analyses, these conditions were positively related to higher scores in above standard buildings.

Discussion

The results of this study support previous studies dealing with student achievement and behavior and the condition of school buildings. The results in this study were perhaps not as strong as in other studies; nevertheless, the body of data supporting this theoretical construct is growing. There is nothing in the teaching methodology or learning processes of social studies that would suggest that discipline is impervious to the condition of the environment. Speculation could only suggest that teaching and learning in the field of social studies is effective in all situations.

The comparisons in this study were not as strong as those found in the studies done by both Edwards and Cash. Nevertheless, the findings continue to provide support for the conclusions reached by these researchers that there is a relationship between the condition of a school building and the performance of students on achievement tests. The present research effort is the fourth iteration of basically the same research design of comparing student achievement and behavior and the condition of the building. The Cash study investigated small high schools in one state, Edwards investigated elementary schools in a large metropolitan city, a third effort currently under way includes data from large high schools. Perhaps this line of research has reached a plateau where further studies of this research design are redundant and a new research design must be developed. Sufficient data exists to state that the condition of a building does result in a difference in student scores and actions, but new data, resulting from an investigation using a different research design, are now needed to properly address this concern.

The results of the comparison of behavior incidents and building condition were different from what Cash (1993) found. In all comparisons, she found there were more reported incidents in above standard schools than in substandard schools. This led her to believe there was a reverse ratio between these two variables. In the comparison between the structural conditions of a building and the reported disciplinary incidents, the above standard schools reported more incidents. This supports the findings of Cash. Nevertheless, the findings seem to indicate that

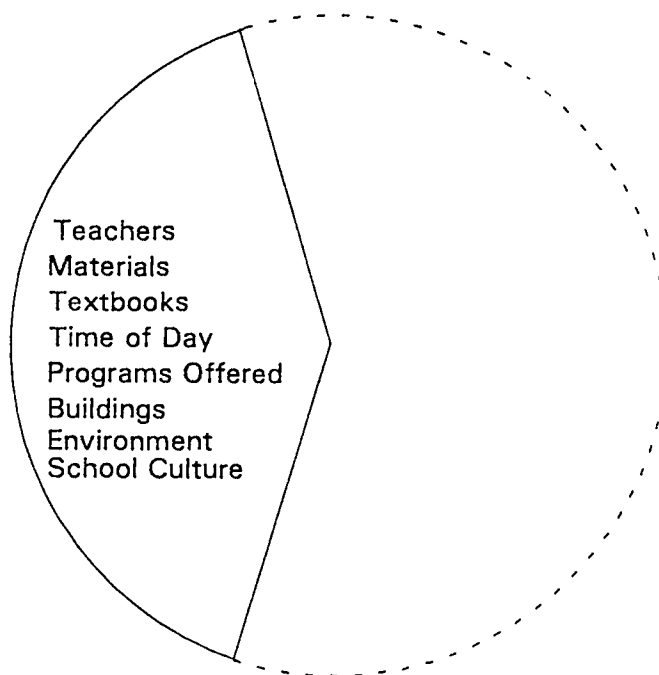
further research in the area of student behavior and building condition is warranted. A closely designed study of disciplinary incidents and school climate compared to building condition would shed some additional light on that relationship. There are several research designs that could be used in such an investigation and there are numerous sites where fruitful research would result.

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July 11, 1995

Test Score Variables



Contributions to Student Achievement

