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ABSTRACT

The learning environment and its interrelationship with educational policies and the coordinated planning and design of schools and their facilities are discussed in the light of the human organism or student. The problems and hazards of present learning environments are reviewed in conjunction with environmental control and its influence on school plant quality. Environmental criteria are included for the effects of the thermal, acoustic, and luminous environments on the learning process. Classroom space and flexible utilization are also discussed with regard to efficient and effective learning. Bibliographic citations are included. (TG)

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PLANNING THE LEARNING ENVIRONMENT

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A PROBLEM TODAY IS TO PROVIDE THE DESIGN OF THE LEARNING ENVIRONMENT THAT WILL BETTER SATISFY THE NEED FOR GREATER LEARNING.

New school physical plants are being constructed and existing buildings are being remodeled and modified at an unprecedented rate to provide more and much different settings in which the needs of the educational programs can be better accommodated. Because of the rising costs of construction, primarily due to labor wages, and the rapid increase of total school expenditures, much of which is chargeable to salaries, school monies available which come mostly from tax sources, are a factor which could limit the design of school plants to the point where the building utilization plan would move toward a position of jeopardy. If this is not true generally, it is at least a local school district problem. This problem can create a setting which causes added deterents to the educational progress which should be taking place in the new environments being designed for meeting emerging educational needs.

The student's learning is vitally influenced by his physical surround. It is often said that in every class space there are two teachers, the human teacher who plans and implements the child's educational experience, and that combination of physical forces and forms from which the student derives other kinds of learnings. These physical forces and forms set into action the student's biological behaviors from which he derives most social and much personal learning.[1] His ability to learn is governed more by the external factors than by the internal or inherent factors of his make-up. This suggests that improved facilities for learning in terms of visual accommodation, aural intensities,

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[1] Harmon, D. B. The Coordinated Classroom. American Seating Company. Grand Rapids 2, Michigan. 1950.

and thermal comfort will increase the learning functions. A crude paraphrase of the Winston Churchill remark is that our structures do more to direct our way of thinking, than our thinking does to change our structures.

THE HAZARDS THAT EXIST IN TODAY'S LEARNING ENVIRONMENT TEND TO DETER EFFICIENT AND EFFECTIVE LEARNING.

"The human organism strives to grow, develop, and function as an integrated whole. In each of its responses to the forces or restraints in its environment which stimulate it, it performs organically by seeking physical balances with those forces and restraints ..." The work environment of the immature organism (the student) must be equally co-ordinated with the organism itself, if we would have the child arrive at an optimum maturity fully capable of using its resources and developmental experiences in meeting its needs ..."[1] Four of the forces or restraints that are of immediate concern in school design and more particularly in the continued operation of the school include school layout as it affects size and use of spaces as well as movement within the total building, the thermal conditions within the spaces particularly as the users and the equipment being used changes, auditory stresses that generate when the noise level of the study space is increased, if only by adding other students to the room, and visual considerations in terms of light and color conditions. Each of these conditions can have a striking effect on the users of the space particularly if there is some predisposed feeling involved on the part of the various users.

During his study of the relationship between school planning procedures and the quality of the resultant schools one of Campbell's[2] conclusions was that there is a negative relationship between the comprehensiveness of planning and juror evaluations of plant quality. More important, however, was another conclusion that the more teachers participated in the planning process, the greater was their satisfaction with the resultant facilities. In a school district that has a stable teaching staff, this could be used effectively, but most school districts in Wisconsin, and presumably also in other states, are small with relatively high rates of turn-over. In Madison, the replacement rate is currently about 25% annually, and it is perhaps about the same in other larger cities. This takes on greater import as the study points out that the responses by the teachers revealed that the most serious deficiencies in the new school plant pertained to the lack of flexibility to meet the needs of emerging educational practices and to the inadequate control of the light, heat and sound factors.

The effective use of the school plant is often discussed in relation to program changes, and the impact on the school. The lack of flexibility recorded in the Campbell study is reaffirmed in much of the related literature.[3] It is felt that as programs change, the educational adequacy of school plants decreases significantly, more so in older buildings, less in newer buildings. This is often related to the subjective feeling by the respondents that classroom space is too small or that there are inadequate facilities for the desired open labs, or that it is difficult to move from place to place in the school plant.

Falacies exist too as educationists claim greater flexibility as they eliminate load bearing partitions or reduce corridor space. This may well be defensible for future space changes but often in present usage these provisions in fact create greater passage space (i.e. Barrington, Illinois Middle School has two peripheral corridors where a single double loaded corridor could suffice), or intolerable sound conditions (i.e. McArthur Elementary at Livonia, Michigan, has no corridor-classroom wall and the circulation noise is great), or other created problems whether recognized or not. With each of these hazards/forces/restraints, the organism (the student) has to readjust to make commensurate physiological and emotional accommodations. Probably more conspicuous is the readjustment of the physical balance of the body to the environment.

What often is not pointed out by the respondents to questionnaires is the way they administer the facilities provided. Adequate heat control for the design capacity of a given space but where severe overcrowding in relation to design capacity is scheduled can cause disenchantment by the users be they teachers or students. Similarly, the expectation that study spaces can be cool and comfortable during 85 degree and warmer weather is unrealistic unless refrigeration of the air is available. Seldom is lack of heat in the winter an expressed concern. Each problem causes the student to react in seeking a balance with the force or restraint causing the problem.

Considering this seems to contradict in part at least, the conclusions of Akerman,[4] "Elements involved in the thermally related environment are not physical phenomena which can be used in communication as can light or sound. It is not surprising therefore that there is very little evidence that the thermally related environment has any effect on the learning process so long as the human body is in the neutral (comfort) zone of heat regulation. However, he further concludes that, "no research P4
has been done on the effects of learning when the environment is either so hot or so cold that a substantial amount of physiological stress results. It seems reasonable to believe that such conditions must have an effect on the learning process." If this be true, why consider heating the outdoor space? How gross must the force be, before the organism seeks to balance the forces of the body with those of the immediate and physical surround?

A third of the hazards being considered is that of sound control or more properly of acoustical environment. There is a trend in recently constructed school buildings in the United States to design interior spaces which are more open. In the search for relationships between the teaching/learning functions and the educational space in which the function can be accomplished, promoters of current teaching methods request more loft type or open space where partitions are not as frequently used to isolate one space from another. A major problem presented by this trend is the design and treatment of the acoustical surround that will stimulate the learning process.

Although it was not the first attempt at open-space planning for public schools, the Dilworth School in San Jose, California,[5] is perhaps the turning point in this concept's wide-spread use. The large open areas have full acoustical treatment of the ceilings, with dropped panels to roll back some sound and to also act as sound carriers for the teacher who locates herself immediately below the hard surface. Wall treatment and carpeting complete the treatment. The hazard may be in the plan itself, in the adjustments the users (students) have to make to successfully carry on their responsibilities of learning, or the adjustments the users (teachers) have to make with respect to their teaching. An almost identical plan developed by the Madison district using constant laison with school personnel produced complete failure. Within the first year such severe opposition developed that folding partitions were added to the big-room. The stated problem by the users was the inability of the acoustical design to cope with the sound generated with the space. P5

In a similar manner the sound generated in any space must be able to get to where it can be used. Because of the tight squeeze on money, some architects point to the use of low-ceiling, intimate school performance areas, while excluding the need for larger performance areas. They suggest the flyloft and procenium arch can easily be eliminated, that ceilings can be lowered, that sloped floors are not needed. For some functions this is true but some kinds of performances, some kinds of sound need distance and volume to be effective.

Writing in the Nation's Schools, McKay[6] asks if functional items are sometimes mislabelled luxuries. Contradicting Caudill et al, McKay writes, "room volume and height is vital to reverberation. Auditoriums 90 feet deep require 25 feet or more of ceiling height." Can some of these contradictions develop with respect to classroom design? It appears one hazard to good acoustical design might be money restrictions. A more disasterous hazard might easily be the restrictions the student must adjust to as a result of less than desirable design which in turn produces exaggerated forces to be accommodated. Many reported studies such as Jerison's[7] indicate noise conditions lower performance levels, that the effect of noise resembles the effect of fatigue both in kind and in that it appears during that type of task where fatigue effects are expected to appear, and that noise effects to exist apart from fatigue effects.

Finally, the hazards of light control and visual adjustment are probably those that have received great study by school people perhaps because most anyone can walk through an area with a light meter, and administer tests of various kinds to measure student behavior be it physical or mental. Harmon's[8] early studies (1945) indicate "there appears to be a relationship between the seating location in the classroom and the child's health. There appears to be improved well-being when the visual environment is designed to reduce glare and improve illuminating levels." Turner and Brainerd[9] attempted to view the brightness and brightness contrast in classrooms as seen through the eyes of a student and to show the effects of these variables due to modernization. Their general conclusions included the ideas that it is extremely difficult to obtain adequate light distribution from natural light alone and unless natural light is well controlled it may become a source of serious glare. They also concluded that light colored chalkboards reduce brightness contrasts without introducing visual discomfort. More recently researchers have reaffirmed the concern for control of light, color and glare but have added that women and firls seem to be less sensitive to glare than do men.

Considering the limited examples as illustrative of the hazards that must be considered in planning todays learning environment and recognizing that the human organism strives for balance as it meets these variety of forces and restraints, it appears one of the plant planners primary and constant concerns must be to, first, identify the functions that are going to be carried out in a given space, and then plan the most desirable environment possible to accommodate the functions. This, with the fewest possible hazards that will cause the student to divert energy to seeking a reasonable organic balance, allowing most energy to be directed to the learning tasks.

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THE PLANNING OF STUDY SPACES TO PROVIDE GREATER INHERENT BALANCE BETWEEN DETERENT FORCES AND THE HUMAN ORGANISM WILL TEND TO PROMOTE MORE EFFICIENT AND EFFECTIVE LEARNING BY THE ORGANISM (THE STUDENT).

Of the studies undertaken to compare desirable school building characteristics, many take the position of discussing what functional areas are being included in schools judged good by juror evaluators. It is important to provide certain physical facilities and services to serve students, teachers and other users? Does the environmental design make a difference in instructional practices of the users? Does the design make a difference in the utilization of educational space?

In 1960 the Association of School Business Officials undertook a study which summarized the functional areas of the modern school building and included such areas as those for counseling services, student social centers, teacher-planning areas, and even school air-conditioning. The University of Kentucky, like many other institutions published a "Guide" in 1964 to measure the good school and included discussions of projecting enrollments, plant balance vs. capacity, inventorying the plant facilities, and other items. The West Virginia Department of Education did much the same thing in its "Handbook" but stressed sanitary facilities, electric services, audio and visual needs, and program facilities. These reports, typical of those on the shelves of most school planning/building divisions differ somewhat from the kind that is typlified by studying relationships of instructional practices to design.

The later kind of report would be illustrated by the study of Kyzar[1] in 1962 at the University of Texas. Within the limitations of the classrooms studied, Kyzar concluded that (1) in five of the seven components of instruction observed, differences were found favoring the "open plan" design schools. These data may be indicative of more desirable instructional practices. There is some questions as to the extent to which the building design was totally responsible for these differences, (2) the design of classrooms does not appear to affect the utilization of activities in the instructional program. These data might indicate that the curriculum practices of the schools under study did not require spaces other than the classroom, (3) classroom design in the schools studied did not appear to influence the utilization of classroom floor or display area. While the design of the classroom may be altered, there is little evidence to support the hypothesis that teachers will change their perceptions of space. On the contrary, while adjustments may be made, practices might not be changed at all. If not confirming the forgoing conclusions, at least supporting them is this statement from the NCSC Guide,[2] about general purpose (interchangeable) classrooms, "Sometimes pupils are in small groups, on other occasions the group meets as a whole in traditional single-row arrangement, or a U-shape or some other design to the teacher's liking."

To respond in part to the initial questions, it appears that statistically based research does not support the idea that design will affect a difference in utilization, but it is also important to recognize that regardless of the statistics, Mr. Churchill may have been more right than we care to admit. Throughout time users have said the shortcomings of the schools are in the building, it is not the teaching, nor is it the learning process that cause the problems, it is rather the lack of convenient arrangement, the lack of control of heat or sound or light.

In the chapter on "Environment Educates" in the AASA Planning America's School Buildings, it is written that, "The school environment may be likened to conditions conducive to growth of a flowering plant in the garden. (If the conditions are good) the plant will be healthy, growth will be vigorous, (the crop) will be abundant. (If the conditions are less than good) the plant will be scrawny and of poor quality."[3] Similarly, the school environment influences teaching and learning.

The school environment envelopes the student from the time he enters school until he leaves at the end of the day. It is encompassing. Its quality is determined by each student's sensitivity ... to his physical surroundings and his relationships with others. The student is a part of his environment and cannot readily or easily separate himself from it. If it is not too hot nor cold, too noisy nor too dark, too bright nor too crowded, he is at ease and comfortable and his learning will be as natural as the growth of a vigorous and healthy plant. The beauty, order, warmth, and cheerfulness of the environment become a part of his attitudes, a part of his behavior, becomes a part of him."[3] School design does make a difference.

Within the environmental design of a school plant are three other factors which teachers mentioned in the Campbell study as being areas likely to develop serious deficiencies. One of these, the thermal consideration, affects the human organism from a physical standpoint most noticably for if it is too hot, the organism becomes restless, of too cool, it shivers.

A common regulation of the thermal environment is to attempt to keep the temperatures within the neutral (comfort) zone. Within this zone there is little adjustment needed to maintain the balance between normal body temperature and that of the surround, not considering other thermal factors. The average human body produces about 400 BTU (240 sensible plus 160 latent) per hour. This means that with no radiative nor convective heat loss, a person will raise 2000 cubic feet of 60 degree air to 70 degrees in an hour.[4] An average Madison classroom is about 900 s.f. or about 8100 cubic feet. On this purely thermal basis it would appear the old 30 cfm per person standard of the early 20th century is perhaps more desirable than the current standards. Considering the tremendous generation of heat by the bodies that occupy the study spaces, and the reliance on natural ventilation in many of the schools of the nation, Winslow and Herrington[5] suggested the following operating temperatures ranges.

SPACE	RANGE	DESIGN
Sedentary activity, i.e. offices, classrooms, cafeterias.	68-72	70
Moderate activity, i.e. shops, labs, kitchens, corridors.	66-70	68
Vigorous activity, i.e. gyms.	60-70	65
Locker and Shower Rooms.	76-80	78
Swimming Pool Areas.	80-86	83

In addition to varying room temperatures according to tasks, it may be equally important to vary room temperatures according to the time of day.

Using a standard similar to the above and other accepted criterion, Mincy[6] found in his study that 44% of all classrooms' air temperature readings were above 75 degrees, the upper limit criterion, while only 2% of the readings were below 70 degrees, the lower limit criterion. Of the 21% of the classrooms that met all criterior, all but one used the unit ventilator type of system. While this has been a common heating and ventilating unit in the past, it holds more for the future as refrigeration is introduced in newer experimental models for the market. In the interim, circulated water or forced air are being used because of the

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ability to chill the fluid and consequently the discharged air.

Other findings in the Mincy study indicated that the mean radiant temperatures were most easily controlled when the effects of sunshine on window glass were reduced to a minimum. This can be done with reduced glass area and/or the use of colored glass.

Another factor, humidity, was studied and found to be within the criterion limitations during only 40% of the days studied. In most cases the humidity fell below the minimum criterion limit of 40% while only one classroom registered humidity above the 60% upper criterion limit. Although it is readily accepted the body can tolerate greater changes in temperature if the humidity is low, optimum performance might be encouraged if the humidity is held within the desired limits.

A final factor, odors, was studied and although the rooms with unit ventilation showed no perceptible odors, some were found in other rooms. Odors,generally have been associated with children and principally because of a lacking of bathing habits. However, treatment of air by washing, humidifying, cooling, and dehumidifying apparently condition the air in all respects[7] and would seemingly improve study performance at all levels.

To attain some of the control desirable, MacConnell[8] suggests a "systems" approach. This does seem to better allow for the inclusion of air conditioning and factors other than the increase in power consumed are considered, such as the reducing of the heat load by using the user and lighting systems output, as pointed out by Price[9] the feasibility is further increased.

Most important however, are the effects on student and teacher attitudes, performance, and behavior patterns. In a relatively recent study, McDonald[10] in a questionnaire study found that air conditioning seemed to create less fatigue, make users more agreeable and willing to study, aided in learning new material and in the ability to concentrate, and reduced tensions and drowsiness. This was verified by Wright[11] who tried to answer the two most pressing problems of schoolmen, "How much does it cost?" and "Do we really need it?" Wright found there is increased costs but cites learning rates in hot weather vs. rates in cool weather, and increased use of buildings both as schools and by the community throughout the year as ample educational justification.

The data of other researchers has shown that air conditioning did not significantly improve performance although most subjects feel at a disadvantage without it. Regardless, a commonly held conclusion is that there is a significant positive relationship between the thermal environment in which students work and their efficiency in learning.[12] This being true, it is important that as study spaces are planned they have the greatest possible balance inherent within them to promote better accomplishment of the task for which they were designed.

The sonic implications of an educational environment perhaps deserve greater investigation than has been given them to date. There is long standing research involving the student and the apparent effects of sound on his work. Industry in its quest for greater productivity has done extensive experimentation with the introduction of sound into the production environment. It was long held that the effects of noise on performance of any task was directly related to the intrinsic difficulty of task. The more difficult or more different the types of tasks, the more likely they were to show the effects of noise. Much of this type of experimentation was done in laboratory situations. In one of his many studies concerning the effects of noise on subjects, at assigned tasks, Jerison[13] found mostly negative results.

The tasks developed by Jerison were the monitoring of clocks, a light display board, and a telegraph key. Subject reaction of both speed and accuracy were studied as there was change in the sonic environment. During the test periods, alertness deteriorated, time judgements became distorted, and rather complex degradation of performance upon mental counting was found. Noise conditions did lower the performance levels in this study. Other studies by Jerison did recognize that there were increased fatigue rates perhaps induced by stress which was induced by the noise, or perhaps the fatigue was a primary effect of the noise. Regardless, these studies did show negative results that should be of concern when study space is being designed.

Noise can enter a study space because of lack of coordination of the utility systems which act as expressways for sound. Noise can be transmitted through intervening walls or floors as well as along any interconnecting structure. As previously pointed out in the McKay[14] study, sound does need special design to be effective, performance areas do need ways of projecting sound but they do not need the cloaking noise created when air flows over diffusers, or regulators, or grills. This, however, may be extremely useful in offices, in sales areas, or in classrooms,
but in each the purposes are quite different. P15

Noise does require some attention whether conscious or not. The attention it commands might be compared to the blinking of the eye. It would seem that if these moments of attention to a sound come between the critical moments of the task at hand, the task will show little or no effect. If on the other hand the command for attention comes during a critical moment of the task or if the task requires consistent attention, then it would seem the noise would have an adverse effect on the performance.

This indicates that tasks which first, require great concentration, and second, which require responses to information received at uncertain times are peculiarly vulnerable to the effects of noise. With this in mind and considering that some school study spaces have this kind of a task levied against them, the studies at the University of Tennessee[15] are significant in that they indicate none of the classrooms studied met all the criterion for reverberation, that no corridor-classroom walls met the criterion for noise reduction and that only 11% of the between-classroom walls were found to meet the noise reduction criterion. If this is true and if schools do require tasks of students that demand great concentration, then, according to Harmon, there will have to be almost constant accommodation by the organism in its attempt to balance itself with the sonic restraints and forces of the surround.

While much of this data is descriptive of the research being done in the early part of the century, current research tends to bring just a slightly different light (sound) on the problem. Noise is still a factor that has to be consiuered. However, another factor, background music has been introduced that may have quite a different and perhaps even a cancelling effect on the noise. Hall[16] in his current research shows that while P16
using the Nelson Silent Reading Test, under acceptable procedural conditions almost all students showed some degree of gain. The following conclusions were drawn: (1) The greatest advantage appears during the first period of the morning and during the first and second periods after lunch. This is very similar to findings in industry. (2) Increased accuracy is the chief advantage of background music. (3) Students who are below average in achievement and intelligence appear to profit most by the background music. Average and above students show little or no effect. (4) 83% of the students expressed a desire for music as a part of the study hall but programming is an important

variable to be carefully observed.

At the college level, the Stanford University Study[17] of over 700 community college students concluded that among other things, the study areas should be restricted to studying and exclude socializing, eating, and relaxing, and that students appear to strongly favor a study area free of all extraneous sound and noise. This finding is supported to a great extent by the findings of Conrad and Biggins[18] who suggest that the carpeted classroom provides a measurable superior sonic environment compared to the non-carpeted classroom, but this superiority is reflected in greater pupil achievement only in the primary grades. King[19] found that while carpeting absorbs sound, it does not absorb as much as does the better quality acoustic tile and reflective room center ceilings enhance sound control. Other factors such as non-parallel walls, reflective windows, and in-room variety of furnishings help significantly. P17

In planning study spaces to provide greater inherent balance with the student it appears there are several implications for the better control of the sonic environment. These implications appear to vary for the age group to be served, for the tasks to be solved, and for the esthetic values to be achieved.

Vision is probably the dominent function of the student's development and learning. It has been long estimated that 80% of the student's time in school is devoted to visually centered tasks and activities. With the increased emphasis on visual as well as audio learning devices that percentage is unlikely to change drastically, vision is the body's primary receptor in the learning process. Vision however, "from the view-point of learning is the adjustive, or adaptive, action aroused by a pattern of light distribution. It is the total behavior of the (student) organism elicited by a pattern of brightness differences, or contrasts.

The child does not see to see, he sees to act".[20]

The principle aim of lighting is to promote visual efficiency and comfort. It is generally felt the centers of attention should be brighter and more colorful for efficiency, but they should be graded into the surround for comfort. "The efficiency of the visual task is increased with but is not proportional to the illumination level. As a consequence, it is not necessary and perhaps not even desirable to try to duplicate outdoor lighting, indoors, for the most efficient use of vision and performance of the tasks."[21] It is true that man's sight has adapted through years of evolution to outdoor light, but in terms of outdoor seeing tasks.

The problem of lighting a modern indoor environment is not merely a problem of how to make seeing as much more comfortable, or more speedy, or more accurate. The real problem of lighting is the problem of fitting light of various kinds into man's civilized environments in such a way that he can perform his culture-made tasks in not only a socially satisfactory way, but, more important, in a biologically efficient manner in keeping with the way all his light-related structures have evolved. As stated in his paper "Lighting and Child Development" where Harmon concluded, "There appears to be improved well-being when the visual environment is designed to reduce glare and improve illuminating levels."[22]

The external visual task is divided into four factors: size, contrasts, time of exposure, and task brightness. The visual environment is an interaction between the influence of surrounding brightness and one or more of the task factors.[23] Glare results from high brightness ratios in the vision field. It may originate inside or outside the room and may be seen as direct glare from a light source, as reflected glare, or as a veiling glare where the bright area is indistinct. Brightness is a different kind of discomfort.

In writing about brightness, Tinker[24] made these several suggestions. (1) Avoid peripheral light sources that reach into the field of vision. (2) Avoid the use of glazed paper if possible and highly polished working surfaces. (3) Avoid marked changes in brightness from one area of the field of vision to other areas of the field. (4) Keep the surface brightness of light fixtures within the limits of 1 to 2 foot candles/square inch. (5) Maintain as even a distribution of light as possible over all work surfaces.

A University of Tennessee[25] study in 1963 analyzed the illumina-
tion levels in a number of classrooms to develop these major
findings. Only 10% of the classrooms studied met all phases of P19
the criteria relating to brightness ratios, 70% of the classrooms
had excessive window brightness, 67% had unacceptable floor bright-
ness. While only 7% of the classrooms had totally satisfactory
surface reflectances, 73% had satisfactory chalkboard surface
reflectance, 55% had satisfactory desk top surface reflectance,
90% had satisfactory floor reflectance, 36% had satisfactory
rackboard reflectance, and 73% had satisfactory wall surface
reflectance.

It is extremely difficult to obtain adequate light distribution from natural light alone unless the natural light is well controlled. In terms of student responses, Larson[26] at the University of Michigan compared a school with windows and a windowless school and concluded, "Children ... showed little personal interest in whether their classrooms had windows or not." A windowless environment however, may have some small effect on learning achievement, this depending on the nature of the group and whether the class is task oriented. Larson further reported, "Teachers preferred windowless classrooms after they had the experience of teaching in such an environment."

Included in an article by Gibson[27] concerning school lighting is another statement concerning expanding glass areas to provide more natural light. More important in that article is his discussion of the design of a ceiling which integrates air distribution, acoustics, and lighting. This reaffirms the concepts of MacConnell, suggested earlier about the need for a "systems" approach that will give better control to all the factors of the school environment that need consideration in providing the student with better learning situations.

In another previously cited report, Tinker suggests a 'critical level' of illumination or a level at which performance rates tend to stop increasing. The 'critical level' is not adequate for practical seeing and Tinker estimates that, "adequate lighting should probably require a 10-15 foot candle addition to the critical level for ordinary seeing. More exacting situations may require 20-25 foot candles. There seems to be no reason why more than a total of 50-60 foot candles should be required for even the more exacting visual tasks.

While it is felt by some[28] that color choices are a prime factor in providing an appropriate learning environment to enhance mental, physical, and emotional well-being and that a strong case can be made for very specific color recommendations such as (1) warm tints enhance elementary classroom objectives, (2) the close visual and mental tasks of secondary school seems to be best accommodates by cool light tints of blues, greens and beiges. There are equally strong cases indicating, "The hues, values, and intensities of color ... did not affect student achievement as measured in terms of student grades assigned by teachers." Equally, "student's intelligence quotients were not factors when the painting of a classroom did affect student achievement as measured in terms of student grades assigned by teachers."[29]

In reviewing the research that has been conducted to determine which tasks occupy the most time in the classroom, Robert Boyd[30] found a study that showed about 62% of the classroom time is spent on such tasks as reading, writing, and working with duplicated P21
materials. "This indicates," reported Boyd, "that the greater part of a students visual time is spent on tasks requiring 60 to 100 foot candles of light." As seeing conditions are improved, the student responds more positively and productivity is increased proportionately.

With these findings in mind it would appear that much need be considered by educators, planners, by architects and engineers as they put together the elements that will culminate in a classroom or study space. The important consideration of the physiological effects on the body, to the shortcomings of visual and luminous environments seems to warrant more consideration than has in the past been given it. It is abundantly obvious that if the illuminated space is not designed with respect to the using organism, (the student), it will have to exert change within itself to accommodate these forces and restraints and bring balance to itself within the system. This often can be done only with detrimental effects on the student. It is desirable to consider the accumulated information and design the space initially to avoid as many of the conflicts as possible and develop proper balance internal to the space.

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THE RESPONSIBILITY FOR BETTER LEARNING SPACE DESIGN LIES WITH THE EDUCATOR WHO IS RESPONSIBLE FOR KNOWING WHAT IS NEEDED TO BRING BALANCE TO THE STUDENT'S ENVIRONMENTAL RESPONSES AND HOW TO BRING TOGETHER THE PLANNING AND DESIGN TEAMS THAT CAN PROVIDE THAT BALANCED SPACE.

New school physical plants are being constructed and existing buildings are being modified at an unprecedented rate to provide P25
more and much different settings in which the needs of the educational programs can be better accommodated. While average school construction costs soar, the cost of some of the most important components of good study environments have taken the opposite turn. Vision is the body's primary receptor in the learning process and light is the basis of all vision. Light is an inexpensive component for the learning space, however, its use must be planned with great care. It is the educators responsibility to know what the student needs, to develop a balance with the luminous environment and insist that the design engineer provide what is needed. If the requirement of side window lighting is levied by the school district, at least the administrator can point out P25
to the teacher that a simple arrangement of chairs relieves many of the restraints caused by the natural window lighting demanded.

Some school districts will find the ability to control the light and condition the air that is used in classrooms. If this is totally impossible, the schoolman should be able to direct the architect in the defining of the comfort needs of students. Using this direction, the architect should be able to integrate the natural factors even to the point of providing inexpensive pressure walls or landscape plantings that "turn the wind around" and provide increased natural ventilation. With added monies available the P25
educator should know there are other more versatile solutions available for integrating the natural and the mechanical elements and developing satisfactory study spaces.

The student today is not content to attend school to study anthropology in the way previous generations did. The student today is not content to attend school to study the rote of mathematics as others have. The student today is not content to attend P26
school to study the syntax of language as did the previous generations. Most students today have a direction that in uniquely their own and they attain their goals through the use of a wide variety of media and in schools that are as adaptive to the goals as they are to their emerging society.

But, it is still the student with whom educators must have concern and it is the educator who must take on the responsibility of levying the requirements against the planners, architects, and engineers, so the educational space will be as free of restraints as possible and will allow the student to achieve an environmental balance with the exertion of the least amount of physiological accommodation.

The challenge is the student. He may be able to "block out" some of the distractions as he takes on greater learning responsibilities with newer approaches to learning and newer devices to aid him. But there are many physical forces that he cannot "block out" and it is "These physical forces and forms (which) set into action the student's biological behaviors from which he derives most social and much personal learning."[1]

"Education is for perpetuating and, hopefully, improving our culture by transmitting it to the young. The school house is not, of course, as important as the school teacher. But the school house, because it stands there to be seen, speaks of the intentions of the community toward the children. Any school (either helps to) anchor the people to the community or, instead, hastens their departure. The school house more than any other structure in town declares the public intention to press on, to rest awhile or to go back." Educators are responsible for providing better learning space. "Winston Churchill said it best: We shape our buildings; thereafter, they shape us."[2]

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