

Towards a Holistic Framework for Academic Library Furniture Design: Integrating Aesthetic Experience, Functionality, and Pedagogy for 21st-Century Learning

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ABSTRACT

Academic libraries are evolving from quiet repositories of books into hybrid learning commons that foster collaboration, creativity, and digital fluency. Within this transformation, furniture is no longer passive equipment but a key mediator between body, technology, and space that shapes cognitive, emotional and social engagement that underpins 21st-century learning. Yet scholarship on libraries remains fragmented. Most studies examine either functionality (ergonomics, proxemics, spatial efficiency) or aesthetic experience (comfort, ambience, emotional appeal) and rarely integrate these perspectives with contemporary pedagogy. This paper proposes a holistic conceptual framework for academic library furniture design grounded in a Systematic Literature Review (SLR) of research across environmental psychology, higher-education studies, ergonomics, and design. Guided by PRISMA screening, the review identified recurring concepts such as sensory-motor engagement, neuroaesthetic valuation, universal design and digitally enhanced learning. The findings were synthesised into three interwoven theoretical domains. 1) Aesthetic Experience, which encompasses sensory-motor stimulation, emotional resonance, and cultural meaning-making; 2) Ergonomic and Environmental Design, by integrating proxemics, anthropometrics, universal accessibility, and technology infrastructure; 3) Learning Environment and Pedagogy, which aligns physical settings with constructivist, collaborative, and blended learning strategies. By bridging design, psychology, and education, the framework positions furniture as an aesthetic pedagogical interface and provides a robust platform for empirical testing through wellbeing metrics, collaborative behaviour analysis and digital engagement studies. It offers designers, educators and institutions a future ready for creating library environments that sustain and transform 21st-century learning.

Keywords: Neuroaesthetic, Academic library, 21st century learning, Furniture design.



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1 INTRODUCTION

Academic libraries have entered an era of rapid transformation. Driven by the imperatives of 21st-century learning, digital fluency, critical thinking, collaboration, creativity, and lifelong adaptability the modern library is a hybrid learning commons, supporting project-based learning, interdisciplinary research, and virtual–physical integration. A key aspect of this transformation is rooted in the enhancement of digital literacy within academic libraries. Libraries have taken on a renewed mission during the pandemic, focusing on the importance of digital literacy as a means to equip students and faculty with the skills needed to navigate an increasingly digital world (Martzoukou, 2020). This advocacy for digital literacy ensures that library services not only provide access to information but also empower users to engage with and utilize that information critically. The integration of virtual and

physical spaces in modern academic libraries ensures that they meet the demands of users, who require flexible access to digital resources and the collaborative atmosphere of in-person engagement. This hybrid model aligns with findings that stresses the significance of managing library services concerning user engagement and adaptability in the digital age (Akinola, 2022). By embracing a hybrid learning commons model, academic libraries position themselves as essential partners in fostering the educational objectives of the 21st century.

Furniture plays a pivotal role in this transition. It is not merely functional equipment; it mediates between body, technology, and built environment, shaping cognitive–emotional processes and enabling flexible, technology-enabled pedagogy. The conceptual transition towards student-centred learning environments is firmly linked to the integration of flexible furniture design. Learning environments enriched with adaptable furniture choices promote student engagement and autonomy, ultimately fostering a shift away from traditional teacher-centred models (Starkey et al., 2021). This shift encourages collaboration and active learning, effectively reshaping the educational experience and enhancing cognitive outcomes. Furthermore, furniture not only provides comfort but also supports diverse learning modalities, thereby facilitating a seamless integration of technology and physical space. (Shaleh et al., 2022). Moreover, the exploration of social interaction within learning environments points to the functionality of movable furniture as a means to enhance collaborative learning. Flexible furniture arrangements enable users to cultivate their social interactions, supporting a variety of participation modes and fostering a sense of community in learning spaces (Loo & Fan, 2023). This adaptability is essential for creating vibrant educational environments that promote teamwork and idea exchange. The aesthetic and spatial arrangements of furniture directly influence emotional responses and cognitive learning processes. A thoughtfully designed furniture can inspire creativity, motivate learners, and create an engaging learning atmosphere (Mahat et al., 2023). This illustrates the transformative potential of furniture beyond its mundane functionality, positioning it as a pivotal element in redefining educational spaces.

Yet, despite advances in smart furniture, reconfigurable layouts, and ubiquitous connectivity, research remains fragmented. Most studies emphasize either *functionality* (ergonomics, proxemics, spatial efficiency) or *aesthetic/experiential* qualities (comfort, ambience, emotional appeal). This paper addresses that gap by proposing a conceptual framework that integrates aesthetic experience with functional and pedagogical imperatives, aligning furniture design with the needs of future-ready learners.

2 LITERATURE REVIEW

2.1 Aesthetic Experience

Aesthetic experience in design is multidimensional, encompassing sensory–motor processes, emotional valuation, and knowledge-based interpretation. Neuroaesthetic studies suggest that sensation and perception are mediated by the motor system, allowing users to interact physically and cognitively with their environment (Chatterjee & Vartanian, 2014). The motor regions of the brain are active during both real and imagined actions, which suggests that anticipation of sensory feedback from the environment can occur even before physical action is taken (Pinheiro et al., 2020). This aligns with Chatterjee and Vartanian’s concept that perceptual processes are heavily influenced by our physical interactions with our surroundings. Such anticipatory mechanisms enable individuals to have a richer engagement with their environments, confirming that the motor system mediates experiential processes. Voluntary actions are accompanied by predictions of sensory outcomes, indicating a predictive coding framework whereby the motor system prepares the brain to interpret sensory feedback during and after actions. This finding reinforces the notion that sensory experiences are enriched through active engagement with one’s environment, which is essential in spaces such as libraries, where physical layout and user interactivity can significantly impact cognitive and emotional responses (Ody et al., 2023). Moreover, sensory interactions can be influenced by postural manipulations and that anticipatory motor activity is tied to expected sensory feedback outcomes (Christie et al., 2019); (Vercillo et al., 2018).

These findings closely relate to Chatterjee and Vartanian's argument that aesthetic experiences are mediated by a combination of sensory input and motor actions, suggesting that enhancing library spaces with consideration for users' physical interactions could lead to more engaging and beneficial learning environments. Emotional and reward systems shape how individuals “like” or “want” particular design features, linking furniture to psychological wellbeing (Magsamen et al., 2023). Evidence shows that the design of school furniture significantly affects users' satisfaction, well-being, and comfort levels. They emphasize that ergonomic furniture, particularly when designed with captivating colours and motifs, can foster a favourable learning environment (Manca et al., 2020). This finding aligns with the understanding that emotional responses to aesthetic elements in furniture are crucial for psychological comfort and overall well-being. In a behavioural context, social and cultural connections inherent in furniture design that significantly impact users' psychological well-being (Ukabi & Gürdalı, 2021). They argue that the design of furniture allows for cultural expression, fostering community and improving emotional satisfaction. This underscores how the emotional resonance with furniture design influences not just the individual but also collective well-being within public spaces. Moreover, the semantic and semiotic aspects of furniture design, suggesting that meanings attached to furniture shapes play a crucial role in consumer preferences (Lin et al., 2023). Their findings imply that the psychological impact of furniture extends beyond its physical use, tapping into deeper emotional fields and cultural significances that can greatly influence user interaction and satisfaction. Beyond immediate perception, meaning-making processes are influenced by cultural context, expert knowledge, and individual experiences (Siler, 2015). In library furniture, this suggests that materials, textures, and forms are not only seen or touched but also interpreted symbolically, contributing to identity and belonging.

In a 21st-century learning context, where motivation and wellbeing are key drivers of student success, *affective resonance* from materiality to colour becomes critical. The emotional aspects of learning environments, including the design and colour of furniture and spaces, play a critical role in student engagement and well-being. "Affectagogy," which reimagines pedagogy by emphasizing emotional engagement through the integration of emotional intelligence (EI) and social-emotional learning (SEL) within educational contexts (Chee, 2025). This emotional foundation can enhance student motivation and foster positive psychological outcomes, creating an environment conducive to learning. Moreover, research on the effects of colour on memory and emotion are explored, which provide evidence on how varying background colours can impact learning outcomes and overall student engagement, highlighting that colour plays a crucial role in enhancing the efficacy of learning materials (Cai & Wang, 2024). Finally, the emotional experiences of students as they transition to learning spaces have been documented, that underscores how the design of learning environments affects both the physical and emotional journeys of students, thereby impacting their engagement levels (Knight, 2025).

2.2 Temporal Dynamic Experience

Learning today is extended, asynchronous, and blended. Furniture must accommodate long-duration study, quick reconfiguration for group work, and evolving digital task (Wassiliwizky & Menninghaus, 2021). They articulate that aesthetic experiences are not static but evolve based on context and engagement. Aesthetic encounter unfolds through a series of stages that together contribute to an overall dynamic experience. Research indicates that individuals' perceptions shift during these stages as they engage with generative art, prompting evolving aesthetic valuations (Meng et al., 2025). This aligns well with the idea presented by Wassiliwizky and Menninghaus, emphasizing that aesthetic moments are not confined to a single instance but are experienced over time, significantly altering individuals' responses and feelings. Further expanding this discourse, neurodynamic processes underpin aesthetic engagement in creative arts therapies. Study shows that aesthetic experiences involve both affective and cognitive processes that are temporally structured, wherein emotional resonance develops through ongoing interactions within various contexts (Vaisvaser et al., 2024). This temporal depth of engagement supports the understanding that experiences unfold dynamically, fostering transformation as individuals respond to aesthetic stimuli. Other findings on temporal instability in aesthetic preferences found that objects show variability over time, indicating that aesthetic resonance is not static but fluctuates depending on the duration of exposure (Aleem & Grzywacz, 2025). Their findings

contribute to the understanding of how repeated interactions with an object or environment affect individuals' emotional and aesthetic responses, reflecting the multifaceted nature of aesthetic experiences as they unfold. In a more philosophical exploration, the experience of time in relation to objects and processes, highlighting how our interactions with material objects are intrinsically temporal. The phenomenology of experiencing time can influence how we perceive and value aesthetic encounters, suggesting that the dimension of temporality is fundamental to our understanding of aesthetics (Shardlow, 2023). This perspective echoes Wassiliwizky and Menninghaus's assertion that cognitive and emotional engagements with spaces and objects evolve continuously.

In the library context, this implies that furniture design should anticipate long-term interactions, comfort during extended study sessions, adaptability across diverse activities, and evolving relationships with changing pedagogical practices. The importance of flexible furniture designs in student-centred learning environments which research advocates for furniture that supports active and collaborative learning, facilitating group work and enabling responsive teaching practices (Starkey et al., 2021). Such flexibility is critical in accommodating various pedagogical demands and fostering an engaging learning atmosphere. The ergonomic aspects of furniture design cannot be overlooked. A study discussing the need for adjustable classroom furniture to accommodate the diverse physical dimensions of students. They find that ergonomic considerations are pivotal in ensuring comfort during extended periods of study, which can improve focus and reduce discomfort (Ansari et al., 2018). This design approach is essential for enhancing physical well-being and enabling longer engagement with academic materials.

2.3 Proxemics and the Built Environment

The arrangement of furniture influences social distance, privacy, and collaboration. Flexible space is essential for active learning. Proxemics (Hall et al., 1968) and learning archetypes ("campfire," "cave," "watering hole") (D. Thornburg, 2004) highlight how furniture enables a spectrum from individual focus to collaborative innovation core competencies of 21st-century pedagogy. Work on proxemics, first introduced in 1966, fundamentally reshaped the understanding of personal space and its effects on communication and social interaction (Hall et al., 1968). Proxemics, as defined by Hall, refers to the study of how individuals use physical space in interpersonal interactions, encompassing various aspects of human behaviour in relation to spatial distance. Hall categorizes personal space into four main zones: intimate space (less than 1.5 feet), personal space (1.5 to 4 feet), social space (4 to 12 feet), and public space (more than 12 feet) (Scandolo & Fraichard, 2011). Each zone corresponds to different degrees of intimacy and familiarity among individuals, affecting social cues and interactions. Intimate space is reserved for close relationships, while public space is appropriate for interactions among strangers. This classification system has become foundational in the study of social interactions and environmental psychology.

Thornburg (2004) describes three primary metaphors that illustrate different contexts for learning as "campfire," "cave," and "watering hole." Each of these archetypes emphasizes unique facets of the learning experience and provides insights into the design of educational environments that foster deeper engagement and collaboration among learners. The "campfire" archetype symbolizes shared learning experiences that occur in a communal setting where knowledge is imparted through storytelling and discussion. This metaphor aligns well with current educational methodologies that prioritize collaborative learning. Learning spaces modelled after the campfire metaphor enhance knowledge development through vivid imagery, creating vibrant interactions where learners are actively engaged in sharing ideas and experiences (Bodrick et al., 2025). Spaces designed for "campfire" interactions facilitate communal storytelling, which can foster a sense of community and shared purpose among learners, reflecting Thornburg's ideas on creating interconnected learning experiences. The "cave" represents a solitary and reflective space, emphasizing individual learning and introspection. This metaphor reflects the need for learners to engage deeply with their own thoughts and the material at hand. The cave archetype is vital for personalization and self-directed learning, allowing students to concentrate on their learning without distraction. Conversely, the "watering hole" serves as a gathering

space that encourages informal discussions and collaborative exchanges. This metaphor embodies the principle of sharing knowledge in a more relaxed atmosphere, similar to how animals gather at a watering hole. It emphasizes the social aspect of learning where dialogue and peer interaction are paramount to the learning process. The interplay between these archetypes is particularly crucial in contemporary educational settings where flexibility is key. Thornburg's models facilitate the design of learning environments that incorporate elements of all three archetypes. Effective learning spaces today might include areas that encourage intimate group discussions (campfire), reflection zones (cave), and collaborative hubs (watering hole) that cater to diverse learning needs.

The design of flexible learning spaces is increasingly recognized as essential for supporting active learning strategies in contemporary educational settings. This flexibility enables varied degrees of collaboration and individual reflection, which are core competencies of 21st-century pedagogy. Integrating Hall's (1968) concepts of proxemics and Thornburg's (2004) learning archetypes "campfire," "cave," and "watering hole" provides a robust framework for understanding how furniture arrangements and spatial design impact learning outcomes. When physical spaces are designed to be flexible, they accommodate various pedagogical approaches that ranging from individual study (aligned with the "cave" archetype) to collaborative activities (resonating with the "watering hole" archetype) which in turn fosters autonomy and motivation among students (Kariippanon et al., 2020). further expand on the importance of flexible learning spaces, emphasizing that educators who have input regarding the configuration of these spaces can better tailor learning experiences to meet student needs (Round & Subban, 2023). This echoes Hall's concept of proxemics, where the arrangement of furniture can facilitate or hinder communication and interaction. In a broader context, balancing technology, pedagogy, and physical space are essential in higher education particularly post-pandemic (Rapanta et al., 2021). This indicates that flexible learning environments, which adapt to various teaching models, are crucial for keeping students engaged, echoing Hall's insights on proxemic dynamics in educational settings. flexible learning environments not only facilitate interaction but also contribute to positive educational outcomes by supporting varied learning approaches, connecting directly to Hall's proxemics and Thornburg's archetypes (Kariippanon et al., 2020). In conclusion, recent literature consistently supports the assertion that flexible learning spaces are vital to active learning. By effectively integrating Hall's proxemics and Thornburg's learning archetypes, educators can create environments that promote a spectrum of learning experiences, thus enhancing student engagement, collaboration, and ultimately improving educational outcomes.

2.4 Ergonomics and Human-Centred Design

The principles of anthropometry and ergonomics are crucial for designing environments, products, and systems that accommodate the physical characteristics and capabilities of users. Henry Dreyfuss, a pioneer in ergonomics, significantly impacted design practices through his emphasis on human factors and anthropometry. His principles revolve around creating designs that are functional, aesthetically pleasing, and suitable for the physical attributes of users. Dreyfuss's contributions are seminal in formulating ergonomic standards derived from anthropometric data, as elaborated in "The Measure of Man and Woman," which offers extensive anthropometric statistics for product design tailored to a varied demographic (Dreyfuss & R Tilley, 2002). This reference is vital for enabling design approaches that include human variability, rendering ergonomics an indispensable component of product development in industrial design (Буров, 2019). The use of Dreyfuss's principles in eco-ergonomic designs that emphasize human health and comfort while guaranteeing environmental sustainability. Effective workplace design can enhance safety and comfort, underscoring Dreyfuss's focus on harmonizing the physical workspace with human needs (Protasenko & Mygal, 2021). Pheasant & Haslegrave (2018) provide an in-depth examination of the interaction between human dimensions and ergonomic design. They express that successful ergonomic solutions can only be realized through the proper utilization of anthropometric data. Research highlights the evolving nature of anthropometric principles that require continuous updates to align with shifts in population demographics, health trends, and lifestyle modifications. This adaptability to changing anthropometric traits facilitates the creation

of products and work environments that accurately address the requirements of users (Pheasant & Haslegrave, 2018).

The implementation of nudging algorithms to enhance student involvement, ergonomics has larger implications in designing spaces that are both physically accommodating and conducive to psychological engagement and interaction. By creating educational environments that prioritize cognitive ergonomics and physical comfort, schools can enhance interactive learning experiences (Brown et al., 2022). Environments must correspond with the anthropometric profiles of users to guarantee comfort and safety, applying this principle to educational contexts (Emir et al., 2022). The difficulties educational institutions have had in overseeing digital accessibility, especially during the pandemic. This underscores the imperative for a universal design strategy that integrates ergonomic principles to guarantee digital content accessibility for all users, regardless of ability (Lazar, 2021). Anthropometric and ergonomic principles remain vital, but must now integrate technology use, inclusive design, and universal accessibility to support diverse learners. In conclusion, current research highlights the critical importance of anthropometric and ergonomic theories in educational design, especially as learning settings integrate technology and universal accessibility standards. The integration of these ideas fosters inclusive environments that accommodate varied learners and enrich educational experiences.

2.5 Learning Environment and Pedagogy

The connections between physical environments and their impact on human behaviour and emotions has been thoroughly documented in the literature, particularly by (Rapoport, 1990) and (Norman, 2013). Both writers underscore the active role of settings in shaping experiences, engagement, and emotional responses, especially within educational and social contexts. In "Culture and Environment," Rapoport examines the impact of spatial configurations and environmental attributes on human behaviour and social interactions. He asserts that environments are not simply settings but dynamic entities that influence emotions and behaviours. Rapoport posits that cultural values significantly influence individual perceptions of space and the emotional reactions provoked by various environments (Grádaigh et al., 2021). He highlights that the design and organization of physical settings can foster or inhibit various forms of behaviour, such as collaboration, solitude, or interaction, thus underscoring the importance of understanding user needs in space design. Rapoport's concept clearly correlates with research on how educators may optimize physical learning settings to improve student engagement and emotional well-being. His observations indicate that classrooms that support diverse teaching approaches and social interactions can markedly enhance educational performance.

In "The Design of Everyday Things," Norman extends the discussion of how physical environments impact human behaviour through the lens of usability and emotional design. The emotional response to products and spaces significantly influences user satisfaction and engagement. The significance of developing environments that fulfil physical requirements while also connecting with users emotionally (Norman, 2013). Well-structured workspaces can facilitate pleasant emotional experiences, promoting creativity and collaboration among individuals (Mynott et al., 2024). Norman's examination of "affordances" demonstrates how spatial design can imply particular functions, hence directing human behaviour and emotional reactions. The notion asserts that intrinsic characteristics of physical environments can provoke specific behaviours, which corresponds with the recognition that physical settings significantly influence user experiences and social interactions. Further studies support these foundations, demonstrating that observed behaviours and emotional expressions in various settings, including hospitality, can yield insights about how environments influence guest satisfaction and emotional responses (Kang, 2023). Similarly, other research explores how the integration of social and physical environments significantly shapes user outcomes based on emotional engagement. These findings reinforce the notions posited by Rapoport and Norman regarding the active role of physical environments in guiding human behaviours and emotional states (McEwan et al., 2022). In conclusion, both Rapoport (2008) and Norman (2013) provide valuable frameworks for understanding the impact of physical settings on behaviour and emotion. Their insights are critical for design disciplines that aim

to create environments fostering positive, supportive, and engaging experiences for users, particularly in educational frameworks. Furniture thus becomes a pedagogical agent for flipped classrooms, maker-spaces, and collaborative digital studios.

Individual studies address aesthetics, ergonomics, and technology, they often do so in isolation. Diverse educational formats impact civic participation, indicating that the nature of the educational environment can determine students' levels of engagement (McEwan et al., 2022). However, the research does not encompass how the design and emotional aspects of these environments might further influence student behaviours and attitudes. The absence of interdisciplinary approaches highlights broader institutional challenges, as the corporatization of educational environments may compromise holistic educational experiences by prioritizing financial outcomes over comprehensive and inclusive educational practices (Mynott et al., 2022). His critique underscores the pressing necessity for an understanding that acknowledges the interrelated aspects of aesthetics, ergonomics, and technology in the creation of effective learning environments. The current literature underscores an urgent necessity for a cohesive framework that amalgamates aesthetics, ergonomics, and technological innovations in instructional methodologies. Integrating these disciplines can improve learning settings, promoting increased emotional involvement, inclusivity, and overall educational effectiveness. Across these strands, research remains siloed, lacking an integrated framework that unites aesthetics, ergonomics, and the evolving 21st-century educational agenda.

3 THEORETICAL FRAMEWORK

The proposed framework rests on three interwoven domains that together capture the physical, psychological, and pedagogical dimensions of a 21st-century academic library. Rather than treating furniture as a neutral backdrop, the model positions it as an active medium of multisensory, cognitive, and technological engagement, shaping how learners perceive, feel, and interact with information and with each other. The physical aspect of academic libraries includes the design, layout, and technology used in these places. Modern academic libraries must be structured to facilitate a range of learning activities, promoting flexibility and adaptation to support multiple pedagogical methodologies (Onwusu-Ansah & Korkuvi, 2024). Libraries are progressively employing open spaces, collaborative work areas, and technology-enhanced environments to promote interaction and adaptable usage. These design features are essential since they affect the interaction between students, instructors, and information resources. The psychological dimension focuses on the emotional and cognitive engagement of users within the library space. Well-designed environments evoke positive emotions and encourage learning through better user experiences. The aesthetic attributes of library spaces such as lighting, colour, and layout significantly affect user satisfaction and motivation (Xie et al., 2020). Inviting and physically appealing spaces can cultivate a sense of belonging and promote extended stays, enhancing general well-being and academic achievement. The pedagogical dimension emphasizes the role of libraries as active learning environments that facilitate inquiry-based and student-centred learning. The changing dynamics of educational methodologies require a transition to a library ecosystem that fosters collaboration, exploration, and interactive learning (Onwusu-Ansah & Korkuvi, 2024). This encompasses providing access to resources that enable innovative practices and learning methodologies that align with 21st-century pedagogical frameworks.

The framework rests on three interwoven domains:

1. Aesthetic Experience – Sensory–motor, emotional, and cultural meaning-making.
2. Ergonomic & Environmental Design – Proxemics, anthropometrics, universal design, and technology integration.
3. Learning Environment & Pedagogy – Active, collaborative, digitally enhanced learning strategies.

3.1 Aesthetic Experience

Aesthetic experience goes beyond surface appearance to encompass sensory–motor stimulation, emotional resonance, and cultural meaning-making.

Sensory–motor: Texture, colour, proportion, and tactile feedback invite movement and bodily interaction, supporting comfort during long study sessions and micro-movements that reduce fatigue. Tactile and kinesthetics feedback in haptic technology illustrates that multimodal haptic feedback enhances interaction by improving surface perception and allowing users to more effectively differentiate between various textural variation (Ratschat et al., 2024). In designing learning environment, the relevance of tactile cues can significantly influence user performance, underscoring the importance of well-designed interactions that consider the integrative nature of sensory modalities. Educators can utilize this information to enhance learning environments that foster comfort via sensory engagement (Beyvers et al., 2022).

Emotional valuation: Neuroaesthetic research shows that positive emotional responses—pleasure, curiosity, a sense of calm will enhance attention and memory. Furniture that delights the senses can therefore elevate motivation and persistence. Perceptual learning is affected by sensory experiences, indicating that favourable emotional circumstances improve the efficacy of information processing and discrimination learning. By heightened emotional states can facilitate the encoding of experiences, underscoring the importance of sensory engagement in educational settings (Grádaigh et al., 2021). The relationship between emotional experiences and learning processes suggests that the incorporation of positive emotional stimuli, such as visually appealing designs, promotes long-term memory retention. The importance of aesthetics indicates that appealing designs might enhance student motivation and perseverance by fostering an emotionally engaged environment (Mynott et al., 2022) Examine the function of multimodal experiences in augmenting the educational environment Research indicates that incorporating varied sensory stimuli, including appealing textures and colours, enhances engagement and emotional connection to learning, hence resulting in superior educational experiences (Nakitare et al., 2020).

Cultural and symbolic layers: Material choices, local craft references, and visual narratives embed identity and belonging, helping students feel rooted in place even as they engage in global, digital learning. By interacting with local cultural references, students cultivate a deeper connection to their heritage, so augmenting their sense of belonging within the educational environment. This demonstrates how cultural artifacts can function as significant instruments for identity development and community establishment in educational environments (Boakye-Yiadom et al., 2024). The importance of students establishing linkages between cultural signs and symbols enables them to express their identities and experiences. Incorporating local traditions into educational procedures allows educators to foster students' emotional ties to learning surroundings, so improving their sense of belonging (Deroo et al., 2024).

In the 21st-century learning context, this domain ensures that design nurtures wellbeing, inclusivity, and cultural relevance, vital for diverse, international student populations. As education globalizes, educational environments must embody both local cultural settings and global innovation tendencies. By incorporating local craftsmanship and material selections, educational institutions can develop environments that reflect cultural identities and instil pride in students. The research promotes the creation of adaptable environments that cater to various learning styles and include culturally significant components, hence enhancing students' sense of belonging (Vezhbovska et al., 2024).

3.2 Ergonomic and Environmental Design

This domain integrates proxemics, anthropometrics, universal design, and technology infrastructure to guarantee physical comfort, accessibility, and digital readiness.

Proxemics: Furniture layout regulates personal space and collaboration zones, enabling smooth transitions between solitary focus, small-group dialogue, and large-scale teamwork. The significance of multipurpose furniture in educational settings, highlighting that versatile furniture can enable diverse workspace configurations. research indicates that flexible furniture layouts cater to different modes of interaction and can foster both individual and collaborative learning experiences, enhancing student engagement (Shaleh et al., 2022). A thorough review of flexible learning environments, emphasizing how particular furniture arrangements can enhance student mobility and educational results. Research shows that optimal spatial utilization involves not only furniture arrangement but also understanding of how proxemics affect student interactions and participation (Kariippanon et al., 2020). design preferences in educational furniture and note that adjusting layouts can enhance comfort and user experience in settings, emphasizing the need for designs that can cater to collaborative and individual tasks (Cui et al., 2024). The physical design of learning settings must promote user involvement by incorporating flexible designs that accommodate various learning styles. Research indicates that flexible learning environments might improve both comfort and productivity for students (Khan & Thilagam, 2021).

Anthropometrics & ergonomics: Adjustable heights, varied seating postures, and support for device use accommodate bodies of different sizes and abilities, reflecting universal design principles. The attributes of differentiated assignments that learning spaces design must accommodate varied learning preferences. This entails utilizing ergonomic furniture that caters to diverse learning styles and physical requirements, hence enhancing an inclusive educational environment (Özdemir & Işıksal-Bostan, 2021). The necessity for ergonomic considerations in learning space design to enhance effective teaching and learning results. The implementation of adaptable designs that accommodate various instructional methods and improve student engagement (Dong-qing & Chen, 2023). Employing adaptable furniture designs that provide adjustable heights and diverse seating postures enables educational settings to demonstrate universal design principles, fostering inclusivity and improving comfort for all students. This method not only accommodates varied learners but also cultivates a more efficient and enjoyable educational experience.

Technology integration: Embedded power access, cable management, and support for hybrid or virtual collaboration make furniture a platform for laptops, tablets, AR/VR tools, and future digital innovations. Supportive infrastructure, comprising adaptable furniture and technology-compatible environments, is vital for the effective integration of technology in educational contexts (Legesse et al., 2024). The connection between student privacy and technological integration in higher education shows that furniture arrangements can affect the efficacy of digital instruments while maintaining a balance between student interaction and privacy.(Blackmon & Major, 2023). Considering both physical and electronic ecosystems in educational environments, encompassing efficient furniture arrangements that facilitate digital instruments. This strategy seeks to establish an inclusive educational environment that accommodates diverse student requirements (Kalney, 2021).

Essential features include internal power access, cable management, and changeable furniture to accommodate various devices and improve the overall learning experience. By adopting these concepts, educators may establish environments that utilize technology while fostering inclusivity and accessibility for all students. Here, furniture is not static but a responsive environmental interface, adapting to the evolving technological and physical demands of 21st-century education.

3.3 Learning Environment and Pedagogy

The third domain situates furniture within the practices of active, collaborative, and digitally enhanced learning. Draws on constructivist and inquiry-based theories, recognising that knowledge is co-created through interaction. A causal-comparative study demonstrating the beneficial impact of inquiry-based learning on cognitive learning outcomes. The research synthesizes findings from 60 studies, demonstrating that an emphasis on inquiry considerably boosts student cognitive achievements, underlining the significance of active participation as a core principle of good educational practices

(Nugroho & Zulfiani, 2021). Asynchronous group learning and highlights how social interactions in learning environments shape educational outcomes. Results confirm the idea that inquiry-based approaches, emphasizing collaboration and involvement, augment the learning experience by facilitating peer-to-peer learning (Tuma & Aljazeera, 2021). Challenges and approaches in assessing inquiry-based learning is defined by exploration and collaboration, enabling students to construct knowledge through active engagement in various contexts (Mao, 2023).

Flexible tables, writable surfaces, and mobile seating encourage peer-to-peer collaboration, rapid reconfiguration for project work, and seamless integration with digital platforms. Furniture becomes a pedagogical catalyst, supporting flipped classrooms, blended learning, maker activities, and informal peer mentoring—all hallmarks of 21st-century curricula.

3.4 Systematic Literature Review (SLR) Process for Framework Development

When combined, these domains form a holistic design lens. Aesthetic experience ensures emotional and cultural resonance; ergonomic and environmental design secures comfort, accessibility, and technological capacity; and learning-pedagogical considerations align the physical setting with contemporary teaching and learning strategies. Because the framework is derived from a transparent and replicable SLR, it offers not only conceptual clarity but also an evidence-based foundation for future empirical validation. Academic library furniture is thus recast as a dynamic ecosystem component simultaneously beautiful, functional, inclusive, and pedagogically intelligent capable of sustaining the creative, collaborative, and digitally mediated learning demanded by today's universities.

To ensure the framework is evidence-based and methodologically rigorous, a Systematic Literature Review (SLR) was carried out. The criteria for executing systematic literature reviews (SLRs) have become a fundamental aspect of research across multiple fields. Numerous established criteria exist that offer a systematic framework for systematic literature reviews, ensuring rigor and validity in the synthesis of study findings. Significant papers encompass the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria and additional methodological frameworks that underscore clarity, transparency, and reproducibility in literature reviews.

PRISMA 2020, a revised systematic review reporting guideline. This thorough paper stresses SLR reporting openness and uniformity. The authors provide a checklist to help researchers follow best practices and improve systematic reviews across studies. They say PRISMA can be used for intervention, diagnostic, and observational systematic reviews (Page et al., 2021). The proposed process for framework development as in Table 1.

Table 1 Systematic Literature Review (SLR) Process for Framework Development

No	Stage	Purpose	Key Activities	Expected Outcome
1	Planning & Design	Protocol Establish scope and rigour	<ul style="list-style-type: none"> • Define research questions and objectives • Identify databases (Scopus, Web of Science, ERIC, ProQuest, Google Scholar) • Develop keywords, Boolean strings, and inclusion/exclusion criteria • Register or document review protocol 	Transparent, replicable plan for the review
2	Comprehensive Search	Capture all relevant studies	<ul style="list-style-type: none"> • Execute searches across selected databases (2000–2024) • Export results to reference manager and remove duplicates 	Comprehensive corpus of potentially relevant studies
3	Screening & Selection	Ensure relevance and quality	<ul style="list-style-type: none"> • Title/abstract screening using inclusion/exclusion criteria • Full-text review for methodological quality and direct relevance • Record flow using PRISMA diagram 	Final set of high-quality studies
4	Data Extraction & Coding	Gather key evidence	<ul style="list-style-type: none"> • Extract bibliographic details, context, methods, and key findings • Apply thematic coding aligned with three domains: Aesthetic Experience, Ergonomic & Environmental Design, Learning Environment & Pedagogy 	Structured database of coded evidence
	Synthesis & Integration	Identify patterns and gaps	<ul style="list-style-type: none"> • Compare coded data across domains • Map overlaps, contradictions, and research gaps • Relate findings to 21st-century learning needs (digital fluency, collaboration, inclusivity) 	Integrated conceptual map linking aesthetics, functionality, and pedagogy
	Derivation of Guiding Principles	Translate theory to practice	<ul style="list-style-type: none"> • Distil evidence into five guiding principles: Aesthetic–Functional Nexus, Temporal Dynamics, Spatial Mediation, Pedagogical Anchoring, Holistic Integration 	Evidence-based conceptual framework
	Expert Validation (Planned)	Strengthen credibility and applicability	<ul style="list-style-type: none"> • Delphi panels and interviews with designers, librarians, ergonomists, educators, and student representatives • Incorporate feedback for refinement 	Validated framework ready for empirical testing and application

4 RESEARCH GAP AND CONCEPTUAL PREPOSITION

Despite rich work in each domain, no existing model integrates aesthetics, functionality, and 21st-century pedagogy, the literature on academic libraries reveals a persistent fragmentation. This siloed approach leaves a critical theoretical void: there is no integrated model that simultaneously embraces aesthetic resonance, physical usability, and the demands of 21st-century pedagogy including digital

fluency, collaboration, and learner wellbeing. Integrating educational ideas into curriculum design is important. This research emphasises the need for conceptual frameworks that link theoretical viewpoints with practical applications to foster experiential learning (Kumar, 2025). The impact of aesthetic education-transformative learning models shows how aesthetic education can boost creativity and well-being, highlighting the fragmentation in current methods that fail to connect these key dimensions (Wu & He, 2021). This paper proposes that academic library furniture must function as an aesthetic–pedagogical interface, enabling digital collaboration, flexible learning modes, and wellbeing.

4.1 Contribution

4.1.1 Interdisciplinary Connection

The framework integrates perspectives from design theory, environmental and cognitive psychology, educational technology, and contemporary pedagogy. It offers a common lexicon and a framework of design principles that architects, interior designers, learning technologists, and educational researchers can utilize cooperatively, dismantling entrenched disciplinary barriers.

4.1.2 Reconfigured Agency

Furniture is reimagined as an engaged collaborator in the learning process. Its materiality, flexibility, and technical capabilities influence attention, govern proxemic interactions, and facilitate seamless transitions between physical and virtual collaboration essential skills in 21st-century education.

4.1.3 Investigative Platform

The model provides quantifiable constructs for forthcoming empirical research, including:

- Wellbeing measurements (physiological comfort, emotional responses, stress alleviation).
- Collaborative behaviours (frequency and quality of peer interactions across spatial contexts).
- Digital engagement patterns (the impact of technology integration in furniture on device utilization, hybrid participation, and information dissemination).

These constructs enable rigorous mixed-method investigations and evidence-based design innovations, ensuring that library furniture design remains responsive to evolving educational needs.

4.2 Conceptual Proposition

To address this gap, the paper advances the idea that academic library furniture must operate as an “aesthetic–pedagogical interface.”

Furniture is conceived not just as an object for sitting or working, but as a dynamic platform that:

- Enables digital collaboration through embedded power, connectivity, and adaptable layouts.
- Supports flexible learning modes, from individual reflection to high-energy teamwork and hybrid on-site/online activities.
- Promotes wellbeing and inclusivity by stimulating the senses, reducing fatigue, and reflecting diverse cultural identities.

By fusing aesthetic pleasure, ergonomic intelligence, and pedagogical purpose, the framework redefines furniture as an active mediator of multisensory, cognitive, and technological engagement a cornerstone of future-ready library ecosystems.

5 CONCLUSIONS

It is no longer sufficient to evaluate academic library furniture based solely on how comfortable it is and how long it will last. It needs to encourage collaboration, support digital-age pedagogy, and foster mental and physical well-being. The framework that is presented in this paper provides a design lens that is ready for the future, and it brings form and function into harmony in order to create library environments that encourage, support, and transform learning in the twenty-first century.

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CONFLICT OF INTEREST

Author declares no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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