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RESEARCH PAPER

Impact of School Layouts on Student Learning and Interaction: A Comparative Analysis of Linear and Courtyard Designs in Educational Environments

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ABSTRACT

This study aims to explore the impact of school layouts on students' learning, behavior, and interactions within educational environments. By examining both government and private schools featuring linear and courtyard designs, the research investigates how different spatial arrangements influence student movement, engagement, and social interactions. Utilizing space syntax analysis, observational study and activity log, this study found how students navigated and utilized various school spaces, with a particular focus on circulation areas such as hallways, and courtyards. The findings reveal that the organization of school spaces has a significant impact on student interaction patterns. Specifically, courtyard layouts were found to facilitate more frequent and meaningful interactions among students from different grades, enhancing social cohesion. The study underscores the importance of considering physical design as a critical factor in shaping students' learning experiences. It recommends that schools, irrespective of their type, adopt layouts that promote better interaction and engagement among students.

Keywords: Accessibility, Cognitive Abilities, Layout, Space Syntax, Spatial Analysis

Introduction

Last century has witnessed that learning is a continuous process and in academic life the mental abilities of students are judged without considering their social behavior pattern (Brown, 2001). Hiller emphasizes that in order to enable creativity, an interactive space must be enhanced (Gehl, 2011). People's perception of a space and their ability to meet the right people at the right time and place both have an impact on creativity(Gehl, 2011). Environmental psychologists believe that humans are constantly interacting with their surroundings (Gifford, 2007). As a result, social conduct requires interaction with the environment to develop naturally. Schools can be conceptualized as a composite of spatial interfaces that host teachers and students, who are continuously engaging in and carrying out educational activities. A school's physical design creates an atmosphere that supports the Social Relation key ideals of the school environment and the complex interactions between different groups within it.

Literature Review

School is made up of three physical components roads/corridors - building structure and study spaces (Smith, 2011). These form the physical environment whether permanent (infrastructure & building) or semi-permanent (landscape / shrubs / plants / seating benches / pavilions sheds) (Abu-Ghazzeh, 1999). Outdoor spaces shaped by permanent and semi-permanent components to determine quality of student life / interaction. Outdoor areas in between classrooms serve as focal points that influence students' behavior in a

favorable way (Abu-Ghazzeh, 1999). The physical environment create impact on user characteristics that can be translated in functional activities as well as visual / sensory qualities. the relationship between social and unique spaces in "life between buildings." According to the book "Places for People," there are three categories of activities: required, optional, and social (Gehl, 2011). These categories are used to analyze the physical aspects of buildings and the ways in which their occupants interact with one another and strike up conversations. In her book "The Eyes of the Skin," psychologists. Social environments stimulate your senses (exteroceptive and interceptive) and your cognitive abilities, which contribute in learning (Pallasmaa, 2012). Walking areas and corridors are crucial components of schools because they serve as promenades and encourage student interaction and environmental exploration (Mather, 2016).

The "eyes on the street" by Jane Jacobs, notes that open areas and their dimensions have a significant influence on how well students learn (Jacobs, 1961). Schools should function as homes where students feel at ease and school spaces should be welcoming and connected to the outdoors (Lynch, 2013). The Social Logic of Space, explain how human behavior and spatial organization are related (Hillier & Hanson, 1989).

The study looks at three main areas for each school setting for analysis:

1. **Spatial**: Examines how different areas in the school are arranged and how this affects the layout for learning and social activities.

2. **Behavioral**: Looks at how the design of the school influences the types of activities students engage in and where these activities happen.

3. **Social**: Explores how students feel about their school and how the layout impacts their social interactions and sense of belonging.

The study attempts to provide a comprehensive and complicated understanding of the interplay by merging these approaches. The final study explores how students view the school community and the social framework that underpins it. In order to help architects create better learning environments, this social analysis thoroughly examines the relationship between the design of school spaces and the behaviors and social interactions that result. These interactions include the way students interact with one another, how they form and maintain friendships, how they participate in cooperative (group) activities, and how they are generally aware of others in the school environment. Additionally, it evaluates the general sense of community among students as well.

Twenty years ago, Barker & Gump, found that Small schools are found to provide a better education compared to larger ones (Barker & Gump, 1964). They offer more extracurricular activities, and students are more likely to take on leadership roles and feel satisfied with their involvement. Studies show that students in smaller schools and classrooms are more likely to know and care about each other than those in larger schools figure 1.

Research by Barker & Gump, also highlights that smaller schools enhance interpersonal relationships and social connections rather than hindering them Small schools act as community hubs, encouraging frequent student interactions and a strong sense of belonging (Barker & Gump, 1964). This Research is also supported by recents study, which found that smaller schools create a better sense of community by improving the school environment (Cotton, 2003).

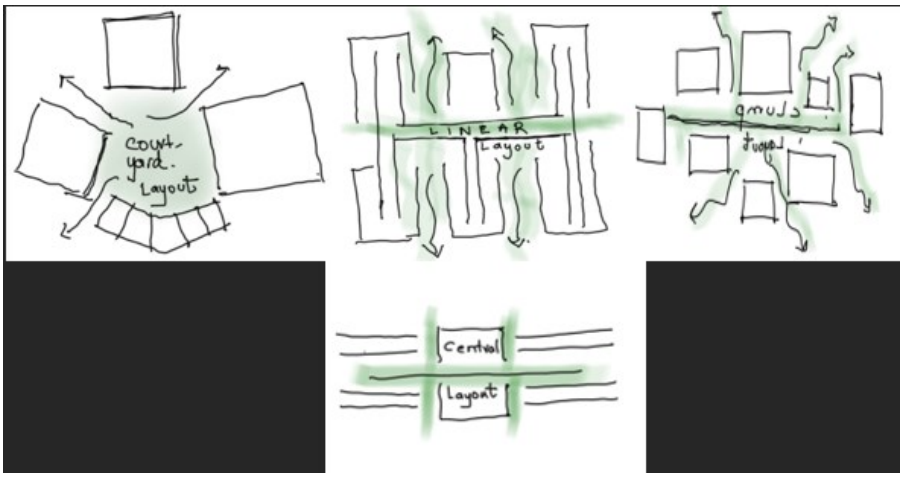

Figure 1 (Perkins, 2002).

This study looked at how the layout of the school affects where activities and student interactions happen throughout the building. This involved gathering detailed data on how activities are linked to their locations, students' movement patterns, and how spaces are used. Both behavioral mapping methodologies and activity logs were employed to capture and analyze these spatial and behavioral dynamics. It is well-documented that individuals often engage in similar activities, yet these activities are frequently situated in different locations (Smith, 2011). Consequently, the activity log technique allows for the identification of correlations among individuals, locations, activities, and temporal patterns. These correlations subsequently illuminate how these connections are effectively accommodated within a designed environment. The study concentrated on students, who follow a strict schedule during the school day. The timetable outlines the precise times, durations, and locations for their various classroom activities.

To assess how students interact and use their school environment, an activity log was used. For three days, the log recorded:

a) What activity was taking place?

b) Where it happened, and

c) How many students were actively - passively involved?

The study used a 35-questionnaire designed based on latest research from educational and psychological perspectives. It included questions about students' sense of community and social interactions in schools. The questionnaire drew from sources like Moos, and Abu-Ghazzeh (Moos, 1973; Abu-Ghazzeh, 1999). The survey comprised of seven sections with both closed- and open-ended questions. The questions in the first four sections focused on study habits, knowing people at school, friendships, and both group and individual work. The purpose of these questions was to gauge students' sense of community and social interaction. Ratings ranged from 1 for strongly agreeing to 5 for strongly disagreeing.

Students were questioned about their thoughts on the design of the school in the last sections of the survey. Five questions in the first section featured a rating system from 1 to 5 (strongly disagree & strongly agree). In the second section, students were to select pictures of various parts of their school, describe the activities that take place there, and provide an explanation for their selections. Space syntax is a method for analyzing and understanding the layout of buildings and communities (Gomaa et al., 2024; Din et al., 2023; Lackney, 1994). These techniques are used in research to see how the design of spaces

affects people's behavior and interactions (Ammar et al., 2024; Ahmad et al., 2024; Hillier & Hanson, 1989). This approach helps us understand how different spaces influence social interactions among various groups, such as residents, visitors, men, and women (Sehar et al., 2024; Hillier & Hanson, 1989). An analytical approach to understand the relationship between society and space is to analyze spatial configuration. The empirical results obtained through the application of space syntactic tools reveal social tendencies that are closely related to geographical characteristics. Thus, concerns about how social and cultural content is incorporated in geographical patterns and how physical places might impact social connections can be answered by analyzing spatial patterns.

Therefore, information derived from syntactic measurements of the spatial arrangement of school buildings was utilized for assessing the connection between space and how students interact and distribute their activities in their respected spaces.

Material and Methods

To identify the correlations between the physical and communal characteristics of 4 intermediate schools in Abbottabad, this study (Creswell & Poth, 1998). By integrating both qualitative and quantitative methods, the study benefits from a comprehensive data collection process (Creswell & Poth, 1998). The techniques used were surveys, activity areas, behavioral analysis, spatial syntactic analysis, and casual conversation. These complex data collection approaches created a sophisticated framework for unraveling the intricate connections between Tangible design and Interpersonal dynamics within educational settings. A detailed and nuanced study of the intricate connection between a school's architectural design and social order will be the focus of the analysis. This involves a thorough assessment of how well social dynamics and geographical structures align. In addition, the floor design and activity areas of every school will be carefully noted, examined, and analyzed to find trends and connections. Table A. This multi-faceted approach aims to provide profound insights into the efficacy of spatial arrangements in facilitating social interactions and achieving the organizational objectives of the educational institutions.

Due to a surge in student enrollment, Abbottabad has recently witnessed the construction of new school buildings and the modification of existing ones (Abu-Ghazzeh, 1999). Several criteria were considered when selecting each school as a case study. Each school had to have either undergone substantial renovations or been recently developed within the past 5 to 12 years, thereby exemplifying cutting-edge Advancements in educational architecture. A pair of educational institutions were chosen from the private and public sectors in Abbottabad, Abbottabad City is rapidly expanding and strives to offer top-notch educational resources that will improve students' academic and social experiences (Jackson, 2003).

Research Framework

Integration is the syntactic characteristic that helps the most in characterizing and evaluating the spatial configurations (Ullah et al., 2023a; Ullah et al., 2023b; Ullah & Park, 2016). According to Hillier & Hanson (1989), Integration is a global metric since it takes into account a space's links to every other space in the system. The Spatial Analysis was collected from public areas accessible to all students and the entire layout of each school building. Using the space syntax method, the spatial Analysis of individual building was visually represented with axial lines, color-coded to show the level of path integration and connections within the layout.

Rather than focusing on the separation between places, the idea of integration addresses their depth. It is distinguished by a space's connectedness to every other space, both directly and indirectly. Integration is based on how many connections, like lines or

spaces, are crossed when taking the shortest path (**Smith, 2011).** This is the integration value that each building's space provides. It considers the entire spatial system, enabling students to reach particular locations inside the building.

Results

Case 1: School Building at District Abbottabad

Figure 2, below shows the floor plan of case-1 School building located at Abbottabad. The main building consists of two floors, redrawn by the author as illustrated below. Figure 2 also shows the activity nodes and flow patterns as observed by the authors during observational study.

Figure 2: Floor plan of case-1 school building

For the purposes of this study, a selection process was employed whereby two classrooms per grade level were identified, culminating in a sample size of 140 students across all grades within each school. The rigidly structured schedule of a standard school day ruled out the chance for random selection from classroom groups for student participation. The principals of the chosen schools were contacted when the cases were determined. The researcher was then provided by principals with a list of classrooms that have offered to participate in the study.

To clarify any potential ambiguities in the questions, the researcher was present to assist students while they completed the questionnaires. At the commencement of each class session, students were mandated to diligently record their activities. This process, which spanned three days, involved logging detailed information on every undertaken activity, specifying the exact locations, and indicating whether the participation was individual or in a group context. Concurrently, students were tasked with annotating their positions on the provided school floor plans

Spatial Analysis

When examining places that are a few steps distant, the axial analysis of case-1 School revealed a substantial spatial connection (R2 = 0.9237) related to the relationship between the axial lines' connectivity and their integration level across different local areas. Globally, the overall spatial system (R2 = 0.47) showed less integration and links between places.

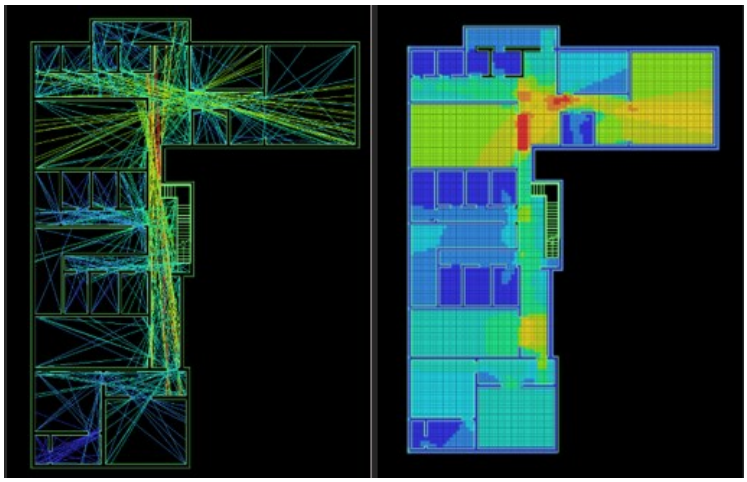

Figure 3: Axial Map Analysis & VGA of Case-1 school building

Case 2: School Building at District Abbottabad

This one-story building utilizes skylights to bring daylight into the interior. The architectural design also includes windows that ensure the proper amount of natural light to the students' academic and social spaces, with the building having a linear layout. With classrooms arranged in distinct wings for each grade level Figure 4.

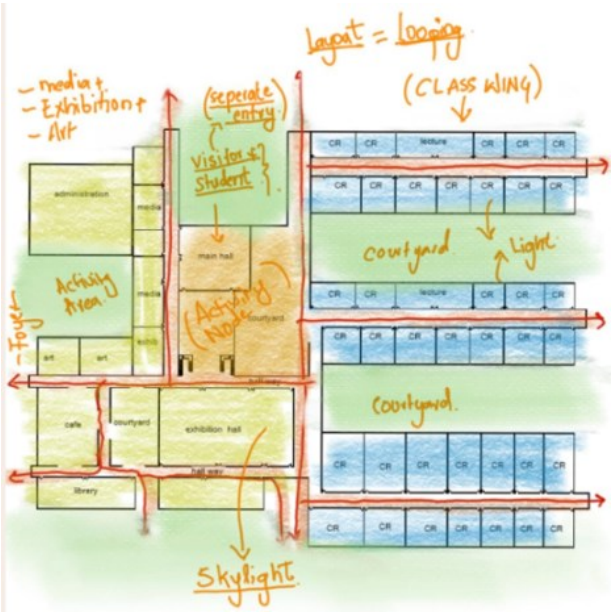

Figure 4: Floor plan of Case-4 school building

Spatial Analysis

The classroom wings generally exhibited suitable global integration values, indicating that the spatial layout's local integration values were higher than its global integration values. This suggests that the design of the classroom wings effectively supports students by providing reasonable access to shared areas beyond the classroom wings in terms of physical and visual connectivity. In other words, it is easy and straightforward for students to move from the classroom wings to other areas of the school this straight forward physical and visual connection to common areas enhances students' sense of place and consequently increases awareness of their surroundings. Figure 5

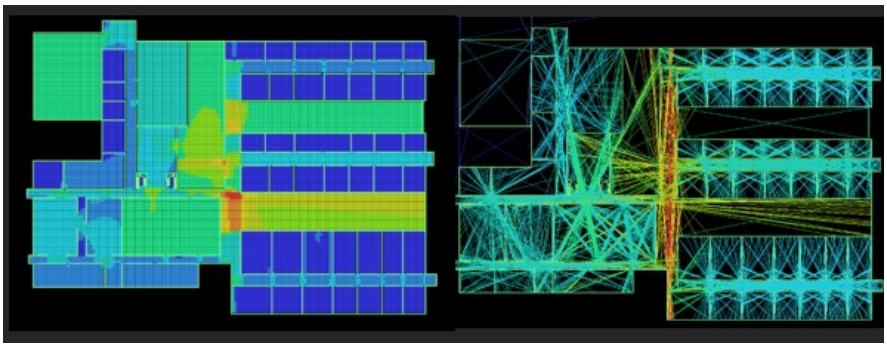

Figure 5: Axial Map Analysis & VGA of Case-2 school building

The public axial system in case-2 exhibited a poor relationship between the integration and connectivity values of the public areas. Resulting in lower global intelligence (R2 = 0.2307). This indicates that the arrangement of public areas is planned to give students with a clear navigational guide as they move through these spaces. By focusing on what is visible from or through each public place, students can develop an understanding and Students can perceive the overall public spatial system due to the design of the public areas. Whereas, the building's spatial arrangement includes a limited selection of both integrated and isolated public spaces.

Case 3: School Building at District Abbottabad

The formation of small groups within the school is designed to foster intimate interactions and create a supportive environment for meaningful communication. This structure facilitates team planning, allows for more flexible use of time, and helps teachers better understand and leverage students' interests, abilities, and learning styles. The scheduling system provides continuous, time-blocked instruction for both teachers and students. Additionally, the building's physical layout, by utilizing time, space, and grouping techniques, allows educators and learners to fully realize the potential of active, integrated learning.

Figure 6: Floor plan of Case-3 school building, Source: Author

Spatial Analysis

Case-3 School's overall spatial arrangement demonstrated reasonable global intelligibility (R2=0.5772), indicating that the system's components were both well-integrated and well-connected. This suggests that as one navigates through the spaces, the overall spatial pattern can be perceived and made sense of through its separate parts. However, the local understanding of the spatial layout (R2=0.8) was greater than the global values.

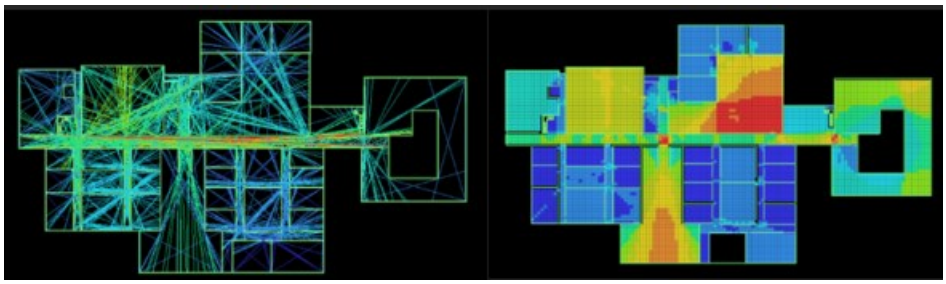

Figure 7: Axial Map Analysis & VGA of Case-3 school building

An examination of case-3 School's overall spatial system revealed that the building's main circulation areas were highly integrated. This includes hallways encircling the courtyard, those extending into the instructional wing, the entrance hall connecting the loop corridors to the foyer/lobby situated before the gym, the passageway joining the corridors across from each other around the courtyard, and the corridor that extends from the side walkway into the administration zone. These areas form the 10% integration core, demonstrating their significance in the overall alignment and integration of spatial configuration of school.

Case 4: School Building at District Abbottabad

Figure 8, below shows the floor plan of case-4 School building located at Abbottabad. The main building consists of one floor, redrawn by the author as illustrated below. Figure 8 also shows the activity nodes and flow patterns as observed by the authors during observational study.

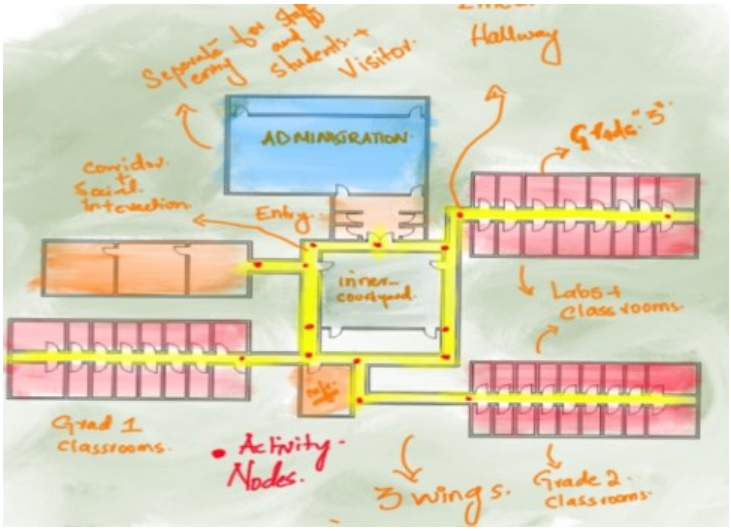

Figure 8: Floor plan of Case-2 school building, Source: Author

Spatial Analysis

Case-4 School's overall spatial arrangement demonstrated a respectable level of global intelligibility (R2 = 0.5772), indicating that the various regions within the spatial system were both less-integrated and less-connected. This suggests that one can understand and comprehend the complete spatial arrangement from its individual components as they navigate the areas. However, the local perceptibility of the all spatial layout (R2 = 0.3) showed a low value than the global intelligibility. This implies that while the school's spatial configuration is coherent and understandable on a global scale, the immediate local relationships between spaces are even less apparent and less accessible to the users.

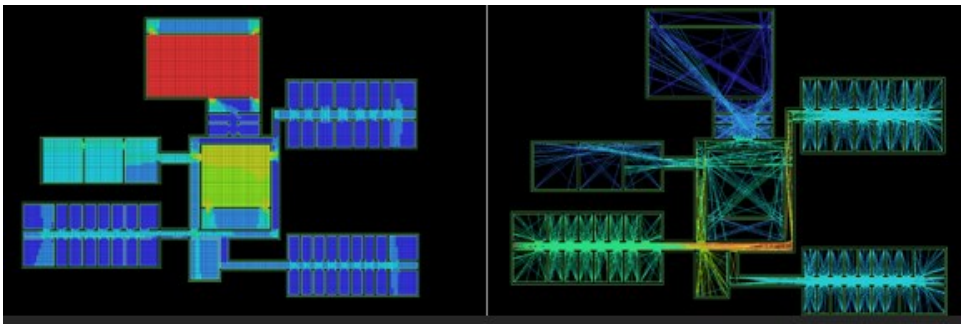

Figure 9: Axial Map Analysis & VGA of Case-4 school building

Conclusion

Case-1 School building is organized in a linear fashion, with the main hallway and core situated at the center. This continuous and linear core simplifies student interaction. The most integrated sections of the Case-3 School building were found along the linear main hallway, which connected communal rooms, stairs, and housing units. Conversely, in case-2 and case-4 Schools, which have a more radial and dispersed spatial plan, the main entry serves as the primary core and the integrated core is centralized, dividing the corridors that split off to the classrooms. This configuration results in a lack of community and lower integration values. A central looping hallway system and a more dispersed arrangement in the design of the school areas suggested improved spatial integration. The intersection of the halls offers optimal visual access to nearby locations where students tend to congregate informally. Students can socialize informally in the large, highly integrated halls of case-1 and case-3 Schools. Student activities in school buildings were heavily scheduled, with a strong focus on the curriculum, before and after classes. Students generally took the most direct and efficient routes to reach their destinations within the blocks.

The complete evaluation of spatial elements on both local and global scales revealed several key findings:

- The school buildings with both minimum and maximum global integration levels exhibited considerable local perceptibility.
- The low global intelligibility observed in double story school buildings suggests that individual spaces did not adequately reflect the spatial scheme.
- School buildings with dispersed layouts and core looping hallway systems exhibited better local and global connectivity values in public spaces.
- Hallway intersections with the Regions with the most effective visual access to surrounding areas showed elevated occupancy rates and were frequently used by students as social gathering spots.
- The interrelations among floors in double story school buildings could be strengthened /weakened based on the placement of circulation elements.

Schools must maintain a strong sense of community, which is crucial for fostering an engaging and meaningful learning environment. They should be places where students develop their identity, find learning enjoyable and significant, and feel welcomed. Additionally, schools should reflect their surrounding environments and provide a safe space for both students and staff. Therefore, it is important to focus more on spatial connections and planning in school design. By enhancing our understanding of how spatial elements influence educational and social experiences, we can improve school architecture

and better support student development. Architects designing educational facilities, such as schools, must be acutely aware of how spatial features can significantly influence organizational and developmental goals. A deep understanding of it is crucial to analyze how diverse spatial layouts and their attributes affect student behavior and interactions. This insight enables designers to create spatial arrangements that enhance the layout's intelligibility and better meet the needs and actions of young students within school environments.

The study investigated the association between the spatial designs of school areas and students' usage patterns in those spaces. The primary aim was to understand how the physical arrangement influences formal and informal socialization processes. By mapping the relationships between the spatial analysis and the observed activity, insights were gained into potential interactions between students and their environments. This comprehension of interactions provides a clearer grasp of the ways students engage with the environment shaped by the spatial arrangement, which is a crucial element of design. The methodologies employed in this study facilitated a comprehensive understanding of school environments. The analysis of different school building layouts revealed that spatial organization plays a significant role in shaping student interactions, social behaviors, and the overall learning environment. Schools with linear and continuous hallway systems, such as in Case-1 and Case-3, demonstrated higher levels of spatial integration, fostering a strong sense of community and enabling frequent informal social interactions among students. Conversely, schools with radial or dispersed layouts, as seen in Case-2 and Case-4, exhibited lower integration values, resulting in fragmented student interactions and a weaker sense of community.

Key findings from the study emphasized the importance of both global and local spatial intelligibility in school buildings. Schools with dispersed layouts and central looping hallway systems achieved better connectivity in public spaces, enhancing the ease of movement and increasing opportunities for social engagement. Hallway intersections, particularly those with high visual access to surrounding areas, were identified as critical points for student gatherings and social interactions. However, the study also highlighted challenges in double-story school buildings, where low global intelligibility suggested that individual spaces did not sufficiently reflect the overall spatial scheme. The placement of circulation elements between floors was found to either strengthen or weaken the interrelations among different areas, influencing how students navigated and interacted within the space.

Recommendations

1. **Enhance Spatial Integration:** Schools should be designed with a focus on creating highly integrated and continuous spatial layouts. Linear or looping hallway systems with strategically placed intersections can improve connectivity, encourage social interaction, and foster a strong sense of community.

2. **Optimize Circulation Elements:** In multi-story school buildings, careful consideration should be given to the placement of circulation elements such as stairs and elevators. These elements should be positioned to strengthen the connection between floors, enhancing the overall intelligibility of the space and facilitating smoother movement for students.

3. **Prioritize Visual Access:** Architects should design hallways and intersections with high visual access to surrounding areas. This approach not only improves wayfinding but also identifies key areas where students naturally congregate, providing opportunities to create informal social spaces that support student engagement.

4. **Promote Community and Safety:** School designs should reflect and reinforce a sense of community, ensuring that students feel welcomed and secure. Public spaces should be designed to accommodate social activities, while still maintaining a clear and intuitive layout that supports safety and ease of supervision.

By implementing these recommendations, architects can create educational spaces that not only support academic goals but also promote social development, well-being, and a strong sense of community among students.

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