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Design Guidelines for Active Learning – A Case Study of Contemporary Schools

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ABSTRACT

In recent decades, traditional learning methods and their environments have been unable to meet the future needs and challenges. This has necessitated a reliance on active learning methods, which have demonstrated their potential to satisfy the requirements of the 21st century. This paper put forward a framework for the design guidelines of active learning schools using an inductive research method based on previous studies. It investigates the common design characteristics of six active learning contemporary schools. The guidelines are arranged in four axes: the school layouts, the interior design features, the furniture, and finally the outdoor spaces. The findings revealed that designing active learning schools requires flexibility, communication and openness, integration and sustainability. The flexibility of design layout is applied using framed structural and modular systems, movable walls, and portable furniture to accommodate diverse active learning curricula. Communication and openness have been enhanced using partitions and glass walls that separate classrooms, corridors, outdoor spaces, and informal learning areas, in addition to minimizing the length of paths between spaces. Integrating learning spaces with supportive spaces extends learning beyond traditional classrooms to include corridors, libraries, and gathering areas. Finally, the mutual support of sustainability and active learning enhances the development of future generations.

1. INTRODUCTION

Studies indicate that traditional learning methods and their environments have become insufficient to meet the requirements of future professional life and the aspirations of parents, teachers, and students, alongside the rapid technological advancements and the desire to enhance digital skills [1-3]. Consequently, it has become essential for schools to be capable of addressing these challenges by adopting changes in traditional learning methods and transitioning to active learning approaches, shifting from merely sitting and taking notes to more student-centered methods that place the student at the core of the learning process [2, 4, 5]. This transformation in teaching methods necessitates changes in three intersecting factors, which are: teaching methods, the design of the physical space, and technology [3, 6] (Figure 1).

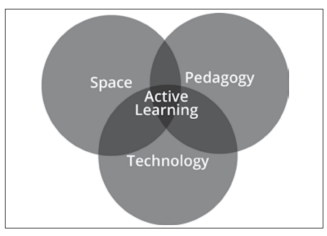


Figure 1. Active learning is the intersection of teaching methods, space, and technology [2]

The change in teaching methods requires a transformation in the design of physical space to enhance these methods, focusing on the organization and flexibility of spaces and the use of flexible furniture. Additionally, it necessitates the use of technology to support educational spaces according to the needs of teaching activities [3, 6]. Thus, the traditional model of the school environment, consisting of uniform-sized classrooms and narrow hallways with fixed, heavy furniture, is not compatible with these active methods, as such spaces do not accommodate change [7].

Studies define active learning as a practice and philosophy that supports student engagement by providing diverse learning options that enable students to collaborate, foster curiosity, cultivate creativity, and deepen their understanding through practical and beneficial experiences [2]. Active learning represents an educational approach that involves students actively and effectively in the learning process, rather than passively receiving instructions. It includes various individual and group activities that require critical thinking and reflection, such as discussions, hands-on learning, teamwork, and other methods [4, 8].

Active learning spaces are defined as places that help students develop essential skills such as active participation in the learning process [2]. Research emphasizes that active learning stimulates students' minds and bodies, aiding them in becoming independent thinkers, effective communicators, and collaborators. It positively influences their engagement,

improves their outcomes and performance, and prepares them for the future by building competencies known as 21st-century skills, which include communication, collaboration, participation, creativity, problem-solving, and critical thinking. Students practice these skills during learning, which are crucial for their future work [4, 9-11].

Active learning is achieved through the implementation of several pedagogical methods and strategies. Therefore, active learning classrooms should be characterized by the creation of environments that foster positive relationships among students and between students and teachers [12]. Consequently, there is a need to implement changes in the educational environment towards flexible sustainable and Comfortable and diverse spaces that respond to the demands of active learning [10, 11, 13].

This paper focuses on exploring the design characteristics of active learning environments to put forward design guidelines that architects can adopt in the design of future schools. The second section of the paper reviews previous studies, followed by the identification of the research problem and its objectives in the third section. The fourth section outlines the theoretical framework for the principles of designing active learning schools. In the fifth section, the research investigates the most common design principles for active learning schools through real case studies. Finally, the research presents its findings and conclusions.

2. PREVIOUS STUDIES

Lam et al. [14] investigated the recent developments in pedagogical theory and how architectural design can facilitate and enhance learning spaces. They addressed the architecture of spaces designed for active learning, illustrating the relationships between modern technology and educational transformation. The study emphasized that active learning necessitates the design of spaces that promote interaction and collaboration between teachers and students, supporting cooperative learning, presentations, and group work while also enhancing focus in learning. The aim of the study was to revitalize traditional spaces at the University of Hong Kong, transforming them into active learning environments. The researchers relied on surveys and student observations to assess the project's success. The study identified a set of design characteristics that support active learning environments, summarized as follows: flexibility and diversity of the learning space through the use of movable partitions and flexible furniture to accommodate various activities (Figure 2); creating an engaging educational environment using vibrant colors and materials; equipping learning spaces with necessary technology such as projectors and interactive devices to facilitate collaboration; designing a comfortable environment with ergonomic furniture (Figure 3); and the ability to adjust lighting levels, indoor temperature, and acoustic design considerations.

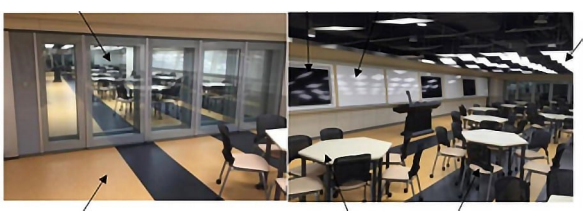


Figure 2. Reshaping classrooms [14]

Figure 3. Replacement of original tables and chairs in right image with swivel chairs in left image to enhance personal comfort and facilitate student gatherings [14]

Kepez and Ust [15] focused on the planning of active classrooms that meet the needs of both students and teachers. It emphasized that classroom layouts should be diverse and support various forms of learning. The research utilized an action research methodology by conducting a workshop with two groups, one consisting of students and the other of teachers. This workshop aimed to collaboratively design active classrooms using flexible furniture and available technology. The findings revealed that teachers preferred traditional layouts more than students, who were more enthusiastic and experimental with new designs. The new layouts allowed for practical and time-efficient flexibility, utilizing supportive learning technologies to facilitate various activities within the space. The designs also provided different levels of privacy with individual and collaborative areas, as well as presentation zones, while ensuring freedom of movement for teachers and visual communication among students and between students and teachers, thereby increasing student participation.

Sigurdardottir and Hjartarson's study [13] identified the characteristics of change in the design of modern school buildings in Iceland and their impact on teaching practices. They employed observation, photography, and document analysis of twenty case studies of modern school designs, along with the conducting of 720 surveys. The study found that features of modern school design included flexibility for multiple uses of space, the ability to adjust room sizes using movable partitions, and transparency through the use of glass walls. The spaces were also designed to be comprehensible and easily accessible, with an attractive layout and integrated technological support. Furthermore, outdoor teaching was facilitated by easy access to exterior spaces, and the school facilities could also be utilized by the community during holidays.

The study by Kariippanon et al. [11] aimed to understand the relationship between flexible learning spaces and the outcomes of teaching, learning, and well-being. The study used a qualitative case study approach and conducted interviews in eight Australian schools. The findings indicated that flexible learning spaces, supported by technology and adaptable furniture, enabled a shift toward student-centered teaching methods. This shift fostered critical thinking, creativity, problem-solving, collaboration, teamwork, and interaction between students as well as between students and teachers. These spaces also facilitated independent work and enhanced student engagement. Additionally, the aesthetic qualities of these spaces, such as the use of colorful and comfortable furniture (Figure 4), access to natural light, improved air quality, and the incorporation of plants, contributed to the well-being and positive feelings of both students and teachers.

Figure 4. A flexible learning space in primary schools featuring adaptable furniture [11]

Eldin et al. [16] aimed to understand the impact of learning space design on learner-centered approaches and to develop standards for enhancing the functional efficiency of learning spaces. The study found that flexible classroom spaces support collaborative and individual learning, peer-to-peer learning, interaction, and engagement between students and teachers. These spaces allow freedom of movement for both teachers and students, facilitate visual communication through decentralized, multi-focal classroom layouts, and accommodate various learning activities with movable furniture suited to the task at hand, while also providing access to technology.

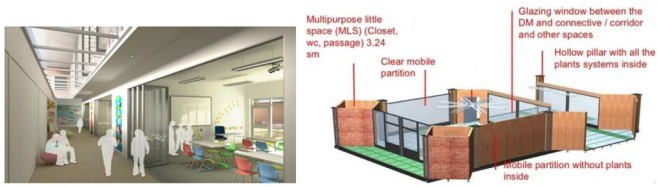
The study by Whiteside and Fitzgerald [17] focused on exploring the relationship between learning space design, teaching practices, and outcomes for students, aiming to develop evidence-based criteria for active learning spaces. It employed experimental methods by organizing three lectures in three flexible, student-centered classrooms and conducting interviews with teachers and students before and after the sessions. The study found that round tables (Figure 5) enhanced interaction and collaborative work, while the classroom layout fostered group discussions and engagement. Additionally, the use of technology elevated students' learning experiences, and the flexibility of the space, comfortable furniture, and suitable lighting positively influenced students' well-being and comfort.

Figure 5. Active classroom layouts [17]

Duffy [18] emphasized the integration of nature into the design of educational projects to create healthier, more supportive, and connected environments. It suggests that such designs positively impact the learning environment, enhance the learning experience, improve students' comprehension abilities, and support their health and well-being. The study highlights biophilic design principles, including access to natural light and fresh air, the use of natural materials, direct connections and views of nature, good acoustic design, and the presence of water.

Similarly, the study by Almusaed et al. [19] examined the application of biophilic concepts in educational institutions in Scandinavian countries to foster creativity, increase concentration, and improve knowledge retention among students while involving them in the design process. The study adopted the appreciative inquiry approach as a method to enhance the effectiveness of school spaces, consisting of four stages: discovering new school ideas, defining expectations and concepts, designing ideas, and implementing them. Feedback from students in five schools across the Scandinavian region was gathered as case studies. The results demonstrated that utilizing natural light, paying more attention to the colors of spaces, simplifying and clarifying circulation paths and corridors, employing flexibility in space management, integrating indoor plants, and linking open educational spaces with nature create a sustainable educational model. Additionally, utilizing outdoor spaces for lessons, while focusing on garden landscaping and corridor design, all contribute to a more creative and efficient learning environment.

The study by Mirpadyab et al. [20] explored how flexibility in school design can support sustainability and longevity over time, allowing spaces to accommodate various activities without significant changes to their organization. This approach aims to better support teaching and learning methods. The study employed a descriptive, analytical, and inductive methodology, showcasing examples of flexible and global schools while establishing design criteria to achieve flexibility in educational spaces. Key aspects include the use of large windows and glass ceilings to maximize natural light, multi-functional spaces, foldable partitions between areas (Figure 6), movable furniture, and integrating nature and outdoor spaces with the interiors.



Use of Foldable Classroom Walls Use of Movable Partitions

Figure 6. Methods for achieving flexibility in school design [20]

The study by Johnston [21] discusses design trends and color selection in schools to support students' developing minds. It highlights several factors influencing school design, including technological advancements, changes in teaching and learning methods, evolving philosophies, and the emerging principle of designing schools as home-like environments. These environments should be safe, conducive to learning, diverse, easily accessible, and flexible to encourage various interactions among students and meet their needs. The study emphasizes the importance of harnessing color as an effective tool in designing stimulating, creative, and inspiring educational environments due to its impact on students' moods and psychological states, while also considering the effects and characteristics of each color (Figure 7).

Figure 7. The use of stimulating colors in educational environments [21]

From the above, it is clear that the dominant and important design concepts in active learning schools include flexibility and adaptability, openness, communication and transparency. Additionally, the sustainable integration of school spaces, where these spaces are designed to adapt to the changing educational needs while maintaining sustainable environmental practices that enhance resource efficiency and reduce environmental impact. Previous studies focused mostly on the architectural specifications of active learning schools related to the concept of flexibility in learning spaces, along with other characteristics such as lighting, comfortable furniture, the use of colors, and technology integration. These studies did not address all design aspects at the level of the whole school design or classroom spaces. To achieve a comprehensive understanding of the guiding principles that designers can adopt in designing active learning schools, this research will concentrate in the following sections on constructing a framework to define the active learning design principles and then exploring the most common characteristics in global designs for active learning schools.

3. RESEARCH PROBLEM, OBJECTIVES, AND METHODOLOGY

The research problem is the lack of a comprehensive definition of the design characteristics of active learning schools. The aim of the study is to build a framework for the guiding principles of the design of active learning schools. The study conducted an inductive research approach based on previous studies to extract the most important design characteristics that support active learning environments.

In addition, the study investigates how active learning concepts such as flexibility, communication, and integration are implemented in real case studies. A descriptive analysis of six contemporary active learning schools was conducted to conclude the most common characteristics associated with active learning design concepts.

4. DESIGN GUIDELINES FOR ACTIVE LEARNING SCHOOLS

The research addresses the guiding principles within four main areas: layout organization patterns, interior design, furniture design, and finally the design of outdoor spaces.

4.1 Layouts of active learning classroom and methods for achieving flexibility

Studies indicate that the organization of spaces contributes to either empowering or constraining users and affects the ease with which they can control their environment. The design of learning spaces shapes the behavior of both teachers and students, thereby influencing the types of activities that occur within them [4, 7]. Effective planning of learning environments requires a clear understanding of the learning rhythm, which changes throughout the semester, the day, and even within individual lessons [3]. As teaching methods and technology have evolved, traditional school layouts with corridors and classrooms have become inadequate, leading to the emergence of new approaches to space organization. These approaches consider all school areas as effective learning spaces, designed in various forms to support changing learning contexts [5]. Figure 8 illustrates the traditional organization of classrooms along narrow corridors, in contrast to open and collaborative learning spaces accommodating large groups of students.

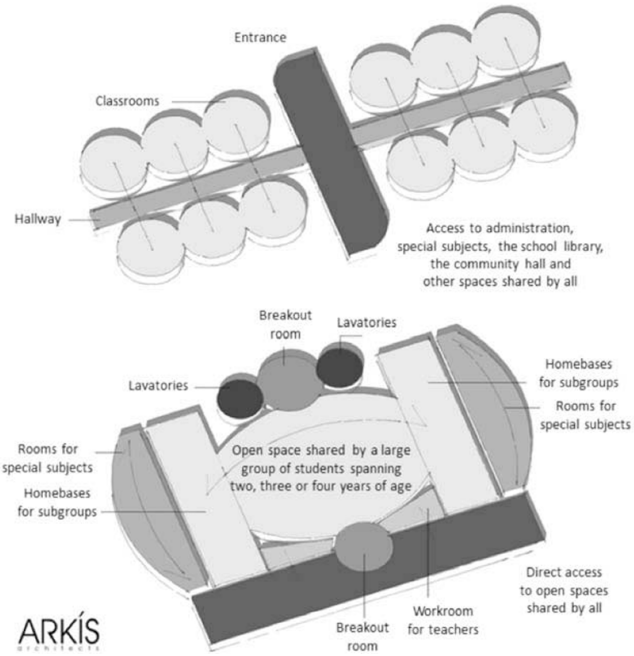


Figure 8. Traditional learning and active learning layouts by ARKIS, 2011 [13]

Previous studies have indicated the role of organizational patterns of school layouts in activating active learning. This study can draw the following guidelines:

Regarding the **linear pattern**, it is advised to avoid the traditional linear layout characterized by long, narrow corridors with classrooms located either on one side or along both sides of the corridor. This configuration results in an extended building footprint, requiring a larger space, and separating students by age can only be achieved by distributing them across different floors [22]. In contrast, it is advised to adopt a learning street pattern (Figure 9), or a backbone design features as a central, wide, and dominant main corridor. Classrooms are located on one or both sides of this corridor, which serves as an area for activities and social interaction. This layout is simple and offers high flexibility, with the entrance positioned at one end to create a strong focal point. It allows for higher ceiling heights and the installation of skylights to facilitate natural light and good ventilation. Using appropriate materials and furniture makes this space a welcoming and vibrant environment for the school [22-24].

Regarding the courtyard pattern, this type of layout is the most commonly used in traditional schools. Studies indicate that what distinguishes this type is the protected internal space, which provides a sense of safety, visual focus on the internal areas, and good access to natural light and ventilation. Additionally, this type of planning emphasizes the importance of outdoor spaces that support educational methods. The forms of this pattern vary with different degrees of openness; it can feature a single enclosed courtyard, an open courtyard, or multiple courtyards. Studies suggest that an enclosed courtyard surrounded by a narrow traditional corridor is unsuitable for active learning activities, as the narrow corridors make it difficult to use them as shared social spaces.

In contrast, open courtyards (Figure 10) on one side or more, surrounded by wide corridors, allow for active learning activities [23, 24].

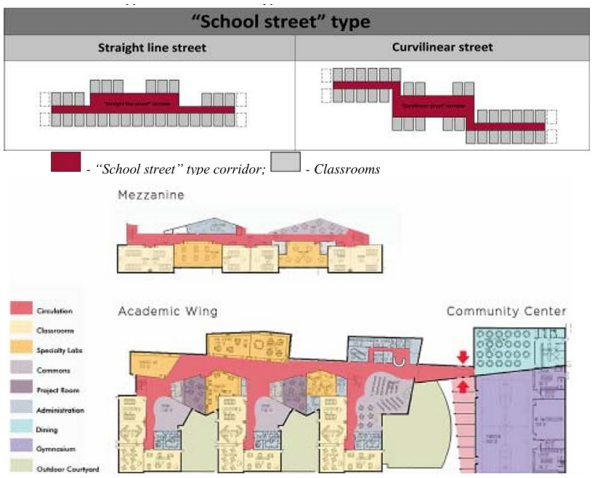


Figure 9. The school street pattern [22, 24]

Figure 10. The courtyard pattern [23]

The multi-story **atrium pattern** is characterized by its support for active learning activities. It features simple layouts, minimizing long walking distances, and includes a shared central space for social interaction that is directly connected to educational areas such as classrooms and laboratories. The full-height atrium serves as an organizational hub that brings natural light indoors. This layout offers high flexibility, with glass walls used as transparent partitions between classrooms to promote communication and openness within the interior spaces while allowing light to enter (Figure 11). This pattern is considered most suitable for multi-story secondary schools [23, 24].

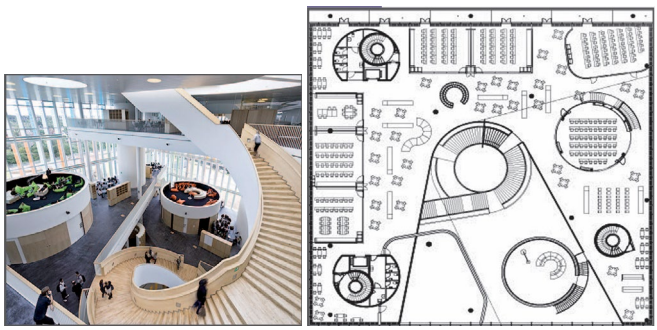


Figure 11. The multi-story atrium pattern at Ørestad College, Copenhagen [23]

The **cluster pattern**, also known as the aggregative pattern (Figure 12), is suitable for active learning schools. The main characteristic of this type is that the school is divided into blocks, with each block representing an educational unit. This division allows the school to be segmented into smaller units that can be more easily managed according to students' ages and grade levels. Each educational unit contains classrooms, supporting spaces, and multifunctional areas. These units can be arranged either linearly around a vibrant corridor or centrally around a shared social space for the school [22-24].

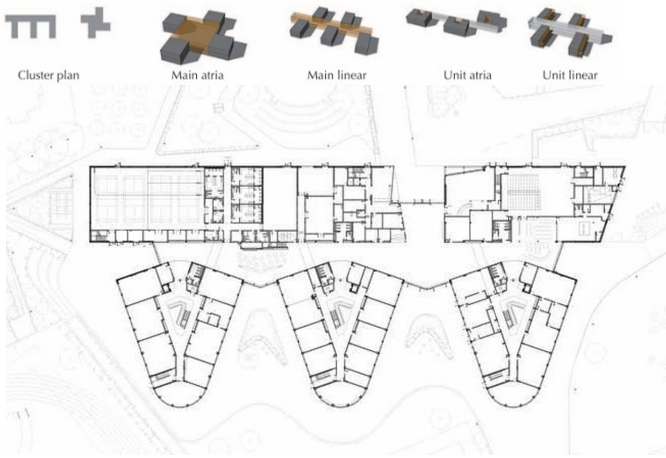


Figure 12. The cluster pattern [23, 24]

The **urban pattern** is also suitable for active learning schools, featuring multiple blocks within a single layout composed of flexible social spaces such as libraries and multipurpose halls, which are connected by pathways leading to classrooms. This layout is characterized by its flexibility, accommodating varying student numbers, and is commonly used in elementary schools. There are two types of this pattern: complex blocks, which can be a single-story layout with multiple blocks and integrated spaces, or a collection of complex, freely arranged, and multi-story structures (Figure 13). Studies suggest that this layout, along with the previously mentioned cluster pattern, can be adopted in elementary schools due to the gradation in the design from specific to general and the presence of small gathering spaces close to classrooms that are suitable for children [23, 24].

Figure 13. The urban pattern [23]

The **single-block pattern** can be employed in active learning schools, representing the organization of the school within a single block. Studies indicate that this type of planning is used in schools with a small number of students, most of whom belong to the same age group. The layout relies on a closed internal climate for the school, featuring spatial gradation and flexibility in the use of partitioning elements. However, studies have noted that a drawback of this pattern is the lack of outdoor spaces for social interaction among students, making it more suitable for locations that require inward-focused planning, such as schools situated near infrastructure [22, 23].

4.1.1 Methods for achieving flexibility in school layouts

Studies have addressed several definitions of flexibility, considering it as the ability to adapt. Flexibility related to spatial organization pertains to the capacity for expansion at the structural level. Expansion requires a fundamental change in the building's structure and depends on the design of the construction system, its location, and whether there is

sufficient space for horizontal expansion or the ability for vertical expansion to add additional floors. The reason for this change is to accommodate more students [7, 25]. Flexibility in the constructed structure can be achieved through one of the following methods:

- **Adaptive design:** This approach features ease and possibility for modification in shape and characteristics without obstacles. Within this method, it is essential to avoid central structural columns in open spaces and the use of load-bearing walls. The placement of structural elements should allow for the opening of spaces and the creation of larger areas [24, 25].
- **Standardized and modular design:** This method allows for the opening, closing, or changing of space shapes, providing the building with the flexibility to respond to changes and adapt to them without rejection [25].

4.2 Characteristics of interior design in active learning schools and methods for achieving flexibility

Studies indicate that school spaces can be interconnected, with easy and clear navigation among them, emphasizing the need to minimize distances and avoid long, complicated corridors that can hinder and delay student movement, resulting in physical strain [5, 22, 26]. Research underscores the importance of achieving transparency and visual openness between interior spaces, which enhances and stimulates learning through the use of glass walls and partitions. This design feature allows members of the school community, including students and teachers, to observe activities occurring within these spaces [27, 28].

Furthermore, studies indicate that the flexibility of spaces and their adaptability are linked to the concept of sustainability, with the school being an environmentally, socially, and economically sustainable design model [26]. The quality, flexibility, and adaptability of learning environments are associated with the design of effective and sustainable spaces by reshaping them for multiple purposes, users, and diverse conditions, in response to social, technological, and educational changes [29-31]. In addition, attention is given to the implementation of natural daylight, natural ventilation, acoustics, and the use of sustainable building materials [13]. One of the ways to enhance the relationship between the physical design of schools and sustainability is to involve students and teachers in the design process, as they are the actual users and are best equipped to identify their true needs in creating a sustainable educational environment that supports active learning methods [29].

Studies highlight the significance of establishing connections between interior spaces and outdoor areas in new schools, as this has a substantial impact on student creativity and positively correlates with their participation and academic performance. This can be achieved by lowering window levels and openings and using folding glass doors to facilitate access to the outdoors and allow for natural light [19, 27, 32]. This feature is also linked to environmental sustainability, emphasizing the need to utilize natural lighting, in addition to the presence of adjustable artificial lighting that can change according to natural light levels throughout the day leading to decrease energy consumption [13, 33].

Research also emphasizes the need to design informal learning spaces outside of classrooms to serve as multifunctional areas that support learning and foster collaboration among students through discussions and group work, such as libraries and corridors. This can be accomplished by promoting seamless transitions and reducing spatial boundaries between these areas and classrooms, equipping them with comfortable furnishings, technology, and all necessary learning resources [2, 5, 34]. Spaces adjacent to learning areas, corridors, or shared spaces can expand options for students and learning activities, such as creating cooperative project and discussion zones, quiet areas for focus and individual work, and dedicated study zones with teachers. Students are given the freedom to choose and arrange their furniture, allowing them to select their study area from various spaces based on their personal preferences [3, 35].

Schools can also be considered an active educational tool by incorporating design elements that provide students with a practical understanding and real-world application of the concepts they study in the classroom [2, 26]. For example, designing the school according to sustainability standards can guide students toward many beneficial practices, such as environmental awareness and energy conservation, or its generation through solar panels, as well as simple measures that ensure thermal comfort, among other aspects [36, 37].

Studies emphasize the importance of focusing on the aesthetics of interior design in modern schools to create an engaging and attractive learning environment. This can be achieved by using colors in a balanced manner between refreshing, stimulating colors and calming tones [24, 26]. To positively impact students' experience in school spaces, as well as their learning outcomes, well-being, and psychological state, and to incorporate the use of calming colors in classrooms that enhance psychological and social sustainability, thus achieving a balanced and sustainable educational environment [11]. It is important to note that each color has a specific impact on the psychology of space users. Colors can also be used for visual coding, defining pathways, guiding students, and distinguishing areas based on their activities (Figure 14). For instance, cool colors like blue and green can be used in quiet spaces such as classrooms to enhance students' concentration, while bright and warm colors like red and orange are suitable for collaborative work areas to stimulate creativity and refresh energy [2, 27, 38, 39].

Figure 14. The ability of colors to stimulate students' senses and facilitate their self-direction [38]

Spaces can also be defined and distinguished through the use of materials with varying nature and texture, such as employing different types of flooring to delineate areas or using carpets in informal or quiet zones. This contrast between materials and textures—such as smooth, rough, transparent, and opaque surfaces—also adds richness and visual stimulation. In addition, there is an emphasis on using paint types free of chemicals and natural materials for carpets, ceilings, and wall finishings to prevent the emission of toxic substances [38].

Furthermore, studies confirm that incorporating plants into the interior spaces of schools and integrating them into the design of the learning environment fosters a sense of place and contributes to the aesthetics of the school. It is also considered a sustainable design feature which positively impacts students' grades and well-being [11, 20, 38].

4.2.1 Flexibility in the interior design (adaptability, modification, and variation)

Flexibility in interior design represents the ability to accommodate different functions according to the activities conducted without the need to change the arrangement of spaces [25]. This flexibility is considered an essential part of sustainability principles, as it helps reduce the need for continuous modifications and renovations, thereby minimizing resource consumption and enhancing space efficiency. It allows for the reshaping of the environment in different ways to create new educational settings [13, 24, 40].

Spatial flexibility allows for reshaping the environment in various ways to create new educational settings [40]. In the designs of future schools, it is essential to direct thinking towards the functional and educational development of learning environments, making them more adaptable to modern teaching and learning methods [5]. Studies emphasize the necessity for continuous, periodic assessment of the building's spaces and functions to identify the changes needed by users and teaching methods and how these should adapt [7]. Flexibility in interior design can be achieved on two levels: the first is flexibility in organizing the boundaries of spaces, and the second is flexibility in the functions of spaces.

Firstly, the flexibility of a space or building and its adaptability, which allow for changes in spatial boundaries, can be applicable either in the short term or the long term [25].

In the short term, flexibility at the level of interior spaces allows for the accommodation of different activities through the use of partitions and movable walls in response to the demands of learning methods. This enables the space to become larger, smaller, or configured differently, involving changes in structure or technical systems but not in the built framework [7].

Studies have indicated that the organization of traditional classrooms in a fixed arrangement with rows and narrow corridors or entry spaces, without the possibility of opening up to other teaching areas, restricts active teaching and learning methods due to the limited ability of these spaces to meet the requirements of such methods, which need flexible environments to accommodate various activities such as group work on projects, collaborative assessments, peer learning, and individual work [2, 6, 11, 31, 41].

Additionally, organizing classrooms along a school street layout with an expanded corridor that accommodates activities while remaining isolated from changes meets learning needs in a limited way. In contrast, a classroom arrangement that allows for groups of classrooms to open into the corridor space to create a larger area while retaining the option to revert to the standard classroom size significantly responds to the demands and methods of active learning due to the ability to transform classrooms with operable walls. This type of layout has become a model for student-centered learning and can be implemented while still maintaining traditional practices [31].

Another type of classroom organization features an open layout without folding walls, lacking the ability to revert to smaller spaces. This design requires associated educational spaces, special arrangements for classrooms, and careful scheduling and management of curricula [42]. This transformation can be summarized either by allocating a set of sub-spaces around the learning area and opening doors between them as needed, or by incorporating shared spaces between classrooms. Using flexible walls and partitions, these areas can be combined or separated as required [24].

In the long term, this refers to making changes in the interior design by removing or adding partitions, walls, and doors. Studies indicate that one of the most significant modifications that can be made to an existing school is the removal of walls and barriers to increase space, as well as adding windows and doors to allow more natural light to enter [2].

Secondly, it is the flexibility in function (diversity of functions). The diversity of functions reflects the flexibility of a space or building, enabling it to change its function or accommodate multiple functions [25]. This flexibility operates on two levels:

In the short term, this is achieved by defining and creating spaces that are multifunctional, capable of hosting a variety of activities along with all necessary tools, furniture, and technology [24, 35]. The design of multipurpose spaces facilitates the flexible use of the building based on different situations and the needs of diverse student groups [5].

In the long term, each school has underutilized spaces, or areas that can be added to learning environments, such as corridors, halls, intermediate spaces, and so on [6]. There are numerous examples of repurposing these spaces to support the learning process. For instance, Humfry Davy School (established in 1912) features a large underutilized area connecting the school's two wings, which has been transformed into a collaborative learning space that accommodates multiple learning scenarios for students [2]. Such adaptable spaces enhance the long-term viability of facilities by accommodating the changing needs of their users [24].

4.3 Characteristics of furniture in active learning schools and methods for achieving flexibility

The design and selection of furniture is a fundamental element in the design of active learning schools, as it significantly impacts learning outcomes, collaboration, interaction, and participation among students [11, 28, 40, 43]. This furniture includes seats, chairs, tables, writable surfaces or boards, display screens, and more [2, 28, 44]. Spaces can be divided into different areas not only by adding walls but also by rearranging furniture and using dividers and partitions as needed [6]. Desks or tables with whiteboard-like surfaces can be utilized to create writable spaces [45]. Furniture suitable for active learning should have the following characteristics:

First, Flexibility: Studies indicate that one of the essential considerations for furniture in active learning schools is flexibility and the ability to support various activities such as lectures, discussions, group activities, presentations, and other learning methods, as this facilitates learning and enhances student engagement, interaction, and collaboration [2, 7, 43]. This can be achieved by:

- **Use of Mobile and Movable Furniture:** Studies emphasize that furniture should be portable to enable smooth transitions between activities, allowing it to be lightweight so that both teachers and students can easily move it [7, 27, 41, 46]. Alternatively, furniture can be equipped with wheels to facilitate movement within the space, creating designated work areas,

especially for heavier items like tables and boards [10, 27, 43, 47]. Flexible furniture can serve multiple purposes; in addition to quick reconfiguration that allows teachers to shift from one layout to another in a short time, a bookshelf can be used as a fixed workspace, or a mobile whiteboard can serve as a space divider [2, 12].

- **Use of Shapeable Furniture in Multiple Configurations:** Studies indicate the possibility of using shapeable furniture that allows for various arrangements, enabling a transition from traditional classroom layouts to collaborative setups by interconnecting tables to create a larger workspace. This facilitates interaction and communication among students [43, 47, 48]. As illustrated in the images below Figure 15.
- **Use of Foldable Furniture:** Studies have shown that the use of foldable furniture and the ability to set it aside when not needed is beneficial and ideal in active learning spaces. This allows for the space to be cleared when necessary, enabling the setup of different activities [2, 35].

Figure 15. Shapeable furniture [43, 49]

Secondly, Comfort: Recent studies emphasize that one of the most important design characteristics of furniture in active learning spaces is comfort, which arises from its suitability for the sizes and ages of students (Figure 16). This includes adjustable height features according to the student's size or chairs designed to support the spine and posture. Uncomfortable furniture can lead to health issues, distract students, and negatively impact the quality of learning and their performance [38, 50]. Additionally, rocking furniture can allow for gentle movement and stretching of legs. Swivel chairs can also facilitate changing seating orientation, thereby enhancing student collaboration and participation, allowing transitions from information reception to peer discussions [2, 10].

Figure 16. The suitability of furniture for students' sizes [51]

Thirdly, Diversity: Studies have shown that active learning spaces should provide various types of furniture to support different learning situations and activities, such as individual and collaborative worktables, chairs, soft seating, swivel chairs, bean bags, and more [2, 3, 26, 27, 48] (Figure 17).

Figure 17. The diversity in furniture [47]

Fourthly, Other Characteristics: Furniture in active learning spaces should include additional considerations, such as having attractive and bright colors, as well as unconventional shapes. It should also be durable and strong to withstand frequent rearrangements and movement [27, 46, 52]. Furthermore, it should support and integrate with technology, such as incorporating power outlets and cable management [43].

4.4 Characteristics of outdoor spaces in active learning schools

Studies indicate the importance of outdoor spaces in active learning schools and their positive impact on the learning process, supporting students' mental and physical health, enhancing their well-being, reducing stress, and aiding in the retention of information for longer periods [35, 48]. In addition to serving as areas for play and social interaction among students, these spaces are effective tools for enhancing learning, as they provide additional environments for educational activities. For instance, shaded seating areas and terraces can be created for reading, and vegetable gardens can be cultivated, allowing students to monitor growth, make observations, and compare these with the theoretical material provided, leading to a deeper and more practical understanding [2, 26]. In addition to its importance in influencing students' perceptions and guiding them towards understanding the significance of environmental care, it helps in shaping their environmental values by identifying the crises and issues the environment faces and providing students with the necessary tools and methods for change and conservation. This includes encouraging activities such as gardening, reusing greywater for irrigation, and utilizing vegetables grown in the school garden in the school cafeteria. Studies suggest that students who spend time in nature, enjoy it, and interact with it are the ones who will continue to nurture it in adulthood [38, 53]. Outdoor spaces also serve as venues for various educational activities, such as conducting classes in open air (Figure 18) and hosting larger or noisier events that cannot be accommodated indoors, including performances and presentations [2, 35, 45].

Figure 18. Outdoor classrooms at Dougherty Elementary School in Garland, Texas [54]

Outdoor spaces are equipped with amenities such as shaded areas, comfortable furniture, and internet access, utilizing attractive colors and shapes, as well as age-appropriate games, to stimulate and engage students' curiosity [48, 54] (Figure 19).

The pedestrian walkway is an important area in outdoor spaces that requires careful design concerning its shape, colors, and the materials used for paving (Figure 20). Additionally, shading plants and trees helps create a positive and vibrant environment that encourages students to utilize it [19].

In addition to the above, studies indicate that the school environment should be purposeful and effective for the community and can enhance community sustainability through the use of gardens and some of its spaces outside of regular working hours and during holidays [24, 38].

Based on the above, Table 1 presents the key characteristics of active learning school design.

Figure 19. The diversity and use of attractive colors and shapes in the furniture of outdoor spaces [48]

Figure 20. The attention given to the design of pedestrian walkways in outdoor spaces within schools [38]

Table 1. Guidelines for designing active learning schools

No.	Design Features of Active Learning Schools
1	**General Guidelines for the Design Layout of School**
1.1	Avoid using a narrow linear corridor pattern in organizing active learning schools
1.2	It can be used as a main corridor or a school street pattern in organizing active learning schools
1.3	It is not preferred to use the closed courtyard pattern surrounded, where spaces are distributed around it
1.4	It can be used as an open courtyard pattern with one or more open sides
1.5	It can be used as a multi-story atrium in organizing active learning schools
1.6	It can be used as a cluster pattern utilized in organizing active learning schools
1.7	It can be used as a single-mass pattern in organizing active learning schools
1.8	It can be used as a town-like pattern, consisting of a collection of space blocks with varied functions, such as lobby, multipurpose halls, and libraries
2	**General Guidelines for Flexibility and Expandability**
2.1	School buildings should have the capacity for future expansion due to changes in student numbers; for example, the structure should allow for adaptability and the ability to add more floors or additional adjacent spaces
2.2	It can be modified and changed in shape and building characteristics without obstacles, such as central structural columns
2.3	It can use the modular design, which consists of units that can be added, removed, and reshaped which consists of units that can be added, removed, and reshaped
3	**General Guidelines for Interior Design – Learning Spaces**
3.1	Should enhance the connection and integration of interior spaces with exterior ones
3.2	Should achieve openness and transparency between learning spaces and ensure they are visually connected to one another
3.3	Should consider the spaces of the corridor, library, and outdoor areas as extensions of the classrooms, allowing the spaces, furniture, and technology to support diverse learning and adapt to its needs
3.4	Corridors in modern schools should not be limited to movement and connecting spaces, but should also serve educational functions
3.5	Should design diverse spaces in informal learning areas, such as collaborative zones and areas for student focus and individual study, equipping them with all necessary tools and furniture
3.6	Should equip school spaces designated for learning with all necessary tools and furniture, along with technology and devices to support the educational environment
3.7	Should ensure that movement between spaces is easy and that corridors are clear and uncomplicated
3.8	Avoid long corridors that cause delays in students reaching classrooms and physical strain
3.9	Should achieve a balance in choosing the colors of the school's interior spaces between stimulating colors like red, orange, and yellow, and calming colors like blue, green, and purple
3.10	It can be used the colors to mark pathways and corridors leading to different school spaces, such as assigning a specific color for paths leading to classrooms for a certain stage
3.11	It can be used to define and distinguish areas and activities
3.12	It can be used for spatial differentiation through materials, textures, and flooring shapes, such as using carpets in specific areas or designating a floor area with a particular color
3.13	Should ensure that the properties of materials, elements, and textures used in interior and exterior spaces are diverse to provide richness, visual stimulation, and engage students' interest

4	**General Guidelines for Interior Flexibility**
	The building should be flexible, able to accommodate change, and responsive to users' needs over time. This can be achieved by:
4.1	Avoid using traditional classroom layouts that consist of fixed rows defined by walls around a corridor, as this limits openness to adjacent classrooms and the corridor, contradicting active learning methods
4.2	It can be used to implement flexible classroom layouts that can open to each other due to the presence of movable partitions between them. Although they cannot open to the corridors, they provide opportunities for using more diverse learning methods than traditional layouts
4.3	It is preferring to use classrooms that can open to adjacent spaces like wide corridors or meeting areas through having multiple flexible walls, while retaining the option to revert to a single enclosed classroom
4.4	It can be used to implement open-free layouts without defined walls, where space is defined by movable partitions and flexible furniture, allowing for adaptability and control of size based on educational activities. When using this type of layout, it is advisable to add enclosed spaces designated for activities that require quiet and privacy
4.5	It can be used to change the shape and size of the learning space by having adjacent areas and opening doors between them
4.6	It can be used to transform the space by altering its arrangement and internal size using movable walls and partitions, incorporating a shared area between classrooms or corridors, for example
4.7	Should provide multifunctional spaces that accommodate a variety of activities, along with all necessary tools, furniture, and technology
4.8	Should ensure that the ideal learning environment is free of corridors and neglected areas; thus, school spaces should be continuously assessed and underutilized areas should be optimized
5	**General Guidelines for Furniture**
5.1	Furniture should be lightweight and movable, allowing students to shift and rearrange it
5.2	Furniture, whiteboards, and display boards should preferably be on wheels to allow easy reconfiguration
5.3	Should equip the classroom with flexible and adjustable desks and chairs to allow for various seating arrangements
5.4	Furniture should be flexible, allowing for changes according to the educational activity
5.5	It can be used to utilize furniture for dividing and defining space and for designating specific areas
5.6	It can be used to utilize furniture for other functions, such as using bookshelves to divide space or to serve as a work surface
5.7	It can be used the tables with whiteboard surfaces that allow for writing
5.8	Furniture should have the capability to be folded or stacked and set aside when not needed
5.9	Furniture size should be suitable for the students' ages and sizes to prevent health issues and ensure proper posture
5.10	Should be used comfortable furniture, such as ergonomic chairs, rocking chairs, and chairs with lumbar support, as well as tables that allow students to stretch their legs and more
5.11	It can use the swivel chairs that allow students to shift from group work to facing the teacher when needed
5.12	Furniture should be diverse, including rugs, soft seating, bean bags, collaborative furniture, and more
5.13	Furniture design should be modern, non-traditional, and featuring attractive and vibrant colors
5.14	It can be used the furniture that supports technology, such as equipping seats with integrated power outlets
6	**General Guidelines for Outdoor Spaces**
6.1	Outdoor areas of the school should include additional learning zones, like a vegetable garden, social interaction spaces like seating areas, terraces, and shaded reading zones
6.2	It prefers to turn outdoor areas into real educational tools, such as creating a vegetable garden where students can observe plant growth and record notes
6.3	Outdoor areas should include a variety of activities, such as play and large-scale activities that cannot be conducted indoors
6.4	It can conduct lessons and create an outdoor theater for student performances
6.5	Outdoor spaces should be equipped with appropriate furniture, tools, and toys suitable for the students' age
6.6	Furniture in outdoor spaces should be diverse, colorful, vibrant, and fun
6.7	The design of pedestrian paths should consider shape, colors, and paving materials, along with shading with plants and trees to create a positive and lively environment that encourages use by students
7	**Sustainability Guidelines**
7.1	Should expand the size of the windows to achieve the appropriate amount of natural light and ensure good ventilation for the spaces
7.2	It is preferable to use the design elements of school building as an educational tool to support learning of sustainability standards
7.3	It is preferable to use one of the sustainability approaches to instill in students the importance of environmental design and environmental conservation
7.4	It is preferring to use indoor plants in the design of the school's interior spaces to encourage a love for the environment
7.5	It is preferable to use treated greywater for irrigating the plants in the school garden
7.6	Students and teachers should be involved in the process of designing the school or modifying and improving its spaces to gain practical experience in various contemporary skills, such as collaboration, problem-solving, and creativity
7.7	The school spaces can be used by the community after regular hours, as well as during weekends and summer holidays, such as using the outdoor areas and some indoor spaces within the school
7.8	It can use natural materials, such as plywood, for cladding walls, floors, or ceilings in indoor spaces, while avoiding materials that emit toxic gas

5. PRACTICAL STUDY

To investigate the common characteristics in the actual designs of active learning schools among the guidelines proposed by the research, the study analyzed six designs of primary schools that adopt active learning in their educational curriculum. Below is a brief overview of the six schools.

First: School Name: Jesmond Gardens Primary School, located in Hartlepool, United Kingdom. Year of Construction: 2011. Area: 2,055 m². Number of Students: 315. Designers: Architecture ADP.

Its spaces are designed to support active learning methods and consist of a central area and flexible spaces, featuring circular educational pods divided into smaller sections by acoustic curtains. The main hall and foyer serve as gathering spaces and multifunctional areas, including collaborative zones and small group spaces with teachers, all equipped with the necessary technology to extend classroom activities. The outdoor areas are also designed as supportive learning environments, offering a variety of sports and play facilities,

as well as wildlife learning areas [55]. This is illustrated in Figure 21.

Figure 21. Jesmond Gardens Primary School [55-57]

Second: School Name: Discovery Elementary School, located in Virginia, USA. Year of establishment: 2015. Area: 9,067 m². Number of students: 650. Designer: VMDO Architects.

The school layout follows a main corridor or school street design, integrating seamlessly with sustainability and active learning principles. It features diverse and flexible learning areas, optimizing all spaces to support the learning process. The school includes collaborative spaces for student-teacher interaction, niches for individual study, and expansions in the corridors. The interior design employs stimulating and appealing colors, balancing color shades while distinguishing between areas and grade levels through specific colors and labels for each educational stage. The furniture is flexible, comfortable, and features attractive, modern designs enhanced with necessary technology. The school is characterized by the widespread presence of educational tools in both its indoor and outdoor spaces [58]. As illustrated in Figure 22 below.

Figure 22. Discovery elementary school [58]

Third: School Name: Summit Elementary School, located in Casper, Wyoming, United States. Year of establishment: 2010. Area: 5,202 m². Number of students: 450. Designers: Inc – Architect of Record RB+B Architects and Vesta Design – Landscape Architect.

The school employs active learning methods and consists of a central area with three wings, each designated for a specific age group. Each wing contains classrooms, a small group room, a glass teachers' room for observing students, and a shared area between classrooms. Other spaces in the school include a music room, a "Creative Studio" for teaching arts and sciences, a library, and a technology lab. The school is characterized by flexible spaces, with classrooms open to the shared corridor and a multifunctional central hall for gatherings, study, and school events. The furniture is flexible, mobile, and equipped with wheels to facilitate rearrangement based on activities [59, 60], as shown in Figure 23.

Figure 23. Summit elementary school [61, 62]

Fourth: School Name: Centerview Elementary School, located in the United States, was established in 2018, with an area of 9,290 m² and a student population of 637. Designed by Wold Architects and Engineers, the school accommodates active learning methods that focus on both collaborative and individual learning. The layout features a multi-story atrium, dividing the school into several educational units that cater to various sizes of individuals and groups. The spaces are multifunctional and flexible, with glass walls that can be folded to open classrooms to adjacent spaces and shared corridors.

The school includes diverse areas that support both collaborative and individual learning, with a central common space extending across two floors to connect the learning units and host multiple activities. It also features a library with learning zones, a cafeteria, and a gymnasium. The interior design employs attractive colors and shapes in gathering spaces, while classrooms are decorated in calm hues with touches of color, utilizing colorful, contemporary, and unconventional furniture [63, 64]. As illustrated in Figure 24 below.

Figure 24. Centerview Elementary School [63-66]

Figure 25. Vittra School Telefonplan [67, 68]

Fifth: School Name: Vittra School Telefonplan, located in Stockholm, Sweden. Year of establishment: 2011. Area: 1900 m². Number of students: 210. Designer: Rosan Bosch.

The learning environment in this school, which employs active learning methods, is characterized by being open, wall-free, flexible, diverse, and stimulating. It consists of built-in elements rather than conventional spaces defined by walls or partitions. The school utilizes features such as a tree and a garden-like area for play and gathering, an island that serves as a large green sofa for laptop users, and an iceberg that encompasses various learning areas, functioning as a cinema and presentation platform, along with a relaxation and individual work room inside. The school includes various collaborative and individual areas for lectures, utilizing a variety of furniture in bright and attractive colors [67, 68]. As illustrated in Figure 25.

The sixth school is Lisle Elementary School, located in Illinois, United States. Built in 2019, it covers an area of 9,773 m² and accommodates 750 students, designed by the Perkins and Will design team.

The school features a multi-story atrium layout surrounded by classrooms and diverse learning areas to meet the requirements of active learning methods. The two-story library serves as the heart of the school, connecting to classrooms, wide hallways, and a central staircase. The hallways include individual learning zones and spaces for small groups. Large windows surrounding the library make these areas bright and inviting, providing open sightlines for teacher supervision across all learning spaces. The furniture is highly flexible, designed in vibrant colors and modern shapes [69]. As illustrated in Figure 26.

The characteristics of each school were identified based on the analysis of the architectural plans of the building's floors, as well as the available images and videos found on the internet, as illustrated in Table 2.

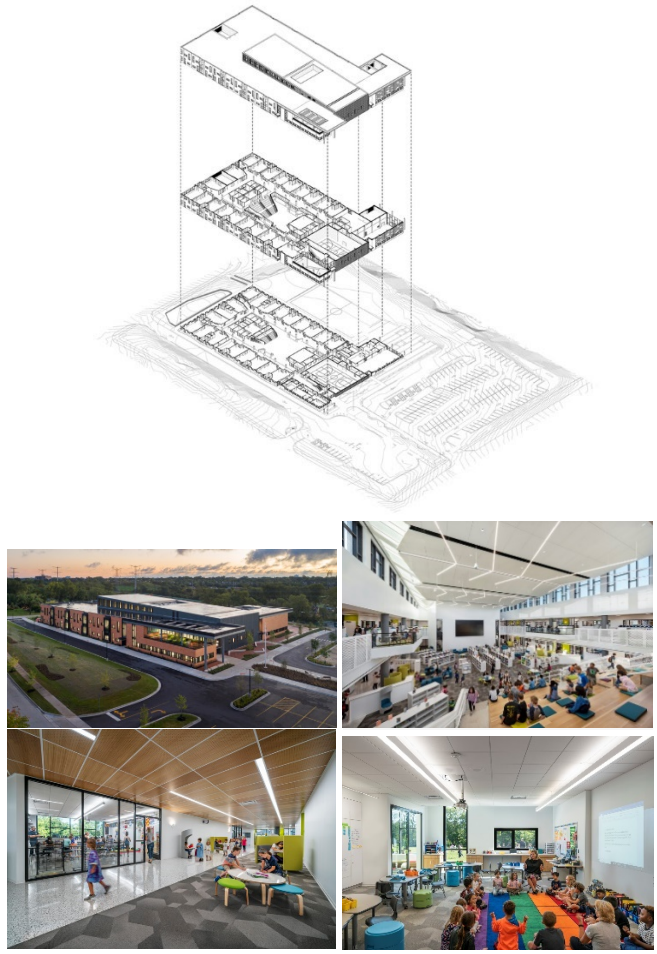


Figure 26. Lisle Elementary School [69]

Table 2. Design characteristics of active learning in the investigated schools

No. of Design Principle	Jesmond Gardens Primary School	Discovery Elementary School	Summit Elementary School	Centerview Elementary School	Vittra School Telefonplan	Lisle Elementary School	The Percentage of the Attribute's Application in the Study Sample
1	**General Guidelines for the Design Layout of School**						
1.1	✓	✓	✓	✓	✓	✓	100%
1.2		✓	✓				33.3%
1.3	✓	✓	✓	✓	✓	✓	100%
1.4	✓						16.7%
1.5						✓	16.7%
1.6				✓			16.7%
1.7					✓		16.7%
1.8							0%
2	**General Guidelines for Flexibility and Expandability**						
2.1	✓	✓	✓	✓			66.7%
2.2	✓	✓	✓	✓	✓		83.3%
2.3				✓		✓	33.3%
3	**General Guidelines for Interior Design – Learning Spaces**						
3.1	✓	✓	✓	✓	✓	✓	100%
3.2	✓	✓	✓	✓	✓	✓	100%
3.3	✓	✓	✓	✓	✓	✓	100%
3.4	✓	✓	✓	✓	✓	✓	100%
3.5	✓	✓	✓	✓	✓	✓	100%
3.6	✓	✓	✓	✓	✓	✓	100%
3.7	✓	✓	✓	✓	✓	✓	100%
3.8	✓	✓	✓	✓	✓		83.3%
3.9	✓	✓	✓	✓	✓	✓	100%
3.10		✓					16.7%
3.11	✓	✓	✓	✓	✓		83.3%
3.12	✓	✓			✓		50%
3.13	✓	✓	✓	✓	✓	✓	100%
4	**General Guidelines for Interior Flexibility**						
4.1	✓	✓	✓	✓	✓		83.3%
4.2							0%
4.3	✓	✓	✓	✓			66.7%
4.4					✓		16.7%
4.5	✓	✓	✓	✓	✓		83.3%
4.6	✓	✓	✓	✓	✓		83.3%
4.7	✓	✓	✓	✓	✓	✓	100%
4.8	✓	✓	✓	✓	✓	✓	100%
5	**General Guidelines for Furniture**						
5.1	✓	✓	✓	✓	✓	✓	100%
5.2		✓	✓	✓		✓	66.7%
5.3	✓	✓	✓	✓		✓	83.3%
5.4	✓	✓	✓	✓	✓	✓	100%
5.5	✓	✓	✓		✓	✓	83.3%
5.6		✓	✓			✓	50%
5.7							0%
5.8	✓	✓		✓	✓	✓	83.3%
5.9	✓	✓	✓	✓	✓	✓	100%
5.10	✓	✓	✓	✓	✓	✓	100%
5.11		✓					16.7%
5.12	✓	✓	✓	✓	✓	✓	100%
5.13	✓	✓	✓	✓	✓	✓	100%
5.14		✓					16.7%
6	**General Guidelines for Outdoor Spaces**						
6.1		✓	✓		✓		50%
6.2		✓				✓	33.3%
6.3	✓	✓	✓	✓	✓	✓	100%
6.4	✓	✓					33.3%
6.5	✓	✓		✓			50%

6.6	✓					✓	33.3%
6.7	✓	✓				✓	50%
7			**Sustainability Guidelines**				
7.1	✓	✓	✓	✓	✓	✓	100%
7.2		✓					16.7%
7.3	✓	✓	✓			✓	66.7%
7.4						✓	16.7%
7.5		✓					16.7%
7.6	✓	✓	✓		✓	✓	83.3%
7.7		✓	✓				33.3%
7.8	✓		✓	✓		✓	66.7%

6. RESULTS

Regarding the outcomes of applying the general guidelines to the architectural styles of the schools, it is evident that all six schools avoided both the linear layout and the enclosed courtyard style. Two out of six cases employed a wide main corridor style, while the remaining four utilized open courtyard designs, atrium layouts, clustered patterns, and single mass configurations.

In terms of the flexibility and expandability of the designs, five of the schools demonstrated the ability to modify and change the shape and characteristics of the building. Four cases featured structures capable of future expansion, allowing for the addition of more floors or adjacent areas. Modular design was utilized in two instances, enabling units to be added or removed, and reshaped.

On the interior design level of learning spaces, all six schools emphasized connectivity and the integration of indoor and outdoor areas. achieved openness and transparency among visually connected learning spaces. The corridors, libraries, and outdoor areas were considered extensions of the classrooms, serving educational purposes beyond mere circulation.

Moreover, the schools provided diverse learning zones, equipping designated learning spaces with all necessary tools, furniture, and technology. The designs facilitated easy movement between spaces, with clear and uncomplicated corridors. A balance was maintained in the selection of interior colors, blending stimulating tones with calming shades, while the materials and textures used in both interior and exterior spaces were varied, enriching visual interest and engaging students.

In five designs, long corridors were avoided, with colors applied to elements and walls to define and differentiate areas and activities. In three cases, spatial differentiation was achieved through materials, textures, and floor shapes, such as using carpets in specific areas or designating a particular color for the flooring of a zone. In two out of six cases, colors were used to mark paths and corridors leading to various school spaces, for example, assigning a unique color to the route leading to a particular classroom.

Across all six designs, the educational environment was free from long corridors and neglected areas, effectively utilizing underused spaces and providing multipurpose areas that accommodate a variety of activities along with all necessary tools, furniture, and technology.

In five instances, traditional classroom layouts, characterized by fixed walls around a corridor, were avoided, embracing the potential to alter the shape and size of educational spaces through adjacent areas. This included opening doors between spaces and adjusting the arrangement and size through movable walls and partitions, creating shared spaces between classrooms or corridors. Four cases featured classrooms designed to open to adjacent areas, whether they be other classrooms, wide corridors, or meeting spaces, utilizing more than one flexible wall while retaining the option to revert to a closed classroom setting.

The furniture in all six designs was lightweight, mobile, and adaptable, enabling rearrangement of the learning environment according to activities. The size of the furniture was appropriate for the ages and sizes of the students, incorporating comfortable options. The furniture was diverse, including carpets, soft seating, bean bags, and collaborative furniture, designed in a contemporary, non-traditional style with bright, attractive colors. In five designs, classrooms featured shape-shifting desks and chairs that could be rearranged for various layouts, with furniture used to define and allocate space, allowing for folding, stacking, or setting aside when not needed.

In four cases, furniture, whiteboards, and display boards were equipped with wheels, enabling students to move and rearrange them as needed. In three cases, furniture served additional functions, such as using bookshelves to divide space or create work surfaces. In two cases, the furniture supported technology, providing seats with integrated power outlets and allowing for the use of swivel chairs that enable students to shift from group work to facing the teacher when necessary.

Regarding the characteristics of outdoor spaces, all six cases include various activities in external areas, such as play or noisy activities. In three instances, outdoor spaces feature additional learning areas, such as vegetable gardens, flower beds, and social interaction zones with seating, shaded reading areas, and terraces equipped with appropriate furniture, tools, and games for students' ages.

Attention was given to the design of pedestrian pathways concerning their shape, colors, and materials used for paving, along with shading from plants and trees to create a positive, vibrant environment that encourages student use. In two cases, outdoor areas were transformed into genuine educational tools, such as establishing a vegetable garden where students could monitor plant growth and record observations, along with other educational resources that could be placed in the garden. Additionally, outdoor lessons were conducted, and an open-air stage was created for student performances. The furniture used in outdoor spaces is characterized by diversity and bright, attractive colors.

In terms of sustainability, all six schools incorporated larger windows to maximize natural light and ensure good ventilation for the spaces. In five schools, students and teachers were involved in the process of designing their schools. Four cases have applied sustainability principles in the design of the schools using natural materials in the design

and avoiding materials that emit toxic gases. In two cases, the school spaces were utilized by the community outside of official working hours and during holidays.

7. CONCLUSIONS

Active learning is one of the modern educational trends that has emerged in advanced countries, proving its effectiveness in meeting the learning outcomes required in the twenty-first century. This research has outlined the guidelines of design characteristics of active learning schools across four axes:

First Axis: The layout of active learning school plans and the methods for achieving flexibility. These patterns range from linear layouts with wide corridors (school streets) to open courtyards, multi-story designs (atrium), cluster layouts, urban designs, and single-mass designs. Flexibility in the plan can be achieved through vertical or horizontal expansion, determined by the school's location, area, and the presence of surrounding additional spaces. Furthermore, the structure capability for addition, modification, and change can be realized through the use of columns and structural elements, or by adopting a modular design that allows for the alteration of space configuration. Also, flexible and mobile design principles can be utilized in the school's architecture.

Second Axis: Internal design characteristics of active learning schools and methods for achieving flexibility. The spaces are characterized by their interconnectedness, facilitating easy movement and minimizing distances between them while avoiding long, complex corridors. This design promotes openness and transparency among internal spaces and connects to outdoor areas through large windows and folding glass doors, ensuring adequate natural light and ventilation.

There is a focus on designing informal spaces that support learning, such as hallways and libraries, and creating collaborative zones for group work and individual areas for concentration. These spaces are equipped with appropriate furniture, tools, technology, and comfort amenities.

Aesthetic considerations in internal design are also prioritized, employing calming and stimulating colors to delineate spaces and activities, guide movement, and enhance visual richness to foster creativity through color and material characteristics. Flexibility in internal spaces is achieved by allowing for modifications and transformations, either short-term through movable walls and partitions or long-term by removing walls and adding openings and doors to change the space's configuration or introduce natural light.

Furthermore, the diverse use of spaces accommodates multiple activities by equipping them with the necessary furniture and technology to facilitate flexible space utilization or by optimizing underutilized areas in existing schools.

Third Axis: Furniture Characteristics in active learning schools and methods for achieving flexibility. Furniture is utilized for multiple functions, such as defining space through rearrangement or by using partitions and whiteboards. Writable surface tables can also be employed. The furniture in active learning schools possesses several key attributes, including flexibility to support learning activities through mobility and the use of adaptable furniture that allows for various configurations. Additionally, the furniture should be foldable.

Comfort is essential, with furniture designed to accommodate the ages and sizes of students, including adjustable height options that align with ergonomic principles. Moreover, the furniture in active learning environments should be diverse to support various learning scenarios and activities, featuring attractive colors and unconventional, contemporary designs.

Fourth Axis: Characteristics of outdoor spaces in active learning schools. Outdoor areas support an active educational environment and contribute to students' mental well-being by providing spaces for play, communication, and social interaction, such as shaded seating areas and terraces. These spaces can also accommodate outdoor classrooms and host large, lively activities that cannot be managed within the confines of the school building.

Outdoor areas should be equipped with comfortable furniture, internet access, and utilize attractive colors and shapes, along with age-appropriate play equipment. Additionally, the design of pedestrian pathways should be carefully considered, focusing on the materials used for paving and providing shade with trees.

Upon investigating how active learning concepts are implemented in actual school designs, the study can conclude the following:

- **Flexibility and Adaptability:** This is represented by the ability of the layout to expand and the use of a flexible interior design that allows for easy modification and adaptation of spaces in response to active learning requirements. Additionally, flexible furniture that can be moved and rearranged according to activities is provided, along with the design of outdoor spaces that accommodate various activities.
- **Openness, Communication and Transparency:** This is achieved by enhancing visual communication between spaces through the use of glass walls, facilitating movement between areas, and supporting technical communication by providing necessary technology. There is also an emphasis on increasing openness to outdoor spaces to support students' mental well-being and provide natural lighting as well as expanding learning areas.
- **Integration:** This involves considering all school spaces, including corridors, libraries, and outdoor areas as learning environments. These spaces are designed to include collaborative and individual areas equipped with the necessary furniture and tools, with the potential for outdoor areas to serve as zones for interaction and learning.
- **Sustainability:** The principles of sustainable design are focused on enhancing the use of natural lighting and ventilation, as well as incorporating natural materials. Additionally, the schools provided an opportunity for students and teachers to participate in the design process, reflecting a commitment to meeting the needs of the school community. Furthermore, some school spaces were used by the community after official working hours, which strengthens the role of the school as an environment that serves the community in a broader sense.

However, architectural design for active learning schools may face many challenges such as sound insulation and noise control in open space classes, loss of students' concentration resulting from exposure to adjacent spaces, anticipating the rapidly evolving demands of active learning in the future, and making school designs part of the national sustainable development strategy.

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