Converting physical spaces into learning spaces: Integrating universal design and universal design for learning

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The term "Universal Design for Learning (UDL)" is derived from "Universal Design," which is commonly used in the field of architecture, and focuses on proactive designing of the infrastructure that is accessible to all the users, regardless of their age, sex, abilities, etc. When the universal design approach is implemented in education, it focuses on making the curriculum, instruction, materials, and assessments accessible for all the learners, but does not mention anything about the classroom and school infrastructure. This raises a question: is the UDL framework forgetting the origin of universal design by not recognizing the importance of physical spaces or school infrastructure, where all the learning takes place? A way to approach this question is to think of school infrastructure as a learning resource that provides enriching learning experiences to the learners, and not merely a brick-and-mortar structure that houses instruction. The school building comprises various physical spaces such as classrooms, corridors, playgrounds, staircases, etc. that can be transformed into learning spaces to promote subconscious learning in learners and ensure a school-wide implementation of UDL. Transforming the school environment would ensure learners an equitable, inclusive, and accessible environments that address learner variability, and reduce barriers to their learning. This involves a focus on various components, namely, transforming physical spaces (universal design) into learning spaces (universal design for learning), identifying different elements in each learning space to maximize their learning value, and general accessibility of the school infrastructure. The chapter aims to provide a framework to design inclusive learning spaces by deriving insights from the work of various groups of architects in India, Ireland, and the United States that have explored the relationship between physical spaces and UDL.

KEYWORDS

universal design (UD), school design, inclusive spaces, learner variability, infrastructure planning

Introduction

For a very long period, educational pedagogists like Piaget, Vygotsky, Plato, Montessori, etc. have stressed the importance of constructivism, child-centered learning, and learning that is holistic. This means that children learn the best when they construct their knowledge from their experiences rather than being fed with information, and when learner variability is considered. For years, Universal Design for Learning has been implemented in numerous countries, yet it does not pay attention to the interface between school architecture and teaching pedagogy and instruction delivery, i.e., how the use of school building design and its elements, including classroom furniture, walls, pillars, doors, etc., can support varied activities and provide enriching learning experiences to all the children apart from the commonly practiced pedagogical teaching that comprises of the group and individual learning opportunities.

Not many people have focused on the pertinence of utilizing the physical space as a learning resource in improving teaching-learning experiences. Despite school buildings being the most expensive asset of a school, this resource has received scant attention. A handful of architects, who have explored the school's entire physical environment as a learning resource focused on the structured spaces (interior and exterior of school infrastructure) and loose spaces (open spaces like playgrounds, and courts). The spaces offer myriad opportunities that complement instructional delivery and aid the information given in the textbooks. The three-dimensional space, if utilized well, can offer a multi-sensory experience and distinct space for a child to experience learning and supplement the uni-dimensional learning material and blackboard teaching. Further, it can help children experience abstract concepts in concrete form. There are several components in each element of the school design that can be used to create multi-sensory experiences for the learners, for example, various textures can be added to different elements, and angles and shapes can be taught using innumerable material resources that are present in the school, dimensions and movements can be used to teach concepts of language arts, mathematics, and science.

One such project that is carried out widely in India is Building as a Learning Aid (BaLA), which was supported by UNICEF, India. The concept of BaLA was developed by Vinyas, Centre for Architectural Research and Design, who also trained educators and school leaders to plan, implement, and effectively use it in the schools. BaLA is considered to holistically plan and utilize the school space and design to incorporate activity-based learning, enriching, child-friendly and inclusive education for children, including children with disabilities (Kaushika, 2008; Vajpeyi, 2010). There are two levels of intervention, (1) develop spaces, such as classrooms, corridors, steps, and outdoor spaces, to provide a variety of learning experiences, and (2) develop the elements (floor, walls, window, ceiling, door, etc.) in these spaces as teaching-learning aids (Vinyas, 2012).

Building as a learning aid aims to use the elements, like floors, windows, fans, trees, flowers, and pillars in various physical spaces like classrooms, corridors, playgrounds, etc. as a learning resource. For instance, a range of angles can be marked on the door shutter on the floor to depict the concept of angles, a flagpole can act as a sundial and concept of measuring time can be taught to students there, and planting seasonal trees and plants can clarify the change in season, different flowers, plant types, growing season, etc., rainwater harvesting pipe can be used as a periscope and concept of mirrors and its uses can be taught using it, etc.

In addition to BaLA, there is another architectural marvel in the heart of the Thar Desert in India-Rajkumari Ratnavati Girls School that not only has a sustainable infrastructure but also envisions empowering women (Manoj, 2021). The school aims to provide a better future to young girls and their mothers in the state of Rajasthan, where literacy rate is just 32 per cent. It is designed by New York-based architect Diana Kellogg and built by CITTA[1].The school is located in Jaisalmer, and is made of sandstone (locally abundant resource), which keeps the building cool from within, when the outside temperature soars to over 50 degree Celsius. The classrooms have plenty of air and light circulation, and the canopy of solar panels on the building generates and supplies electricity and keeps the structure under shade. Besides this, a part of the school houses a textile museum that typically displays the textiles of the region, another part is a performance/exhibition hall, and there is also an area to train women in traditional arts like weaving. This architectural wonder demonstrates the use of locally abundant resources like sandstone, sunlight, and skills of local artisans and women to create a space that is sustainable and empowering in nature.

Further, a group of architects from Ireland that developed a guide named "UDL Learning Spaces Idea Kit" that provides a crosswalk among the kit and the UDL guidelines to give suggestions on designing learning environments considering learner variability within the learning environment. The UDL Learning Spaces Kit (Evans, 2022) was a combined product of the effort of Gould Evans and UDL-IRN. It enables educators to rethink learning spaces and create a diverse palette of experiences using the school building. The guide suggests students "make space," give students a choice of where, with whom, and how they wish to work, create innovation labs in schools for educators and school leadership to experiment with novel approaches, and design spaces that provide multi-sensory experiences to learners and allow them to move around and fidget (if needed) while working, redesigning floor and "negative space" to serve as a learning aid, offer a variety of work settings, huddle, team and "get away" spaces, and engaging with walls, other surfaces, outdoor spaces.

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1 https://citta.org/watch-the-progress-of-the-rani-ratnavati-girls-school-in-jaisalmer-india/

Additionally, Evans designed teacher experience cards that support collaboration among educators doing project-based learning, providing shared workspaces, creating a culture of learning among faculty, and ensuring child-friendly classrooms wherein the focus shifts from "teacher's space" to "teacher and students' space." Further, it provides "paradigms" that talk about innovation more than technology, adopting low-tech aids, and creating anti-classrooms that offer new learning approaches, creativity, and autonomy to learners. It also emphasizes experiential learning and project-based learning that facilitate lifelong learning. Lastly, CAST and UDL-IRN created indicators for UDL School Implementation and Certification Criteria (UDL-SICC) that focus on School Culture and Environment, Teaching and Learning, Leadership and Management, and Professional Learning (CAST, and UDL-IRN, 2022).

The abovementioned projects offer a unique perspective on rethinking physical spaces, which are oftentimes ignored in the teaching-learning process. They propose child-centered, integrated, holistic (Miller, 1999; Hargreaves and Shirley, 2012), and fun-oriented approaches to teaching that create a culture of harmony between educator and their learners. Interestingly, both the projects focus on using localized resources that are relatable to the learners, use low technological aids, and promotes subconscious learning by using the school building as a resource (Khurana, 2019). For schools to develop expert learners, it is critical for the school leaders and educators to focus on, cultural equity, educational equity, and infrastructural equity.

Cultural equity

The article "Cracks in the Foundation" (Rose et al., 2021) highlighted how despite having accessible infrastructure, our implicit biases and opinions create barriers to inclusion and equitable learning. Therefore, it is pertinent that the entire school community is responsible for designing a culture that supports inclusion and equity of all learners and ensures it provides equitable and inclusive learning experiences and environments that consider learner variability from the lens of culture, language, society, emotions, and cognitive variability. This means that the learning experiences in the school should be designed from a person-centered perspective rather than a teacher- or society-centered perspective. A school environment that commits to UDL focuses on creating expert learners, who are knowledgeable, resourceful, purposeful, motivated, goal-directed, and strategic. Lastly, the school community should also revamp school spaces to support variability and reduce barriers to inclusion and learning. For this, the schools should focus on the following key areas (see Table 1) (and their relationship with the UDL guidelines) that ensure effective implementation of UDL at the school level.

TABLE 1   Key areas to ensure cultural equity in an educational setting and their alignment with Universal Design for Learning (UDL).

Key areas	Relation with UDL guidelines
Create space that uses locally abundant resources to build school infrastructure and support skills of locals	7.2 Optimize relevance, value, and authenticity 8.3 Foster collaboration and community
Cultivate spaces that foster a sense of belonging for every member of the school	7.3 Minimize threats and distractions 8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation
Provide opportunities to foster deep, healthy, and meaningful relationships with different stakeholders in a school	3.1 Activate or supply background knowledge 4.1 Vary the methods for response and navigation 8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation
Address variability of learners and educators from the lens of culture, society, emotions, language, etc.	7.2 Optimize relevance, value, and authenticity 8.1 Heighten salience of goals and objectives 8.2 Vary demands and resources to optimize challenge 9.1 Promote expectations and beliefs that optimize motivation 9.2 Facilitate personal coping skills and strategies
Setting realistic and individualized expectations from learners	7.2 Optimize relevance, value, and authenticity 8.1 Heighten salience of goals and objectives 8.2 Vary demands and resources to optimize challenge 9.1 Promote expectations and beliefs that optimize motivation 9.2 Facilitate personal coping skills and strategies 9.3 Develop self-assessment and reflection
Prioritizing developing expert learners, who reach their maximum potential, through modification in the school environment, activities, and procedures	8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation 9.3 Develop self-assessment and reflection
Ensure accessibility in curriculum and textbook content	1.1 Offer ways of customizing the display of information 1.2 Offer alternatives for auditory information 3.3 Guide information processing, visualization, and manipulation 4.1 Vary the methods for response and navigation

Educational equity

To enrich learners' experiences, school design should also be thought of as a learning resource, and educators should proactively design evidence-based learning experiences: teaching goals, methods, materials, assessments, and classroom environment should be conducive to learners' needs and

TABLE 2   Key areas to ensure educational equity and their alignment with UDL.

Key areas	Relation with UDL guidelines
Learner oriented areas	
Transform school spaces like classrooms, playgrounds, courts, washrooms, etc. into learning spaces, for example, Use corridors as a walking museum, or gallery walk, to depict different ideas and timeline of events Use steps to teach about numbers, number operations, measurement, etc. Use outdoor spaces like courts to talk about symmetry in the shapes/formations, open ground to depict illustrations of abstract concepts like a flagpole to teach time concept, floor to depict solar system, etc. Encourage teaching-learning in natural settings amidst nature whenever possible	1.1 Offer ways of customizing the display of information 1.2 Offer alternatives for auditory information 3.3 Guide information processing, visualization, and manipulation 4.1 Vary the methods for response and navigation 5.1 Use multiple media for communication 5.2 Use multiple tools for construction and decomposition 8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation 9.3 Develop self-assessment and reflection
Transform different elements in the abovementioned spaces into learning aids, for example, Have a few fixed elements on black/white/green/digital boards such as a calendar, and adjust the height of the board for it to be accessible to the learners Print an inch/cm scale on desks or tables in the classroom to in tegrate the concept of measurement (learners can measure different objects like notebooks, lunch boxes, etc. using it) Print a scale on the wall to measure the height Have a 'door angle protractor' painted on classroom entrances, and add symmetrical shapes and patterns on the door surface Paint the fans in rainbow colors to show how the seven colors combine to form white color Paint or tile the floor in different patterns, grids, symmetry, etc. to teach about various mathematical concepts.	1.1 Offer ways of customizing the display of information 1.3 Offer alternatives for auditory information 3.3 Guide information processing, visualization, and manipulation 4.1 Vary the methods for response and navigation 5.1 Use multiple media for communication 5.2 Use multiple tools for construction and decomposition 9.3 Develop self-assessment and reflection
Utilize open spaces in the school to make grids, tangrams, and magic squares to teach numerous math and science concepts	4.1 Vary the methods for response and navigation 5.1 Use multiple media for communication
Leave some spaces as "mystery spaces" to allow creative use of them, "get away spaces" to disconnect and reconnect with peers, and "collaborative spaces" to support work in small groups	7.1 Optimize individual choice and autonomy 7.3 Minimize threats and distractions 8.3 Foster collaboration and community
Provide alternatives for interacting with material, manipulatives	4.1 Vary the methods for response and navigation

(Continued)

TABLE 2   (Continued)

Key areas	Relation with UDL guidelines
	5.1 Use multiple media for communication
Offer flexibility in timing, speed, and range of instructional materials to work with,	4.1 Vary the methods for response and navigation
Use various forms of media for communication and construction, for example, speech, text, illustrations, physical manipulatives, web tools, comic strips, storyboards, software, mathematical manipulatives, etc.	4.1 Vary the methods for response and navigation 5.1 Use multiple media for communication 5.2 Use multiple tools for construction and decomposition
Provide opportunities to support spiral learning by offering differentiated approaches and skills to teach the same concept, and provide multiple examples to solve problems	5.3 Build fluencies with graduated levels of support for practice and performance.
Provide learners with more discretion and autonomy and opportunity for reflection and self-assessment, allow them to participate in structuring the spaces and elements in the classroom	7.1 Optimize individual choice and autonomy 6.4 Enhance capacity for monitoring progress 9.1 Promote expectations and beliefs that optimize motivation
Create welcoming classrooms that offer varying levels of tasks, sensory experiences, scaffolds, and set individualized expectations from each learner.	1.1 Offer ways of customizing the display of information 1.2 Offer alternatives for auditory information 1.3 Offer alternatives for visual information 4.1 Vary the methods for response and navigation 5.1 Use multiple media for communication 5.2 Use multiple tools for construction and decomposition 7.2 Optimize relevance, value, and authenticity 7.3 Minimize threats and distractions 8.1 Heighten salience of goals and objectives 8.2 Vary demands and resources to optimize challenge 9.2 Facilitate personal coping skills and strategies
Encourage opportunities for peer interactions and collaborations, and individual and group work.	8.3 Foster collaboration and community
Allow effective and efficient use and management of classroom resources (including technological aids), such as ensuring accessibility for all learners, keeping them in spaces accessible to all learners, and having a variety of learning aids to support spiral learning	4.2 Optimize access to tools and technologies 8.2 Vary demands and resources to optimize challenge
Differentiate the degree of difficulty or complexity of tasks and activities.	7.3 Minimize threats and distractions

(Continued)

TABLE 2   (Continued)

Key areas	Relation with UDL guidelines
Vary the level of sensory stimulation, demands, and requirements for tasks.	8.2 Vary demands and resources to optimize challenge
Promote a growth mindset and project-based learning that presents real-world issues and encourages learners to find solutions to them	4.1 Use of multiple media for communication 8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation 9.2 Facilitate personal coping skills and strategies
Create spaces that are learner friendly, minimize distractions for sound and light-sensitive learners, and allow access to the buildings	1.2 Offer alternatives for auditory information 7.1 Optimize individual choice and autonomy 9.2 Facilitate personal coping skills and strategies
Educator oriented areas	
Create shared workspaces to promote professional growth and collaboration among educators	8.3 Foster collaboration and community
Encourage peer mentoring among educators	8.3 Foster collaboration and community 9.2 Facilitate personal coping skills and strategies
Encourage project-based learning and professional learning opportunities amongst educators to foster a collaborative culture and improve instructional delivery methods.	3.1 Activate or supply background knowledge 4.1 Vary methods for response and navigation 8.3 Foster collaboration and community 9.2 Facilitate personal coping skills and strategies
Foster a culture of learning amongst educators, where their needs and knowledge are nurtured	8.3 Foster collaboration and community 9.2 Facilitate personal coping skills and strategies
Create equitable spaces for educators in the classroom and consider them as mentors, not omniscient	7.1 Optimize individual choice and autonomy 7.3 Minimize threats and distractions 8.3 Foster collaboration and community 9.1 Promote expectations and beliefs that optimize motivation 9.2 Facilitate personal coping skills and strategies

TABLE 3   Key areas to ensure infrastructural equity in an educational setting and their alignment with UDL.

Key areas	Relation with UDL guidelines
Creating/improving accessibility and user-friendliness, for example, having wide doors and hallways, automated doors	7.3 Minimize threats and distractions
Focus on basic infrastructural aspects like smooth and level flooring at the entrance, wide doors, and hallways	7.3 Minimize threats and distractions 8.2 Vary demands and resources to optimize challenge
Accommodations for right- and left-handed access and use	7.3 Minimize threats and distractions
Adopt technology/signs for hearing impaired individuals	1.1 Offer ways of customizing the display of information 1.2 Offer alternatives for auditory information 1.3 Offer alternatives for visual information 7.3 Minimize threats and distractions 8.2 Vary demands and resources to optimize challenge
High contrast finish on displays, signs, and floor finish to increase visibility	7.3 Minimize threats and distractions

to be intentionally designed or adapted to be accessible and flexible. This requires the schools to identify spaces that would need restructuring to reduce existing infrastructural barriers or proactive planning of new indoor, outdoor and digital spaces incorporating UDL guidelines and checkpoints (see **Table 3**).

Discussion

To focus on access, expert learning, equitable learning, and inclusion, the school community needs to proactively and intentionally design physical spaces in school that incorporate curriculum and foster healthy relations amongst the educators, learners, and the learning environment. These spaces are the language and behaviors of the school and depict their stance on culture, beliefs, and inclusion. The spaces should be aligned to the curriculum, and support teaching methodology, and learner experiences. The spaces and elements in them should be innovatively designed to make the school architecture more resourceful that improves the educational value in a child-centered manner. As this perspective is adapted from the extant literature on school design and use, it presents a holistic view of rethinking the entire school community and system by revamping the school design and infrastructure, promoting collaboration amongst educators, developing expert learners,

variability, and reduce learning barriers, for them to become expert learners (Meo, 2008). For this, the school's physical space can be used in numerous ways (see **Table 2**).

Infrastructural equity

Often, the first step to inclusion is the physical access and reduction of physical barriers that can affect the participation of the learners in a school. Therefore, school spaces need

varying demands and resources provided to learners to optimize challenge, and minimizing threats and distractions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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