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The Relationship between the Physical Characteristics of Classroom Settings and Lower Elementary Students' On-task Behavior*

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ABSTRACT

This study investigated the relationship between physical characteristics of classroom settings (i.e., classroom density, noise, seating position, windows, temperature, wall attachments, ceiling attachments, and lighting) and on-task behavior of 60 students in 20 Mid-west elementary classrooms. Results indicate that specific physical characteristics of the classroom have value in predicting on-task behavior. Findings indicate that ceiling attachments are the single most useful predictor of on-task behavior and that children do not habituate to their environments over time as was previously believed.

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Introduction

One of the goals of education is to teach children what they need to know and to meet parents' and society's expectations as well as meet governmental mandates for learning (Unger, 1996). Educators measure these expectations with tests of achievement that indicate to some level and degree how much a child is learning. Achievement is not only a goal within education; it is also a way in which an individual validates his or her competence within a society (Lesgold & Glaser, 1989). Thus, achievement is deemed desirable from social, educational, and individual perspectives.

The physical classroom (environment) has been shown to either directly or indirectly, influence academic achievement (Jason & Kuchay, 1985; Short & Short, 1988). On-task behavior, or the ability to stay engaged in the classroom task, has been positively related with academic achievement (Capie & Tobin, 1981; Gettinger & Fayne, 1982; Rosenshine, 1977). There is, however, much in the way of classroom environment that detracts from a student's ability to remain on-task. Physical classroom characteristics have been shown to predict on-task behavior (Bronzaft & McCarthy, 1975; Krantz & Risley, 1972; Santrock, 1976; Schwebel & Cherlin, 1972; Zifferblatt, 1972) both positively and negatively. The physical characteristics, collectively or individually, may relate to children's on-task behavior that is positively correlated with achievement (Capie & Tobin, 1981; Gettinger & Fayne, 1982; Rosenshine, 1977).

Classroom characteristics may be identified as seating position, classroom density, noise, window space, temperature, room lighting, wall attachments, and ceiling attachments. Historically, when density has increased, children have been shown to be less attentive, more aggressive, and more nervous (Hutt & Vaizey, 1966; Krantz & Risley, 1972). Noise levels have shown similar results in that as classroom noise grew, children scored lower on reading tests (Bronzaft & McCarthy, 1975). Seating position (i.e., students sitting in the front rows) has been shown to increase on-task behavior (Schwebel & Cherlin, 1972). The presence of windows, on the other hand, has not historically been shown to influence achievement (Larson, 1965; Tognoli, 1973). Temperature and lighting have both been shown to affect task performance. Most learners do their best work with an optimal balance of lighting and/or temperature (American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1966-1967; Knirk, 1970; Pepler & Warner, 1968). Still

other research (Dunn, 1983; McNall & Nevins, 1967) has shown that the difficulty of the task being performed has changed only slightly with the optimum amounts of heat and lighting.

Research to date, (Bronzaft & McCarthy, 1975; Krantz & Risley, 1972; Santrock, 1976; Schwebel & Cherlin, 1972; Zifferblatt, 1972), has demonstrated that by measuring physical characteristics and on-task behavior in a classroom, it is possible to discern how such characteristics, collectively as well as individually, interact with on-task behavior. The literature on physical characteristics of the classroom in relation to on-task behavior is too limited and dated, most studies having been conducted in the 1960's, 1970's and 1980's. Only one recent study, Cheng (1994), was found taking place in Hong Kong. The recommendations based on the findings of Cheng suggested that the physical environment of the classroom required needed changes to affect achievement. This study, however, did not address what the needed changes were in the physical environment that would affect achievement. Similarly, Weinstein (1979) mentioned that minimum standards should be established for lighting, heating, and noise, but noted that no agreed upon standards could be found in the literature.

To date, no research regarding the effects of ceiling or wall attachments, two variables that fit well within classroom physical characteristics, has been undertaken. In addition, it is possible that children also may habituate to their surroundings, and that classroom physical characteristics, when viewed over time, may have little or no effect on childre'n on-task behavior. Although Weinstein (1979) recommended further research in this area, a review of the literature found no additional studies. Finally, although the aforementioned studies have indeed addressed the physical environment of older children in high school and college settings, little has been done to explicate the physical classroom environments of grades four through six (Bates, 1973; Holliman & Anderson, 1986; Koneya, 1976; Pepler & Warner, 1968; Tognoli, 1973). Classrooms of today, while looking very much like classrooms of the past, have changed given the amenities required for both comfortable and informative surroundings.

The goals of this study are fourfold. First, given the dated information in the literature, the present study was undertaken to provide a current illustration concerning

the physical characteristics (classroom density, noise, seating position, windows, temperature, wall attachments, ceiling attachments, and lighting of the classroom) and how these characteristics relate to on-task behavior. In this way, the findings of the present study would be used to validate previous findings regarding classroom characteristics affecting on-task behavior. Secondly, this study was designed to evaluate which of those characteristics predict on-task behavior the most, and if children habituate over time to any or all of the defined physical classroom characteristics. Thirdly, no research regarding the effects of ceiling or wall attachments, two additional variables of classroom physical characteristics has been undertaken. Thus, the current study would add to the existing literature regarding classroom characteristics that might also interfere with on-task behavior. Lastly, because little has been done to describe the physical classroom environments of lower elementary grades, the current study in its focus of such grade levels, would add to the existing literature regarding classroom characteristics that might affect on-task behavior of lower elementary grade students. Such results, if supported, could add further clarity regarding characteristics associated with classroom environments, allowing improved predictions of academic achievement to be made in relationship to on-task behavior. Moreover, such results may provide teachers with a more comprehensive plan for setting up the physical setting of their classrooms so as to maximize their students' achievement potential.

Method

Participants

The sample for this study was comprised of 60 children from fourth-grade through sixth-grade classrooms in a Mid-west state. A total of 60 participants were used to approximate the requirement that there be 10 participants for each independent variable in a multiple regression analysis (Neter, Wasserman, & Kutner, 1990). The independent variables are seating position, classroom density, noise, window space, temperature, room lighting, wall attachments, and ceiling attachments. Superintendents of schools within a 150 mile radius of the capital of a Mid-west state were sent a request seeking participation and consent. Those superintendents intending to participate were asked to return the

consent form within two weeks. Superintendents not replying within two weeks were contacted by phone to confirm the status of their participation. Once the superintendent confirmed a district's participation within the study, additional consent forms were sent to the principals and teachers of those schools volunteering to participate.

For equal representation of both urban and rural schools, 20 classrooms were systematically selected (Gall, Gall, & Borg, 2003). Three occupied seats were randomly selected from each classroom, to obtain a measure of on-task behavior through observing the children in the selected seats. Two additional seat locations were selected as alternates should one or two of the first three seats chosen not be occupied at the time of the behavioral observations.

Instrument

The instrument used to gather data for this study was an adaptation, by the researchers, of the Observation of On-Task Behavior Form developed by Wilson (1987) for teachers. This form provided the researchers with a format to record on-task behaviors in the classroom over a short period of time. For the purpose of this study, on-task behavior was operationally defined as students appropriately attending to the teacher or the instructional object being used at the time (Wilson, 1987).

A 60-minute time schedule was developed and broken down into six 10 minute intervals. The first child was observed for the first and fourth time interval. The second child was observed for the second and fifth time interval, and the third child was observed for the third and sixth time interval. Point-time interval sampling was used to record the children's on-task behavior (Sattler, 2002). Each 10-minute interval was broken down into 20 to 30 second intervals. Each child was observed in the first 10 seconds of each of the 20 to 30 second intervals. If the child was on-task for the entire 10 seconds, the observer noted this on the form. Conversely, if the child was not on-task for the entire 10-second interval, this was also noted. Dividing the total number of on-task observations by the total number of observations, then multiplying this number by 100 calculated a total on-task behavior percentage for each child.

The following eight variables were measured by the researchers: (a) seating position, (b) density, (c) noise, (d) classroom windows, (e) temperature, (f) lighting, (g) wall attachments, and (h) ceiling attachments. Seating position was measured by finding the average distance in inches of the child from the teacher. The researchers then create map of each classroom including the main structures such as furniture, students' desks, and the teacher's desk. The observer was given the map of the classroom being observed prior to the observation period. The observer estimated the teacher's position in the classroom six times during a 60 minute observation and marked that position on the map of the given classroom. The observer then measured the distances at times when the class was not in session. The six measures were averaged to form the seating position measure. This and all other distances and area measures were recorded in inches with a standard tape measure.

Density was measured as the total amount of square inches of classroom space, minus the total amount of furniture space, divided by the total number of people in the classroom. This and all other classroom measurements were made prior to the observation period.

Noise was measured by a microphone with a sound level meter for the average number of decibels present (Harris, 1957). The observer measured the amount of noise present in the classroom six times during the class period at intervals of 10 minutes (i.e., at 2, 12, 22, 32, 42, and 52 minutes). A mean was calculated from the six measures.

In the present study, classroom window space was specifically defined as the unobstructed view of the outside and was measured in square inches of window space in the classroom divided by the total area of wall space. In the Tognoli (1973) and Demo's (1965) research, window space was defined and measured as the number of classroom windows and total window space. Thus, the differentiation between the current study and previous research is the specification of window space as an unobstructed view.

The temperature was measured in degrees Celsius using a thermometer. Six readings were taken during the 60 minute observation period. A mean was calculated from the six measures. The lighting measure was made in candle feet using a light meter. Six readings

were taken during the 60 minute observation period. A mean was calculated from the six measures.

The wall attachments were measured as the total square inches of attachment space divided by the total square inches of wall space. Finally, ceiling attachments were measured as the total square inches of ceiling attachment space divided by the total square inches of ceiling space.

Procedure

Before the study began, one research assistant was selected and trained regarding data collection and trained in the recognition of on-task behavior by the researcher. In an effort to reduce observer effects on the collection of data, the trained research assistant/ observer was not made aware of the nature of the study until after it was completed.

Each classroom that participated was assigned an identification number so anonymity of selected classrooms and classroom teachers was maintained. Individual classroom maps were developed with students' desks assigned identification numbers. Three seats were then randomly selected, using a table of random numbers, for each participating classroom. The children in the selected seats were the children to be observed. Two additional seats were randomly chosen as forth and fifth choices in the event that a chair was unoccupied at the time observations were completed. Observations, continued for 60 minutes for the three children in each of the selected classrooms by observing from the least obtrusive location that was in the rear of the classroom. Sixty students were observed in this process.

Before data were collected, an agreement was made with each teacher that they keep their room arrangements and decorations the same for three weeks. Because of the need to control for habituation, the first data collection took place the day after a classroom was redecorated. For example, data were collected after the teacher had redecorated for Halloween, Thanksgiving, Christmas, Easter, or the beginning of the school year. Data were then collected again, in identical fashion as described, three weeks after the first data collection.

Results

Descriptive statistics are presented in Table 1. Means and standard deviations for all physical classroom characteristic variables as well as on-task behavior are shown for both the first and second observations. All means are expressed in the units of measure as described in the definition of terms section.

Table 1 Means and Standard Deviations for Physical Classroom Characteristics and On-Task Behavior (N = 60)

Characteristic	1st Observation		2nd Observation	
	M	SD	M	SD
Seating Position (inches)	118.792	26.171	123.484	33.011
ensity (inches)	3564.64	1607.714	3903.380	2522.323
Noise (decibels)	62.223	3.230	62.275	3.508
Window Space (percent)	.082	.058	.082	.058
Temperature (Celsius)	21.108	.926	21.117	.997
Room Lighting (foot candles)	62.250	17.883	70.250	30.886
Wall Attachments (percents)	.397	.159	.397	.159
Ceiling Attachments (percents)	.126	.061	.126	.061
On-Task Behavior (percent)	.857	.100	.832	.113

A multiple regression analysis was conducted to determine which physical characteristics of the classroom setting in the first and second observations were most likely to predict on-task behavior. The results are presented in Table 2. The multiple regression analyses for the first observation yielded five significant variables related to on-task behavior: wall attachments, ceiling attachments, window space, temperature and room lighting. The adjusted R^2 = .486 was statistically significant, $p < .05$. The multiple regression analyses for the second observation yielded four significant variables related to on-task behavior: wall attachments, ceiling attachments, window space, and temperature. The adjusted R^2 = .356 was statistically significant, $p < .05$.

Table 2 Summary of Multiple Regression Analysis for Variables Predicting On-Task Behavior for Observation 1 and for Observation 2 (N = 60)

Characteristic	B	SE B	β
Step 1			
Seating position	-.00086	.00	-.23
	(-.00037)	(.00)	(-.09)
Student density	-.000012	.00	-.20
	(-.00000040)	(.00)	(.009)
Classroom noise	-.0035	.004	-.12
	(-.0033)	(.004)	(-.10)
Windows	.91	.27	.53*
	(1.15)	(.22)	(.58*)
Temperature	.032	.013	.30*
	(.048)	(.02)	(.42*)
Room light	.0019	.001	.36*
	(.00056)	(.001)	(.15)
Wall attachments	.20	.09	.33*
	(.29)	(.09)	(.41*)
Ceiling attachments	-1.01	.22	.63*
	(-1.18)	(.22)	(.63*)

Note. Observation 2 is presented in parenthesis under observation 1 results.

*p < .05.

The intercorrelation among variables is provided in Table 3. Both first and second observations are presented with second observations in parentheses.

Table 3 Pearson Product-Moment Correlation Coefficients Among Classroom Characteristics and On-Task Behavior (N = 60)

	OTB	L	T	SP	N	D	WS	CA
WA	-.15	-.13	.28*	.46**	-.08	-.35**	-.28*	.54*
	(-.01)	(-.15)	(.26*)	(-.02)	(-.03)	(-.23)	(-.28*)	(.54**)
CA	-.43**	.02	.26*	.23	-.24	-.15	-.12	
	(-.31*)	(-.02)	(.33**)	(-.21)	(-.03)	(-.10)	(-.12)	
WS	.23	-.37**	-.43**	-.22	.31*	.17		
	(.36**)	(.05)	(-.42**)	(.29*)	(-.19)	(.20)		
D	.01	.31*	-.13	-.21	-.18			
	(.28*)	(.68**)	(.08)	(-.09)	(-.38**)			
N	.18	.10	-.18	.04				
	(-.27*)	(-.36**)	(-.06)	(-.14)				
SP	-.32*	-.24	.23					
	(-.09)	(-.32*)	(-.55**)					
T	.03	.10						
	(.18)	(.25)						
L	.12							
	(.31*)							

Note. WA - Wall Attachments, CA - Ceiling Attachments, WS - Window Space D - Density, N - Noise, SP - Seating Position, T - Temperature, L - Lighting, OTB - On-Task Behavior. Observation 2 is presented in parenthesis under observation 1.

* $p < .05$, ** $p < .01$

Discussion

In the current study, there were four questions to be answered. The first question had to do with providing a current illustration concerning the physical characteristics of the classroom and how these characteristics relate to on-task behavior. Seating position was measured in a manner that was not found previously in literature. The average distance from the teacher over a period of time was used as the seating position measure. The distances of 9.8 feet and 10.3 feet for the first and second observations respectively do not relay the complete picture of the data. Unlike the classrooms in Koneya (1976), Holliman and Anderson (1986), Bates (1973), Delefes and Jackson (1972), and Schwebel and Cherlin's (1972) studies, in the present study, teachers moved around the classrooms continuously. That movement was taken into consideration and did not appear to significantly account for any variance in on-task behavior as Weinstein (1979) predicted that it might.

Student density also did not appear to significantly account for the variance in on-task behavior similar to that in Holliman and Anderson's (1986) study. The densities of the classrooms observed showed high variability and still produced nonsignificant results that might be accounted for by an additional variable such as teacher characteristics not measured in this study.

The relationship between noise and on-task behavior was insignificant, which would support both Slater (1968) and Weinstein and Weinstein's (1979) studies. One of the other studies (Bronzaft & McCarthy, 1975) reviewed, had high variability in noise which did produce differing reading scores. Noise in the current study remained at a relatively constant level of 62.2 decibels for both observations with little variance, which would fit into the average noise condition in Slater's (1968) study. Thus, it is not surprising that noise did not significantly account for any change in on-task behavior.

The variance accounted for by window space with respect to on-task behavior was significant which was inconsistent with both the Tognoli (1973) and Demos' (1965) studies. This may be accounted for in the differentiation of how window space was measured in the current study. Historically, window space was defined and measured as the number of classroom windows and total window space. In the present study, classroom window space was specifically defined as the unobstructed view of the outside.

Findings related to temperature did significantly account for variance with on-task behavior. The mean temperature of 21.1 degrees Celsius or 70 degrees Fahrenheit was very constant across classrooms and observations. This temperature is very close to the American Society of Heating, Refrigerating and Air Conditioning Engineer's (1966-1967) optimum temperature of 72 degrees Fahrenheit and Robert McCardell's (University of Iowa Center for Research in School Administration, n.d.) optimum temperature of 70 to 74 degrees Fahrenheit. The little variability in temperature did appear to relate to on-task behavior in that as temperature increased, so did on-task behavior. These findings are similar to findings by Hedge (2004) in that office workers were more productive when the room temperature increased from 68 degrees to 77 degrees farenheit, suggesting that temperature may be an important element in performance.

The amount of lighting in the classroom in relation to on-task behavior was significant in the first observation but not in the second observation. The mean lighting was 62.3 candle feet and 70.3 candle feet for the first and second observations respectively with a great deal of variance. These mean illuminations in candle feet, candle power, approach a warning level of too bright according to Knirk (1970), yet was not consistently significant in both observations with on-task behavior. Lighting may indeed be individualistic to the specific task in the classroom (Dunn, 1983).

Wall attachments and ceiling attachments, which have not historically been studied, both related to on-task behavior but in different directions as indicated by the non-standardized regression coefficients (B's) shown in Table 2 (i.e., given that, in each case, the other seven predictors are already in the regression equation). It appears that the more wall attachments in a classroom, the higher the on-task behavior. One possible explanation is that individuals become familiar with the wall attachments and it no longer takes their attention away from what is being presented in the classroom. Wall attachments are a more common fixture not only in classrooms but also in homes and businesses and therefore are not unique.

Ceiling attachments had the opposite effect of wall attachments in that the lower the number of ceiling attachments a class had, the higher the on-task behavior. One

possible explanation is that ceiling attachments are more unique in that they are not found to the same degree in homes and businesses and may take attention away in the classroom.

This study was also designed to evaluate characteristics to which students may habituate over time. The only variable that may have led to habituation was room lighting. This variable significantly accounted for some degree of on-task behavior in the first observation but was not significant in the second observation, which may be a result of students habituating to the room lighting.

The third question to be answered by this study involved two new variables of classroom characteristics that have not been studied previously: wall attachments and ceiling attachments. Both of these classroom characteristics were significantly related to on-task behavior. Interestingly, the more wall attachments, the more on-task behavior but the more ceiling attachments, the less on-task behavior. Clearly both of these classroom characteristics, which have previously been neglected in the literature do appear to impact on-task behavior. Ceiling attachments were shown to be at a significant enough level to be a useful predictor of on-task versus off-task behavior.

The last question to be addressed in the current study is the relationship between the classroom characteristics as a whole and on-task behavior. Multiple regression analysis showed that 49 percent for the first observation and 36 percent for the second observation of the variance in on-task behavior could be explained by the physical classroom characteristics. Both of these are significant results. Thus, if the researcher knows the measurements of the physical classroom characteristics, the researcher can explain 49 to 36 percent of the variance in on-task behavior. Physical classroom characteristics do relate significantly to children's on-task behavior.

Conclusion

The current study presented the relationship between physical classroom characteristics and on-task behaviors collectively and individually specific to each characteristic. The research found that window space, temperature, and the two new research variables, wall attachments and ceiling attachments were significantly predictive of on-task behavior. Regarding habituation, this study found the characteristic of room

lighting only, to show evidence of students adapting to their classroom characteristics relative to on-task behavior. This becomes an important finding because it implies that the physical classroom environment throughout the school year and not the physical classroom environment at any one single point in time influences children. The overall physical classroom characteristics did explain 49 and 36 percent of the variance in on-task behavior over two observations. Thus, the physical classroom does have value in predicting on-task behavior, therefore as stated by Capie and Tobin (1981), Gettinger and Fayne (1982) and Rosenshine (1977), this study may also support that on-task behavior is positively related to academic achievement. Finally, if the physical classroom characteristics influence on-task behavior then it would seem that classroom characteristics could also relate to academic achievement.

Implications

This research supports prior findings in that on-task behavior influences academic achievement yet it does not clarify which specific physical characteristics positively impact academic achievement. Further research should be focused on exploring the relationship between specific physical classroom characteristics and academic achievement.

More questions were also raised with the two new characteristics, wall attachments and ceiling attachments. Since the type of wall attachment and ceiling attachment was not measured, the researchers have no knowledge of whether the type of attachment may impact on-task behavior (e.g., ceiling attachments could have been posters or attachments that dangle). In addition, the length of time the attachments had been in place prior to the first observation was not measured and may impact on-task behavior. Therefore, further research is suggested specific to habituation in that students may have already habituated to the attachments prior to the observations.

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