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A Systematic Literature Review on the Application of Space Syntax in Designing Schools

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Abstract-This systematic literature review explores the application of Space Syntax theory and methodologies in the design of school environments, focusing on studies published between 2015 and 2025. The review synthesizes empirical research and theoretical contributions to examine how spatial configurations influence wayfinding, movement patterns, pedagogical practices, and social interactions in educational settings. A rigorous search strategy using defined keywords, Boolean operators, and multiple academic databases—including specialized Space Syntax conference proceedings—was employed to identify relevant studies. Findings reveal that Space Syntax provides powerful analytical tools for optimizing functional efficiency, enhancing spatial legibility, and supporting student-centered, flexible pedagogies. The evidence underscores the growing recognition of space as an active agent in shaping user experience and learning dynamics, shifting school design beyond a merely functional paradigm. The review also identifies several research gaps, including limited educational typologies, underexplored integration of qualitative and quantitative data, and a need for longitudinal studies. These gaps point to opportunities for future interdisciplinary research that bridges spatial analysis with educational theory, organizational behavior, and real-world practice, thereby advancing both the academic field and the design of responsive learning environments.

Key Words: Space Syntax; Wayfinding; School; Movement; Learning.

1. INTRODUCTION

Space Syntax is a sophisticated theoretical framework and analytical methodology developed by Bill Hillier, Julienne Hanson, and their colleagues at University College London (UCL) in the 1980s. This approach is rooted in the configurational theory of space, which posits that spatial formations are not merely passive backdrops but actively influence human activity and social interactions (Dursun, 2007; Kinda et.al., 2014). The fundamental premise of Space Syntax is that the events and behaviors occurring within any individual space—such as a room, corridor, street, or public area—are profoundly shaped by its relationships within the broader network of connected spaces. The methodology provides a systematic means to quantify spatial configurations and their impact on various aspects of human behavior, including movement patterns, accessibility, and social dynamics within built environments. It offers a scientific, research-based approach to architectural design, allowing architects to explore design ideas and understand the potential effects of their proposals (Balaban et.al., 2019; Vaughan & McEachan, 2024). The analytical process relies heavily on mathematical and graphical techniques, drawing from graph theory to represent and analyze spatial structures. Specialized software, notably Depthmap X, is a pivotal tool for conducting various analyses, including axial map analysis, visibility graph analysis (VGA), and segment analysis (Nes, 2022; Hammadamin et.al., 2024).

Space Syntax comprises four fundamental components that are integral to all its applications: representations of space, the analysis of spatial relations, the development of interpretive models, and the establishment of theories linking spatial patterns with social phenomena (Sarıberberoğlu & Ünlü, 2024). Representations of space involve abstracting spatial elements through their geometric forms or functional definitions, such as points, axial lines, segments, convex spaces, and isovists (McElhinney, 2024). The analysis of spatial relations objectively quantifies the relationships between these elements using various measures. Key quantitative measures include integration, which reflects the ease of access or "to-movement potential" within a spatial network, and choice, which quantifies the passing flow or "through-movement potential" through a space. Another important measure is depth distance, which provides an intuitive understanding of linear distance between spaces (Hillier & Hanson, 1989; Klarqvist, 1993).

While the foundational descriptions of Space Syntax often highlight its predictive power for pedestrian and vehicular movement, its application has significantly expanded beyond this initial focus, particularly in educational contexts. Early Space Syntax literature and its core principles emphasize its ability to predict where people move based on integration and choice measures (Hillier & Hanson, 1989; Koch, 2024). However, a closer examination of its use in educational environments reveals a broader utility. Studies in this domain explicitly apply Space Syntax to assess a built environment's "functional performance and physical and psychological impact" and its influence on "human behaviour and social interactions" in higher education as studied by Hammadamin (2024). Furthermore, research extends to investigating "the social organisation of teaching and learning" and "socialisation" within schools (Sailer, 2015; Mohamed et.al., 2023). This progression signifies a maturation in the field's application, moving from basic predictive models of movement to more comprehensive analyses of human interaction, learning processes, and spatial experiences. This broader application demonstrates that Space Syntax is increasingly recognized for its capacity to provide a nuanced understanding of complex socio-spatial dynamics in various settings, including educational institutions.

Contemporary educational research points to a profound paradigm shift in the design of school buildings, moving away from traditional, often rigid, architectural models. The demands of 21st-century education necessitate a fundamental reconfiguration of school environments to accommodate evolving societal contexts, diverse teaching and learning

practices, and increasingly decentralized learning processes that extend beyond the confines of conventional classrooms (Gislason, 2010; Heitor & Pinto, 2012; Peng, 2022). There is a growing emphasis on creating flexible learning spaces, informal learning precincts, and dynamic social areas. These adaptable environments are crucial for supporting a wide spectrum of collaborative, exploratory, and experimental learning activities that characterize modern curricula. The widespread integration of digital technologies and the portability of technological devices have also significantly altered student learning habits. Consequently, students' choices of learning locations are increasingly driven by the attractiveness and adaptability of spaces, rather than solely by their pre-assigned functional labels (Heitor & Pinto, 2012; Griffiths, 2022).

Traditional school layouts, often structured around a teacher-centered model with the classroom as the primary spatial unit, are proving to be ill-suited to contemporary educational needs. They frequently lack the complementary learning and support spaces essential for modern pedagogical approaches. This has led to a shift in educational architecture towards user-centered design, which prioritizes the health, functionality, and the social, psychological, and cultural dimensions of performance within learning environments (Serra & Pinho, 2013; Psarra, 2022). The pronounced demand for flexible school spaces to support new pedagogical approaches highlights a significant interplay between spatial adaptability and pedagogical innovation.

The literature explicitly states that "learning spaces must be reconfigured to support changes in the societal context of education and to respond to different teaching and learning practices". This recognition underscores the limitations of "stationary" school models and advocates for "more neutral non-specific layout type" that can be "easily adapted to changing requirements over time". This establishes a clear relationship where the emergence of innovative, student-centered pedagogies, such as collaborative and exploratory learning, directly necessitates more flexible and adaptable physical spaces. Conversely, the provision of such spatially flexible environments can, in turn, foster and encourage the adoption of these new pedagogical practices, creating a dynamic feedback loop. This implies that Space Syntax, by offering tools to analyze and predict the adaptability and functional potential of spatial configurations, becomes an essential instrument for designing educational spaces that not only accommodate but actively promote pedagogical innovation and evolving learning styles (McCoshan et.al., 2022).

Despite its extensive application across various building typologies, including museums, offices, and hospitals, the specific use of Space Syntax in school buildings has received comparatively less attention in academic discourse (Sailer, 2015). This relative scarcity of dedicated research has resulted in a limited understanding of the intricate relationship between spatial configuration and critical social processes within educational settings, such as teaching, learning, and social interaction. This systematic review is undertaken to address this identified gap by comprehensively synthesizing recent research, specifically from 2015 to 2025, on the applications of Space Syntax in school design. By consolidating and analyzing the most current findings, this review aims to provide evidence-based strategies that can enhance the functionality of educational spaces and promote best practices in contemporary educational architecture.2 The deliberate focus on the most recent literature ensures that the review remains highly relevant to current challenges, emerging trends, and innovative solutions in the design of educational environments.

This systematic literature review is guided by the following research questions: 1) What are the key findings regarding the impact of Space Syntax-informed school design on wayfinding and movement patterns?. 2) How does Space Syntax analysis contribute to understanding the relationship between spatial layouts and pedagogical approaches or learning environments?. The research objective are as follows: 1) To identify and synthesize key findings on how Space Syntax-informed school design influences wayfinding and movement patterns. 2) To examine the contribution of Space Syntax analysis in understanding the relationship between spatial layouts and pedagogical approaches or learning environments.

2. METHODOLOGY

2.1 Search Strategy: Databases, Keywords, and Boolean Operators

To ensure a comprehensive and current synthesis of the literature, the search strategy for this review targeted major academic databases with strong reputations for indexing scholarly work in architecture, urban planning, and educational research. This research used quantitative research method to produce the review on the application of space syntax in designing schools. The author adopted Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines to deliver standard peer accepted methodology that uses a guideline checklist as shown in Figure 1. Thus, it contributes to the quality assurance of the revision procedure and to its replicability. The databases included Web of Science (WoS) and Scopus, both widely recognized for their coverage of peer-reviewed publications and frequently used in similar systematic reviews related to primary school settings. In addition, Google Scholar was employed to capture a broader range of academic outputs, including grey literature, preprints, and self-archived manuscripts (Askarizad et.al., 2024).

ResearchGate was also used as it often provides access to preprints, conference papers, and full texts directly uploaded by authors, including a substantial number of Space Syntax-related studies. Moreover, proceedings from the International Space Syntax Symposium—specifically the 10th (2015), 11th (2017), 12th (2019), 13th (2022), and 14th (2024) editions—were reviewed, as these serve as primary outlets for cutting-edge research in the field. Search queries were constructed using Boolean logic to combine the core concept of “Space Syntax” with terminology related to

educational environments and specific analytical tools. A representative query was: ("Space Syntax") AND ("school design" OR "educational buildings" OR "learning environments" OR "university campus") AND ("wayfinding" OR "pedagogy" OR "layout" OR "Justified Graph"). The use of "AND" helped narrow results by requiring all major themes to be present, while "OR" broadened the scope to capture variation in terminology. The inclusion criteria were limited to studies published between January 1, 2015, and December 31, 2025, ensuring that only recent and relevant literature was analyzed.

A notable methodological challenge was the retrieval of data from niche and interdisciplinary sources. While mainstream academic databases typically suffice for general topics, much of the key literature on Space Syntax appears in specialized Symposium or institutional repositories, and is not always indexed in WoS or Scopus. In particular, full-text access to certain Symposium proceedings was inconsistent across institutional subscriptions and open-access platforms. This underscores a common limitation in systematic reviews of specialized fields: the fragmented nature of publication and access. To address this, the review employed a robust data extraction protocol, including direct access via conference websites, university repositories, and personal communication with authors (Burkut, 2023; Zhand et. al., 2024). These strategies were essential to ensure the comprehensiveness and reliability of the final dataset.

2.2 Inclusion and Exclusion Criteria for Study Selection

To maintain the focus and rigor of this systematic review, specific inclusion and exclusion criteria were applied during the study selection process:

Inclusion Criteria: To uphold the focus and methodological rigor of this systematic review, clearly defined inclusion and exclusion criteria were implemented during the study selection process. Studies were included if they were published within the defined timeframe of January 1, 2015, to December 31, 2025, and explicitly employed Space Syntax theory or its methodologies as a primary analytical framework. Eligible research focused on the design, analysis, or evaluation of educational spaces, including school buildings, universities, campuses, or purposefully designed learning environments. Moreover, studies were required to address key spatial concepts such as wayfinding, human movement patterns, spatial configuration, pedagogical impact, social interaction, or the functional efficiency of educational architecture. Only peer-reviewed journal articles, recognized conference proceedings particularly from Space Syntax Symposium and publicly accessible, peer-reviewed dissertations or theses were considered for inclusion.

Exclusion Criteria: Studies were excluded if they fell outside the designated publication period or if they consisted solely of conceptual or theoretical discussions without presenting original Space Syntax analysis or empirical data directly related to school design. Research focusing exclusively on urban planning or general public spaces, without a direct link to educational environments, was also excluded. Additionally, studies that referenced Space Syntax superficially without integrating it as a substantive analytical tool were not considered. Non-academic sources, such as popular media articles or publications lacking sufficient methodological detail for critical evaluation, were likewise excluded from this review.

2.3 Data Synthesis and Analysis Approach

The extracted data were meticulously organized into a structured table (Table 1) to facilitate clear presentation, systematic comparison, and ease of access for readers. A thematic analysis approach was rigorously employed to synthesize both the qualitative and quantitative findings across the included studies. This process involved identifying recurring themes, consistent patterns, and significant relationships concerning how Space Syntax is applied in school design and the insights it yields. Cross-study comparisons were conducted to discern consistent findings, highlight any contradictions or discrepancies in results, and identify emerging trends related to wayfinding, pedagogical impact, spatial layouts, and the utilization of specific Space Syntax measures. The synthesis also critically evaluated methodological variations across studies and discussed their implications for the robustness, validity, and generalizability of the reported findings.

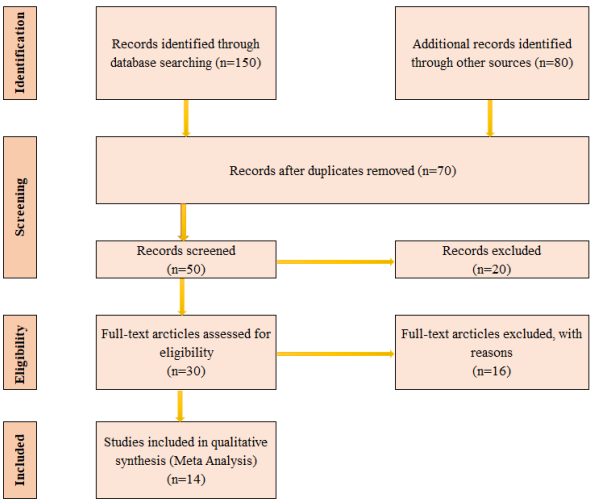

Figure 1. Flowchart of data gathering and record screening adopted from PRISMA 2009

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3. RESULTS AND DISCUSSION

3.1 Overview of Included Studies

This section provides an overview of the studies that met the inclusion criteria and were incorporated into this systematic review. The review period (2015-2025) notably encompasses the proceedings from the 10th (2015), 11th (2017), 12th (2019), 13th (2022), and 14th (2024) International Space Syntax Symposium. This consistent presence underscores this Symposium as a crucial and enduring platform for the dissemination of cutting-edge research within the Space Syntax community. The recurring appearance of International Space Syntax Symposium proceedings within the relevant timeframe, coupled with the challenges in accessing some full texts, indicates a significant reliance on these specialized conferences for disseminating new research in this domain. This suggests that the International Space Syntax Symposium serve as a primary, if not the dominant, venue for the publication of new research applying Space Syntax to educational buildings within the specified timeframe (Maureira & Karimi, 2017; Karimi, 2019).

This implies that a substantial portion of cutting-edge and emerging findings in this niche area is first presented and published in these specialized conference proceedings, rather than exclusively in mainstream academic journals. This observation is critical for future researchers in the field, guiding their search strategies to prioritize this Symposium. It also highlights the unique publication ecosystem of Space Syntax, where a dedicated conference series plays a central role in knowledge dissemination, potentially making some research less visible in general academic databases. While a comprehensive global geographical distribution across all potential included studies is not fully detailed in the provided materials, several specific locations are mentioned. These include Erbil (Iraq), Cyprus, the Greater Cairo Region (Egypt), London (UK), Lisbon (Portugal), and Riyadh (Saudi Arabia). The included studies represent a balanced mix of empirical case studies and conceptual reviews, with a strong emphasis on the practical application of Space Syntax methodologies to real-world educational settings.

3.2 Thematic Analysis of Space Syntax Applications in School Design

3.2.1 Impact on Wayfinding and Movement Patterns

Space Syntax is extensively utilized to model and understand human movement flows within both open and closed built environments, providing a valuable understanding of user flows that enables innovative design solutions to enhance the quality of movement and spatial experience (Silva et.al., 2017; Leite et.al., 2024). Wayfinding, a critical aspect of spatial navigation, involves the cognitive process individuals undertake to identify and navigate the most efficient route to a destination, relying on a combination of cognitive, affective, and informational cues. The physical environment's elements, such as streetscape, connectivity, and overall spatial configuration, are fundamental in defining the navigational space (Celik, 2025). Research indicates that a higher degree of visual access within an environment can significantly reduce feelings of mystery and uncertainty, thereby decreasing stress in complex or unfamiliar settings and facilitating easier spatial orientation (Montello, 2007).

Studies suggest that architectural designers with formal training in Space Syntax tend to exhibit a stronger focus on the functional aspects of human movement and adopt a more user-centric perspective during the design process. This often translates into design outcomes featuring simplified hallway configurations, which are generally considered more conducive to effective wayfinding (Hoelscher et.al., 2010). A recent study by Binabid (2024) applied Visibility Graph Analysis (VGA) and movement mapping to analyze student experience in a university building. The findings indicated that main corridors, characterized by high integration values, significantly influenced student movement patterns. However, the study also revealed that wayfinding posed a considerable challenge for first-year students, primarily due to the presence of "look-alike" corridors that lacked distinguishing elements or interior features, leading to disorientation (Binabid, 2024).

This finding highlights a crucial point: while Space Syntax analysis can identify structurally integrated paths, structural integration alone does not guarantee intuitive wayfinding. The perception of space and the presence of cognitive cues are equally, if not more, crucial. The initial interpretation of Space Syntax's role in wayfinding often focuses on optimizing topological measures like integration to create "simplified hallway configurations" (Hoelscher et.al., 2010). However, Binabid's study presents a critical nuance. Despite the main corridors in the university building exhibiting high integration values, first-year students still reported disorientation. Hillier and Hanson (1989) has suggests that human wayfinding is not purely a function of the shortest topological path or high integration, but is heavily mediated by cognitive factors such as the presence of memorable landmarks, visual distinctiveness, and clear perceptual cues (Montello, 2007).

The study's recommendation to add "distinguished interior features (landmarks) and improving visual connections" directly addresses this cognitive dimension. This observation moves beyond a purely geometric or topological understanding of wayfinding to emphasize its complex cognitive and experiential nature, suggesting that Space Syntax analyses for wayfinding should be integrated with qualitative assessments of environmental legibility and human perception. The study concluded that factors beyond pure spatial configuration, such as design aesthetics, scheduling, student academic level, and even parking location, collectively impacted movement and path choices. It recommended incorporating distinguished interior features (landmarks) and improving visual connections between spaces to enhance wayfinding (Binabid, 2024). Further research, such as that by Fuchkina, Schneider, and Bielik (2024), has investigated route choice behavior in complex indoor environments, specifically within a standard school building typology featuring

numerous path alternatives. While not directly focused on schools, a study by Zhai, Wu, and Zhang (2024) on wayfinding in metro interchange hubs using Space Syntax further illustrates the method's versatility in analyzing complex indoor navigation challenges.

3.2.2 Influence on Pedagogical Approaches and Learning Environments

The spatial structure of school buildings plays a pivotal role in shaping the social organization of teaching and learning. Beyond their academic function of knowledge transmission, schools are critical environments for children's socialization, where they learn about societal norms, group interactions, and their place in the world (Su Jin et.al., 2015; Sailer, 2015). Space Syntax analysis offers a powerful tool to generate insights into spatial configurations that can enhance functional efficiency and promote best practices in educational architecture. Specifically, it can be utilized to investigate how the spatial arrangement of higher education environments has the potential to revolutionize learning processes and significantly elevate student experiences.

A conceptual framework for studying school buildings in relation to pedagogy proposes a shift in focus from merely optimizing classroom conditions to embracing the broader idea that learning is inherently social and occurs in a multitude of diverse settings and places within the school environment. This is further supported by a 2015 study on Hogwarts School of Witchcraft and Wizardry, which found that only 10% of learning in the movies occurred in classroom settings, with the majority of peer learning taking place in common rooms, dormitories, and courtyards, often in more integrated spaces. This highlights the importance of social and public spaces for diverse learning processes. Sailer's (2015) work also directly discusses the impact of school layout on pedagogy and social behaviors, reinforcing this connection.

In a significant contribution, Fouad and Sailer (2024) conducted a Space Syntax analysis of seven school library case studies, complemented by detailed fieldwork observations in two of these. Their research revealed that while the library's spatial configuration (as determined by Space Syntax) establishes the potential for student interactions and self-directed activities, the actual operational patterns often diverge from this design potential. This divergence was attributed to external factors such as student routes, supervision patterns, and library regulations. For instance, Library A1, characterized by a segregated and quiet atmosphere, fostered independent reading and discrete interactions, whereas Library B1, despite being highly accessible and vibrant, experienced fewer interactions due to active librarian control and a disciplined environment.

This finding reveals a significant complexity: the paradox of accessibility and social interaction in learning environments. Space Syntax theory generally posits a positive correlation between spatial accessibility (integration) and social interaction. However, the Fouad and Sailer's (2024) study introduces a critical counter-example where high accessibility did not lead to more interaction, suggesting mediating factors. Library B1, described as a "highly accessible vibrant activity-driven atmosphere," surprisingly showed "fewer interactions" among students. This counter-intuitive outcome was attributed to external factors, specifically the "librarian who wants to maintain a disciplined environment, restricts interactions and controls which activities emerge".29 In contrast, the less accessible Library A1, with "less control from the librarian," fostered "discrete student interactions." This moves beyond a simple, direct cause-and-effect relationship (spatial integration leads to social interaction) to reveal a more complex, multi-factorial reality. It demonstrates that the potential for interaction created by spatial configuration can be significantly mediated, or even overridden, by human agency, institutional policies, and managerial practices.

This implies that for Space Syntax analyses to provide truly actionable insights in educational design, they must incorporate a robust understanding of organizational culture, supervision strategies, and user behavior patterns, moving beyond purely configurational metrics. Sak Acur, Sailer, and Penn (2024) employed Space Syntax and 3D view shed analysis to investigate primary school children's games on a climbing frame. Their findings demonstrated a clear interconnectedness between the structures governing the game and the underlying spatial structures. Through play, children learned to create rules, manage power dynamics, and control access, mirroring broader societal dynamics. Binabid's (2024) study further highlighted the social dimension of educational spaces, noting that a substantial majority (69.3%) of students utilized common spaces for social behaviors, while a smaller but significant portion (16.3%) engaged in class-related discussions. A key concern raised by students was the lack of privacy in common spaces, reported by 87.7% of respondents.

A conceptual review on co-working spaces in educational institutions (2024) underscored the urgent need to update traditional educational layouts to more modern, flexible designs. These contemporary spaces are envisioned to foster a sense of community and multifunctionality, aiming to improve student interactions, overall well-being, productivity, and knowledge sharing, thereby aligning with Sustainable Development Goals 3 (Good Health and Well-being) and 4 (Quality Education). Anteet (2024) explored the pedagogical integration of Space Syntax by embedding it into architecture studio curricula, assessing student perceptions of environment-behavior issues in design projects. Furthermore, a 2019 study by Karimi explored how Space Syntax can serve as a platform for teaching analytical, research-based design, proposing a methodology for this objective.

3.2.3 Configuration of Spatial Layouts and Social Interactions

Space Syntax serves as a powerful analytical framework for examining spatial configuration and its direct impacts on human behavior and social interactions. It employs sophisticated mathematical and graphical techniques to study how spatial layouts influence movement patterns, overall accessibility, and the degree of social connectivity within built environments (Law et.al., 2022). An articulated space, broken down into a greater number of distinct parts, generally

presents a higher degree of complexity. Crucially, the manner in which these different parts are organized within the overall layout is paramount. Certain patterns of path networks can inherently be more or less psychologically complex; for instance, oblique turns are often more disorienting for users than orthogonal turns (Iranmanesh & Kamalipour, 2023).

The contemporary concept of co-working spaces, increasingly being integrated into educational institutions, highlights a pressing need to update traditional, often rigid, layouts to more modern, flexible designs. This evolution aims to better accommodate the current and future needs of students, including their mental health and well-being, by fostering a sense of community and providing multifunctional spaces (Yamu et.al, 2021; Mohamad et.al., 2024). These innovative spaces are specifically designed to improve human interactions, enhance overall well-being, boost productivity, and facilitate knowledge sharing among users.

A study examining architecture schools in Bayz et.al. (2024) provided empirical evidence that a ring-like spatial structure, as observed at Cihan University-Erbil, achieved a moderate level of functional performance, notably outperforming schools with more tree-like structures. The findings consistently indicated that "productive spaces" (e.g., design studios, lecture halls) exhibited higher functional performance compared to "supportive spaces" (e.g., administration areas, toilets). This study provides compelling evidence for the direct impact of spatial configuration on functional efficiency. It highlights that Cihan University-Erbil, characterized by a "ring-like spatial structure," demonstrated superior functional performance compared to schools with more "tree-like" structures. The explanation for this difference is tied to the "Real Ring-ness (R-value)" parameter, where a value greater than 1 signifies a ring-like structure, promoting "high flexibility and functional efficiency due to multiple accessible routes among spaces". Conversely, a tree-like structure (R-value < 1) implies "lack of distribution and increased depth of spaces." This establishes a clear cause-and-effect relationship: the fundamental topological organization of a building's layout directly influences its functional efficiency by determining the availability and redundancy of circulation paths.

This understanding is crucial for architects and planners, demonstrating how Space Syntax measures can be directly translated into design principles to optimize functional flow, adaptability, and the potential for spontaneous social encounters within educational buildings. Psathiti (2021) contributed to this thematic area by investigating spatial and social segregation patterns within lower secondary school buildings in Cyprus. Nabil and Randa (2024) conducted a comparative analysis of private university campuses in the Greater Cairo Region, specifically evaluating socio-spatial inclusivity in their open spaces. Earlier work by Bacharel et.al. (2017) on Lisbon schools also highlighted how school buildings contribute to improving the residential environment and fostering social activity, noting a trend towards schools functioning as public socio-cultural centers.

Table 1: Summary of Included Studies (2015-2025)

Authors	Publication Year	Sample Size/Case Study	Specific Space Syntax Methods Used	Key Results
Fouad, A.T.Z. & Sailer, K.	2024	7 school library case studies; fieldwork observations in 2 libraries (Library A1 & B1)	Space Syntax analysis (assessing library configuration relative to school building and interior furniture layout)	Library configuration shapes potential for student interactions and self-directed activities, but actual operational patterns often diverge due to student routes, supervision, and regulations. Library A1 (segregated, quiet) fostered independent reading; Library B1 (accessible, vibrant) had fewer interactions due to librarian control.
Sak Acur, M., Sailer, K. & Penn, A.	2024	A game invented for a London-based primary school's climbing frame (case study)	Space Syntax analysis, 3D viewshed analysis, method to convert 3D climbing frame to weighted-and-directed graph	Interconnectedness between game structures and spatial structures. Children learn rules, power dynamics, and access control through play, reflecting societal dynamics. Certain game functions have underlying spatial logic.
Binabid, J.	2024	College of Architecture and Planning at King	Mixed-method: Visibility Graph Analysis (VGA)	Main corridors with high integration influenced movement. Wayfinding

Authors	Publication Year	Sample Size/Case Study	Specific Space Syntax Methods Used	Key Results
		Saud University, Riyadh, Saudi Arabia; survey of 49 students	(Directed Visibility, Choice, Integration, Compactness); Movement Mapping; Correlation with survey data	challenging for first-year students due to "look-alike" corridors. Most common space use for social behavior (69.3%). Lack of privacy (87.7%). Movement influenced by shortest path and parking. Recommendations: add landmarks, improve visual connections.
Psathiti, C.	2024	Lower secondary school buildings in Cyprus	Space Syntax	Investigated spatial and social segregation patterns in schools.
Mohareb, N. & Khalil, R.	2024	Private university campuses in the Greater Cairo Region	Space Syntax	Evaluated socio-spatial inclusivity in educational open spaces.
Fuchkina, E., Schneider, S. & Bielik, M.	2024	Standard school building typology with many path alternatives	Space Syntax	Investigated route choice behavior in complex indoor environments.
Anteet, Q.	2024	Architecture studio pedagogy; hotel project	Embedding Space Syntax into curriculum	Explored student perceptions of environment-behavior issues in design projects.
Bayz, A. & Nordin, J. & Mustafa, F	2024	Three architecture schools in Erbil (Salahaddin University-Erbil, Koya University, Cihan University-Erbil)	Space Syntax methodologies: axial map analysis, justified graphs (Mean Depth, RA, RRA, R-value, H*); Depthmap X software	Cihan University-Erbil (ring-like structure) achieved moderate functional performance, outperforming others. Productive spaces consistently showed higher functional performance than supportive spaces. Distributedness enhances flexibility and functional efficiency.
Karimi, K.	2019	Experience of teaching analytical design using space syntax over six years; student work on multi-scale architectural and urban design project	Space Syntax as a platform for teaching analytical design	Proposes a teaching methodology for analytical, evidence-based design using space syntax. Demonstrates outcomes of student work.
Sailer, K.	2018	Not specified (general discussion on school layout)	Not specified (discusses impact of school layout)	Discusses the impact of school layout on pedagogy and social behaviors.

Authors	Publication Year	Sample Size/Case Study	Specific Space Syntax Methods Used	Key Results
Bacharel, M., Heitor, T., & Alegre, A.	2017	Polytechnic institutions in Portugal, case study of Lisbon. Research at two scales: institution's location in city and internal spaces.	Space Syntax tools (general application to location and internal deepness)	School buildings contribute to improving residential environment and social activity. Shift towards schools as public socio-cultural centers. Space syntax tools help isolate variables in complex studies.
Coelho, C., & Heitor, T.	2017	Artistic learning environments (details not specified)	Space-use analysis, Post Occupancy Evaluation, space syntax approach to human activity patterns	Research focuses on educational facilities and innovative learning environments. Aims to model human activity patterns and assess adaptability.
Silva, L. C., Heitor, T. V., & Calvo-Sotelo, P. C.	2017	University realm in contemporary urban territory (details not specified)	Space Syntax (details not specified)	Explores the relationship between universities and their urban context, likely concerning accessibility and integration. [59]
Sailer, K.	2015	Fictional Hogwarts School of Witchcraft and Wizardry (from Harry Potter novels/movies). Floor plans analyzed, movie material evaluated.	Visibility Graphs	Only 10% of learning in movies occurred in classrooms; majority of peer learning in common rooms, dormitories, courtyards. Peer learning tended to happen in more integrated spaces. Framework applicable for studying spatial and social organization of teaching/learning. Proposes shifting focus from classroom conditions to broader school environment for learning.

3.2 Discussion

3.2.1 Synthesis of Major Findings and Emerging Trends

The systematic review of Space Syntax applications in school design from 2015 to 2025 reveals a growing and increasingly nuanced understanding of the profound relationship between spatial configuration and human behavior within educational environments. A significant trend is the expansion of Space Syntax's utility beyond its traditional role of predicting movement patterns to encompass a more holistic analysis of functional performance, social interactions, and pedagogical support. This progression signifies that the field is moving towards a more comprehensive assessment of how built environments influence the complex dynamics of learning and social life in schools.

Studies consistently demonstrate that the topological properties of a school's layout, as quantified by Space Syntax measures, directly impact user experience. For instance, the Bayz et.al. study (2024) provided compelling evidence that a "ring-like spatial structure" in an architecture school led to superior functional performance compared to "tree-like" structures. This is attributed to the enhanced flexibility and functional efficiency provided by multiple accessible routes inherent in distributed, ring-like configurations. These finding underscores that the fundamental topological organization of a building's layout is not merely descriptive but is predictive of how efficiently and effectively spaces support their intended functions and user interactions. This understanding is critical for architects and planners, as it illustrates how Space Syntax measures can be directly translated into design principles to optimize functional flow, adaptability, and the potential for spontaneous social encounters within educational buildings.

The application of Space Syntax in understanding wayfinding is also evolving. While measures like integration can identify highly accessible paths, the study by Binabid (2024) on a university building highlights a crucial distinction: structural integration does not automatically guarantee intuitive navigation.31 First-year students experienced disorientation in highly integrated, yet visually undifferentiated, corridors. This indicates that human wayfinding is not solely a function of shortest topological paths but is heavily mediated by cognitive factors such as the presence of memorable landmarks and distinct visual cues (Montello, 2007). This observation moves beyond a purely geometric or topological understanding of wayfinding, emphasizing its complex cognitive and experiential nature. It suggests that Space Syntax analyses for wayfinding should be integrated with qualitative assessments of environmental legibility and human perception to provide truly actionable design recommendations.

Furthermore, the review highlights the increasing recognition of space as an active agent in shaping pedagogical outcomes and social dynamics. The conceptual review on co-working spaces in educational institutions advocates for flexible, multifunctional layouts to foster better student interactions, well-being, and knowledge sharing, aligning with modern pedagogical needs and sustainable development goals.17 This is strongly supported by earlier work, such as Sailer's (2015) study on Hogwarts, which demonstrated that a significant portion of learning, particularly peer learning, occurs outside traditional classrooms in more integrated social spaces like common rooms and courtyards. Sailer's (2018) work further reinforces the direct impact of school layout on pedagogical and social behaviors. The concept of schools evolving into public socio-cultural centers, as explored by Bacharel et al. (2017) in Lisbon, also underscores the broader community role of educational buildings and their contribution to social activity beyond formal learning.

However, the study by Fouad and Sailer (2024) on school libraries introduces a significant complexity: the paradox of accessibility and social interaction. While Space Syntax often correlates high spatial accessibility with increased social interaction, their research found that a highly accessible library (Library B1) had fewer interactions due to active librarian control and disciplinary policies, whereas a less accessible library (Library A1) fostered more discrete interactions due to less supervision. This finding is particularly significant because it moves beyond a simple cause-and-effect relationship between spatial configuration and social behavior. It demonstrates that the potential for interaction created by spatial configuration can be significantly mediated, or even overridden, by human agency, institutional policies, and managerial practices.

This implies that for Space Syntax analyses to provide truly actionable insights in educational design, they must incorporate a robust understanding of organizational culture, supervision strategies, and user behavior patterns, moving beyond purely configurational metrics. The recurring reliance on International Space Syntax Symposium proceedings as primary publication venues also indicates a unique dissemination ecosystem within this niche field. This suggests that a substantial portion of cutting-edge research is first presented and published in these specialized conference proceedings, potentially making some findings less visible in general academic databases.

3.2.2 Identification of Research Gaps and Limitations

Despite the growing body of research on Space Syntax in school design over the past decade, several important gaps and limitations persist. A key limitation is the narrow focus on certain educational typologies- most studies concentrate on university campuses, libraries, and primary schools, with limited attention to diverse contexts such as early childhood centers, vocational institutions, or schools employing alternative pedagogies like Montessori or Waldorf. Another notable gap is the insufficient integration of qualitative and quantitative data. While some studies incorporate surveys or observational methods, few systematically align these with spatial metrics. Richer insights could emerge from combining Space Syntax analysis with qualitative data on user experiences, such as cognitive cues and spatial perception, as emphasized in the Binabid (2024) study. Moreover, most research adopts cross-sectional designs, offering only snapshots of existing spatial conditions. Longitudinal studies are needed to evaluate how spatial configurations and user behavior evolve over time, particularly following design interventions. Non-spatial factors such as institutional norms, supervision, and user agency-also remain underexplored, despite evidence from studies like Fouad and Sailer showing their critical influence. Additionally, the literature lacks global representation and remains concentrated in a few regions. Finally, access to relevant studies often published in less accessible conference proceedings poses a barrier to comprehensive review.

3.2.3 Implications for Educational Architecture and Future Research Directions

This systematic review yields significant implications for both educational architecture and future research. The application of Space Syntax enables evidence-based design by providing architects and planners with analytical tools to move beyond intuition. By quantifying spatial relationships, designers can better anticipate user behavior and optimize learning environments for movement, interaction, and engagement. The review underscores the importance of prioritizing configurational properties such as integration, choice, and ring-ness as these directly influence spatial efficiency and the potential for social interaction as stressed by Askarizad et.al., (2024).

In particular, ring-like or distributed structures offer greater accessibility and adaptability. Moreover, effective wayfinding requires a multisensory strategy that combines spatial integration with cognitive aids, such as landmarks, varied spatial features, and visual differentiation, especially for unfamiliar users. Importantly, spatial design must account for the influence of institutional policies, supervision, and pedagogical models. Collaborative efforts among architects, educators, and administrators are essential to align spatial layouts with intended educational outcomes. Future research should integrate Space Syntax with sociological and organizational behavior frameworks to better understand the

complexity of learning environments. As schools evolve into multifunctional community hubs, adaptable and inclusive spatial designs will be increasingly necessary. Enhancing Space Syntax tools for educational use and conducting comparative, cross-cultural studies will be vital to advance the field.

4. CONCLUSION

This systematic literature review of Space Syntax applications in school design (2015–2025) highlights the method's evolution from a movement prediction tool into a comprehensive framework for analyzing the complex relationship between spatial configuration and educational outcomes. Key findings reveal that ring-like or distributed layouts enhance spatial adaptability and circulation, contributing to functional efficiency. Wayfinding, a critical aspect of user experience, is shaped not only by spatial integration but also by visual and cognitive cues, such as landmarks and differentiated interiors, which are particularly helpful for new users. Importantly, spatial design does not act in isolation; institutional policies, social norms, and managerial practices significantly mediate spatial behavior. The literature also underscores the growing role of informal learning spaces like corridors, atriums, and social zones as integral to peer interaction and pedagogical support. Furthermore, the International Space Syntax Symposium has emerged as a central venue for advancing research in this domain. The findings affirm Space Syntax as a vital analytical tool for designing educational environments that are efficient, intuitive, and socially responsive. Future research should adopt interdisciplinary approaches that combine spatial metrics with qualitative user insights and organizational dynamics to more holistically inform the design of learning spaces that meet evolving educational needs

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