Effects of School Architectural Designs on Students' Accomplishments: A Meta-Analysis

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Abstract

Architectural scholars have called for a complete working alternative to existing ideas about architecture in general. Since 1997 the School Design & Planning Laboratory has sought a similar alternative for school architecture, including the total educational environment, and worked persistently toward this goal. Hence, the objective of one primary cluster of SDPL research was to extend innovative ideas of these highly respected scholars to the field of educational architecture. Findings from the body of research, as discussed in this document, also have been interlocked to Maslow's hierarchy of needs pyramid. The purpose for effecting this association was to guide how we think about the physical environment's capacity to motivate individuals, especially students in school environments.

Introduction

This meta-analysis reviewed interrelated research on the effects of the school's physical environment on students' test scores. Widely used standardized instruments in the field of education in the United States provided the measure of academic achievement. The school's physical environment was symbolized by various design characteristics or patterns outlined in the "Design Appraisal Scales" found in Appendix A. These scales were influenced principally by the classic work, *A Pattern Language,* of Alexander, Ishikawa, and Silverstein (1977).

Scales within the school facility assessment instruments, derived from design items, were validated and tested by practicing school administrators and teachers, architects, advanced graduate students at the University of Georgia's School Design and Planning Laboratory (SDPL), and educational planners. Professional educators trained in educational planning and school design collected data representing the degree that each design existed in the sample of schools visited. Five of the major research accomplishments reviewed here were completed in the late 1990s and early to mid-2000s (Tanner & Lackney, 2006). One dealing with school size was completed in 2010.

Alexander et al., (1977) wanted people to see a complete working alternative to existing ideas about architecture in general. The SDPL sought a similar alternative for the total educational environment and worked diligently toward this goal. Therefore, the objective of one primary cluster of SDPL research was to extend ideas found in *A Pattern Language* to the field of educational architecture. Findings from the body of research, as presented in this document, also have been interconnected to Maslow's hierarchy of needs pyramid (Maslow, 1954; 1998). The purpose for effecting this association was to guide how we think about the physical environment's capacity to motivate individuals, especially students in school environments.

Perhaps the findings and viewpoints found in this study will influence progressive thinking about how we interact with our educational environment and how we view it as a motivational tool.

Conceivably a special academic discipline will soon evolve that focuses on environmental psychology and architecture of school environments, since, in the opinion of the writer, they are just as important as the curriculum itself.

Maslow's Theory of Motivation

An implied objective of this study was to encourage the reader and facility planner to contemplate various characteristics of a school's physical environment and associate them directly or indirectly with Maslow's pyramid (Maslow, 1954; 1998). The goal then turns out to be the linking of human motivation capability to the design of school facilities. From a theoretical point of view the pattern language proposed by Alexander et al., (1977) may be interconnected to Maslow's hierarchy (McMichael, 2004, p. 8) to show how the school's physical environment complements human behavior, cognition, and activities.

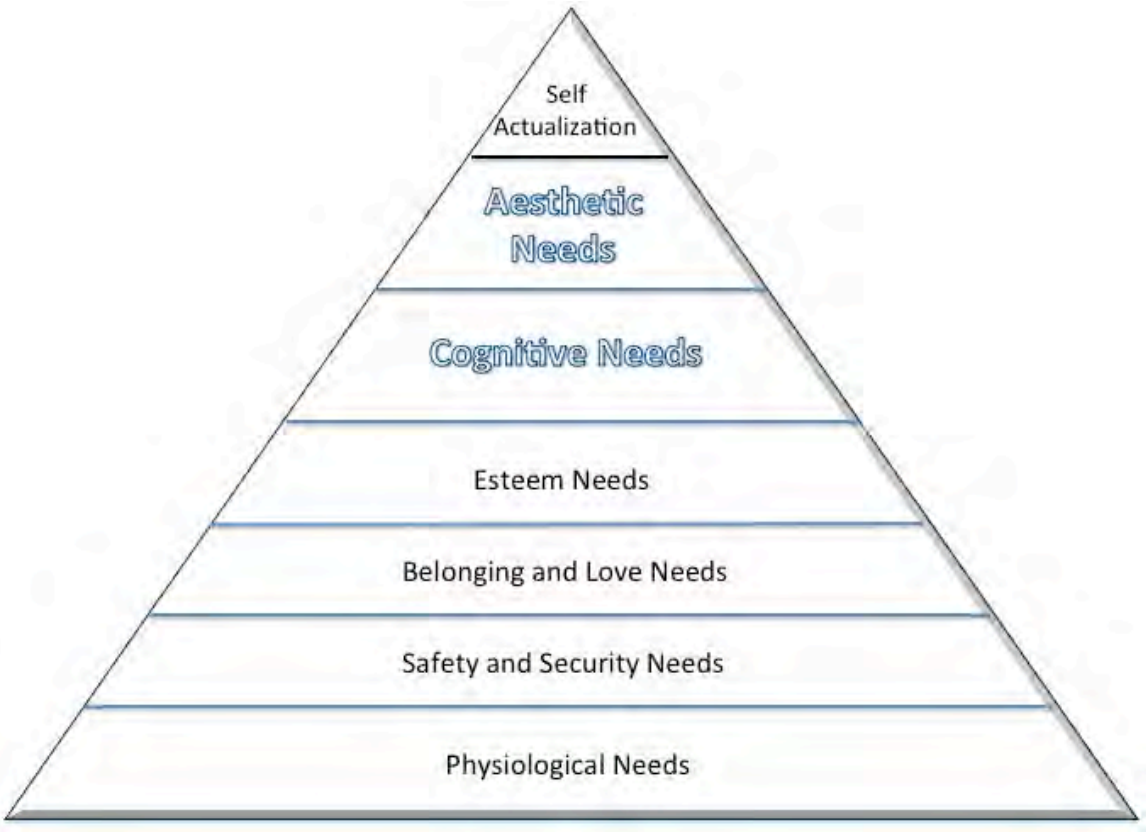
McMichael (2004) described and explained this connection in his extensive work on linking specific school design characteristics to general, conceptual guidelines for planning school facilities. His work included the perception that on a basic level, human beings relate to their world through the function of a combination of five senses as discussed, for example, by Gonzalez-Crussi (1989). These senses are the ways in which all human beings experience their world in some form or another or to some alternative degree. Regarding the school environment, these senses are continuously at high levels of stimulation. Examples include:

- Seeing various classroom colors, room decorations, overhead lights, windows, equipment, and furniture (sight).
- Experiencing a variety of smells from the kitchens, locker rooms, classrooms, heating systems, and nearby industries (smell).
- Touching items form buildings and furniture, playground equipment, computers, books, and school grounds (touch).
- Hearing the way things sound in different school environments, such as carpeted and tiled, outside noise levels, noise from other classes, fire alarms and bells (hearing).
- Tasting food served in school lunchrooms including yeast rolls, oatmeal and raisin cookies, small cartons of milk, ice cream cones, and government cheese products, for example (taste). (McMichael, 2004, p. 8)

How people experience their world when viewed through Maslow's pyramid (Maslow & Lowery, 1998) provides a reasonable and unpretentious way to look at school facilities' contributions to human experiences (Figure 1). From bottom to top, the levels are physiological

needs such as health, food, water, and shelter; safety and security; belongingness and love; the need to be respected and valued by others; and, self-actualization or the need to realize one's full potential. Maslow added levels dealing with cognitive issues (to know, to understand, and explore) and aesthetics, (symmetry, order, beauty, sense of scale, color perception, overall sensory harmony, and intent). As shown in Figure 1, these levels were inserted between the original levels four, the need to be valued by others, and five, self-actualization. Maslow perceived that the needs at each level must be met before a person can progress to the next level. His theory informs educators that a learners' preoccupation with any of the lower four levels always will supersede concentration on the processes involved with learning. For example, in selected cases, the school facility is a place for students to get food, it protects students from extreme weather conditions, and if designed properly, reassures a sense of belonging and safety. Accordingly, a substantial part of this study includes the identification of the places and spaces where students learn within and among the multiple levels below the self-actualization level.

Figure 1. Representation of Maslow's Hierarchy of Needs Pyramid with Two Added Levels



If school facility planners and designers develop learning spaces with the needs identified by Maslow in mind and with awareness of an educational pattern language, then we can

hypothesize that the learners should have a much easier time reaching the self-actualization level. Aesthetic and cognitive needs tie directly to architecture and teaching (including the curriculum), while linking to design patterns that must be grounded in the traditional and essential educational specifications. Given that the physiological, safety, belonging, and esteem needs are major keys to unlocking the door to learning (cognitive), aesthetic needs enhance a sense of place, thereby bringing the individual to the self-actualization level.

McMichael (2004) stated that "this is not to say that a well-designed educational facility can, or should, deal with all of the issues that may be a negative influence on a learner' s life and ability to learn. It would be unrealistic at best to argue that a building or educational environment can mitigate the issues that all human beings bring with them from outside" (p. 9). Nonetheless, well designed school facility environments can enhance and strongly influence the learning process in a positive manner and should never provide negative influence on or interference in the teaching and learning processes they are designed to house.

This human psychological and educational theory supports the idea that the physical design and setting of our school facilities is of high importance on a basic level. How should we treat educational facilities and their designs as secondary concerns, if at all? In a sense, those of us involved in building school facilities literally shape the buildings that help to shape our society. As research points out, (Dejong, 1997; Taylor & Vlastos, 1975) the surroundings and environment in which students find themselves exert influence on the ways in which we learn. It also seems that the morale and quality of work of the educational staff may be related directly to the influences and conditions of the environment in which they work (Borg & Riding, 1981). The classrooms and facilities in which students learn and teachers teach are a very important factor during educational growth and development and should be treated as an active tool to improve and support these processes. Taylor and Vlastos (1975) suggested that the environment of the school itself has large and untapped potential as an active contributor to the overall learning process.

The school building is one prominent type of building in which a high percentage of citizens from all walks of life, ethnicities, genders, and religious backgrounds in the United States spend a large amount of time. The designs of these facilities should therefore be high on the list of concerns when professionals look for ways to improve and enhance student achievement. Educational leaders should be highly concerned with making sure that the facility they develop and manage is as safe, cost efficient, functional, and supportive of the educational process as possible. Unfortunately, more often than not, school building level leaders have very limited input into the actual design process, even when they are assigned to new facilities (U.S. Department of Education, 1999; U.S. Department of Education, 1998). Somehow, we must establish a new paradigm where the well-informed educational planner, the teachers, students, parents, and

school administrators have as much influence on school design as architects and builders. Perhaps bringing Maslow's theory into the mix will expedite this perception.

Design Components That Define the Focus of This Study

Serious and multifaceted efforts have been made to refine ideas about the physical environment and transfer them to valid and representative scales for measurement, while showing their statistical importance. The following condensed review of literature is based on the various University of Georgia dissertations directed by the author (see citations in the reference section).

All references and reviews of literature were originally pooled by SDPL contributors for students to review, use in their studies, update, and refine as we worked our way through the challenge of isolating school design patterns and comparing them to student achievement and behavior. All students whose works appear in the reference section have a significant share of the credit for the literature pool and have contributed directly to the findings and conclusions in this document. The SDPL is indebted to all the writers and researchers that have contributed to this body of information. A very small portion of the SDPL literature reviews is found in the following section. This is followed by our research findings, conclusions, speculations, and recommendations when reviewed through meta-analysis. This study focused on 16 sets of basic design patterns:

Movement and Circulation

When considering school design factors, special attention should be given to circulation patterns. This attention involves avoiding complex structures that cause crowding, forcing students to become disoriented. Movement within a school is an important part of the process of learning, and school design needs pathways to the outside and also indoor pathways and streets (hallways). Indoor pathways may be color coded to assist in keeping students oriented to the front, back, and other important locations within the learning environments. Pathways may tie the structures together and into the natural environment (Tanner, 1999).

Clear pathways to activity areas and classrooms improve utilization of learning areas. Hallways and pathways as characteristics of school design have a direct link to crowding, since poorly designed and crowded pathways can influence student performance. High density and greater crowding have been associated with decreased attention, lower task performance, behavioral problems, and social withdrawal (Tanner, 1999).

Taylor (1995) provided a categorization of the educational settings that students, teachers, and administrators can utilize to aid in school design; and, identified four premises upon which achieving well-ordered learning rests. The first premise is that people are considered an integral part of, not apart from, the environment. The second premise is that the *architectural*

environment can affect behavior. The next premise is that the environment can be designed, engineered, and equipped to function as a learning tool. The final premise is that the learning environment can be evaluated as a learning tool.

Movement and circulation patterns, linking closely to Taylor's second premise, have a direct relationship to Maslow's (1954) implication that physiological and safety needs must be satisfied before higher order needs such as accomplishment can be satisfied. If shelter and security are not realized then it is difficult for the other functions to be met. In particular, to have *psychic security* one must not be overcome with congested surroundings. Overcrowded places and spaces including a barrage of sights, sounds, touches, and smells that disrupt necessary social functions in schools and public meetings are psychologically threatening (Hall, 1966; Steele, 1973). Having enough room to move about enhances the chances that people will observe or hear new ideas not likely to be encountered in close quarters. The freer people are to move around, the more likely they are to come in contact with one another and experience new knowledge, especially if they are not next to each other in specific, assigned seats (Steel, 1973). Freedom of movement and ample circulation patterns enhance psychic security.

Natural Light – Day Lighting and Views

Day lighting in schools added numerous supporters when the definitive study by the Heschong Mahone Group (1999) proved natural light to be significant in student achievement. Preceding the 1999 study, Alexander et al., (1977), proposed patterns identified as *Indoor Sunlight* and *Tapestry of Light and Dark* as evidence of the need for natural lighting in buildings. From these two patterns, we find that rooms should face south to allow for natural light, except art rooms, which should face north to ensure consistent natural light. The concept of tapestry of light and dark is defensible in schools where transition areas and pathways may be slightly darker than classrooms. Research at the SDPL has suggested that classrooms that have light from windows, skylights, borrowed light, reflected light, and artificial sources preferably on two sides of every room is ideal for student learning and comfort (Tanner, 2009).

Natural light is tied to student health. For example, natural light, easily classified as one of Maslow's basic needs, is a very important environmental contribution, following food, in controlling bodily functions; also lights of different colors affect blood pressure, pulse rates, respiration rates, brain activity, and biorhythms (Wurtman, 1975). Full-spectrum light is necessary to influence the pineal gland's synthesis of melatonin, which in turn helps determine the body's output of the neurotransmitter serotonin, is critical to a child's health and development (Ott, 1973). Ample evidence exists to show that people need daylight to regulate circadian rhythms; a natural biological function discussed in the pattern entitled "Wings of Light" (Alexander et al., 1977, p. 527). Poorly lit and windowless classrooms can cause students to

experience a daily form of jet lag; furthermore, forms of florescent lighting may affect some students and teachers negatively by causing mild seizures (Tanner and Lackney, 2006, p. 270).

From Yarborough's (2001) extensive study of elementary schools, the visual environment referred to the use of windows and lighting within the facility. Traditionally windows were included in buildings to allow in a source of light and to provide ventilation. Now buildings are built with artificial illumination and mechanical ventilation. The results from research concerning how windows and light affects students have been varied, at least through the duration of Yarborough's (2001) study; however, in this meta-analysis we hope to weaken the case for no windows in schools. The following summaries indicate that, at the time of the SDPL studies, there was still some doubt about windows in schoolrooms in certain pockets of the educational community.

Tinker (1939) found that as the illumination intensity changed, there was a change upon speed of perception and upon fatigue in reading. He discovered that when foot-candles dropped below 3.1, there was a drop in performance efficiency. However, performance was equally efficient at 3.1, 10.3, 17.4 and 53.3 foot-candles. Although the experiment suggests that only three or four foot-candles are required to read ten-point type, Tinker recommended that a minimum of 10 to 15 foot-candles of intensity be available at desktop level when reading to allow for a margin of safety.

Mayron, Ott, Nations, and Mayron (1974) reported that the use of full-spectrum fluorescent lighting and radiation shielding decreased the hyperactive behavior of students in two first-grade classrooms as compared to the students in two control rooms with standard cool white fluorescent lighting. Research also suggests that the ability to concentrate on instructions is strongly influenced by factors such as lighting (Horton, 1972). Chan (1980), however, found no significant difference in ITBS scores between eighth graders in public school among schools with fluorescent and nonfluorescent lighting.

Romney (1975) studied how a windowed and windowless environment affected rote learning tasks, concept learning tasks, and perceptual tasks of sixth grade students. No significant relationship was found to exist between the absence and presence of windows versus rote, learning, or perceptual tasks. Even with these mixed findings, Kuller and Lindsten (1992) warned that windowless classrooms should be avoided for permanent use.

Outside green spaces and "views" and "views overlooking life" are a logical consequence of having windows in classrooms. More of this aspect of school design will be discussed under the section entitled *Green Spaces*.

Safety and Security

School safety and security design patterns begin with where the school is physically located. School planners also consider the natural surroundings and built environment that surrounds the school so that the school's architecture matches the surrounding environment (Witcher, 1991). They look for safe places having natural or built barriers to protect the school site, and seek sites that are away from danger.

Noise pollution of the surrounding area is an important factor to consider, according to Bronzaft and McCarthy (1975) who conducted a study on the effect of train noise and reading ability. The study showed that the students were hindered in their reading proficiency by elevated levels of noise. They found that students on the side of the school building, which was only 220 feet from an elevated subway track, were academically behind their peers on the quiet west side of the building from three months to as much as one year.

Castaldi (1994) in his classic work on school facilities strongly advocated that the school site should be safe, healthful, attractive, and properly located with respect to students' homes. Sites should be free of air pollution and noxious gases. Sites should be far from sources of noise or danger such as greatly traveled highways, airports, and heavy industry. Aesthetic considerations should be stressed in the selection of a site. Trees, brooks, parks, or golf courses near a school do much to beautify the area surrounding an educational facility. A good site should have several physical characteristics. Its topography should be slightly convex and slightly higher than the area immediately surrounding it. Another definitive source on school site selection has been produced by Earthman (2009), who contends that given all considerations, cost is often a major factor that drives site selection.

Safety should be given high priority when selecting a school site (Earthman, 2009). Sites should not border a heavily traveled highway, railroad, or high-tension electric wires. A landscape architect is an essential person needed in site planning. Landscaping is important to the development of the site. Trees, shrubs, flowerbeds, and the arrangement of walks and drives contribute to the general environment of a school building. Both the design of the building and the layout and development of the site are important ingredients in the creation of an atmosphere that is educationally stimulating. The building should blend pleasingly into the terrain, and the site should accentuate the beauty of the structure (Castaldi, 1994).

Linking the school to the works of Alexander et al., (1977) and Maslow (1954) may be accomplished by considering the school as the main building in a community, a place that is the human institution (Alexander et al., (1977; Pattern 99, p. 485 - 487). The theory supporting Pattern 99 (Mail Building) is that the vital structure is at center of the complex of buildings. It has a higher roofline and serves as the reference point for paths and circulation patterns. This architectural feature provides a key to orientation for the student and helps create a sense of

orientation, security, belonging, safety, and confidence – levels in the Maslow triangle that must be satisfied before self-actualization can be fulfilled.

Display Spaces and Places for Student Artifacts and Mini-Museums

"Things From Your Life," Pattern 253, developed by Alexander et al., (1977, p. 1164) helped to guide the SDPL researchers toward some very common, but often overlooked, elements of school design – the hallway display case, displays on paths with goals, wall displays, displays in classrooms, and mini-museums. There are two ways of viewing this concept: First, we may look at this design pattern from the standpoint of who owns the space, and second, from the standpoint of who comes to see the displays.

Taking this reasoning to the student and teacher levels, we find displays that mean most to students, teachers, and the school as a whole. These exhibits are symbols of accomplishment that have the power to play a part in the continuous process of self-transformation, which is the life of the teacher and student. Displays become an expression of a student, a teacher, and a school so that the person coming to see the exhibition gets a clear view of goals, history, and life of the students, teachers, and the school (Alexander et al., 1977, p. 1165).

When student displays are found in the school setting, they bring the student or teacher through the physiological, safety, belonging, and esteem levels and place him or her in the self-actualization level advanced by Maslow (1954). At this level, the student, teacher, and school display creativity and problem solving examples, moving them positively toward winning the acceptance of the community of viewers.

Although not a direct part of the research studies on linking school design patterns with student achievement, but a most thorough thesis on design standards for a high school museum resource center is the outstanding study by Wallace (2003). He took design standards to an exceptionally clear elevation and provided excellent examples that are useful for educational planners and architects.

Storage Places for Personal Artifacts

The common complaint among teachers since the beginning of teaching in traditional school rooms as we know them is that they do not have enough storage space for their materials and supplies. With the arrival of technology, this complaint has diminished to a degree since we may now use "cloud storage." Technology and information systems are continuously changing, however our studies referenced the need for traditional storage and to that end the SDPL studies focused on places for teachers to store "things."

Good storage, according to Greenman (1988, p. 125), allows an educational program to maximize the use of its resources. "If you can't find it or unsort it, you can't use it." Ample storage allows

one to accumulate resources. “If you can’t store it, you can’t keep it.” Storage allows us to teach children about relations between things. “If you can’t organize things in a way that children understand, you can’t expect children to maintain order.”

Considering children’s play, organized storage allows children to visualize relations and plan future actions. A well-organized book display connotes far more respect for books than a pile of books on a shelf. If adults and children are not provided personal storage space, conflict will ensue (Greenman, 1988).

Children need places and spaces for personal artifacts – places that make them feel that they are needed and belong in the school environment. Maslow (1954) used the term "belongingness" to describe the pattern that human motivations generally move through. Self-actualization depends, in part, on belonging. Especially in the elementary school, children need to have “my place,” a space to call home, a place to display a photo of their favorite thing, or a place to store the “thing” itself. Works by Greenman (1998, 1988) and Olds (2001), for example, are actually classics on designing storage places for students and teachers and should be included in any planning for places and spaces for students to learn.

Overall, storage helps complete any structure or school building. According to Alexander et al., (1977, p. 687), “In . . . workplaces there is always some need for bulk storage space, . . . a place for all those things you are not using every day.” Bulk storage (Pattern 145) should occupy 15 percent to 20 percent of the floor area of any building (Alexander et al., 1977, p. 688).

Quiet Places and Spaces

From the perspective of a society, Crumpacker (1995) noted that needs for privacy vary from place to place and seem to reflect the community in which the school is located. In urban densely populated areas, people like to find a place to get away from others. In a rural area, people view school as a place to meet and gather and are less likely to want places for privacy.

Moving to the individual student’s level, Proshansky and Wolfe (1974) established that privacy contributes to a child's growth and development. Mack (1976) has conducted research on the "privacy booth," which is a classroom niche where a single student can work in seclusion. These privacy booths were often secluded and did not permit a view to the outside. Students like to withdraw but do not like total seclusion. This space, however, must be supervised.

Curtis and Smith (1974) created places for children to hide away, only to discover that children did not use them because they could not see what was happening around them. They solved this problem by adding clear acrylic panels to the private spaces. This allowed the children to see what was going on around them while maintaining their sense of physical privacy.

The three studies cited above are connected to the concepts of "Child Caves" and "Secret Places," patterns 203 and 204 by Alexander et al., (1977). Children like to be in tiny, cave-like places. They work to make special places for themselves and their friends. Because most of the world around them is "adult space," they try to carve out places that are "kid size." Alexander et al., (1977) recommends 5 square feet per child, with space for no more than 15 children. Wherever children play, their caves should be tucked away in natural left over spaces, with low ceilings no higher than four feet Alexander et al., (1977, p. 929). The concepts of child caves and secret places link to Maslow's theory of belonging - a need for children to have a place of their own. To a definite degree these concepts travel up the age ladder, but for older students these spaces may be called "quiet places" to sit and reflect or look into the sky.

Green Spaces

Several specific design features actually may fit into more than one pattern, and it is important to note that this overlap is viewed as a logical consequence to help make the patterns cohesive and complementary. For example, the pattern called "green spaces" or green views also complements the pattern identified as classroom windows with views overlooking life. A detailed background on this aspect of school design is found in Tanner and Lackney (2006) and Tanner (2009). Coherent reasoning for advocating views overlooking life for a school facility is founded on the basic needs people have for nature and the natural outside world. This need may be manifest in a desire to experience a sense of place that includes an authentic human attachment and a sense of belonging, which is a necessary level to reach on Maslow's (1954) triangle before one may achieve self-actualization. Alexander et al., (1977), explained a coupling among relationships identified as the Zen view (Pattern 134), outdoor room (Pattern 163), and windows overlooking life (Pattern 192).

The basis for a Zen view is explained, in part, by the awareness that we should make the most of a view and use it as an aesthetic attraction and a place of transition from one focal length to another for the sake of maintaining good health for the eye. "If the view is correctly placed, people will see a glimpse of the distant view" (Alexander et al., 1977, p. 643). The outdoor room as a place to view is discussed in the next section. It may be a garden or green space, or it may be a place with simple amenities such as sun, wind, and shade for a bench. The pattern we define as windows overlooking life suggests that that for every 100 square feet of floor there should be from 25 to 50 square feet of windows (Alexander et al., 1971, p. 891). Each of these patterns are linked to various other patterns to define a complex building design.

In the SDPL studies we looked for unrestricted views available within the classroom and living views, including some aesthetic indoor spaces and outdoor spaces such as gardens, wildlife, fountains, mountains, and the sky. Functional views allowed the student to easily see at least 50 feet outside the classroom (Nair & Fielding, 2005). Views of parking lots, walls, and roads

received negative or low scores on assessment instruments. It is important to make the best use of a view by ensuring that it is taken from places of transition and not straight on.

Outdoor Rooms

Outdoor rooms for learning include any safe place that is not inside a building. This does not necessarily include a swing set, monkey bars, and slide, but involves a space for connection to nature and a place to just stare into the sky and watch clouds change shape. A small portion of the need for outdoor learning space may be linked to some understanding of getting away from high-density places in schools (Wohlwill & vanVliet, 1985).

Cochran, Hale, and Hissam (1984) measured the personal space required by 96 undergraduate students under indoor (vacant room) and outdoor (empty soccer field) conditions. Twelve male and 12 female students were included in the experimenters. Each approached a male and a female acquaintance on the soccer field and in the vacant room. The person approached said stop when they felt uncomfortable with the proximity of the examiner. The results show that interpersonal closeness generates less discomfort in open spaces, which suggests the need to include larger spaces and outdoor learning in school designs.

Early on, the author placed the following reference into the pool of resources for SDPL, and Yarborough (2001) summarized this work by Stine (1997) very effectively. Stine suggested nine dimensions to assess outside play environments. Both elements in each of the nine pairs are needed to meet the needs of children intellectually, socially, cognitively, and physically. The nine elements are summarized below:

1. Accessible and Inaccessible—A setting should provide cues about what is accessible and what is not. Due to their size, children view the world differently from adults. The ground area is very accessible. Changing the ground surfaces impacts their play. These areas are positive when they provide clarity and safety, but are negative when children cannot reach a piece of equipment.
2. Active and Passive—This space should have areas where children can be loud and participate in large muscle activities in conjunction with areas for children to relax and be calm.
3. Challenge/Risk and Repetition/Security—Children should learn about their competencies and limitations in this area. All children fall along a continuum of low to high physical abilities. This area should allow children to progress along the continuum without frustration.
4. Hard and Soft— Regarding this concept, an environment gives way under the body's touch. It appears "soft." Children need to touch and feel mud, grass, sand, etc. However, for students to use toys with wheels, stack blocks, or colors, a hard surface is required; there should be both hard and soft areas to accommodate children's needs.
5. Natural and Built—To learn about, value, and ultimately protect their world, children need to understand and experience their world in both its natural and built forms. They

need to understand the process to appreciate the product. Providing exercises for students to build things is an excellent aspect of outdoor learning. The Boy Scouts and Girl Scouts of America provide valuable examples for this aspect of outdoor learning.

6. Open and Closed—Open-ended activities let a child become involved with the process of the activity without concern about an end product. There is no particular goal when the activity is finished. These activities allow for discovery and exploration. Closed activities provide the child with feedback, indicating that a product is finished or that an activity is completed. The activities help develop self-esteem.
7. Permanence and Change—Children need landmarks to help them feel safe in knowing that they can negotiate the area and find their way back. Children also need to be a part of changing their environment. When an environment cannot be rearranged, the students lose out on an opportunity for creativity and problem solving.
8. Public and Private—The environment should have different spaces where children can gather and be with friends and spaces where a child can be alone. Children need to be able to make choices to be in a group or alone.
9. Simple and Complex—When an area has more than one type of material with more than one obvious use and allows for manipulation and change, it is called a complex area. Complex areas encourage children to make choices and decisions. Simple areas have items that have one obvious use only. These simple areas provide structure and direction for the child (Stine, 1997).

Instructional neighborhoods

In 1999 graduate students in the SDPL began annual visits to the original Celebration School, Celebration, Florida. This class assignment was completed on the last Saturday in February for six consecutive years, and included six different cohorts of advanced graduate students. Celebration School was advertised as the beginning of a new era in education with state-of-the-art technology, supported by Disney, and showcased as the ideal school design for open space learning. It operated on the concept of instructional neighborhoods housing 125 students in one cluster and was guided by the open space, student centered teaching philosophy in the early years. SDPL students studied Celebration School to gain information for school facility design of the future, but visits were canceled when organizational and leadership changes at Celebration School began to influence its original philosophy. One main attraction that kept SDPL students interested in its outcomes was the open space classroom for 125 students with ample technology for teachers and students.

Given the literature studies and visits to Celebration School, we developed our own description of the ideal instructional neighborhood as a place having teacher-planning spaces, flex zones (places for multiple use), small and large group areas, quiet areas, wet areas for science and art, hearth areas, and restrooms in the instructional compound. One interesting aspect was the specific place where a student might experience a sense of place and belonging. This was

specified as the hearth area, where reading, thinking, and quiet time could be experienced. Such a place provided a sense of belonging, an idea introduced and discussed in a preceding section.

In keeping with the instructional neighborhood concept, Ayers (1999) presented research which advocated that the classroom should be an extension of the home and neighborhood - a place to encourage spatial freedom so that children might explore, work with manipulatives, and complete creative activities. The instructional neighborhood was described by SDPL as a place where teachers and students constitute a small community or a "family" in a "house." To this end, the design includes suites, each with classrooms, lounge space for adults, office space for teachers, lockers, private bathrooms, window seats, terraces, outdoor classrooms, hallway display cases, and small seminar rooms (Genevro, 1992). The instructional neighborhood, ideally, includes places for indoor and outdoor play, since it is through play that children acquire social, cognitive, and physical skills (Gaunt, 1980). Outdoor play area was limited at the original Celebration School.

Technology for Students and Teachers

Words about technology for students and teachers are almost obsolete as soon as they are written. When SDPL was developing instrumentation for assessing technology in school design, one computer for a classroom and one computer laboratory for the entire school was the best we could hope for, except at Celebration School, of course. But, those six adventure trips to Celebration School motivated graduate students to work to improve technology in their local classrooms and schools. Nevertheless, in 1998 we were not thinking of wireless computers or cell phones that are now actually computers. We did not know what an electronic tablet might be used for, but we heard discussions on the best wiring techniques and how to install wired computer laboratories. Arguments for wired or not wired classrooms later evolved. We now know how that outcome turned out and who could be declared the winner.

Just how Alexander et al., (1977) and Maslow (1954) might view technology for teachers and students is only speculation at best. Assuming the teacher and student have current technology and if it is mastered to a usable degree, then self-actualization might be an automatic result.

Public Areas

Public areas are needed in learning environments to regulate the rhythm of social relationships (Ayers, 1999). Students need opportunities to develop social skills in an effort to better understand others and how to communicate with them. Public areas are spaces, as defined in the SDPL studies, which foster a sense of community (unity and belonging). The areas are inviting and comfortable settings that include ample lighting: auditorium, amphitheater, media center, commons (spaces for casual student meeting), and dining room.

These spaces have the shared thread or attraction of people coming together and enhance a sense of belonging, which is a significant component of Maslow's (1954) hierarchy of needs. Regarding the influence of the activities that evolve in these areas, for example, Pattern 147 (Alexander et al., 1977, p. 696) stresses the necessity of communal eating: "There are almost no important human events or institutions which are not given their power to bind, their sacral character, by food and drink" (p. 697). "The mere act of eating together, quite apart from a banquet or some other festive occasion is by its very nature a sign of friendship and of communion" (p. 697). "No social group – whether family, a work group, or a school group – can survive without constant informal contact among its members" (p. 618).

Color Configurations

The aesthetic environment suggests color schemes and patterns in the school building; and the influence of interior coloring on academic achievement has been shown to have some effect on student achievement and behavior. For example, Horton (1972) noted that repetition of color is boring unless it is interrupted by variations and contrasts. In 1953 Rice conducted a study of three schools in the Baltimore area that were similar in size, age, teacher-pupil ratio, and socio-economic status. One facility was not painted, another was painted in the traditional white ceiling and green wall scheme, while the third was painted according to a paint manufacturer's specifications and involved bright, warm, or cool colors. Report cards before the schools were painted were compared to report cards after the schools were painted. Kindergarten children in the unpainted school experienced a 3 percent improvement; students in the traditionally painted school had a 7.3 percent improvement; and students in the experimentally painted school had a 33.9 percent improvement.

Red, orange, and pink colors are warm and stimulating colors, while most blues and greens are considered cool and relaxing (Yarborough 2001). Yarborough summarized work by Smith (1980) and noted that grays are thought of as neutral. Tints are "receding" and make the room look larger, while deep tones are "approaching" and make the room look smaller. Different age children prefer different colors. Young children prefer red, blue, green, violet, orange, and yellow. Although young children prefer bright colors, too many high contrasts should be avoided because they can produce fatigue. Upper elementary classrooms should be painted with the cooler hues of blue and green. Secondary school students require less visual distraction and do well with the cooler hues such as pastel green or aqua.

In an auditorium the center of attention is the stage. The stage area should be in contrast to the surrounding sidewalls, which should be a relaxing color like beige, peach, or pastel green. The gymnasium is a room that produces more body heat; therefore, it should be painted in a cool receding color with little color contrast. The cafeteria should be painted a color that will stimulate the appetite such as pearl, coral, rose, or pumpkin (Smith, 1980).

People and animals are stimulated by brightness and by warm color. An increase in muscular tension, respiration rate, heart action, blood pressure, and brain activity occur under these conditions (Smith, 1980). Dim light and cool colors have the opposite effect. They encourage withdrawal from external stimuli and decreases in muscular tension, respiration rate, heart action, and blood pressure (Yarborough, 2001).

Overall color has just begun to be studied seriously when learning is the issue. Behavior, has received more press as it relates to color, and information is very scarce on the influence of color on various cultures and socio economic levels of society. Color contrast within a classroom is a way to decrease boredom and influence learning positively. When asked about this issue, the writer recommends that the front of a traditional classroom have a slightly different hue than the other walls. Furthermore, an expert that knows the differences associated with hue, tents, tones, shade, and saturation, for example, should be included in future studies of color in schools and learning environments. Above all, lighting must be considered when planning the classroom color scheme (Castaldi, 1994).

Climate Control

Early on, in the field of educational facility planning, climate control was identified as a significant factor in student behavior and learning. Chan (1980) found that students in schools that are air-conditioned score significantly higher at the .05 level on the vocabulary section of the ITBS than students who are in non-air-conditioned buildings. The achievement of students in an air conditioned versus non air-conditioned buildings was also analyzed for other sections of the ITBS. No significant differences were found for these sections. However, statistics showed a consistent pattern of higher achievement for students in the air-conditioned schools.

In the SDPL studies, climate control was defined as a system to maintain a comfortable temperature in the classroom-learning environment that is controlled in each classroom. The comfort index strongly influences the physiological state of the student and the teacher. A comfortable temperature of 72 degrees Fahrenheit requires a relative humidity of 60 percent. As the temperature of the air rises, the humidity should decrease to maintain comfort level (Castaldi, 1994).

Herrington (1952) found that workers who performed minimal physical exertion produced the least errors at 79 degrees Fahrenheit. As temperatures rose to 97 degrees Fahrenheit, errors increased from 12 per hour to 90 per hour. He also noted that women who control thermostats would set it an average of 3 to 4 degrees higher than men. Also, younger children prefer a temperature of about 5 degrees cooler than an older adult. Nolan (1960) also stated that higher temperatures have a negative impact on academic learning. Peccolo (1962) conducted a study using 44 matched pairs of fourth grade pupils. His study indicated that an appropriate thermal environment had a positive relationship to the learning of new concepts and to the

performance of clerical tasks where quick recognition and response were required. Stuart and Curtis (1964) showed that the gain of student achievement in climate-controlled facilities was superior to those in non-climate-controlled schools. Their study involved 5,000 pupils in three different grade levels at four different schools and spanned two academic years.

The Roof System as a Factor in School Design

Critics denouncing the inclusion of the roof system as having any relationship between school design and learning have less to say now than in the late 1980s. In particular, the founders of SDPL had not yet begun the identification of any links between school design and student outcomes other than, perhaps climate control and foot-candles. Accordingly, and prior to the existence of SDPL, Liska (1988) completed a study on indoor air pollution and found that a portion of the causes for indoor air pollution actually came from the roof system and gutters that allowed water to seep into the buildings. On a site visit to the rural school identified by Liska as having an elevated degree of indoor pollution problems, this writer found mold and mildew throughout the school facility that was obviously caused by neglect of the roof system and gutters.

The high rate of student and teacher absence caused by respiratory problems as identified in the study helped identify this particular school building located in the southern coastal plain of the United States (Liska, 1988). Situations akin to this one actually inspired early dialogue about just how a school building might influence learning and behavior. Ayers (1999) reported findings from a study of 24 schools indicating that the school's roof system has a limited influence on student outcomes. Nevertheless, when a roof system allows water into the school building triggering mold and mildew, a situation making children and teachers ill, that malfunction is significant.

The theory supporting Pattern 99 (Mail Building) in Alexander et al., (1977) is that the vital structure is at center of the complex of buildings. It has a higher roofline and serves as the reference point for paths and circulation patterns. This concept allows us to include the roof system as part of school design that might influence student outcomes. It may also be considered an aesthetic contribution.

A study of working conditions in urban schools by Corcoran, Walker, and White (1988) concluded that physical conditions have direct positive and negative effects on teacher morale, sense of personal safety, feelings of effectiveness in the classroom, and the general learning environment. Building renovations in one district gave teachers a renewed sense of hope, commitment, and a belief that the district cared about what went on in their buildings. In buildings in another district, the atmosphere was punctuated by despair and frustration, with teachers reporting that leaking roofs, burned out lights, and broken toilets were a typical backdrop for teaching and

learning (Corcoran et al., 1988). These researchers concluded that the environment could affect the teachers' attitudes and abilities. As a result, student achievement could be affected.

A Carnegie Foundation (1988) report on urban schools concluded that students' conduct appears to be an extension of the physical environment that surrounds them. Based on a study of teachers, administrators, and students in four schools, Poplin and Weeres (1992) reported that the depressed physical environment of schools is considered to be a reflection of society's lack of priority for students and their education.

Overall Impression

Greenman (1988) provides a source of inspiration for places where students learn. In the preface of this work he began by describing the school environment through the eyes of a student:

> My first experience as a teacher came in 1967, in a summer all day Head Start classroom located in (where else?) a church basement. I waited for my 18 four year olds to come in off the bus, putting the finishing touches on my classroom: tables with assorted activities, block corner, dress-up area, and bookshelf with colorful books. In they came, some shy, most excited. Then came Carlos, two feet tall, (plus an additional foot of attitude) and a look and bearing about him that proclaimed: here was a man among men.
>
> The other children looked up to him (figuratively speaking). Carlos coolly surveyed the room where he was to spend eight hours a day, five days a week, for the next twelve weeks. A sinister uneasiness hung in the air. I began to get nervous, because it was clear that the children were waiting for Carlos' judgment on my efforts. It came soon. "This place is dooky," Carlos Pronounced. (Carlos always pronounced; he never spoke.) Soon all the children began chanting, "This place is dooky," and I saw my summer rapidly deteriorating . . . .
>
> . . . It took me over ten years to learn all the implications of the lesson Carlos taught me. Carlos recognized at a glance that the church basement was a crummy place to spend a summer. My cheery presence and imaginative activities helped only little. Carlos knew that places are *neither containers for experience nor* simple stages for interactions between people, large and small. (p. 1)

A related experience happened to Andersen (1999), one of the researchers whose findings are utilized extensively in this study. He indicated to the writer that he could drive up to the school and predict the ITBS scores within a fair degree of accuracy. One school, in particular, had received several additions over the years and each section had different bricks to easily designate that particular addition. Even the flagpole was not near the main entrance, which could not be

readily found because of the various additions over time. That this school's students were poor performers on the ITBS came as no surprise. This was a depressing place!

This issue of overall impression obviously relates to the whole condition of the school facility. The literature is consistent in supporting the perception that the condition and location of the building consistently influences student achievement (Earthman, Cash, & Berkum, 1995).

School Enrollment Size and Student Outcomes

West (2010) conducted a study of 303 high schools in Georgia to determine if a relationship existed between the total high school population (net enrollment) and outcomes defined in terms of test scores. If a relationship existed, it was hypothesized that statistical effects might be attributed to school size. Achievement was measured by scores from the Scholastic Aptitude Reasoning Test (SAT) and Georgia High School Graduation Test (GHSGT). Data for the 2008-2009 school year were analyzed. Controlling for socioeconomic status (SES), West concluded that school size was an insignificant influence on academic achievement in the 303 Georgia schools. Supporters of both large and small schools can equally say that in Georgia, size has little to no impact on academic achievement or graduation rates.

A similar conclusion was made for middle schools from data analyzed from research by Jones (2006). She studied class size and its impact on student achievement as measured by the Georgia Report Card, but because of the extensive data set, the author was able to reanalyze her data for this meta-analysis by using the portion regarding school size and achievement. Data from the Jones' (2006) study showed no statistically significant relationship between school size and student outcomes.

On a slightly related issue Jones (2006) discovered a statistically significant correlation between the amount of square footage per student and the percentage of students that met or exceeded the Georgia reading and mathematics standards. This discovery agreed with findings by Swift (2000). The Swift study showed that when the architectural area of a school exceeded 100 square feet per student, students performed significantly better on standardized measures.

Another study of high schools was conducted by Gentry (2000) to examine the relationship between school size and students' academic achievement in Georgia's public high schools. Controlling for sampling bias and SES, students in large high schools did not score significantly higher on academic (cognitive) measures than students in smaller high schools in Georgia. Therefore, the data did not support the contention that large high schools in Georgia are better than smaller high schools. Assuming that these findings are within the "best practices" arena, one might consider that they can be extended to a larger population.

How to Interpret These Findings

The guiding principle or conceptualization that supported this study of studies was that the reader should view these findings as *best practices* that have been further validated by well-founded and accepted statistical methodology. The best practice for schoolhouse design may be classified as "rule of thumb" school facility design. Therefore, when significant findings are added, the family of designs may be used as benchmarks in creating and modifying the physical components of the educational environment. Also, a best practice can change to become even better as different school design patterns are discovered and validated through research.

All the studies herein were refereed doctoral dissertations completed at the University of Georgia, a Research I University. If findings discussed in this manuscript are extrapolated beyond the State of Georgia, we may classify them as "generalizing results from a set of statistically controlled studies whose findings are classified as best practices."

Summaries of SDPL Studies Used in This Analysis

A total of six SDPL studies were used in this meta-analysis. Various other SDPL studies were cited that had relevance to certain topics from these six studies as they emerged in the findings. In two cases raw data from the studies were utilized in partial correlations where the control variable was socioeconomic status (SES). In all SDPL studies the SES was defined as the percentage of students receiving free and reduced price lunch. Over numerous studies at SDPL, we found that SES was the best predictor of student outcomes. A summary of the six studies begins with Andersen (1999), who collected data on 50 middle schools and provided baseline procedures for studies that followed.

Andersen (1999) completed a study on the relationship between school design variables and scores on the Iowa Test of Basic Skills. This study explored one factor that historically has received little attention by educational leaders: the influence of school facilities on student achievement. More specifically, this study explored the relationship of 38 middle school design elements, identified in the literature, to student achievement as measured by the eighth grade Iowa Test of Basic Skills (ITBS). The purpose of the study was to attempt to determine if any of the 38 school design elements positively or negatively related to the ITBS scores. The setting of the study included 14 contiguous counties in central Georgia. Within those counties, 50 middles schools were identified for the sample of the study. An analysis of covariance was performed on those 50 schools to remove bias from the composite ITBS scores related to socio-economic status, race and teacher experience.

The researcher made site visits to the schools, and completed the Design Appraisal Scale for the Middle (DASM, See Appendix A). The results of the DASM were then used to determine significant correlations between the design factors and the ITBS scores. The analysis found 27

DASM design factors that had significant positive correlations to the composite ITBS scores. Seven of the design factors (Multifunctionality, Play Areas, Activity Pockets, Green Areas, Exit Doors to the Outside, Overall Impression, and Administration Centralized) entered into the prediction equation for all components of the ITBS. Based upon the results of the analysis, recommendations were made to include the seven sets of design variables in schools and give serious consideration to designing learning environments outside of the traditional classroom. It was also recommended that more attention should be given to the exterior design of school buildings.

Ayers (1999) conducted a study on the relationship between high school facilities and achievement of high school students in Georgia. This study explored the relationship of certain design features identified in the literature to student achievement as measured by the Georgia High School Graduation Test (GHSGT). The purpose of this study was to determine if a relationship existed between the selected design features and the GHSGT. The population of the study included 27 public high schools in two Regional Service Educational Area districts. Both site visits and the Internet were used to collect the data. Multiple regression analyses were conducted on the data set. Predictor variables including socio-economic status, educational background of the teachers, average number of years teaching, and the size of the student population of each school were used as variables in the equation.

The researcher completed the Design Appraisal Scale for High Schools (DASH, see Appendix A) to determine the total score for the educational facilities variable. This also was included in the regression equations as a predictor variable. Regression models were examined to determine the amount of variance that was explained by DASH. Based upon the results of the analyses, school design variables explained 6 percent of the variance related to the English and Social Studies, 3 percent of the variance related to the Science, and 2 percent of the variance related to both the mathematics and writing.

Yarborough (2001) studied the relationship of 11 design subscales (86 design elements) to elementary school students' achievement as measured by the composite reading and mathematics scores on the Iowa Test of Basic Skills (ITBS). The sample for this study was 24 elementary schools located in the West Central Georgia Regional Educational Service Area (RESA). Both site visits and the Internet were used to collect data. Multiple regression analyses were conducted and control variables included the percentage of students receiving free and reduced price lunch, average years of teaching experience, percentage of white students, percentage of students classified as other, and certification levels of the teachers. The Design Appraisal Scale Elementary (DASE, see Appendix A) was completed for each school to determine the score for the design feature subscales. This was also included in the equation as a predictor variable. Regression models revealed the amount of variance explained by the subscales of the

DASE instrument. School design variables explained 14.2 percent of the variance related to the third grade achievement scores and 9.7 percent of the variance related to the fifth grade achievement scores.

Gentry (2001) examined the relationship between school size and student academic achievement in Georgia's public high schools. The research question was: Is there a relationship between school size and academic achievement and scholastic aptitude in Georgia's public high schools as measured by the Georgia High School Graduation Tests (GHSGT) and the Scholastic Assessment Test (SAT)? The population for the study was 346 public high schools in Georgia. The unit of analysis was the school as represented by the academic data set defined as the GHSGT and the SAT. Controlling for sampling bias and SES, students in large high schools scored higher, but not significantly higher on academic (cognitive) measures than students in smaller high schools in Georgia. However, to say that overall, large high schools in Georgia are better than smaller high schools would be a stretch. In the end, all that could be said about the findings in this study was that no statistically significant difference existed!

Jones (2006) investigated the relationship of school population density to student academic achievement of middle school students in Georgia. The study utilized the interior square footage of 326 schools to determine the student population density for each school. The density of each school was determined by dividing the interior square footage of the school by the number students enrolled. Achievement was measured though scores from the Georgia CRCT for eighth grade students.

The null hypothesis for this study stated that there was no significant correlation between the amount of square footage per student and the percentage of students that met or exceeded Georgia's reading and mathematics standards. An analysis of variance, controlling for the percentage of economically disadvantaged students, was computed for reading and mathematics achievement. The null hypothesis was rejected. A statistically significant correlation was found between the amount of square footage per student and the percentage of students that met or exceeded Georgia's reading and mathematics standards. These findings also supported those made by Swift (2000).

Although this study did not address the variable of school size directly, the author of this meta-analysis analyzed the raw data set from the 2006 study by Jones to make a comparison between total school population and academic achievement. Controlling for SES, no statistically significant relationship was found between school size and student achievement.

West (2010) studied the relationship between the total high school population (net enrollment) and student outcomes measured by scores from the Scholastic Aptitude Reasoning Test (SAT) and Georgia High School Graduation Test (GHSGT). The GHSGT included English, mathematics,

science, social studies, and writing for the 2008-2009 school year. The 303 usable data sets were coded for statistical analysis and comparisons among school population and academic achievement measures were made through Pearson's r, multiple regression, and regression reduction. Alpha was set at the .05 level. Based upon the findings of this study, school size played no statistically significant difference in the measures of academic achievement. Supporters of both large and small schools can equally say that in Georgia, size has little to no impact on academic achievement or graduation rates.

Mean Effect Size

This section presents a statistical examination of studies on school design patterns and how these patterns or family of design features impact various measures of student outcomes. This body of research, portions which have been published in national and international journals, was initiated and completed at the School Design and Planning Laboratory, the University of Georgia. A main objective of this investigation was to bring common elements of these studies together with meta-analysis procedures (Ellis, 2010). Accordingly, the first order of business after categorizing the studies was to define composite reliability estimates of the Design Assessment Scales (Tanner, 1999) found in each individual study. Descriptions of the development of the instruments are found in Tanner (1999) and Tanner and Lackney (2006). Selected components of the instruments are described and explained in the overview of the studies utilized in formulating this document. The reliabilities of all the standardized instruments used in student testing were statistically equivalent, making this component a constant throughout the investigation. The following 16 classifications form the basis for analysis:

1. Movement and Circulation

Movement and circulation design patterns comprise a Likert scale, while a family of descriptors is identified as Likert items. The following cluster or set of Likert items forms the Likert scale identified as "movement and circulation":

- Outside walkways link main buildings.
- Clear comfortable pathways allow freedom of movement and orientation among and within structures and provide freedom of movement within broad and well-lit indoor spaces.
- Hallways allowing students personal space when moving within the school and supervisable circulation patterns, including ample egress, or the ability to exit directly from each classroom also are examples of this important pattern.

Each of these Likert items was normalized to define a Likert scale for each design pattern.

Keeping in mind the designs shown in *A Pattern Language* (Alexander et al., 1977), we might categorize the movement and circulation patterns studied here and represented in Table 1 as important as the rooms and spaces themselves. Furthermore, the movement patterns among spaces and places have as much effect on social interaction as the interiors of the rooms (Alexander et al., 1977, p. 628). Obviously, we must think of the school as a social system as well as a place to learn. Whether the assessment data represent a high school, middle school, or an elementary school, the design element becomes a constant across the three categories. For example, if we are evaluating *scale* as an influence on student outcomes, the number coded into the data set will be the same if each of the schools meets the criterion identified as "Appropriate = 10" or "Inappropriate = 1". Hence we are evaluating the scale of the place and not an elementary school or a high school organization.

The data in Table 1 represent three studies where movement and circulation design components were pooled to correlate with student outcomes measured on standardized instruments. For example, controlling for SES, Andersen (1999) found that the Pearson correlation of .503 was statistically significant ($\alpha = 0.05$) in a sample of 50 schools assessed with the Design Assessment Scale for Middle Schools (see Appendix A). The reliability index of the instrument was .94.

Raw data from the studies completed by Ayers (1999) and Yarborough (2001) were used to calculate partial correlations (Pearson's "r") between design variables and standardized scores. The control variable was SES. These two studies applied other statistical measures from which to make conclusions and recommendations and did not report correlations used in this meta-analysis. The Andersen (1999) study had completed the correlations, which were used as the primary guideline in selecting the design patterns to be used in this meta-analysis. The research question is: Is there a statistically significant effect of movement and circulation patterns on student outcomes?

Table 1 - Movement and Circulation Patterns

Study	r	p	n	Reliability
Andersen (1999)	.503	0.05	50	.94
Ayers (1999)	.300	0.164	24	.88
Yarborough (2001)	.267	0.219	24	.86

The diagnostic phase of meta-analysis begins by calculating *Weighted Mean Effect Size* with the following formula:

$$WMES = \frac{\Sigma\, n_i\, r_i}{\Sigma\, n_i},$$

Where the symbols n_i and r_i represent the sample size and correlation in study i. First, our attention is on *movement and circulation patterns*. Taking data from Table 1, we find that WMES = [(24x.267)+(50x.503)+(24x.300)]/ (24+50+24) = **0.395**. According to Cohen (1988), the index of "0.395" is on the upper level of the *medium* effect size classification.

Further refinement of the WMES involves the calculation of the weighted mean corrected for measurement error:

$$WMCME = [50x\ (.503/\sqrt{.94}) + 24x(.300/\sqrt{.88}) + 24x(.267/\sqrt{.86})]\ /(50+24+24) =$$

$$[(50x.5188)+(24x.3198)+(24x.2879)]/98 =$$

$$0.4135$$

Given that the corrected weighted mean is "0.4135," how much confidence can we have in this finding? By employing procedures from Ellis (2010, p. 103 – 105), the 95 percent confidence limits of the corrected weighted mean is 0.2912 to 0.5357; or the 95 percent CI = 0.4135 $\pm$ (1.96 x 0.06237). *Since this interval excludes the null value of zero, we may conclude that the weighted mean of 0.4135, corrected for measurement error, is significantly different from zero if the sample is homogeneous and Q statistic is significant.* Note the following steps.

In reviewing the probabilities in Table 1 we see that one of the three probabilities (p) was significant at the 0.05 level. This mixed finding explained back when the studies were originally completed, led to the conclusion that there is no influence on student outcomes attributed to circulation and movement patterns in school design. *By completing the WMES measurement and correction for error, we discover a strong candidate for an indicator showing that a family of ample movement and circulation patterns in a school facility has a significant influence on student achievement.*

The final verdict on this issue must be held back until one more step is completed. Given the range of the confidence interval (0.2945 to 0.5475), we need to be concerned about homogeneity of variance among the effect sizes. The Q statistic supports evidence for determining if the three studies represented the same population of school design patterns.

$Q = \sum(n_i - 1)(r_i - WMCME)^2$; where r_i is the observed correlation divided by alpha ($r/\sqrt{\alpha}$), WMCME is the expected effect sizes, and n_i is the sample size. In this study of studies $Q = 1.108$.

Consulting a standard chi–square distribution, k-1 degrees of freedom, we find that the critical value is 5.991 for 2 degrees of freedom (α = .05). Since the calculated Q (1.108) is less than the critical value we conclude that the population of effect sizes is homogeneous and that the same effect of movement and circulation patterns has been observed for all three studies. We may now say with a high level of certainty that the population of school design configurations defined as ***movement and circulation patterns*** represented by this set of samples ***influence student outcomes positively and significantly. Consider this as a best practice and we have a statistically supported finding applicable to larger populations.*** **That is, this finding will reach as far as a best practice.**

How does this finding parallel the theories of Maslow and Alexander et al., (1977)? Given that social interaction and interface with the physical environment itself are interrelated with the concept of freedom of movement and circulation patterns, it requires only a small step to assimilate these concepts from Alexander, et al., (1977) into Maslow's (1954, 1998) *belonging* and *aesthetic needs* categories. Following *physiological, safety, and security* needs of individuals, *belonging* demands a supportive and expansive atmosphere without crowding into the limits of intimacy. Since individuals need aesthetically pleasing surroundings to evolve to *self-actualization*, ample space contributes to the ability to find a refreshing place to view and enjoy the environment, of which crowding is the antithesis.

To replicate this meta-analysis use a spreadsheet to code the formulae using the data in Table 1 as a baseline and after that enter only the correlation for each new family of design characteristics found in each table.

There are two main items to review in each table. One is the confidence interval. If the confidence interval includes "0", then the game is over, even if there is a high WCMES. Remember we are looking for an effect that is significantly different from "0". Second, if the Q statistic exceeds the critical value and the confidence interval does not contain "0" the game is also over because the sample is not homogeneous.

Table 1.1 - Summary Statistics for Movement and Circulation Patterns

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3950
Weighted Corrected Mean Effect Size	WCMES = 0.4135
95% Confidence Limit	CI = 0.2945 to 0.5475
Q - Statistic	Q = 1.108
Critical Value for Q, 2 df	CV = 5.991

2. Natural Light – Patterns of Day Lighting and Views

From the late 1950s and on into the 1980s in the United States, most schools were constructed or renovated with the notion (perceived best practice), or guiding principle that windows allowing natural light in classrooms were not necessary. The arguments supporting this trend were that windows were too costly because they were not energy efficient and because students did not need to look outside while the teacher was teaching, thereby forcing them to stay focused on the lesson. These ill-informed guidelines have all but vanished in today's educational specifications.

Overall, the instruments used in the SDPL studies to evaluate natural light in the classroom guided each investigator to look for spaces that would bring natural light into the schoolroom and other important areas of the facility. Schools having windows with restricted views were negative influences, as some teachers elected to block natural light by posting various items on the windows (One classroom in the studies reported here actually had a mirror in a window, and another schoolroom had black paper plastered to the windows).

In the studies conducted by the SDPL that included the evaluation of natural light in classrooms as outlined above, we found mixed results as noted in Table 2 below. Consequently, when taking the three studies as a whole, the traditional conclusion was that we could not support the value of natural light on the influence of student performance and behavior. At best we could only say the typically mundane conclusion found in many studies; namely "further study is needed."

Table 2 reveals the consolidated data set for natural light within classrooms. One study shows a significant relationship where r = .592, α=0.05. Given the mixed results we move to the research question: Is there a statistically significant effect of natural light in classrooms with views on student outcomes?

Table 2 - Natural Light in Classrooms

Study	r	p	n	Reliability
Andersen (1999)	.592	0.05	50	.94
Ayers (1999)	.206	0.345	24	.88
Yarborough (2001)	.202	0.355	24	.86

With the application of the meta-analysis model we are able to take a closer look at the effect of natural light and views on student outcomes by calculating the weighted mean of the data set in Table 2. Therefore, WMES = [(24x.206)+(50x.592)+(24x.202)]/ (24+50+24) = 0.4020. This result shows a moderate, positive effect of natural light and views on student outcomes (Cohen, 1988), but is more exciting than the mixed results found by interpreting the probabilities found in Table 2.

In keeping with the meta-analysis model, it was necessary to complete the calculation of the *weighted mean corrected for measurement error*.

$$WMCME = [50x (.592/\sqrt{.94}) + 24x(.206/\sqrt{.88})+ 24x(.355/\sqrt{.86})]/(50+24+24)=$$

$$\{[50x(.592/.9695)]+[(24x(.206/.9381])+[24x(.202/.9274)]\}/98 =$$

$$(30.5301 + 5.2703 + 5.2277)/98 =$$

$$0.4186$$

This adjustment for error increased the effect size, but did not answer the question "is this effect statistically significant?" To add credibility and closure it was necessary to determine confidence limits for the adjusted weighted mean effect size. In accomplishing this we assumed the traditional and widely accepted 95 percent confidence interval as a standard of measure (The alpha level of .05 is used through this meta-analysis).

Ellis (2010) provides a straightforward procedure illustrated below. In keeping with the current study of natural light and views in the classroom, the following presents the *variation of sample correlation*, $v._r = \{50[(r/\sqrt{\alpha})\text{-WMCME}]^2\} + \{24[(r/\sqrt{\alpha})\text{-WMCME}]^2\}= \{24[(r/\sqrt{\alpha})\text{-WMCME}]^2\}/\{50+24+24\} = \{50[(.6106)\text{-}.4186]^2\} + \{24[(.2196)\text{- }.4186\ ]^2\}= \{24[(.2178)\text{- }.4186\ ]^2\}/98 = [1.8422+0.9510+0.9680]/98 = 3.7612/98 = .0384$

Next, the standard error $SE = \sqrt{(v._r/k)}= \sqrt{(.0384/3)} =0\ .1131$, where k is the number of cases in the analysis. The 95 percent confidence limits are determined as follows:

$95\%CI = 0.4186 \pm (1.96xSE) = 0.4186 \pm (1.96 \times 0.1131) = 0.4186 \pm (0.2216) = 0.1970; 0.6402.$

The weighted mean corrected for measurement error (0.4186) is within the confidence limits (0.1970 to 0.6402), whose range obviously excludes zero. This encourages hope that perhaps the effect of natural light and views on student outcomes in this analysis is positive and significantly different from "zero."

This finding notwithstanding, the wide confidence interval suggests that the three distributions might be heterogeneous. The Q statistic assists in determining if this suggestion is true:

$Q = \sum(n_i - 1)(r_i - WMCME)^2$; where r_i is the observed correlation divided by alpha ($r/\sqrt{\alpha}$), WMCME is the expected effect sizes, and n_i is the sample size. In this study $Q = [(50 - 1)x(.6106 - .4186)^2] + [(24 - 1)x(.219 - .4186)^2] + [(24 - 1)x(.217 - .4186)^2] = 1.805 + 0.911 + 0.928 = 3.644$.

Consulting a standard chi–square distribution, k-1 degrees of freedom, we find that the critical value is 5.991 for 2 degrees of freedom ($\alpha = .05$). Since the calculated Q (3.644) is less than the critical value we have a high level of certainty that the population of effect sizes are homogeneous, meaning the same effect has been observed in each study. With the completion of this final step in the meta-analysis, we may conclude that ***there is a statistically significant link between natural light in classrooms with views and student achievement.***

Prior to this meta-analysis, limited work conducted by the author led to speculation noting that a learning space having a view (window) overlooking life contributed positively to student learning, especially if light came into the space from at least two sides (Tanner, 1999). Alexander et al., (1977, p. 890) wrote "Rooms without a view are prisons for the people who have to stay there."

Both *physiological and aesthetic* needs from Maslow's hierarchy of needs pyramid link to views and natural light in classrooms (McMichael, 2004). Alexander et al., (1977) reveal that people occupying a place for any length of time need to refresh themselves by looking at a different place from the one they are in. This pattern matches the *physiological need* to rest the eyes by merely changing the focal length by at least 50 feet (Tanner, 2009). Living and green views such as gardens and trees support the student's *aesthetic needs*. In summary, the studies showed that views overlooking life, unrestricted views, living views, functional views, green areas, and classrooms with light from windows and skylights, plus borrowed and reflected light, have a positive impact on learning.

Table 2.1 provides a summary of the findings regarding natural light in classrooms. The format below will be repeated for each finding based on the meta-analysis procedure.

Table 2.1 - Summary Statistics for Natural Light in Classrooms

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.4020
Weighted Corrected Mean Effect Size	WCMES = 0.4186
95% Confidence Limit	CI = 0.1970 to 0.6402
Q - Statistic	Q = 3.644
Critical Value for Q, 2 df	CV = 5.991

3. Safety and Security

Safety and security issues were addressed in three studies where SDPL researchers found varied results as noted below (Table 3). These data dealt with the various issues regarding where the school is located. It did not show enough strength to make statistically consistent statements regarding the links among safety and security and student performance and behavior. At best we could only say that the findings were "mixed." Hence the meta-analysis technique was applied to see if an effect might exist.

Table 3 - Safety and Security

Study	r	p	n	Reliability
Andersen (1999)	.439	0.050	50	.94
Ayers (1999)	.230	0.290	24	.88
Yarborough (2001)	.023	0.918	24	.86

With the application of the meta-analysis model we are able to take a closer look at the effects of safety and security measures on student outcomes by calculating the weighted mean of the data set in Table 3. The weighted mean effect size, WMES, was 0.2859. This result shows a low-moderate effect of the safety and security characteristics in school design on student outcomes (Cohen, 1988). It is an improvement over the mixed results found when relying only on the probability levels found in Table 1.3.

The next step was to complete the calculation of the *weighted mean corrected for measurement error*:

$$WMCME = 0.2971.$$

This adjustment for error increased the effect size, and to move toward closure, confidence limits were needed. Through steps outlined earlier, we found that the 95 percent confidence limits are = $0.2971 \pm (1.96 \times 0.1019) = 0.4969, 0.0973$. The weighted mean corrected for measurement error (0.2971) is within the confidence limits (0.0937 to 0.4969), whose range obviously excludes zero. This allowed for a possible conclusion that safety and security measures as defined in these

studies *have a statistically significant impact on student outcomes. However, this conclusion was dependent on an acceptable Q statistic.*

Given the extensive confidence intervals, questions arose as to whether the two distributions were heterogeneous. The Q statistic was calculated to determine if this assertion were true. $Q = \sum(n_i - 1)(r_i - WMCME)^2$; where r_i is the observed correlation divided by alpha ($r/\sqrt{\alpha}$), WMCME is the expected effect sizes, and n_i is the sample size. In this study Q = 2.9551. By consulting a standard chi–square distribution, k-1 degrees of freedom, we found that the critical value is 5.991 for 2 degrees of freedom ($\alpha = .05$). Since the calculated Q (2.9551) was less than the critical value we concluded that the population of effect sizes is homogeneous ($\alpha = 0.05$). Having cleared this final hurdle, we may conclude that ***safety and security measures as defined in these three studies have a statistically significant impact on student outcomes.*** Security, belonging, safety, and confidence are levels in the Maslow triangle that must be satisfied before self-actualization can be fulfilled.

Table 3.1 - Summary Statistics for Safety and Security

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.2859
Weighted Corrected Mean Effect Size	WCMES = 0.2971
95% Confidence Limit	CI = 0.0937 to 0.4969
Q - Statistic	Q = 2.955
Critical Value for Q, 2 df	CV = 5.991

4. Display Spaces and Places for Student Artifacts and Mini-Museums

With emphasis on instructional areas and academic stimulation within the school facility, the Design Assessment Scales provide sections to measure the degree and availability of spaces for displaying student work and other artifacts. The focus is on whether the hallways and classrooms are designed to emphasize these school design patterns for exhibition spaces. The topic of mini-museums is not emphasized in the assessment scales, but when a researcher is interested in this comprehensive area for educational program enhancement, the study by Wallace (2003) is an excellent point for departure. Table 4 shows the data from three SDPL studies regarding display spaces and places.

Table 4 - Display Spaces and Places for Student Artifacts and Mini- Museums

Study	r	p	n	Reliability
Andersen (1999)	.475	0.050	50	.94
Ayers (1999)	.141	0.522	24	.88
Yarborough (2001)	.192	0.380	24	.86

In Table 4.1 we see a summary of findings from the analysis of data in Table 4. This format will be followed throughout the remainder of study, since repeating each step shown in the three cases above would soon become redundant and detract from the overall findings.

Table 4.1 - Summary Statistics for Display Spaces and Places for Mini Museums

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3239
Weighted Corrected Mean Effect Size	WCMES = 0.3375
95% Confidence Limit	CI = 0.1599 to 0.5149
Q - Statistic	Q = 2.336
Critical Value for Q, 2 df	CV = 5.991

With the statistical procedures well illustrated in the cases above, we may now focus on the data and findings for each design set. Since the findings in Table 4.1 are within the constraints of the meta-analysis, it may be concluded that ***display spaces and places for student artifacts and mini-museums influence student outcomes positively.***

Displays become an expression of a student, a teacher, and a school, revealing a clear view of goals, history, and life of the students, teachers, and the school (Alexander et al., 1977, p. 1165). Display places and spaces place the student in the self-actualization level advanced by Maslow (1954). At this level the school displays creativity and problem solving examples, moving it toward winning the acceptance of the community.

5. Storage Places for Personal Artifacts

It might strike one as somewhat outrageous to link places for secure storage to student achievement. In fact, the author was one of the first persons to raise this issue with the graduate classes as the assessment scales were being developed. It was hypothesized that having a place

in a school to call home provided students with a more secure feeling, whether it was a cubby for young students or lockers for older students. While this rationale definitely applies to teachers and school leaders that might take personal space for granted, those with an office and desks with lock, it is easy to overlook the importance of secure storage for students that are closely and constantly supervised.

In defining Likert items to represent this design element, we considered secured spaces for teachers and students to store their personal artifacts, tools, and supplies. Table 5 reveals the findings aligned with storage places for personal items.

Table 5 - Storage Places for Artifacts

Study	r	p	n	Reliability
Andersen (1999)	.468	0.050	50	.94
Ayers (1999)	.266	0.220	24	.88
Yarborough (2001)	.298	0.167	24	.86

Table 5.1 - Summary Statistics for Storage Places for Artifacts

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3769
Weighted Corrected Mean Effect Size	WCMES = 0.3944
95% Confidence Limit	CI = 0.2914 to 0.4975
Q - Statistic	Q = 0.787
Critical Value for Q, 2 df	CV = 5.991

Data in Table 5.1 show that there is a statistically significant relationship between storage places for artifacts and student performance on standardized measures. Children need places and spaces for personal artifacts that make them feel that they are needed and belong in the school environment. Maslow (1954) used the term "belongingness" to describe the pattern that human motivations generally move through. Self-actualization depends, in part, on belonging.

6. Quiet Places and Spaces for Reflection

The impact of solitary places inside and outside the classroom where students may go to pause and refresh themselves in a quiet, supervisable setting are analyzed with respect to student achievement in Table 6. It is a common belief that students need private, but supervised spaces, to reflect, read, think, do nothing, or work with technology. Do quiet places and spaces for reflection impact student achievement?

Table 6 - Quiet Places and Spaces for Reflection

Study	r	p	n	Reliability
Andersen (1999)	.478	0.050	50	.94
Ayers (1999)	.532	0.009	24	.88
Yarborough (2001)	.293	0.175	24	.86

According to calculations found in Table 6.1, the ***design family of quiet places and spaces for reflection has a statistically significant influence on student outcomes.*** Children need places that make them feel that they are needed and belong in the school environment. Maslow (1954) used the term "belongingness" to describe the pattern that human motivations generally move through. Self-actualization depends, in part, on belonging and a place for reflection to reinforce this need.

Table 6.1 - Summary Statistics for Quiet Places and Spaces for Reflection

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.4459
Weighted Corrected Mean Effect Size	WCMES = 0.4678
95% Confidence Limit	CI = 0.3642 to 0.5714
Q - Statistic	Q = 0.788
Critical Value for Q, 2 df	CV = 5.991

7. Green Spaces

"Going green" has recently become a catch phrase for teaching students how to conserve and preserve natural items in our environment. This growing body of knowledge and application is welcome; however, green spaces in the research being analyzed here refer to outside places close to the school where trees, grass, or gardens may be viewed from inside the classroom. This pattern connects to a reasonable degree on two from Alexander et al., (1977): "Connection to the Earth" (# 168,) and "Windows Overlooking Life"(# 92). It includes the views of indoor and outdoor green gardens, plants, places for animals, fountains and mountains, and nature in general – places that allow minds and eyes to take a break.

Table 7 - Green Spaces

Study	r	p	n	Reliability
Andersen (1999)	.502	0.050	50	.94
Ayers (1999)	.360	0.092	24	.88
Yarborough (2001)	.221	0.311	24	.86

In reviewing Table 7.1, it is clear that ***green spaces as defined in this study have a statistically positive impact on student outcomes.*** Reasoning for advocating views overlooking life is founded on the basic needs people have for nature and the natural outside world. This need may be manifest in a desire to experience a sense of place and a sense of belonging, which is a necessary level to reach on Maslow's (1954) triangle before one may achieve self-actualization. Alexander et al., (1977), explained a coupling among relationships identified as windows overlooking life (Pattern 192).

Table 7.1 - Summary Statistics for Green Spaces

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3984
Weighted Corrected Mean Effect Size	WCMES = 0.4165
95% Confidence Limit	CI = 0.2862 to 0.5469
Q - Statistic	Q = 1.257
Critical Value for Q, 2 df	CV = 5.991

8. Outdoor Rooms

Outdoor rooms for learning include any safe place that is not inside a building. This involves a place to watch clouds change shape and vapor trails develop after a jet plane has flown through the atmosphere. An outdoor room allows students to connect to natural surroundings. A small portion of the need for outdoor learning space may be linked to some understanding of getting away from high-density places in schools. This enhances safety and security feelings and sets the stage for self-actualization.

Table 8 reveals the data set for this design pattern. It also shows mixed findings. Table 8.1 confirms that ***there is a statistically positive impact of outdoor rooms on student achievement.***

Table 8 - Outdoor Rooms

Study	r	p	n	Reliability
Andersen (1999)	.650	0.050	50	.94
Ayers (1999)	.195	0.373	24	.88
Yarborough (2001)	.157	0.474	24	.86

Table 8.1 - Summary Statistics for Outdoor Rooms

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.4178
Weighted Corrected Mean Effect Size	WCMES = 0.4344
95% Confidence Limit	CI = 0.1614 to 0.7074
Q - Statistic	Q = 5.526
Critical Value for Q, 2 df	CV = 5.991

9. Instructional neighborhoods

Instructional neighborhoods as first experienced at Celebration School were not duplicated in any of the schools studied by the SDPL. However, bits and pieces of the design components at Celebration were used in our studies and found in the samples of schools.

All of the eight design sets above might well fit into the family of design patterns that make up an instructional neighborhood. The design components at Celebration School were incorporated throughout the Design Assessment Scales (See Appendix A) and became a teaching tool and also an evaluation instrument. The demise of the instructional neighborhood as originally perceived was a comedy of errors where the higher educational systems that were training teachers and administrators failed. The biggest folly was training teachers in a self-contained classroom and then expecting them to perform in an open space with 125 students and five teachers.

Given the collapse described above, the instructional neighborhood is still an excellent idea given properly trained teachers and administrators. This hurdle notwithstanding, outdoor rooms, green spaces, quiet places for reflection, ample storage for personal artifacts, display spaces and mini museums, flex zones, large and small group areas, and toilets within each classroom are part of the family of designs needed to produce an ideal instructional neighborhood.

The data in Table 9 are further analyzed in Table 9.1 where we find a strong WCMES. All the data found in Table 9.1 support the conclusion that ***the major components of an instructional neighborhood design has a statistically significant and positive impact on student achievement.***

Table 9 - Instructional Neighborhoods

Study	r	p	n	Reliability
Andersen (1999)	.736	0.050	50	.94
Ayers (1999)	.269	0.215	24	.88
Yarborough (2001)	.278	0.198	24	.86

Table 9.1 - Summary Statistics for Instructional Neighborhoods

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.5095
Weighted Corrected Mean Effect Size	WCMES = 0.5309
95% Confidence Limit	CI = 0.2674 to 0.7945
Q - Statistic	Q = 5.152
Critical Value for Q, 2 df	CV = 5.991

10. Technology for Students and Teachers

It is impossible to imagine the technology that will be used in schools 10 years from now. Some of the technology in use when these SDPL studies were completed have been replaced today, including compact disks, the opaque projector, and the land line telephone. Instruction is being delivered through the Internet, files are stored in "the cloud", and the study of drones for domestic use has entered the school world. ***Ample state-of-the-art technology for teachers and students makes a statistically significant contribution to student achievement*** (See data in Tables 10, 10.1, 10.2, and 10.3).

Table 10 - Technology for Students

Study	r	p	n	Reliability
Andersen (1999)	.506	0.050	50	.94
Ayers (1999)	.050	0.982	24	.88
*Yarborough (2001)	.202	0.356	24	.86

* This study combined student and teacher technology

Table 10.1 - Summary Statistics for Technology for Students

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3199
Weighted Corrected Mean Effect Size	WCMES = 0.3327
95% Confidence Limit	CI = 0.1046. to 0.5607
Q - Statistic	Q = 3.853
Critical Value for Q, 2 df	CV = 5.991

Table 10.2 - Technology for Teachers

Study	r	p	n	Reliability
Andersen (1999)	.606	0.050	50	.94
Ayers (1999)	.193	0.378	24	.88
*Yarborough (2001)	.202	0.356	24	.86

* This study combined student and teacher technology

Table 10.3 - Summary Statistics for Technology for Teachers

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.4059
Weighted Corrected Mean Effect Size	WCMES = 0.4226
95% Confidence Limit	CI = 0.1888 to 0.6564
Q - Statistic	Q = 4.054
Critical Value for Q, 2 df	CV = 5.991

11. Public Areas

Table 11 reveals the data set for this design family. Since the set of samples proved to be heterogeneous as noted in Table 11.1 (Q=7.886), we conclude that ***public areas as defined in the assessment scales do not significantly influence student achievement.*** Exactly what went against the positive references in the literature that support public areas is a function of the confidence interval as well as the low correlation in the Ayers (1999) study. This design pattern is a *best practice* without support of the SDPL studies.

Table 11 - Public Areas

Study	r	p	n	Reliability
Andersen (1999)	.681	0.050	50	.94
Ayers (1999)	.053	0.810	24	.88
Yarborough (2001)	.202	0.354	24	.86

Table 11.1 - Summary Statistics for Public Areas

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.4098
Weighted Corrected Mean Effect Size	WCMES = 0.4255
95% Confidence Limit	CI = 0.0995 to 0.7516
Q - Statistic	Q = 7.886
Critical Value for Q, 2 df	CV = 5.991

12. Color Patterns

The silent contribution that color makes to a learning environment is not fully known. This is one of the first set of studies calling attention to the importance of color and light together. The basic data set in Table 12, when analyzed revealed that ***the effect of color on student achievement is statistically significant*** (Table 12.1).

Color patterns throughout the facility can influence motivation. Hot colors encourage students to become more physically active, while cool colors tend to convey a reassuring effect.

Table 12 - Color Patterns

Study	r	p	n	Reliability
Andersen (1999)	.545	0.050	50	.94
Ayers (1999)	.162	0.459	24	.88
Yarborough (2001)	.218	0.317	24	.86

Table 12.1 - Summary Statistics for Color Patterns

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.3711
Weighted Corrected Mean Effect Size	WCMES = 0.3867
95% Confidence Limit	CI = 0.1825 to 0.5908
Q - Statistic	Q = 3.900
Critical Value for Q, 2 df	CV = 5.991

13. Climate Control

The findings regarding this design pattern set contradict the literature. The negative correlation in Table 13 influences the findings in Table 13.1, where Q = 30.363. With the large Q and a confidence interval that includes "0", the effect of 0.2954 is not significant. These studies indicate that ***climate control as defined in the assessment scales does not influence student outcomes significantly.***

Since credible studies exist as noted earlier in this analysis*, the best practices associated with climate control should be considered*. Unfortunately, this meta-analysis does not lend support to the literature on best practices for climate control.

Table 13 - Climate Control

Study	r	p	n	Reliability
Andersen (1999)	.723	0.050	50	.94
Ayers (1999)	.281	0.194	24	.88
Yarborough (2001)	-.060	0.784	24	.86

Table 13.1 - Summary Statistics for Climate Control

Meta-Analysis Component	**Index**
Weighted Mean Effect Size	WMES = 0.2907
Weighted Corrected Mean Effect Size	WCMES = 0.2954
95% Confidence Limit	CI = -0.3457 to 0.9364
Q - Statistic	Q = 30.363
Critical Value for Q, 2 df	CV = 5.991

14. Roof System as a Major Factor in School Design

Data and analysis results in Tables 14 and 14.1 do not support the proposal that the roof system is a major factor in school design that significantly influences student achievement. However, in the "Propositions and Recommendations" section found later in this document several items are listed that support this design pattern as ***"best practices."***

Table 14 - The Roof System as a Design Pattern

Study	r	p	n	Reliability
Andersen (1999)	.549	0.050	50	.94
Ayers (1999)	.072	0.745	24	.88
Yarborough (2001)	-.246	0.258	24	.86

Table 14.1 - Summary Statistics for the Roof System as a Design Pattern

Meta-Analysis Component	Index
Weighted Mean Effect Size	WMES = 0.2375
Weighted Corrected Mean Effect Size	WCMES = 0.2427
95% Confidence Limit	CI = -0.1547to 0.6402
Q - Statistic	Q = 11.698
Critical Value for Q, 2 df	CV = 5.991

15. Overall Impression

There was no information on this design pattern from Yarborough (2001), but the other studies were positive in emphasizing that overall impression is an important consideration in schoolhouse design. There is strong evidence found in Tables 15 and 15.1 to support the overall impression as a statistically significant family of design sets***. The overall impression of a school facility covers all the design patterns discussed in this document and influences student outcomes significantly.***

Table 15 - Overall Impression

Study	r	p	n	Reliability
Andersen (1999)	.821	0.050	50	.94
Ayers (1999)	.408	0.053	24	.88

Table 15.1 - Summary Statistics for Overall Impression

Meta-Analysis Component	Index
Weighted Mean Effect Size	WMES = 0.6870
Weighted Corrected Mean Effect Size	WCMES = 0.7132
95% Confidence Limit	CI = 0.4950 to 0.9314
Q - Statistic	Q = 1.862
Critical Value for Q, 1 df	CV = 3.841

Andersen (1999), one of the researchers in this study, indicated to this writer that he could drive up to the school and predict the ITBS scores within a fair degree of accuracy. One school, in particular, had received several additions over the years and each section had different bricks to easily designate that particular addition. Even the flagpole was not near the main entrance, which could not be readily found because of the various additions over time. This individual school's students were poor performers on the ITBS.

Overall impression matters and is greatly influenced by whether the school is in harmony with the community architecture and whether or not one feels that they belong there. Obviously *a sense of place* drives the motivational level of belonging. A plus feature is added when the school is also *in harmony with nature*, which means that trees and green areas abound on the site.

16. School Enrollment Size and Student Outcomes

Given a wide berth, we may classify school size as a design feature that matters. Architecture is driven by how many students a school house serves and may be considered as a school design pattern in that a large school requires different patterns for circulation, for example (loading and unloading students).

Tables 16 and 16.1 reveal that in the SDPL studies ***school size does not predict student success or failure.*** *Table* 16.1 reveals that the 95 percent Confidence limits include "Zero." We conclude that the studies revealed no statistically significant effects of enrollment size on student outcomes. The Q value indicates that the population of effect sizes is homogeneous. ***There is no statistically significant effect of school enrollment size on student outcomes as measured on standardized instruments.***

Table 16 - School Enrollment Size and Student Outcomes

Study	r	p	n	Reliability
Gentry (2000)	0.025	0.697	239	.90 *
Jones (2006)	-0.066	0.239	326	___**
West (2010)	0.041	0.482	303	.90

*http://professionals.collegeboard.com/profdownload/Test_Characteristics_of_the_SAT.pdf
** See Ellis (2010) pages 101 to 104 for details on an entry without a reliability coefficient.

Table 16.1 - Summary Statistics for School Enrollment Size and Student Outcomes

Meta-Analysis Component	Index
Weighted Mean Effect Size	WMES = 0.0066
Weighted Corrected Mean Effect Size	WCMES = 0.0068
95% Confidence Limit	CI = -0.0437 to 0.0572
Q - Statistic	Q = 0.187
Critical Value for Q, 2 df	CV = 5.991

This writer has long been in favor of small schools (600 students or less), but there is no consistent hard data to support this opinion. In fact it should not even be a best practice. One issue that stands out when considering student achievement is the amount of space within a school facility per student matters (Swift, 2000). Appendix B presents an interesting discussion of personal and public space or territoriality questions that might be used in school design. Presently, we can conclude very little about enrollment size of schools and its influence on achievement and behavior of students.

Appendix B provides one of the most popular works and most requested research efforts of the SDPL. The topic is "Minimum Class Size and Number of Students per Classroom."

Summary of the Meta-Analysis

One conclusion is straightforward from this study: Maslow's esteem needs, belonging and love needs, safety and security needs, and physiological needs may be summed up in architectural terms as "***a sense of place***." If the school provides a sense of place or makes the student feel special and wanted, then learning will be enhanced and the self-actualization level will be achieved. Given this overriding conclusion, each design pattern should be interpreted as part of a family of strategies that contributes to the enhancement of the educational facility, thereby the advancement of learning. Table 17 provides a list of statistically significant design patterns. Twelve of these classifications are statistically significant. Fifteen are also best practices. All 15 classifications are postulated to have positive effects on student outcomes.

The magnitude of student enrollment or school size, in the opinion of this author, may not be classified as significant or as a best practice. This comment is based on mixed reviews found in the massive amount of literature compiled by SDPL researchers (West, 2010; Jones, 2006; Gentry, 2000) and findings in this meta-analysis. The classification was added only to the study of design patterns because it is very controversial.

Statistical significance contributes credibility to what we know in the world of educational facility planning as "best practices." Likewise, best practices gives reliability to statistically significant effects on student accomplishments. Linking these two schools of thought together makes for the strong inferences found in this study.

Table 17 - Summary of the Findings from This Meta-Analysis

Family of Design Patterns	Statistically Significant	Best Practice
Pattern 1 – Movement and Circulation	YES	YES
Pattern 2 - Natural Light – Day Lighting and Views	YES	YES
Pattern 3 - Safety and Security	YES	YES
Pattern 4 - Display Spaces and Places for Student Artifacts and Mini-Museums	YES	YES
Pattern 5 - Storage Places for Personal Artifacts	YES	YES
Pattern 6 - Quiet Places and Spaces	YES	YES
Pattern 7 – Green Spaces	YES	YES
Pattern 8 – Outdoor Rooms	YES	YES
Pattern 9 – Instructional Neighborhoods	YES	YES
Pattern 10 – Technology for Teaching and Learning	YES	YES
Pattern 11 – Public Areas	NO	YES
Pattern 12 - Color Configurations	YES	YES
Pattern 13 - Climate Control	NO	YES
Pattern 14 - The Roof System as a Major Factor in School Design	NO	YES
15 - Overall Impression	YES	YES
16 - School Enrollment Size and Student Outcomes	N/A	N/A

Propositions and Recommendations

A Design Language for Educational Environments

Consider each pattern set in this section as a family of Likert items that relates to the various sections presented above. Within each family there are items, which may be linked to more than one set of patterns, and inside each defined pattern set there exists research-based propositions

and recommendations. This follows the same logic used by Alexander et al., (1977) in proposing "A Pattern Language" for architecture.

All 15 design sets contain information to form a language specifically for the enrichment of school architecture. They exclude, however, many mandatory or comprehensive specifications concerning structural and traditional school design requirements. The language that may evolve from these studies is not intended to diminish the importance of the basic, standard checklist of items necessary for developing a school building, but to emphasize features normally overlooked or minimized in school facility design, planning, and building. The language focus is on an affective, behavioral, and cognitive set of design concerns relevant to where students learn. These design components create a language for learning.

Although the language evolving from these sets speaks to a reduced but vitally important part of the total physical environment of a school complex, it should not be viewed as exclusively serving all dimensions of learning linked to architectural and motivational theories. Some very necessary and traditional concepts are dispersed throughout the families of patterns or design sets. The working list below is capable of generating designs necessary to increase student achievement and improve overall behavior, while touching the emotional dimension of learning through meeting cognitive and aesthetic needs. This language for developing educational environments helps connect the school facility to the affective, behavioral, and cognitive dimensions of learning – the ABCs of education.

<u>Pattern 1 – Movement and Circulation</u>

- The school's design is judged regarding its ability to enable stakeholders to enter and move freely within and around a facility.
- Walkways link main outside areas; ideally placing major activity centers at the extremes.
- The entrance is a friendly space connecting the outside world to the inside world. This age appropriate space built to the scale of the student it serves should be inviting and highly visible for students and visitors. It should evoke a 'welcome' feeling.
- Classrooms should have access to one another for sharing, and large group work. Examples may be connecting doors or collapsible walls.
- The main building has an obvious point of reference among the school's buildings in which paths and buildings connect. This design feature heightens the sense of community. An example might be a clock tower at front entrance.

- Overall, pathways are defined areas that allow freedom of movement among structures including covered walkways that are partly inside and partly outside. These play a vital role in the way people interact with buildings. Pathways may also connect buildings to one another so that a person can walk under the cover of arcades. The concept of paths with goals is relevant to movement and circulation.

- The school is adjacent to community areas like parks, playgrounds, and recreation complexes, allowing circulation among formal teaching areas and local community places.

- Indoor spaces for circulation should be well-lit allowing for freedom of movement within and among learning environments.

- Hallways and passageways within the school should allow students ample personal space when moving within the school.

- At least 50 square feet per student is recommended for each student within teaching areas (See Appendix B).

Pattern 2 - Natural Light – Day Lighting and Views

- This design pattern involves spaces, windows for example, that bring natural light into the learning environment. Windows may have some form of glare control, but should be in use (when glare is not a problem), and be without painted obstructions and other devices that restrict views. Windows should invite the outdoors inside.

- Unrestricted views (when glare is not a problem) provide a perspective to ease eye strain and bring the outside and inside worlds together.

- Sources of natural light (includes skylights and borrowed natural light, reflected light) ease the negative aspects of some man-made lighting systems.

- An acceptable design includes artificial light plus natural light from the outside, preferably on two sides of every room.

- Having natural light within a space allows views of outside spaces, close to the school building, where trees, grass or gardens may be seen [but no cars or roads].

- Windows should allow views of indoor and outdoor spaces (gardens, animals, fountains, mountains, people, etc.) These views allow minds and eyes to take a break.

- For each 100 square feet of classroom floor space, allow at least 25 to 50 square feet of window space (Alexander et al., 1977, p. 891).

Pattern 3 - Safety and Security

The studies focused primarily on a safe place, including location. General representation of indoor and outdoor environment was the overall concern, with the main question guiding the research being: Is this a safe, secure, and comfortable place to learn?

- Centrally located administrative offices help make a school a safer place for students.
- Separate age-level playgrounds are important for younger students.
- Separation of large and small children provides a sense of security and safety among young children.
- Bathrooms in classrooms help reduce fear among children as compared to gang-toilets.
- Supervisable circulation patterns offer a sense of protection and security.
- Day security systems (alarms, lights, cameras, locks) provide elevated levels of security when installed and operated properly.
- Developmentally appropriate playground equipment minimizes accidents.
- Safe playground equipment reduces hazards.
- An evening security system (alarms, lights, cameras, locks) protects property and individuals that must be in the buildings after hours.
- The site and learning environments are free of excessive non-pedestrian traffic, hazards, and noise.
- The school is not located near a landfill.
- The setback from high voltage power lines is no less than 300 feet. *Although this item was not stated or implied in the studies, it is an issue that is addressed by codes in most governments.*
- Natural or built barriers protect the school.

Patterns 4 - Display Spaces and Places for Student Artifacts and Mini-Museums

Here are two patterns that blended together and required two separate statistical analyses. Since there was overlap in logic and function, they were treated as one in the descriptor section but viewed as two in the analysis to get more specific about impact. Note there is no significant effect found in Table 4 (classroom display), hence we turned to the school as a whole to discuss

display spaces. This is probably a result in the weakness of instrumentation, and this aspect needs further study.

- To enhance a sense of place and belonging, students need selected places designed for items of a personal nature that relate to them.
- Various locations in hallways should be conducive for displaying students' work.
- Design a special space in the school entrance area for displaying artifacts of student accomplishments.
- Defined display areas in the school entrance area are conducive to displaying artifacts of school and community accomplishments.
- The school should provide selected areas to display a living expression of the students, school, and community.

Pattern 5 - Storage Places for Personal Artifacts

- Students and teachers require secured spaces to store personal belongings, tools, and supplies.
- Students must have convenient areas for storage of supplies, materials, and personal items whether it is a locker for older students or a cubby for young children.
- Teachers need storage areas within classrooms and workrooms for teaching supplies, materials, and personal items.
- Overall, the school must have small places located appropriately and designed for items of a personal nature for each student, teacher, staff member, and custodian.
- The amount of storage space is never less than 10 percent of the built area and normally 15 to 20 percent (Pattern 145, Alexander et al., 1977, p. 687).

Pattern 6 - Quiet Places and Spaces

- Students need inside and outside solitary places, easily supervised, to pause and refresh themselves in a quiet setting.
- Social spaces, inside and outside the school facility, where a small group of children may go to be alone (i.e. reading areas, quiet places, reflection areas, listening areas, etc.) enhance a sense of place, belonging, and community.

- Quiet places and spaces are referred to by Alexander et al., (1977) as child caves. Each child needs about 5 square feet, but this area should accommodate no more than 15 students (p. 928). These quiet places should be tucked away in left over spaces.

Pattern 7 – Green Spaces

- Views from inside the classroom overlooking life augment a student's emotional and physical health.

- A classroom having a garden view immediately outside and connected by a door leading from the inside to the garden area is an ideal setting to integrate the values of green space into the curriculum.

- This green space becomes a science lab and a mini farm for growing vegetables and fruits. It is a place to teach value of life by having students erect birdhouses and butterfly houses to observe change in seasons.

- Perhaps the most famous green space in America is "The Lawn and Pavilion" at the University of Virginia, a green space designed by Thomas Jefferson.

- The green space immediately outside the classroom permits the mind and eyes to take a break.

- Keep the garden area simple and allow plants to grow in a natural way without formal flowerbeds and barriers (Alexander et al., 1977, p. 803).

Pattern 8 – Outdoor Rooms

- Overall, a school facility should have defined spaces outdoors, enough like a classroom, but with the added beauties of nature.

- An amphitheater readily available for outdoor plays, performances, and presentations enhances the total learning environment.

- An outdoor room may be a small soft area such as a bench under a tree for students to work and study or relax.

- Positive outdoor spaces may be surrounded by wings of buildings and double as an outdoor classroom.

- "An outdoor space becomes a special outdoor room when it is well enclosed with walls of the building, walls of foliage, columns, trellis, and sky; and when the outdoor room, together with indoor space, forms a virtually continuous living area" (Alexander et al., 1977, p. 766). This reasoning also may extend to an outdoor classroom adjacent to an indoor classroom.

Pattern 9 – Instructional Neighborhoods

- The concept of an instructional neighborhood is linked to the original Celebration School and may be defined as we outlined it in the brief review earlier in this document. However, this is a complex space and includes many of the characteristics distributed throughout the design language for educational environments.

- Having ample classroom space is necessary in any instructional setting. Considering social distance, the best theoretical evidence calls for approximately 50 square feet per person in a classroom setting (see Appendix B).

- Ideally, an instructional neighborhood will have most of the following characteristics:

- Teacher planning areas

- Flex zones (places for multiple use)

- Small group areas

- Large group areas

- Wet areas for science

- Wet areas for art

- Hearth areas – space for reading and quiet time

- Activity pockets designed for small group work

- Toilets in classrooms

- Secured spaces for teachers and students to store their personal belongings, tools and supplies

- Walls adequate for displaying students' work

- Solitary places where students may go to pause and refresh themselves in a quiet, supervisable setting

- Social, supervisable places where a small group of children may go to be alone (i.e. reading areas, quiet places, reflection areas, listening areas, etc.)

- Classrooms that create an atmosphere of excitement for learning

- Computers which are placed within the learning environment in a manner that complements teaching and learning

- Computers and related technology as an integral part of the curriculum

Patterns 10 – Technology for Teaching and Learning

Everywhere, technology is changing at warp speed. Comparing what we expected 15 years ago for an ideal set up for integrating this knowledge and skill set into educational programs now holds only a shade of the expectations we had for technology back then. However, with this fact in mind, we still have room in facilities planning for the old, not so old, and new, since the educational community is slow to adopt change.

Considered collectively from a motivational point of view, the following elements of school design provide a sense of place and belonging for teachers and students. Proper communications facilitate safety and security. Pattern 9 assists a student in achieving self-actualization.

- Any space designed for technology use must be flexible. Considerations should be given to the structure and interior of the building to ensure that satellite and tower signals are not blocked or diverted. Before designing any structure where technology is going to be an integral part, it is wise to consult several sources. Never settle on one person or consulting firm to give advice on the future of this fast paced sector.

- Regarding the future of technology in education, consider the various changes over the past 15 years and then start looking for advice on facility design. Seeking help from several sources is strongly advised.

- A school having adequate technology provides spaces for computers that minimize glare.

- Depending on where a school is in the adoption of change process, there may be some need for direct Internet and LAN wiring to ensure data security in the management of educational operations.

- Proper wiring for connection to television is still necessary, although wireless is expected to be dominant in the future.

- Technology laboratories are necessary for the development of various research projects.

- Ceilings no less than 20 feet high are essential in laboratories that study applications of drones and robotics.

- Outside power lines should be underground on the school's campus where drone and robotic technology are being studied.

- Arrange computers in a laboratory setting where the instructor may keep students on task. The teacher should be able to view all computer stations from one centralized location. In some cases this will entail a master screen at the teaching station so the teacher can check on each student. In other situations it may be desirable to locate computers against a wall(s) of the classroom.

- Computers (including laptops), multimedia, and Internet connections are easily accessible for students and teachers.

- Teachers should have access to technology at teacher planning stations (outside the media center) for use in research and planning lessons.

- School cell phones that also serve as small computers should be issued to teachers.

- Teachers need official school phones within classrooms with authorized school identification for outgoing calls.

- It is essential for teachers to have official school phones within workrooms with formal school identification for outgoing calls.

- Teachers should have access to FAX systems in workrooms or a scanner to send documents via the computer.

- A two-way intercom system is necessary for school communications and safety.

Pattern 11 – Public Areas

While this family of design patterns has strong support in the literature, the SDPL studies did not find that these variables make a statistically significant difference in student outcomes. We cannot recommend these design patterns with a statistical and a best practices endorsement together as has been the case for the preceding 10 design patterns. However, ***the best practices outlined below and in the literature are worthy of consideration in school facility design.***

A sense of unity, community, and belonging is fostered in public spaces. This is true especially in the school environment. Spaces and places that provide these three characteristics correlate with Maslow's levels necessary to reach self-actualization. Furthermore, knowing that the school is a social system, we recognize that for mere survival, students cannot endure and prosper without constant contact among themselves.

- Public areas are inviting and comfortable settings that include ample lighting.

- A school needs an auditorium as a place for formal contact and communications.
- The need for a media center as we now know it is diminishing, trailing personal technology such as cell phones, computers, and cloud storage. Search engines are becoming dictionaries and encyclopedias. Schools of the future will need to rethink the purpose and function of their media centers.
- Commons areas provide places for casual student meetings.
- An amphitheater provides students a connection to nature as well as formal and informal communications and contact.
- The school lunchroom offers food, friendship, and a place to form relationships.
- A gymnasium is necessary for desired physical activity, sports events, communications, and development of interactions across school lines, and improvement of school unity.

Pattern 12 - Color Configurations

Our knowledge of color was very limited at the time of these original SDPL studies. Although much more information on this important topic is available today, finding a well-documented study dealing with the impact of color on learning and behavior is still elusive. Above all, when looking for the right color for a particular age group and subject matter, always consider color and lighting together. All of the propositions for color configurations assume adequate lighting.

- Different age children prefer different colors.
- Ceilings should be white or off-white.
- Young children prefer red, blue, green, violet, orange, and yellow.
- Too many high contrasts should be avoided because they can produce fatigue.
- Upper elementary classrooms should be painted with the cooler hues of blue and green.
- Secondary school students require less visual distraction and do well with the cooler hues such as pastel green or aqua.
- Paint colors should be appropriate for and conducive to learning.
- Light blues and purples have a calming effect on learners.
- Students having emotional and behavioral challenges perform best in light blue classrooms.

- Tranquil space will help emotionally and behaviorally challenged students improve academic performance.
- Consider visual stimulation as a motivational factor.
- In classrooms for younger children consider spaces for colorful displays on walls and doors (e.g. light switches, wall outlets, louvers, and surface raceways) that might be unnoticed by adults.
- Warm tones such as taupe and peach provide a relaxing atmosphere allowing learners to focus on their studies rather than the color of their environment.
- Warm tones stimulate creativity in students.
- In a well-lit classroom aim for light hue with a stronger color for the front wall.
- On hallway walls plan for light hue with bright ends.
- The lunchroom should have a light hue with bright color accents.
- Consider light tones with bright color accents in gymnasiums.

Pattern 13 - Climate Control

Given that the family of design patterns regarding climate control has strong support in the literature implies that it is vital to student performance. However, the SDPL studies did not find that this family of design elements makes a statistically significant difference in student outcomes. Based on the parameters of this study we cannot recommend these design patterns with a statistical and a best practices endorsement together. However, ***the best practices outlined below and in the literature are worthy of consideration in school facility design***.

Early on, in the field of educational facility planning, climate control was identified as a significant factor in student behavior and learning, especially the use of air-conditioning in warm climates. Research findings in the early years were mixed. Reviewing the literature and observing trends regarding climate control, the SDPL has provided the following suggestions:

- Relative humidity influences how temperatures actually feel to the skin, and should be approximately within the 50 to 60 percent range.
- Older adults prefer temperatures from 75 to 79 degrees Fahrenheit.
- Avoiding elevated temperatures above 77 degrees Fahrenheit tends to improve educational attainment for children.

- A range from 68 degrees to 77 degrees Fahrenheit is optimal, where the classroom teacher has control of a range of 7 degrees Fahrenheit.
- Quality and rate of airflow are important factors for health and learning. Local regulations often set these rates for school rooms and may differ from ASHRAE standards.
- The ideal ventilation rate for a schoolroom is 10 cubic feet per person per minute.
- See ASHRAE for suggested ventilation rates for all indoor spaces.
- Classroom teachers desire to control temperatures in each classroom in which they teach.
- Air conditioning improves student performance mostly by providing a climate in which it is easier to concentrate.
- Air conditioning tends to improve the students attitude and behavior patterns mainly due to less drowsiness and fatigue.
- A comfortable temperature of 72 degrees Fahrenheit requires a relative humidity of 60 percent.
- As the temperature of the air rises, the humidity should decrease to maintain comfort level.
- An appropriate thermal environment has a positive relationship to the learning of new concepts.
- The installation of solar heating and cooling technology moves the school toward "A Green School."

Pattern 14 - The Roof System as a Major Factor in School Design

As a design pattern the roof system was not found to be statistically significant in influencing student outcomes. ***However, this is an important element in school facilities design and should be viewed as a "best practice."*** A roof system serves as an agent of protection for the school and enhances safety and health of students and teachers. It should contribute to the esthetic qualities of a school. Flat roofs add little to aesthetics, while vaulted roof lines can draw attention to the school and add beauty to the community where it is located.

- The roofline serves as the reference point for paths and circulation patterns in the school complex.
- A roof system should make a contribution to aesthetics of the school.

- The roof system can have a direct link to the health and safety of students and teachers.
- A roof system that leaks may increase the rate of absence of teachers and students.
- A school's physical conditions has direct positive and negative effects on teacher morale, sense of personal safety sense of personal safety.
- Indoor air pollution can initiate from a failing roof system and gutters, allowing water to seep into the building.
- Leaking roofs can be a significant part of the school environment and may cause despair and frustration among teachers and students.
- The environment can affect the teachers' attitudes and abilities, and as a result, student achievement could be affected.
- Students' conduct appears to be an extension of the physical environment that surrounds them.
- A depressed physical environment of school is considered to be a reflection of society's lack of priority for students and their education.

15 - Overall Impression

- In general, the overall impression is judged on the basis of whether the learning environments are student friendly and teacher friendly.
- The overall impression involves aspects of all design patterns within the school facility.
- A majority of all the components of the basic school design patterns stand out during the site review.
- The school is in harmony with the community where it is located.
- The school is in harmony with nature.
- The school facility is built to the scale of the students it serves.
- The overall impression of the school environment may be assessed according to whether or not it gives the students, teachers, and visitors a feeling of a sense of place.
- Overall, avoid a school environment that has to be endured rather than enjoyed.

16 - School Enrollment Size and Student Outcomes

In the SDPL studies ***school size does not predict student accomplishment or failure.*** School size is not necessarily a school design pattern and may not be classified as a best practice or a statistically significant factor in student success. It was included in this list because it has been a constant question from practitioners and researchers alike since the beginning of SDPL and long before that. Only three SDPL studies have been completed on the relationship between school size and student outcomes (West, 2010; Jones, 2006; Gentry, 2000). All revealed *no statistical relationship between the size of school enrollment and student achievement*. As we have no hard evidence that school size matters, how does school enrollment size relate to school design? So, if size does not matter, a good planning strategy is to follow the relevant patterns outlined in this document and include the following concepts classified as best practices:

- Become immersed within the setting where the school is to be built prior to designing the school.
- Know all about the educational program that the school is expected to facilitate.
- Develop a design that brings a sense of place to the school.
- Bring educators and architects together often and listen to what each group is saying.
- Know what type of scheduling is going to be followed in the school.
- Allow for ample technology and flexible places.
- Keep the school in harmony with nature and the community.
- Know the teaching styles to be employed in the school and design accordingly.
- Link the learning support systems to program goals and objectives and design the school to accommodate the program objectives.
- Plan for outdoor classrooms.
- Follow the design patterns presented in this document.
- Allow aesthetics to abound in the school's design.
- Keep the scale to fit the physical size of the students.
- Use every opportunity to provide egress from each classroom to outdoor learning environment.

- Consider the values and sense of place of design revealed by the architecture of The Lawn at the University of Virginia.
- In smaller schools consider the development of a campus plan instead of one monolithic building.

Coda

Regarding the last item above, one may speculate what would the outcome have been if Columbine High School were not a monolithic structure that violated many of the design principles found in this document. Students may have been trapped with no place to go. Think about this issue when designing schools and other buildings. Locking down in a monolithic building where violence is occurring seems to violate the natural instinctive defense for life. Remaining in one classroom makes the target easy for the violator. Does building a school designed as a trap enhance safety and security issues?

Overall, this list of design patterns is devoted to a language for building a school by including the consideration of motivational components presented in Maslow's theory of human needs. Starting with Pattern 1, the school planner can move through the list (1 to 15) selecting all or some of the items from each family of patterns (even those that are considered as best practices only) and find that these pieces of the puzzle fit together to enhance existing educational specifications. Making a layer cake is an analogy where the basic layers form "best practices" of school design, while adding the cream cheese (research based designs) frosting reaches a higher level bringing closure and honors.

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Appendix A
Design Assessment Scales

This set of assessment scales was developed to be used by a professional educator, educational planner, or architect. To distribute this as a questionnaire to a large group of people would defeat the purpose unless all responders were qualified facility planners, architects, or educators trained in school facility planning.

The school facility is to be studied by a walk-through or investigated by the responder over a short time period and then evaluated on each section accordingly. It is helpful if two or more people study the facility and then collectively fill out each section. There are other creative ways to accomplish one score per school facility since the school is the unit of analysis in this category of research.

These instruments may be classified as descriptors of "Best Practices."

Design Appraisal Scale Elementary (Not a Mail Out Questionnaire*)

Version, 2000 –DASE

Name of Appraiser: _____ / Date: _____

School Name _____

Setting (Context): Urban _ Suburban _ Small City _ Rural _

Site-Acreage: _____ / Gross Sq. Footage: _____

Grades Housed: _____ /Student Capacity: _____

Number of Teaching Stations: _____ / Number of Students: _____

AC: _____ / Number of Floors: _____

Number of Mobile Units: _____

Date of Original Construction: _____/ Comments:

Remodeled/Renovated: ____

Learning Signature: _____

Total Score: _____

Instructions: Please score design patterns on the scale (1 to 10) as defined in each section. If the school does not have a specific feature, the score is "0" for that item. Place each score at the left of individual items. Design includes the way the schoolhouse is made, how it is arranged, and how the outside areas, near the school complement the curriculum.

The scale measures the degree to which each item is present in the learning environment. The following sample scale suggests that the "stronger" the element is the higher the assigned score.

Weaker <----------> Stronger

0 1 2 3 4 5 6 7 8 9 10

Place each score at the left of individual items. Design includes the way the schoolhouse is made, how it is arranged, and how the outside areas near the school complement the curriculum.

Movement Patterns

The school's design may be judged regarding its ability to enable students and teachers to enter and move freely within and around a facility.

1- _ - **Promenade** – Outside walkways linking main areas; ideally placing major activity centers at the extremes.

Ambiguous Distinct

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

2-____ – **Pathways** - Clear and comfortable pathways that allow freedom of movement and orientation among structures. These play a vital role in the way people interact with buildings. This pattern defines the overall philosophy of the layout.

Ambiguous Clear

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Circulation Patterns - Indoor spaces for circulation. The passages should be broad and well-lit allowing for freedom of movement.

3- __ within learning environments.

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

4-_____ - **Hallways** – Passageways, allowing students personal space when moving within the school. [Ample spaces – non-crowded]

Meager Space Ample Space

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

5-___. Supervisable circulation patterns [Percentage of supervisable circulation patterns: 0=0%, 1=10%, 10=100%]

6-_____ - **Egress** - Many exits from the building. The best situations are where students may exit directly from their classrooms.

None Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

7- - **Classrooms** - Exterior doors lead to a courtyard.

Lacking Extensive

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Spaces for Physically Challenged Students

Limited Unlimited

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

8-__ a. Access to Classrooms

9-__b. Access to Hallways

10-__c. Access to Lunchroom

11-____ d. Access to Gymnasium

12-____ e. Access to School Buildings

13-____ f. Access to Toilets

14-____ g. Access to Drinking Fountains

15-____ h. Access to Computer Stations

16-____ i. Access to School Grounds

17-_____ j. Access to Living Center (Teaching center)

Large Group Meeting Places

Public Areas – Spaces that foster a sense of community (unity and belonging). Inviting and comfortable settings including ample lighting.

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

18-_____a. Auditorium

19-_____b. Amphitheater

20-__c. Media center

21-__d. Commons (Spaces for casual student meeting)

22-_____e. Dining room

Historical Archives - Spaces for students to browse historical works of all cultures. Quality refers to the amount of space made available and how it blends with the setting. Accessibility is also an aspect of quality.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

23-____ d. Media Centers (Library) - Artifacts

24-_____ e. Media Centers (Library) - Documents

25-____ f. Media Centers (Library) – Literature

Architectural Design

26-____ **- Entrance Area** – A friendly space connecting the outside world to the inside world. This age appropriate space should be inviting and highly visible for students and visitors. It should evoke a 'welcome' feeling.

Not welcoming Welcoming

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

27-____-**Administration Centralized** - The main administrative offices are grouped together in a centralized area allowing for connection and convenience (Assistant principals may be located elsewhere in the school). If there are schools within a school or a campus plan, the person in charge should be readily accessible, at least for the safety of the children. (Accessibility)

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

28-____- **Reference** - Main building has an obvious point of reference among the school's buildings in which paths and buildings connect. This design feature heightens the sense of community. An example might be a clock tower at front entrance.

Obscure Obvious

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

29-_____ - **Paths with Goals** - Places designed to provide focal points when walking to particular locations. (e.g. Displays of students, work, meaningful posters, benches, or plants).

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

30-__ _ - **Intimacy Gradients** - A sequence from larger to smaller - public to private spaces. This gives the effect of drawing people into the area. Usually found in main entrances, but may be used throughout the learning environment.

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

31- - Hallways - Hallways are adequate/inadequate for displaying student work

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

32- –**Workrooms** - Workrooms locations with respect to classrooms.

Far From Classrooms Close to Classrooms

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Territoriality of Place. How comfortable the school is for the student regarding personal and social distance.

33- a. General social distance per student - The complete facility.

Close (4' - 7') Far (7'-12')

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

34- - **Ceiling Heights** - A variation of ceiling heights allowing for individual comfort and intimacy within the school. [Percentage of variation (overall) 0=0%, 1=10%,…, 10=100%]

No Variance Varying

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Daylighting and Views

Windows – Spaces bringing natural light into the learning environment. Windows may have some form of glare control, but should be in use (when glare is not a problem), and be without painted obstructions and other devices that restrict views. Windows should invite the outdoors inside.

35-____a. Views overlooking life

None Numerous

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

36-____b. Unrestricted views (when glare/curtains is/are not a problem)

Sparse Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

37-__ _c. Adequacy of natural light (includes skylights and borrowed light – natural, reflected light)

No Mixture of Lighting Ample Mixture

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

38- - **Living Views** - Views of indoor and outdoor spaces (gardens, animals, fountains, mountains, people, etc.) These allow minds and eyes to take a break.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

39-_____ - **Natural Light/ Full Spectrum** - Artificial light plus natural light from the outside, preferably on two sides of every room.

No Mixture of Lighting Ample Mixture

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Psychological Impact of Color Schemes

[Tone = Quality: Hue = A scale of perceptions ranging (circular) form red - yellow - green - blue - red]

40-____a. Classroom

Warm Hue Neutral Light Hue With Stronger Color For Front Wall

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

41 __b. Hallways

Dark Hue Neutral Light Hue With Bright Ends

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

42-___c. Lunchroom

Dark Hue Neutral Light Hue With Bright Color Accents

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

43-___d.Gymnasium

Dark Tones Neutral Light Tones With Bright Color Accents

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

44-____ - **Background Detail** – Spaces of colorful displays on walls and doors (e.g. light switches, wall outlets, louvers, and surface raceways) that might be unnoticed by adults.

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

45- __ - **Visual Stimulation** - Walls and finishes that effectively display color and vivid patterns.

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Building on Student's Scale

A place designed and built to the scale of children (e.g. Door handles or handrails low enough for children to reach to accommodate their heights.)

46- _a. Light switches

Too High/Low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

47- _c. Door handles

Too High/Low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

48 _d. Hand rails

Too High/Low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

49- _e. Shortened steps

Unsuitable Suitable

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

50-___f. Water fountains

Too High/Low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

51-____g. Views (doors/windows that allow the student to easily see the outside)

Too high/low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

52-___e. [Percentage of developmentally appropriate playground equipment: 0=0%, 1=10%,…, 10=100%]

Location of the School

53-____ - **Safe Location** – The site and learning environments are free of excessive non-pedestrian traffic and noise. Natural or built barriers may protect these areas.

Not Safe Very Safe

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

54-_____ - **Context** - The school and grounds are compatible with the surroundings and sufficient to facilitate the curriculum and programs.

Not Compatible Compatible

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

55-____ - **Harmony** - The school is "in harmony with nature." It blends with the surroundings and brings nature into the learning environments.

Does Not Blend Blends

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Instructional Neighborhoods

Places [wing(s) of the building] that include teacher planning spaces, flex zones (places for multiple use), small and large group areas, wet areas for science and art, hearth areas, and restrooms. The hearth area is a place used for reading and quiet time.

56-____a. Teacher planning areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

57-____b. Flex zones

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

58-____c. Small group areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

59-____d. Large group areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

60-____e. Wet areas for science

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

61-____f. Wet areas for art

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 1

62-____g. Hearth areas

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

63-____ - **Activity Pockets** - Spaces designed for small group work.

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

64-____. Toilets in classrooms [Percentage of toilets in classrooms: 0=0%, 1=10%,…, 10=100%]

65.____ – **Storage** – Secured spaces for teachers and students to store their personal belongings, tools and supplies.

None Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

66-____ - **Classroom Walls** - Walls are adequate/inadequate for displaying students' work.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Quiet Areas –Solitary places where students may go to pause and refresh themselves in a quiet, Supervisable setting.

67-____. Inside Places

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Private Spaces for Children – Social, Supervisable places where a small group of children may go to be alone (i.e. reading areas, quiet places, reflection areas, listening areas, etc.).

68-_. Inside

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

69-____ – **Excitement** - Classrooms create an atmosphere of excitement for learning.

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

70-____. Computers are placed within the learning environment in a manner that complements teaching and learning. Computers appear as an integral part of the curriculum.

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

71-_. General personal distance per student - The classrooms and work areas.

Close (4' - 7') Far (7'-12')

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Outside Learning Areas

72-____a. Outside Places

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

73-____b. The campus contains soft areas for the students to work.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

74-_____ **Outdoor Rooms** - Defined spaces outdoors - enough like a classroom, but with the added beauties of nature.

Lacking Extensive

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

75- ___ - **Outdoor Spaces** - Places which are defined; may be surrounded by wings of buildings, trees, hedges, fences, fields, arcades or walkways.

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

76-____- **Green Areas** - Outside spaces, close to the school building, where trees, grass or gardens may be seen [but no cars or roads].

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

77-__ - **Animal Life** - Places in a school or on the school grounds for animals to live (Includes butterfly houses, bird houses, trees, etc…). Caring for animals helps teach the students a sense of responsibility and respect (Values).

Lacking Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Instructional Laboratories

Technology for Students - Spaces with computers, compact disks, programs, learning packages, Internet connections, television, and video.

78-__b. Computer laboratories are not arranged in a rigid, institutionalized manner.

Rigid Flexible

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Music (MC) - Quality of designated spaces for music

79-____ a. Instruction

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

80-_____b. Performance

Adequate Inadequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Art (MC) - Quality of designated spaces for art.

81-____a. Instruction

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

82-____b. Display [International photo gallery]

Adequate Inadequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

83-____c. Display [Students' display areas]

Adequate Inadequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Environmental

84-____ – **Acoustics** - Control of internal and external noises levels.

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

85- _ - **Climate Control** - A system to maintain a comfortable temperature in the classroom learning environment.

Centrally Controlled Individually Controlled

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

86-__ - **Roof system** – A leaking roof can disrupt student learning.

Leaky No Evidence of Leaks

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

*I wish to thank Dr. Kathleen Yarborough for the work she did on this the development of this instrument. *CKT*

Design Appraisal Scale for the Middle School, 1999 (DASM)

Developed by

Ken Tanner and Scott Andersen

Name of Appraiser: _____ / Date: _____

School Name _____

Setting (Context – Circle One): Urban, Suburban, Small City, Rural

Number of Administrative Computers _____

Number of Computers for Teachers _____

Number of Computers for Students _____

Site-Acreage: _____ / Gross Sq. Footage: _____

Grades Housed: _____ /Student Capacity: _____

Number of Teaching Stations: _____ / Number of Students: _____

AC: _____ / Number of Floors: _____

Number of Mobile Units: _____

Date of Original Construction: _____/ Comments:

Renovation: __/ Remodeled: ___

Total Score: _____ __(Maximum Score = 820)

Instructions: Please score design patterns on the scale (1 to 10) as defined in each section. If the school does not have a specific feature, the score is "0" for that item. Place each score at the left of individual items. Design includes the way the schoolhouse is made, how it is arranged, and how the outside areas, near the school, complement the curriculum. Use the scales listed with each element to determine the score for each element.

The scale measures the ***degree*** that each item is present in the learning environment. The following sample scale suggests that the "stronger" the element is the higher the assigned score.

Weaker < ---------- >Stronger

0 1 2 3 4 5 6 7 8 9 10

The total combined score of all zones is categorized by percent of total score in the following manner:

Percent Range	Point Range	Total Score Classification
90-100	738-820	Excellent
70-89	574-737	Satisfactory
50-69	410-573	Borderline
30-49	246-409	Poor
1-29	1-245	Inadequate
0	0	Non-Existent

Zone 1 – Entry/Movement Zone

The school's design may be judged regarding its ability to enable stakeholders to enter and move freely within and around a facility.

Item - Design Elements

Score

1- **Promenade** (Maximum score 20 points) – Walkways linking main outside areas; ideally placing major activity centers at the extremes.

___a. Activity centers

Not at Extremes Located at Extremes

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Walkways

Ambiguous Distinct

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___2 – **Entrance Area** (Maximum Score = 20) – A friendly space connecting the outside world to the inside world. This age appropriate space should be inviting and highly visible for students and visitors. It should evoke a 'welcome' feeling.

_____a. Entrance

Concealed Visible

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Entrance

Not welcoming Welcoming

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

3 - **Public Areas** (Maximum score = 50) – Spaces that foster a sense of community (unity and belonging).

(Use this scale for parts a-e.)

No Sense of Community Strong Sense of Community

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___a. Auditorium

___b. Amphitheater

___c. Media center

___d. Commons (place for casual student meeting)

___e. Dining room

___4 - **Administration Centralized** (Maximum Score = 20) - Administrative offices are grouped together in a centralized area allowing for connection and convenience. If there are schools within a school or a campus plan, the person in charge should be readily accessible (at least for the safety of the children).

___a. Arrangement

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Accessibility

Restricted Extensive

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___5 – **Access to Adjacent Classrooms** – the degree to which classrooms may have access to one another for sharing, large group work. Examples may be connecting doors or collapsible walls.

Restricted Unrestricted

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___6 – **Reference** -Main building has an obvious point of reference among the school's buildings in which paths and buildings connect. This design feature heightens the sense of community. An example might be a clock tower at front entrance.

Obscure Obvious

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___7 – **Pathways** (Maximum Score = 20 points) - Clearly defined areas that allow freedom of movement among structures including covered walkways that are partly inside and partly outside. These play a vital role in the way people interact with buildings. Pathways may also connect buildings to one another so that a person can walk under the cover of arcades

___a. Pathways

Ambiguous Clear

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Pathways

0% Sheltered 100% Sheltered

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___8 – **Adjacent to Community Areas** – Indicates whether the school is adjacent to community areas like parks, playgrounds, recreation complexes, etc.

No Areas Adjacent Numerous Areas Adjacent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___9 - **Circulation Patterns** (Maximum score = 20) - Indoor spaces for circulation. The passages should be well-lit allowing for freedom of movement.

___a. Circulation **within** learning environments

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Circulation **among** learning environments

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____10 - **Hallways** – Passageways, allowing students personal space when moving within the school. [Ample spaces – non-crowded]

Meager Space Ample Space

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

Zone 1 Total Score (Total Score of items 1-10, _____

Maximum Score = 190)

Zone 2- **Work Zone**

___11 –**Scale** (Maximum score = 70) - A place designed and built to the scale of middle school children (e.g. Door handles or handrails low enough for children to reach to accommodate their heights.)

___a. Light switches - height

Unsuitable Suitable

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Seats fit children - size

Unsuitable Suitable

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___c. Door handles

Too high/low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___d. Hand rails

Too high/low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___e. Steps

Poor Scale Excellent Scale

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___f. Water fountains

Too High/Low Appropriate Height

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___g. Views (doors/windows that allow the student to easily see outside the classroom)

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____12 - **Instructional Neighborhoods** (Maximum Score = 70) – Places [wing(s) of the building] that include teacher planning spaces, flex zones (places for multiple use), small and large group areas, wet areas for science and art, hearth areas, and restrooms.

_____a. Teacher planning areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Flex zones – multiple use

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___c. Small group areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___d. Large group areas

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___e. Wet areas for science

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___f. Wet areas for art

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___g. Hearth areas (quiet spaces for reading)

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___13 – **Multifunctionality** – measures how versatile the facility is in relation to the different tasks it can accomplish.

Rigid Versatile

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___14 - **Play Areas** (Maximum Score = 30) - Special places where children are given the opportunity to be together, use their bodies, build muscles, and test new skills. Using imagination and releasing energy are two important activities seen in these areas.

___a. Activities

Uniformity Variety

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Size

Area Too Small Plenty of Space

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___c. Imagination

No Imagination Stimulation Excites Imagination

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___15 - **Activity Pockets** - Spaces designed for small group work.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___16 - **Safe Place** (Maximum score = 80) – The indoor and outdoor environments guarantee students and teachers secure and comfortable places to learn.

(Use this scale for parts a-h.)

Safety in Question No Safety Concerns

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___a. Separate age-level playgrounds

___b. Separation of large and small children

___c. Bathrooms in classrooms

___d. Supervisable circulation patterns

___e. Day security system (alarms, lights, locks)

___f. Developmentally appropriate playground equipment

___g. Safe playground equipment

___h. Evening security system (alarms, lights, locks)

_____Zone 2 Total Score (Total Score of items 11-16)

Zone 3- **Storage Systems**

___17 – **Storage** (Maximum Score = 20) – Secured spaces for teachers and students to store their personal belongings, tools and supplies.

_____ a. Student storage

None Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____ b. Teacher storage

None Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___18 - **Personal Artifacts** – Small places designed for items of a personal nature that relate to each student.

None Numerous

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____**Zone 3 Total Score** (Total Score of items 17-18)

Zone 4- **Display and Mini-Museums**

___19 - **Classroom Walls** - Walls are conducive for displaying students' work.

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___20 - **Hallway Display** - Hallways are favorable for displaying student work .

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____**Zone 4 Total Score** (Total Score of items 19-20)

Zone 5- **Living Thing**

___21 – **Windows** – (Maximum score = 30) Spaces bringing natural light into the learning environment. Windows may have some form of glare control, but should be in use (when glare is not a problem), and be without painted obstructions and other devices that restrict views. Windows should invite the outdoors inside.

___a. Views overlooking life

None Numerous

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Unrestricted views (when glare is not a problem)

Sparse Ample

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___c. Adequacy of natural light (includes skylights and borrowed light natural, reflected light)

Low Degree High Degree

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___22 - **Natural Light/ Full Spectrum** - Artificial light plus natural light from the outside, preferably on two sides of every room.

No Mixture of Lighting Ample Mixture

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____23 - **Green Areas** - Outside spaces, close to the school building, where trees, grass or gardens may be seen [but no cars or roads].

Non-existent Plentiful

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___24 - **Living Views** (Maximum Score = 20) - Views of indoor and outdoor spaces (gardens, animals, fountains, mountains, people, etc.) These views allow minds and eyes to take a break.

_____ a. Indoor living views

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____ b. Outdoor living views

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____**Zone 5 Total Score** (Total Score of items 21-24)

Zone 6 - **Soft Areas**

___25 - **Quiet Areas** (Maximum score = 20) – Solitary places where students may go to pause and refresh themselves in a quiet setting.

___a. Inside Places

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Outside Places

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___26 - **Private Spaces for Children** (Maximum score = 20) – Social places where a small group of children may go to be alone (i.e. reading areas, quiet places, reflection areas, listening areas, etc.).

___a. Inside

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___b. Outside

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____Zone 6 Total Score (Total Score of items 25-26)

Zone 7 – **Teacher Areas**

___27 –**Workrooms** - Workrooms are near classrooms.

Far From Classrooms Close to Classrooms

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____Zone 7 Total Score (Total Score of item 27)

Zone 8 – **Technology**

___28 –**Technology for Students** (Maximum score = 30) - Spaces with computers, compact disks, programs, learning packages, internet connections, television, and video.

_____a. Computer spaces

Inhibits Learning Promotes Learning

< ---------- >

0 1 2 3 4 5 6 7 8 9 1

___b. Computer arrangement

Rigid Flexible

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___c. View of computers by teacher

Not visible Clearly Visible

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___29 – **Technology for Teachers** – Computers (including laptops), multimedia, and Internet connections are easily accessible. Teachers have access to technology (outside the media center) for use in research and planning lessons.

No Access Easy Access

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___30 – **Communications** (Maximum score = 50) – facilitate the flow of information in many forms.

(Use the following scale for parts a – e.)

Inadequate Adequate

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___a. Phones within classrooms

___b. Two way intercom system

___c. Phones in teachers' workrooms

___d. Fax in teachers' workrooms

____e. Classrooms wiring for networking and internet.

_____Zone 8 Total Score (Total Score of items 28-30)

Zone 9 – **Indoor/Outdoor Relationships**

___31 – **Outdoor Rooms** - Defined spaces outdoors - enough like a classroom, but with the added beauties of nature.

Lacking Extensive

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____32 – **Exit Doors to Outside** – These doors allow easy access to outside environment and learning areas.

Lacking Extensive

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____Zone 9 Total Score (Total Score of items 31-32)

Zone 10 – **Environmental**

___33 – **Acoustics** (Maximum Score = 20) - Control of internal and external noises levels.

_____ a. Internal classroom sound quality

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____ b. External noises

Distracting Not Distracting

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___34 - **Climate Control** - A system to maintain a comfortable temperature in the classroom learning environment that is controlled at the lowest level.

Poor Excellent

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___35 - **Roof system** – A leaking roof can disrupt student learning.

Leaky No Evidence of Leaks

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____Zone 10 Total Score (Total Score of items 33-35)

Zone 11 – **Aesthetics**

_____36 – **Paint** (Maximum score = 20 points)

_____ a. Paint quality – is the paint fresh and well maintained

Low High

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____ b. Paint color –the colors are appropriate and conducive to learning.

WARM (reds and oranges) COOL
(Blues, greens, neutrals and white)

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___37 - **Ceiling Heights** - A variation of ceiling heights allowing for individual comfort and intimacy within the school.

No Variance Varying

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

___38 - **Overall Impression** – Judged on the basis of whether the learning environments are student friendly and teacher friendly. This involves aspects of all design patterns.

Poor Facility Superior Facility

< ---------- >

0 1 2 3 4 5 6 7 8 9 10

_____Zone 11 Total Score (Total Score of items 36-38)

Design Appraisal Scale for High Schools- I – 2012

Developed by
SDPL and Dr. Patti Ayers, University of Georgia

(DASH - I)

Name of Appraiser: _____ Date: _____
School Name: _____
Size of School:
Number of Students: _____
Number of Teachers: _____
Grade Levels: _____
Site Acreage: _____
Gross Square Footage: _____
Number of Mobile Units: _____
Date of Original Construction: _____ Renovation: _____

Remodeled: _____

Comments:

Score: _____

Instructions: Please score each design item on the scale (1 to 10) as defined in each section. If the school does not have a specific feature, the score is "0" for that Likert item. Place each score at the left of individual items. Design includes the way the schoolhouse is made, how it is arranged, and how the outside areas, near the school complement the curriculum.

The scale measures the degree to which each item is present in the learning environment. The following sample scale suggests that the "stronger" the element is the higher the assigned score.

Weaker <----------> Stronger
0 1 2 3 4 5 6 7 8 9 10

The total combined score of all sections is categorized by percent of total score in the following manner:

Percent Range	Point Range	Total Score Classification
90 -100	936 - 1040	Excellent
70 - 89	728 - 935	Satisfactory
50 - 69	520 - 727	Borderline
30 - 49	310 - 519	Poor
1 - 29	1 - 309	Inadequate
0	0	Non-Existent

DASH - I

Entrance Area - A friendly space connecting the outside world. This age appropriate space should be inviting and highly visible for students and visitors. It should evoke a "welcome" feeling.

1._____ a. Visibility of the main entrance to the school building

Hidden — Obvious as main entrance

<---------->

0 1 2 3 4 5 6 7 8 9 10

2._____ b. Entrance to the main office area is inviting

Area is not Welcoming — Area is inviting

<---------->

0 1 2 3 4 5 6 7 8 9 10

3. _____ **Campus Design** - Schools can be designed in a way that allows for student growth to occur. The type of design used as well as the layout of buildings and rooms determine whether or not building additions can be made to the school such that they are still functional and in context.

Inadequate building space. Additions are not possible. — Adequate space, functional design, expandable

<---------->

0 1 2 3 4 5 6 7 8 9 10

4. _____ **Reference** - Main building has an obvious point of reference among the school's buildings in which paths and buildings connect. This design feature heightens the sense of community and stimulates students' imagination. An example might be a clock tower at the front entrance.

Obscure — Obvious

<---------->

0 1 2 3 4 5 6 7 8 9 10

Outside Pathways - Clearly defined areas that allow freedom of movement among structures including walkways. These play a vital role in the way people interact with buildings. Pathways may also connect buildings to one another so that a person can walk under the cover of arcades.

5._____ a. Ground coverings

Dirt worn — Paved

<---------->

0 1 2 3 4 5 6 7 8 9 10

6._____ b. Sheltering

No pathways are covered — All pathways are covered

<---------->

0 1 2 3 4 5 6 7 8 9 10

Administration Centralized - Administrative offices are grouped together in a centralized area allowing for connection and convenience. If there are schools within a school or campus plan, the person in charge should be readily accessible (at least for the safety of the children).

7. _____ a. Arrangement of Offices and Office Area

Poor — Excellent (Functional arrangement/floor plan

<---------->

0 1 2 3 4 5 6 7 8 9 10

8. _____ b. Accessibility of Administrative Offices

Located at remote section of campus — Centrally located

<---------->

0 1 2 3 4 5 6 7 8 9 10

Major Activity Centers -

9._____ a. Media Center (Accessible)

Located at Extremes — Centrally located

<---------->

0 1 2 3 4 5 6 7 8 9 10

10._____ b. Lunchroom

Centrally located — Located at extremes

<---------->

0 1 2 3 4 5 6 7 8 9 10

11. _____ c. Auditorium

Centrally located — Located at extremes

<--->
0 1 2 3 4 5 6 7 8 9 10

12. _____ d. Gymnasium

Centrally located — Located at extremes

<--->
0 1 2 3 4 5 6 7 8 9 10

13. _____ **Inside Paths with Goals** - Places in the hallways designed to provide focal points when walking to particular locations. (e.g. meaningful posters, benches, or plants).

Ambiguous — Obvious

<--->
0 1 2 3 4 5 6 7 8 9 10

14. **_____ Hallways** - Passageways, allowing students personal space when moving within the school. (Ample spaces means non-crowded)

Meager space — Ample Space (meets or exceeds current standards)

<--->
0 1 2 3 4 5 6 7 8 9 10

15. _____ **Hallway Display:** Hallways are favorable for displaying student work.

No mounting devices or display areas exist — Mounting devices and displays areas exist in every hallway

<--->
0 1 2 3 4 5 6 7 8 9 10

16. _____ **Intimacy Gradients** - A sequence of hallways and open spaces from larger to smaller, public to private spaces, giving the effect of drawing people into the area. These are usually found in main entrances, but may be used throughout the learning environment.

None - all areas have same dimensions — Variations in size located throughout

<--->

0 1 2 3 4 5 6 7 8 9 10

17. _____ **Ceiling Heights** - A variation of ceiling heights allowing for individual comfort and intimacy within the school.

No variance Variations throughout

<---------->

0 1 2 3 4 5 6 7 8 9 10

Lunchroom Atmosphere - An inviting setting, including ample lighting and space, allowing students to eat comfortably; gives students a sense of worth and value.

18._____a. Natural Lighting

Dark No artificial light needed

<---------->

0 1 2 3 4 5 6 7 8 9 10

19. _____ b. Availability of Room for Dining

Crowded Open, spacious

<---------->

0 1 2 3 4 5 6 7 8 9 10

20. _____ c. Paint

Warm colors Cool colors

<---------->

0 1 2 3 4 5 6 7 8 9 10

21. _____ **Classroom Display:** Classroom walls and other areas in the classroom are conducive for displaying students' work.

No mounting devices or display areas exist

Mounting devices and display areas exist in every classroom

<---------->

0 1 2 3 4 5 6 7 8 9 10

Arrangement of Classroom Furniture - The design and set up of the classrooms should be flexible and spacious enough to allow for freedom of movement.

22. _____ a. Circulation within learning environments such as classrooms

Poor (too little space for movement) Excellent (very spacious)

<---------->
0 1 2 3 4 5 6 7 8 9 10

23. _____ b. Flexibility of the classroom furniture for large and/or small groups within classrooms.

Movement of furniture is restricted due to space or type of furniture Furniture is easily movable and has a flexible arrangement

<---------->
0 1 2 3 4 5 6 7 8 9 10

Wet Areas in the classrooms - Wet areas allow for various types of activities and experiments to take place indoors. This includes sinks, floor drains, and areas of the room designed where students could work with water

24. _____ a. Wet areas for science

Inadequate (no sinks, etc.) Size and quantity are adequate

<---------->
0 1 2 3 4 5 6 7 8 9 10

25. _____ b. Wet areas for art

Inadequate (no sinks, etc.) Size and quantity are adequate

<---------->
0 1 2 3 4 5 6 7 8 9 10

26. _____ **Science Labs -** Access to various types of up-to-date equipment is needed for increased learning

No equipment — Gas, water, electricity, technology available in all labs

<---------->
0 1 2 3 4 5 6 7 8 9 10

Technology for students - Spaces with computers, compact disks, programs, learning packages, Internet connections, television, and video.

27._____ a. Computer accessibility for students during school day

None or not accessible — Accessible and available in each classroom

<---------->
0 1 2 3 4 5 6 7 8 9 10

28. _____ b. Computer arrangement

Rigid — Flexible

<---------->
0 1 2 3 4 5 6 7 8 9 10

29. _____ c. View of computer screens by teacher from one location

Not visible — All clearly visible

<---------->
0 1 2 3 4 5 6 7 8 9 10

Technology for Teachers - Computers (including laptops), multimedia, and Internet connections should be easily accessible. Teachers should have access to technology (outside the media center) for use in research and planning lessons.

30. _____ a. At School

A computer in each

classroom with
No access Internet connections
<---------->
1 2 3 4 5 6 7 8 9 10

31. _____ b. Outside of School

No access Laptops available
connection to take home for
school use
<---------->
0 1 2 3 4 5 6 7 8 9 10

Storage - Secured spaces for teachers and students to store their personal belongings, tools, and supplies.

32._____ a. Student Storage (lockers in hallways and/or areas in the classroom)

None Ample/Functional
<---------->
0 1 2 3 4 5 6 7 8 9 10

33. _____ b. Teacher Storage (in classroom and/or workroom)

None Ample/Functional
<---------->
0 1 2 3 4 5 6 7 8 9 10

Communications - Flow of information. (Use the following scale for parts a-e)

None All
<---------->
0 1 2 3 4 5 6 7 8 9 10

34. _____ a. An outgoing phone line connection within each classroom
35. _____ b. A two way intercom system within each classroom
36. _____ c. An outgoing phone line in each teacher workroom
37. _____ d. A fax in each teacher workroom

38. _____ e. All classrooms are wired for networking and Internet

39. _____ **Teacher planning areas** - Places where teachers can plan and work (not classrooms).

Inadequate (no planning areas) — Adequate and convenient (1 per 5 teachers)

<---------->
0 1 2 3 4 5 6 7 8 9 10

40. _____ **Flex zones** - Areas of the building that can be rearranged for multiple use, large and small areas

None — Adequate (1 per 100 students)

<---------->
0 1 2 3 4 5 6 7 8 9 10

41. _____ **Acoustics of Classroom**- Control of internal and external noise levels

Poor — Excellent (no disturbance)

<---------->
0 1 2 3 4 5 6 7 8 9 10

42. _____**Climate Control -** A system to maintain a comfortable temperature in the classroom learning environment that is controlled at the lowest level.

Poor non-functioning — Excellent (teacher controlled)

<---------->
0 1 2 3 4 5 6 7 8 9 10

43. _____ **Furniture -** Condition of classroom furniture may affect achievement

Severely damaged and/or scarred — New/excellent condition

<----------->
0 1 2 3 4 5 6 7 8 9 10

44. _____ **Roof System** - A leaking roof can disrupt student learning.

Leaky No evidence of Leaks
<----------->
0 1 2 3 4 5 6 7 8 9 10

45. _____ **Visual Stimulation** - walls and finishes should effectively display color and vivid patterns

None or Poor condition — Colorful and visually stimulating
<----------->
0 1 2 3 4 5 6 7 8 9 10

Paint Color - The colors are appropriate and conducive to learning.

46. _____ a. Classrooms

Warm colors (Reds and oranges) — Cool colors (blues, greens neutrals, and white)
<----------->
0 1 2 3 4 5 6 7 8 9 10

47. _____ b. Hallways

Warm colors (Reds and oranges) — Cool colors (blues, greens neutrals, and white)
<----------->
0 1 2 3 4 5 6 7 8 9 10

48. _____ c. Other areas

Warm colors — Cool colors (blues, greens

(Reds and oranges) neutrals, and white)

<----------->

0 1 2 3 4 5 6 7 8 9 10

Quiet Areas -Solitary places where students may go to pause and refresh themselves in a quiet setting.

49. _____ a. Inside places

None Area available in every classroom

<----------->

0 1 2 3 4 5 6 7 8 9 10

50. _____ b. Outside places

None One per grade level

<----------->

0 1 2 3 4 5 6 7 8 9 10

51. _____ **Windows/Skylights in Classrooms -** Spaces bringing natural light into the learning environment. Windows may have some form of glare control, but should be in use (when glare is not a problem), and be without painted obstructions and other devices that restrict views. Windows should invite the outdoors inside.

None Available in every classroom

<----------->

0 1 2 3 4 5 6 7 8 9 10

52. _____ **Natural Light/ Full Spectrum** - Artificial light plus natural light from the outside, either from windows or skylights

No mixture of lighting Ample Mixture

<----------->

0 1 2 3 4 5 6 7 8 9 10

Views of Nature - Views of indoor and outdoor spaces (gardens, animals, fountains, mountains, people, etc.). These views allow minds and eyes to take a break.

53. _____ a. Indoor living views

Inadequate (no living views) — Adequate (when adjacent to, learning environments overlook living views)

<---------->

0 1 2 3 4 5 6 7 8 9 10

54. _____ b. Outdoor living views

Inadequate (no living views) — Adequate (when adjacent to, learning environments overlooking living views)

<---------->

0 1 2 3 4 5 6 7 8 9 10

55. _____ **Animal Life** - Places in a school or on the school grounds for animals to live (includes butterfly houses, bird houses, trees, etc.) Caring for animals helps teach students a sense of responsibility and respect (values).

None — Adequate

<---------->

0 1 2 3 4 5 6 7 8 9 10

56. _____ **Outdoor Rooms** - Defined spaces outdoors, enough like a classroom, but with the added beauties of nature.

Non-existent — Several areas available

<---------->

0 1 2 3 4 5 6 7 8 9 10

57. _____ **Exit Doors to Outside** - These doors allow easy access to outside environment and learning areas.

Lacking — Extensive (1 per classroom)

<----------->

0 1 2 3 4 5 6 7 8 9 10

58. _____ **Adjacent to Community Areas** - Indicates whether the school is adjacent to community areas like parks, playgrounds, recreation complexes, etc.

No areas adjacent — Numerous areas adjacent

<----------->

0 1 2 3 4 5 6 7 8 9 10

Public Access Areas - Spaces that foster a sense of community (unity and belonging) and allow for public access without opening the entire school.
(use this scale for parts a - e)

Access involves opening entire school — Easily accessible without opening entire school

<----------->

0 1 2 3 4 5 6 7 8 9 10

59. _____ a. Auditorium
60. _____ b. Amphitheater
61. _____ c. Media Center
62. _____ d. Commons (place for casual student meeting)
63. _____ e. Lunchroom
64. _____ f. Gymnasium

Safe Place - The indoor and outdoor environments guarantee students and teachers secure and comfortable places to learn. (Use this scale for parts a - e)

Safety in question — No safety concerns (all measures have been taken)

<--->
0 1 2 3 4 5 6 7 8 9 10

65. _____ a. Separation of younger and older children (when appropriate such as lunch, class changes, etc.)
66. _____ b. Bathrooms in classrooms or near classrooms
67. _____ c. Supervisable circulation patterns throughout campus
68. _____ d. Day security system (alarms, lights, locks, video surveillance)
69. _____ e. Evening security system (alarms, lights, locks, video surveillance)

70. _____ **Egress** - Many exits from the building. The best situations are where students may exit directly from their classrooms.

Limited < ---------- > Very Ample
1 2 3 4 5 6 7 8 9 10

Graffiti - Is graffiti commonly found on school property?

71. _____ a. Location

Every building inside/outside ... None
<--->
0 1 2 3 4 5 6 7 8 9 10

72. _____ b. Frequency

Every day ... Never
<--->
0 1 2 3 4 5 6 7 8 9 10

73. _____ **Context -** The school and grounds are compatible with the surroundings and sufficient to facilitate the curriculum and programs.

Does not blend with surroundings ... School blends in with surroundings
<--->

0 1 2 3 4 5 6 7 8 9 10

74. _____ **Learning Signature** - The school's focus and passion.

Ambiguous Clear

<---------->

0 1 2 3 4 5 6 7 8 9 10

MULTICULTURAL ASPECTS OF SCHOOL DESIGN

Territoriality of Place. How comfortable the school is for the student regarding personal and social distance.

75._____a. General social distance per student - The complete facility.

Close (4' - 7') < --------- > Far (7'-12')

<---------->

1 2 3 4 5 6 7 8 9 10

76._____b. General personal distance per student - The classrooms and work areas.

Close (1.5'- 2.5') < --- > Far (2.5'- 4')

<---------->

1 2 3 4 5 6 7 8 9 10

Psychological Impact of Color Schemes [Tone = Quality: Hue = A scale of perceptions ranging (circular) form red - yellow - green - blue - red]

77._____a. Classroom Walls (White Ceilings)

Warm Hue < --- Neutral --- > Cool Hue With Stronger Color for Front

<---------->

1 2 3 4 5 6 7 8 9 10

78._____b. Hallways

Dark Hue < --- Neutral --- > Light Hue
With Bright Ends

<---------->

1 2 3 4 5 6 7 8 9 10

79. _____c. Lunchroom

Dark Hue < --- Neutral --- > Light Hue with Bright
Color Accents

<---------->

1 2 3 4 5 6 7 8 9 10

80._____d.Gymnasium

Dark Tones < --- Neutral --- > Light Tones with Bright
Color Accents

<---------->

0 1 2 3 4 5 6 7 8 9 10

Music - Quality of designated spaces for music

Low < ---------- > High

1 2 3 4 5 6 7 8 9 10

81._____a. Instruction

82._____b. Performance

Art - Quality of designated spaces for art.

Low < ---------- > High

1 2 3 4 5 6 7 8 9 10

83._____a. Instruction

84._____b. Display [International photo gallery]

85._____c. Display [Students' display areas]

Historical Archives - Spaces for students to browse historical works of all cultures. Quality refers to the amount of space made available and how it blends with the setting. Accessibility is also an aspect of quality.

Low Quality < ---------- > High Quality
1 2 3 4 5 6 7 8 9 10

86._____a. Classrooms - Artifacts

87._____b. Classrooms - Documents

88._____c. Classrooms - Literature

89._____d. Media Centers (Library) - Artifacts

90._____e. Media Centers (Library) - Documents

91._____f. Media Centers (Library) - Literature

92._____g. Classrooms - Computer Stations designated for reviewing historical works

93._____h. Media Center (Library) - Computer Stations designated for review in historical works

Spaces for Physically Challenged Students

Limited < ---------- > Unlimited
1 2 3 4 5 6 7 8 9 10

94._____ a. Access to Classrooms

95._____ b. Access to Hallways

96._____c. Access to Lunchroom

97._____d. Access to Gymnasium

98._____e. Access to School Buildings

99._____f. Access to Toilets

100._____g. Access to Drinking Fountains

101._____h. Access to Public Telephones

102._____i. Access to Computer Stations

103._____j. Access to School Grounds

105-_____k. Access to Living Center (Teaching Center)

106._____- Overall **Impression** - Judged on the basis of whether the learning environments are student friendly and teacher friendly. This involves all aspects of all design patterns.

Poor facility Superior facility

<---------->

0 1 2 3 4 5 6 7 8 9 10

***Final Note about Instruments**:

So, you reviewed these 275 items (many redundant) and said, "no way." But wait, these instruments are designed to be used by professionals who agree on what a poor facility or a superior facility is, for example. That is why it was emphasized earlier that the instruments are not "mail out" or "SurveyMonkey" types. They were designed for use by professional planners and educators that have special formal, graduate level or post graduate level training in school facility planning.

Instruments were designed for face, content, and criterion-related validity. Then the reliability index was held to the standard of 0.70 or higher. That explains the variation of reliability readings in the three sets shown in the meta-analysis. In the process certain concepts and phrases were dropped to improve reliability. Others were clarified and retested.

One successful approach to establishing reliability used in SDPL was to train the graduate level students on the instruments'' content, go to a facility, walk through, rate the school on the Likert

items, and return to class and calculate reliability of the instrument. We kept doing this until it met a standard above 0.70. We used test-retest and Cronbach's Alpha when doing research on the Likert items in the questionnaires. The middle school instrument best illustrates this concept.

Obviously many identical items appear in all three studies. So being redundant was of no concern in this meta-analysis. This writer was responsible for the training of the raters and development of the instruments.

CKT

Appendix B

Retrieved June 20, 2015 from:
http://sdpl.coe.uga.edu/territoriality.html

Minimum Classroom Size and Number of Students Per Classroom:

by
C. Kenneth Tanner
The University of Georgia
School Design and Planning Laboratory
April, 2000
Revised Findings and Conclusions: September 1, 2009

Overview of the Problem

One of the most frequently asked questions that I get from individuals interested in the schools' physical environment is: What size should the classroom be? This is a difficult question because there are many social, educational, and cultural variables that come into the equation. Instead of answering this question directly, let's look at the main problem.

Size and specifications are adequately addressed in the classic works of Hawkins and Lilly (1998) and Castaldi (1994). However, as I review schools and achievement of students from a research standpoint, my conclusion is that the major problem may not be size, but density. How many students should we place within a given space? That is the research question.

We assume that an important factor in achievement is the number of square feet per student. So we should plan for large media centers, dining halls, and courtyards that can serve as important meeting places for students and teachers and help establish identities for schools. Special areas such as science rooms, art rooms, and shops also require more space than the equation we are going to explore in this article. Most importantly of all, the curriculum (activities for learning) should be the dictator of space needs for a classroom. Because the issue of space is complex, the findings presented here should be applied only as minimum guidelines for traditional classroom activities such as lecture and small group activities, with computer

terminals arranged along the walls of the classroom. In addition, evidence is pointing to natural light and outdoor learning areas adjacent to classrooms (especially in elementary schools) as factors in learning. For example, the basic classroom should have at least 72 Square feet (6.70 Square Meters) of windows for natural light, These classrooms should have views overlooking life and an exit door to the outside learning environments (Tanner, 2000). Recent research on daylighting is provided by the Heschong Mahone Group (2000). Ample egress makes sense in light of the trends in school violence (the students and teachers need to be able to get out of harm's way quickly).

Research Based on the Concept of Social Distance

What do researchers say about space needs? Abramson (1991) found higher achievement in schools with adequate space and further noted that if those larger spaces were used for instructional purposes the achievement was even greater. The lesson is clear. Students need ample space because crowding causes problems. For example, a high-density school influences achievement negatively. The effects of high density were summarized by Wohlwill and van Vliet (1985). "It appears as though the consequences of high density conditions that involve either too many children or too little space are: excess levels of stimulation; stress and arousal; a drain on resources available; considerable interference; reductions in desired privacy levels; and loss of control (pp. 108-109).

If we conclude that students need space and crowding is bad, it is our job as school planners and designers to provide an equation for architects and decision makers. This issue may be viewed through the psychological implications from the study of territoriality of place according to Banghart and Trull (1973). We know that the student is always dependent on the environment for psychological and sociological clues. The student is always interacting with the physical environment. Since the school is a social system within the cultural environment, we may consider social distance as a means for calculating minimum size of the classroom. The lower middle range for social distance in man and woman is 7 feet (Banghart & Trull, 1973, p. 233). With this guideline of social distance we can develop a chart that provides a guide for design and planning. The square footage shown in Tables 1 is not measured in terms of architectural or gross square feet, but the actual number of square feet or meters needed by the student within the bounds of the indoor classroom. The calculations for elementary school students were determined according to social distance research findings by using the factor of 49 square feet per person (The lower middle range). Larger students, according to the social distance concept require 64 square feet (The upper limit of the middle range for social distance). Table 1 also reveals the minimum standard according to social distance research for

upper school students.

Table 1
A Minimum Standard for Classroom Size

Number of Students plus 1 Teacher	Elementary School [Square Feet (Meters)]	Secondary School [Square Feet (Meters)]
10	539 (50.13)	704 (65.47)
11	564 (52.45)	768 (71.42)
12	637 (59.24)	832 (77.38)
13	686 (63.80)	896 (83.33)
14	735 (68.36)	960 (89.28)
15	784 (72.91)	1024 (95.23)
16	833 (77.47)	1088 (101.18)
17	882 (82.03)	1152 (107.14)
18	931 (86.58)	1216 (113.09)
19	980 (91.14)	1280 (119.04)
20	1029 (95.70)	1344 (124.99)

With the trend toward smaller classes we should consider social distance as a major factor and adjust the size of classes accordingly. For example, the recommended size of the elementary school classroom in the United States is approximately 900 Square feet. If state policy allows 20 students per teacher, then with social distance as a guide, we expect to find a 1029 square feet per classroom (a deficit of 129 square feet by current standards). Unfortunately these findings regarding social distance (from the field of psychology) come in conflict with educational policy of 20 plus students per classroom in most schools (The classrooms are too small and the result is high density). From the above chart, I can conclude that no more than 17 students per average classroom is the correct number for elementary schools. This straightforward

research-based calculation is also supported by the well-publicized work of Achilles, Finn, and Bain (1998). The average class size for secondary schools is 1024 square feet and should house approximately 14 - 15 students.

These findings have strong implications for government policy. If smaller is better, then fewer students per existing classroom is the answer. We cannot simply put smaller classes in smaller spaces by dividing the spaces we already have. Such action will compound the density problem by having more students in less space. This is not educationally or psychologically sound.

Revised September 1, 2009

Revised Findings and Conclusions:
It is one of the great advantages of the Internet that I am able to review my previous work and adjust the findings and conclusions based on reflective thinking and perhaps some common sense. To this end, I suggest that the reader examine the social distance issue with the formula Area = (pi) x (r squared). [The ratio of a circle's circumference to its diameter is pi or 3.14159 units].

Here we are concerned with "how much space does it take for people to be comfortable;" notwithstanding, there are many cultural differences to be considered in these rough calculations.

If the extent of social distance for interactions among acquaintances is an average of seven (7) feet, with a range of from 4 to 12 feet, then consider developing a chart with the minimum, average and maximum distances as a guide to planning space for interactions in classrooms. For one person the calculations are:

Four feet: A = 3.14159 times 4 (squared) = 50.265 square feet.
Seven Feet: A = 3.14159 times 7 (squared) = 153. 938 square feet.
12 feet: A = 3.14159 times 12 (squared) = 452.389 square feet.

Now weigh these calculations with the reality of building a facility for social interaction. The issue is not as straightforward as I indicated in 2000.

Further, let's examine the issue with other definitions for "distance" as a guideline. Personal distance in Caucasian culture is 1.5 feet to 2.5 feet to 4 feet. You can do the calculations. What we have here to quote "Cool Hand Luke, 1977" is "failure to communicate"

how much learning is accomplished within boundaries defined as intimate distance, personal distance, social distance, or public distance.

What we may comfortably conclude is that ***no one has completed definitive research on the relationship of distance among students and the amount of learning that takes place in defined spaces.*** One thing is for certain, crowding is a negative factor for student outcomes.

I have added two references by Sommer *, and Tanner and Lackney **(see Chapter 4).

Revised September 1, 2000

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The author may be contacted at: cktanner@uga.edu

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