LEARNING BY DESIGN:
Educational Environments as Tools for Pre-School Education

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Abstract

This theoretical paper poses the possibility of learning environments becoming spatial learning aids, particularly in the spatial cognitive development process. Through a survey of research in the area of spatial intelligence and cognition in educational psychology the author establishes the foundation for this possibility. The paper concludes with a proposed initial set of designed principles for pre-school environments based on the research in that field.

Keywords: spatial intelligence, spatial cognition, learning environments

I. Introduction

Architecture is a pervading reality that may be understood in numerous ways. To many it is merely a container of human habitation and activity. To others it is often viewed as an expensive possession prized for its aesthetic and monetary value. It is an omnipresent backdrop to our daily lives and for many it may be unnoticeable except perhaps as a means of orientation in a strange environment. As such architecture is a costly object that fades into an invisible presence beneath conscious perception after some time.

Numerous learning environments mirror these notions. School structures are almost always constructed with an eye on cost, efficiency and time. They may be designed to reflect school owners' or administrators' concept of a specific identity and image often as a marketing tool to entice the parents of prospective students. They rise as structures with a honeycomb of classrooms arranged in ways deemed financially feasible and efficient by decision-makers. And they are often blank canvasses on which the teacher is required to input a particular level of aesthetic ornamentation to meet instructional requirements.

What is often overlooked in the creation of learning environments is the notion that architecture is much more than expensive container for people. Decades of research and writing by architecture theorists and social scientists in the field of environment-behavior studies have long dispelled our notions of architecture's possible common definitions. It has been shown time and again that architecture does not merely background human lives but is, in fact, an active and lively participant in them. Architectural form and space communicate feelings and messages rooted in individual and social signifiers and meanings. Architecture regularly negotiates with us to afford mental comprises between the environments we want or think we deserve and the reality of what exists. Architecture may even prompt the display of specific behaviors through our expectations from a space or from the specific qualities of that space.

Given this we may then inquire whether architecture can aid in learning, more specifically, the spatial cognitive development of children. If architecture can influence the way we feel, think or act, as human agency does, can architecture, then, also help the child to learn to navigate in the four-dimensional designed environment? In the light of contemporary educational thought where parents are also active participants in the human development process along with classroom teachers, can architecture, as suggested by Nicholson (2005), be a "third teacher"?

This paper proposes that the architectural design of learning environments, particularly for pre-school children, must take as its basis the literature on spatial cognition in children which establishes the developmental processes of spatial awareness and intelligence. In doing so more, developmentally appropriate learning environments may result which, in fact, may aid in the proper development of the child.

The paper begins with the establishment of the wealth of research on the human-environment interface from the field of environmental psychology. It then argues for the primacy of spatial design over its formal counterpart stressing the need for a more responsible focus on the spatial aspects of our designed environments. A survey of the literature on spatial cognition is then made and an initial set of design principles for early learning environments is proposed based on the literature.

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II. Architecture's Influence on People

The field of environment psychology has provided much input into the understanding of the relations between designed environments and people. With the aid of interdisciplinary research within the domains of anthropology, sociology and the sciences, theories of human-building interface have been proposed resulting in architectural standards and new design concepts.

For instance, ideas involving the therapeutic possibilities of designed spaces on aging patients and those with dementia compose a well-developed field of scholarship founded on the works of Lawton (1982) and Wohlwill (1966). These have led to architectural design concepts on sensory requirements, quantitative and qualitative lighting needs, safety as well as specific principles in the spatial design of patient facilities.

Complex thought, on the other hand, has risen from research on the possible minimalization or prevention of criminal behaviour through architectural design. The work of Taylor (1988) outlines concepts of population density and crime which have, in turn, provided much insight for the architectural concepts of territoriality, privacy and defensible space of Jacobs (1961) and Newman (1973).

Research on the set of behaviors involving wayfinding and disorientation by Carpman (1991) and Passini (1984) has produced systems of architectural concepts that provide ease for adult population subsets including the elderly and the disabled. These include ideas on surface materials, lighting specifications and space circulation which today have found practical application in many public spaces.

In another vein, much work has been devoted to the understanding of how physical environments can aid and allow people to work more efficiently. Research in this area has thrown light on the specific design aspects of spatial clustering and organization, view control, ease of access to resources, the sensory properties of the work environment, and even the effects of various building materials on physical and psychological health.

Fairly recently, research has been undertaken by Bronzaft (2002) on the control of noise pollution in designed environments and by Peek and Mileti (2002) on the formulation of concepts for disaster architecture in the light of global man-made and natural threats. These provide exciting insights into emerging issues (Bechtel & Churchman, 2002).

Similarly, the domain of architectural theory contains parallel theories and concepts on the mutual influence and relations of designed environments and people. Such ideas, while borrowing initial theories from the social sciences, formulate concepts of architecture and its co-relational associations with both the self and society.

As an example, notions of the self's interactions with architecture involve ideas focused on the body. These have produced discourse on the ideas of anthropomorphism and anthropocentrism in the comprehension of spatial concepts in architecture as basic architectural thought. Likewise, discourse on gender issues and their associative ideas as expressed in architectural form and space are founded on the premise that architecture expresses and negotiates individual and social notions of gender relations. Such discourse, as set forth by the work of Tschumi (1996) and more so by Agrest (1993) range from classic feminism to ideas on masculinism and even embraces startling notions of gay architecture and its implications.

Pragmatically, theoretical text on how architecture engenders human emotions emanates from studies in behavioral psychology and has spawned design concepts currently applied to building types such as discos, bars, restaurants, shopping malls and similar places of commerce and entertainment. Today such places are intentionally designed to attract and hold patrons through sensory and subliminal messages in their architectural design thereby increasing and maintaining patronage and thus enticing users of these facilities to spend more.

The work of Hall in the 1960s on the field of human distancing behaviour, which he terms proxemics, sprung from the pioneering research of Sommer (1969) on personal space. Here Hall (1969) examines the various behavioral phenomena surrounding psycho-physical separation such as fight or flight and behavioral defense mechanisms in its various cultural forms. Hall (1969) interestingly provides experimental data for various architectural concepts including socio-petal and socio-fugal spaces as well as the various permutations of personal space.

Discourse on architecture and society and culture, on the other hand, has emerged with the work of Rapoport (1969) and his texts on the architectural expressions of specific cultures. Drawing heavily on ethnographic methodology these espouse theories on cultural factors which contribute to the determination of specific form and space which, in turn, aid in the comprehension and design of facilities appropriate to the cultural needs of various peoples.

In a similar vein, Abel's (1997) work on architecture and identity and Vale's (1992) discussions on architecture and nationalism have set forth theoretical hypotheses on a society's self-image and its corresponding consequences in architectural design.

Finally, the phenomenological work of Norberg-Schulz (1980) espouses an agenda of architecture as a tangible expression and embodiment of a community's genius loci or what he terms Spirit of Place. He advocates the need for the understanding of designed environments as having intangible but nevertheless valid and pervasive individual and unique identities or Spirits such as feelings of home and unique individuality as well as the need for their description, comprehension and preservation as compelling expressions of a culture.

III. The Argument for Redefining Architecture

Given the wealth of established knowledge on the human-architecture interface perhaps it is time to reconsider our common notions of architecture. In doing so it may then be possible to envision designed environments as tools or even partners in the learning process and, consequently, the development of better communities.

Architecture has traditionally been defined as the art and science of designing and constructing buildings. This statement has led generations to create and reinforce the notion that architecture is a lofty activity to be engaged in only by initiates in its sacred knowledge. Among its implications include the Modernist idea that its products are bestowed from above on the populace and that the latter have no right to voice their opinions on their creation. A pervading perception issuing from the definition is that architecture is merely a product, albeit large by human scalar standards but dispassionate and having no relation to human well-being other than providing shelter or being aesthetically pleasing. Architecture is thus objectified as form that is visually pleasing and perhaps enjoyable to own.

Conversely, however, much writing in latter decades has also conceived of architecture as that which creates Places for people. Here Place has been defined to mean a designed environment that creates and embodies human memory and experience. Places are containers of human meaning as they are imbued with our intentions and remembrances and communicate these back creating a reinforcing cycle of personal or even social interaction with architecture. All architecture communicates meanings through form and space.

Architecture, then, provides Places as fully engaged environments that may be both active and passive in our relations with it. It is through the comprehension and acceptance of this alternative definition that the way may be paved for the eventual realization that architecture can, indeed, facilitate human development. This author has argued extensively in a previous published paper for the inclusive acceptance of felt experienced Place as an objective and subjective reality in the comprehension of architecture (Ozaeta, 2010).

By nature the design of architecture involves the conceptualization of form and space which are traditionally its major components. Architectural form is that which we may appreciate with our senses. Because of its highly visual nature form is often mistaken to be the sole embodiment of architecture's being. Form is the physical material that shelters and provides visual delight and thus is that which is quite obvious to our sight and appreciation.

What is often overlooked, however, is the invisible space which we inhabit and through which we move. Space is assumed to be merely a by-product of the production of physical form. It is that which we fill up with objects and bodies to functionalize architectural form. In fact, however, it is architectural space and not form that has proven to be the major engineer of human well-being in architecture as seen in the array of research on the human-environment relations.

The inherent qualities of a designed space as revealed through its attendant form are that which, in point of fact, communicate to us. Communicated meanings expressed by designed space are first perceived through our sensory equipment but processed and absorbed by our conscious and unconscious faculties inviting response. It is space more than form which we, in fact, inhabit and through which we establish relations with the environment. Norberg-Schulz (1971) has, in fact, identified five spatial schemata elucidating our human relations with designed space. Pragmatic space, he states, is that through which physical action is made and integrates the human entity with the physical environment. Perceptual space is that which aids in locational orientation and is essential to identity. Existential space establishes familiarity and a sense of rootedness thus developing a socio-cultural reality. Cognitive space allows for the mental appreciation of the world while logical space offers the tools to describe space to others. Designed space, then, connects us to our environments in various ways and thereby creates avenues for interaction and human development.

It is then to be seen that spatial intelligence thus logically issues from this realization. To enhance well-being it is obvious, then, that architectural space and our relations with it must be comprehended. Newcombe and Huttenlocher (2000) have stated that, "In order to survive and reproduce all mobile beings must be able to organize their action in the spatial world "(p. 2), while Gardner (2004) emphasizes that it is essential, on a basic level, that we are able to orient ourselves in the world, recognize objects or scenes in its original and altered forms and contexts, create and interpret graphic representations of our spatial environment, and comprehend verbal and visual metaphors bout our spaces. Understanding how we do so, on the other hand, and consequently creating purposefully designed environments that support and enhance spatial abilities thus appears to be the logical next step, one which we overlook often to the detriment of our human development and well-being.

IV. Spatial Intelligence in Children: Cognition and Preferences

Gardner (2004) has characterized spatial intelligence as having the following aspects: the capacities to perceive our spatial environment accurately, to modify and transform these initial perceptions, to re-create aspects of our visual experience without a visual stimulus and to produce forms or manipulate given ones. The development of such abilities allows us to perceive and negotiate our relations with the environment for our safety, comfort and health.

Spatial intelligence begins with the development of spatial cognition at a young age. A large amount of research in this area has provided inroads to our comprehension of spatial ability. In sum this body has appeared to focus on four major areas of human ability: body position and orientation, object location, wayfinding, and the understanding and use of spatial symbols.

Piaget (1956) has provided a substantial foundation of experimentation and research centering on neonatal body orientation. Subjects' evidentiary comprehension of specific views through head and eye positions have led to his postulation of the development of an early image of body layout through the establishment of various frames of reference centered on the body-self. It has been seen that an infant learns, at the outset, to control movement and direction allowing them to differentiate areas in space and later generally locate objects. Spatial parameters are thus perceived according to distances of sensory-motor organization. Frostig has further theorized that these egocentric and even allocentric activities in fact initiate the creation and enhancement of early body image particularly in its subjective state (as cited in Spencer, Blades & Masely, 1989).

Object search and location in space marks a further developmental step by the extension of frames of reference from the self to the immediate world as theorized by Piaget (1956). Such location considers the continuous updating of information of moved objects involving perception, memory and logical inference.

It has been learned that children from two to four years rely on spatial, rather than visual, cues to locate objects. Foreman and Gillet (1997) thus state that it is the relative position of an object itself or its spatial context that determines its location for the child. Familiarity with the object is apparently not significant in younger children as is the significance of landmarks. Older children then begin to adopt the use of visual cues as working memory improves and expands. The transition from spatial to visual cuing is further found to be influenced by both the amount of experience as well as the affective quality of the experience.

Research on children's wayfinding abilities indicates that pre-school children can remember simple and moderately difficult routes even after only one exposure. It is apparent that they are able to use both personal and ephemeral landmarks in both route memory and description. Thus stable landmarks significant to them as well as moveable or changing ones employed through memory serve as signifiers to establish cognitive maps. Experimentation has further shown that pre-school children are able to develop such maps even with limited verbal communication skills. The use of models and sketches reveal their ability to recall environmental features in specific locations and relationships to each other. Such abilities, however, are dependent on direct experience rather than on the viewing of representations or media substitutes. In sum, Pick (1993) identifies wayfinding ability in young children as the development and retention of route knowledge, information on proximity to self-selected landmarks and, in older children, the additional use of mental inferences and differing perspectives of an entire environmental layout which is further developed into young adulthood.

In relation, experimentation has revealed that two and a half year olds are already able to recognize relationships between models and actual spaces. These, however, must have a one-to-one correspondence in terms of number of elements, visual qualities and locational cues. Three year olds have, on average, more developed capabilities in that they require less of a direct correspondence but still necessitate the presence of perceived similarity between elements. Four year olds may already be able to handle multiple correspondences between the model and the actual space through elements in the model and elements in the space itself. This is particularly possible if there is an overall familiar structure in the model or representation, such as the shape of an animal, wherein the child can locate an object, for instance, as being "in the middle of the dog's back leg" (Marzolf & DeLoache, 1997).

In the adjunct research on place preferences by children Wolwhil and Heft (1987) stated that children favoured environments based on their prior knowledge of the area, their predisposition to explore and their level of curiosity (Korpela, 2002). Malinowski and Thurber (1996) in the same text add other compelling factors including their locational histories, specifically whether they had a rural or urban upbringing, level of parental restrictions in visiting particular areas, familiarity with an area through visual media, peer preferences, and the level of negative emotion particularly in male children. General research has shown that places that generate feelings of security and afford the capability to control privacy are favoured by children. In conjunction, outdoor areas and places with easy access to natural environments are also generally selected by children as being favourable.

Summarily, Hill and Michelson (1981) have made the following observations from the array of research on spatial cognition and preferences (Spencer, Blades & Morsley, 1989). First, the existence, provision and geographical distribution of spatial resources and opportunities relevant to young children are a major influence on patterns of behaviour and well-being. Access to such favourable places is apparently a critical factor in their development. Further, the relationship between children and such environments highly depends on their relative distance to them affecting their access as well as their allowed frequency of usage. Finally, natural environments and those with highly sensory qualities are significant for their stimulation. An understanding of the implications of these all indicate possibilities in the conceptualization of designed learning environments for young children.

V. Learning Environments and Pre-school Children

Children learn from their environments by experiencing them. Day (2007) posits that sensory experiences provide the stimulus to the development of relationships with the environment. These include "scentscapes" and their associative memories, textures and their codes, a sense of warmth and its positive connotations, soundscapes and the related space qualities, conceptual associations of sight, a sense of balance and the affordances of active and passive movements.

These all communicate messages to children as do the larger elements of form, space and spatial configurations. Colors, qualities of light, and surface materials have

associated moods and consequently subliminal messages to children. Likewise the major presence of constructed or natural environments and their configurations speaks to children of possibilities and restrictions. And spatial qualities such as permeability or the "openness and closedness" of spaces prompt or relay values, moods or even a sense of psychological security.

The design of learning environments particularly for pre-school children must therefore, through a comprehension of how young children relate to their spaces, necessarily apply the information developed by research on spatial cognition and preferences. Design principles constructed on this foundation may then help provide the impetus for the creative conceptualization of spaces suitable for learning.

From the surveyed body of knowledge on spatial cognition in children focusing on the four areas of human ability, the following are then offered as an initial list of principles for the design of buildings for pre-school children. It is emphasized that these are merely derived from the literature and, as such, must be subject to verification.

1. Schools should be located and positioned on their sites such that landmarks visually significant to young children are present. They should be readily visible upon approach from various established routes. Children should not be visually distracted by adjacent structures or features from direct identification of the school building.
2. Pre-school learning spaces must not have to be accessed from the entrance through the communal spaces of older children. This affords feelings of significance and self-identity aside from the prevention of physical mishaps and a sense of being overwhelmed.
3. Group learning spaces must have distinct imageries to set them apart from each other. This fosters small group as well as individual identity and engenders a sense of home.
4. Learning spaces must have clearly unmistakable hierarchies of clustering from individual to small group communal to larger social spaces to communicate levels of identity.
5. Space dimensions must be perceived as scaled to the bodily dimensions of young children. This again provides messages of self-worth and significance to the child.
6. There must be adjacent or easily accessible break-out spaces for private use for each communal group learning space to provide a periodic respite from emotions associated with social interaction.
7. Barriers to spaces for use by pre-school children must be eliminated or minimized to communicate a sense of openness and delight as well as invite exploration. These barriers may, in fact, be both physical as well as intangible such as lack of daylight.
8. Interior elements of learning spaces must communicate positive emotions. Color combinations must be carefully balanced to foster appropriate moods. There must be a significant use of natural materials to relay feelings of warmth and affinity with the natural environment.
9. A variety of sensory experiences must be available to the pre-school student through the significant use of architectural materials and elements in the learning spaces.
10. Daylight must be the primary source of lighting. Dark or shadowy areas must be minimized to promote a sense of openness and movement. A generous amount of windows must provide visual connections to the outside to stimulate creative imagination.
11. Physical separations between spaces in learning areas must be kept to a minimum to encourage the mental creation and visualization of specific spaces.
12. Specific items in learning spaces must be located in distinctly identifiable areas. Identifying markers must be simple but visually significant. This aids in the development of object location as a spatial cognition skill.
13. Routes from the main building entrance and to and between pre-school spaces must be simple but not direct, allowing for opportunities for explorations and a sense of surprise. They should have visually significant landmarks that engage the imagination.
14. The overall message communicated by the school's architectural spaces as well as physical forms must be perceived as positive and attuned to the pre-school child's development.

VI. The Learning Environment as Teacher

This paper has endeavored to propose the possibility of architecture as a development aid in spatial cognition and intelligence through an argument for the consideration of architecture as more than the common notion of shelter, possessed object, or passive backdrop to human activity. Empirical research and speculative thought from the fields of architecture and the social sciences has long supported the view that architecture engages human thought and behaviour in various ways and negotiates both individual realities and socio-cultural worldviews. Architecture is thus more than a passive set of constructed objects dependent on human agency but is in fact an active participant in the performance of human activity and human creation.

It may therefore be possible to conceive of architecture as also an aid in the human development process. This is particularly significant in the case of pre-school children whose spatial developmental requirements are distinctly unique. The employment of architecture in the spatial cognitive development of pre-school children must then be firmly founded on research. It is only on such a foundation that the spaces conceived through architectural

design can support, enhance or even stimulate the development of spatial intelligence and related cognitive skills necessary for the development of the child. In sum, architecture can indeed be a "third teacher" with proper understanding and enlightened comprehension.

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