A Thesis report on

Reinventing the learning environment of an Architecture school

Neuroscience and Architecture

for

Department of Architecture

Msc. in Architecture in Construction City

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Politecnico di Torino

Under the guidance of

Prof. Paola Gregory

Assistant Professor. Antonio Sorrentino

Submitted by:

Nehul Khilnani s301787

Diksha Kumar s301533

Department of Architecture

Dedicated to

our family

Contents

ABSTRACT

India is a country which is striving to educate its young population up to the international standards. The government of India has made several tie-ups with Ivy League colleges to fill a necessary gap for students who cannot afford to go to international campuses. In 2021, there were 4,44,553 Indians – an overall increase of 41% in just one year. There are over 860 architecture colleges in India where 30k to 40k students pass out yearly. Only about 10-15 are suited to the needs of architecture students. The learning environment plays a very important role in education and academic success. Neuroarchitecture is the interdisciplinary field that ensures the creation of environments that can optimise human behaviour, well-being, and performance. Our behaviour is influenced by how we perceive the environment. Designing environments with beneficial aspects would lessen the adverse physiological, emotional, and cognitive effects, and in turn, educational buildings can have a positive psychological influence on how a student learns. Neuroscience is helping merge the gap between the physical built environment and human perception and behaviour. Incorporating evidence from reviews and academic papers, the thesis focuses on cognitive processes and how architectural aspects can be used to enhance the learning experience of a college-level student. Cognitive processes are the mental operations the brain performs to process information. These include attention, perception, reasoning, emoting, learning, synthesizing. Attention and Memory are considered to be the mainstays that impact the learning environment. Determining the architectural features that can affect users on a short-term level, and these impact the nature of the built environment. Hence, the thesis analyses these architectural elements with reference to neuroscientific architectural research. The architectural elements, in evidence, that prove to be impactful for the cognitive processes are: 1. Light 2. Sound 3. Colour 4. Forms and shapes 5. Ceiling height 6. Nature integration 7. Flexibility 8. Finishing materials This thesis concludes by connecting the learning environment with neuroarchitecture by giving solutions to design each space and classroom based on the purpose of the room. The following positive emotional responses to spaces can make the classroom a tool incorporated into lesson planning and used to improve the educational experience for students and teachers. Keeping a strong identity in each zone can anchor the learning processes in long-term memory. The thesis focuses on each learning

zone by analysing the cognitive processes it needs and using different architectural elements to create spatial layouts that inspire creativity, interaction, attention, and memory as required by each space.

Project Introduction

Aim:

To study the relation between **Neuroscience and Architecture** in Learning Environment and how to enhance it with architectural methods and aspects.

1 Introduction

1.1 Political Aspect

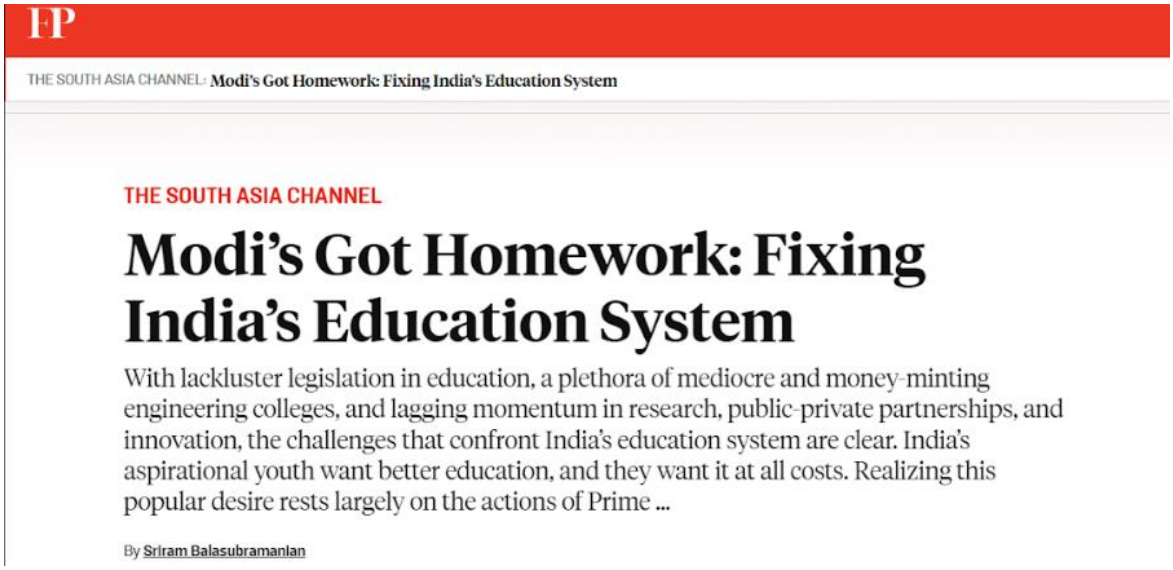
India is a country which is striving to **educate its young population up to the international standards**. Currently, **millions of Indians** go to the **USA, Canada, United Kingdom and Europe** to study in their prestigious universities and world-class campuses. The recent government of India has made s**everal tie-ups with Ivy-league** colleges to fill a necessary gap for students who cannot afford to go to international campuses.

How many Indians go abroad for studies every year?

In the first three months of 2022, **133,135 students** left India for academic pursuits, **an increase from 2020** when 259,655 students studied abroad. In **2021**, there were **4,44,553 Indians** – an **overall increase of 41%** in just one year.

What are the **reasons** behind Indians going abroad for further studies?

1. Attractive salary packages (44%)
2. High quality of education (33%)
3. Pursue niche courses (17%)
4. Gain international exposure (6%)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THE SOUTH ASIA CHANNEL: Modi's Got Homework: Fixing India's Education System

THE SOUTH ASIA CHANNEL

Modi's Got Homework: Fixing India's Education System

With lackluster legislation in education, a plethora of mediocre and money-minting engineering colleges, and lagging momentum in research, public-private partnerships, and innovation, the challenges that confront India's education system are clear. India's aspirational youth want better education, and they want it at all costs. Realizing this popular desire rests largely on the actions of Prime ...

By Sriram Balasubramanian

1.2 Social

What are the **problems in the current learning environment** of India colleges?

- Unsuitable **ventilation** and conditioning
- **Inflexible** cooperative learning arrangement
- Generic and **non-personalisation of classroom** as per the subject being taught.
- No **acoustical treatments** (to balance incoming noise from traffic and surroundings)
- **Absence** of different kinds of **space** (which limits the freedom of movement)

2 Example

2.1 National Institute of Technology Raipur (64th ranking by NIRF)

The National Institute of Technology Raipur ranks among the **top 100 colleges of India**. Yet the buildings of the campus that were built in 1950s lack personalisation, thought or modern amenities. The architecture campus doesn't have **spaces that are required for the teaching of the field**. Spaces like presentation space, collaboration space, self-study zones or workshops are missing.

The classrooms are not personal, very bare. The **furniture is inflexible and not suited to the purpose of the room**. The noise coming from nearby highways make it difficult to concentrate and focus. The studios require **acoustics, better furniture, space to move and work**. In addition to that, other spaces rooted to their purpose, should be planned and made space for.

Figure: The furniture is not suitable for theorotical subject teaching.

Figure: Design Studio

The above image is an example of uneven space distribution and lack of colour texture appropriate for the context given. There are no collaborative spaces for students and teachers alike which makes it difficult for the students to work or present their work.

Figure: Makers Space

Figure: Portion of the patio of the architecture building

The above image showcases the lack of makers space for students' collaborative work on their projects.

Figure: Lack of presentation space has led to the university using teaching areas

2.2 CEPT University, Ahmedabad

The classrooms are very flexible. **Outdoor classrooms** and **jury areas** are very active. Outdoor courtyards play as interactive break out spaces, **bringing vibrancy and fostering learning activities**.

Built in the 1950s, it is a very good example of thinking far ahead in the future. It's planning of the campus is upheld by many critics as fluid, inviting and purposeful for the university. It's new expansions of the library and other dormitories have been constructed keeping the same ethos in principle.

Figure: Presenatation space for juries of architecture students.

Figure: Model and sheet presentation space

These spaces help in creating good learning environment, which fosters creative minds. Separate spaces incur separate purposes. This has been fostered at CEPT through **neutral materials** like bricks, exposed concrete and grey tiling.

Figure: Atelier studios being used as a collaborative zone

Figure: The exhibition space acts a multi-dimensional open space

All the zones have an open flexibility about them which lets the people use it in any way they want. The exhibition space can be used for a guest lecture or a collaborative area.

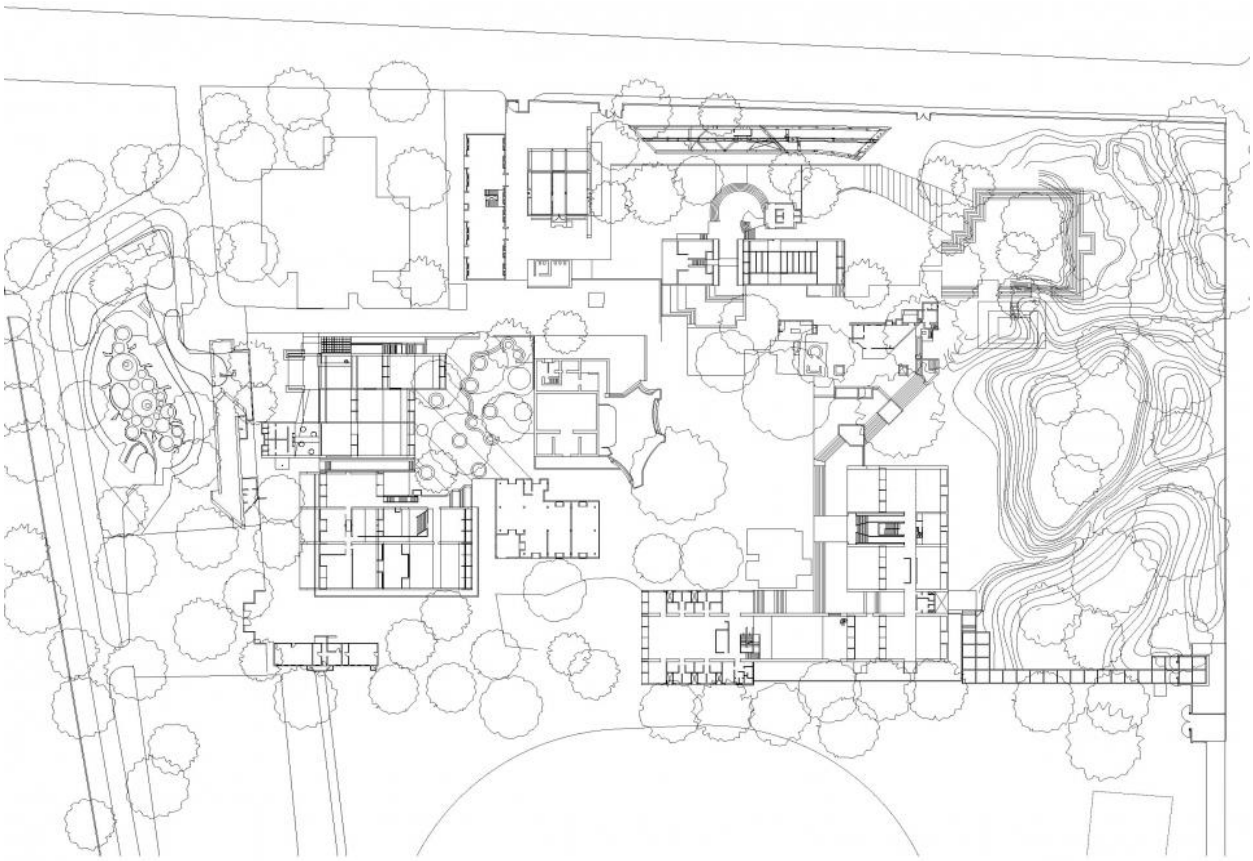


Figure: The plan of CEPT, Ahmedabad has been a case study for many architecture enthusiasts for decades.

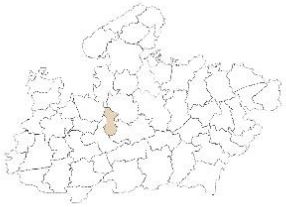
3 Site: Educational Zone

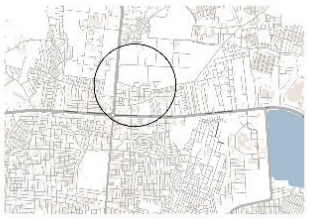
The site chosen is in **Bhopal, Madhya Pradesh, India**. The site comes under the educational zone. It is surrounded by a few universities and agriculture land. It is located in the developing part of the city. The site is 7.43 Acres.

3.1 Location

Figure: Locating India

Figure: The site is located in central India.





3.2 Site Surroundings

Figure: Indian institute of soil sciences

Figure: Central Institute of Agricultural Engineering

4 Neuroarchitecture

4.1 What is neuroarchitecture?

Neuroarchitecture is the interdisciplinary field that ensures the **creation of environments** able to **optimize the human behaviour**, well-being, and performance.

Neuroarchitecture is located where **neurology, psychology and architecture intersect to provide an empirical framework** to create better environments that leads to **improve human behaviour**, overall health and leisure. Architects realize that their designs for **spaces directly affects users of these spaces** as well as knowing the effects of light, colour on users' spatial perception. As a result, neuroarchitecture takes a step further in explaining how architecture-designed environments **affects** our **overall behaviour** in order to optimize the **design process** and providing high quality experiences for users.

4.1.1 Neuroscience and Architecture

Neuroscience explains the **relationship between the environment and the behaviours** which is - *perception to impulse, how neurons in our brains build and store information*.

Everything we **'think'** and **'feel'** are formed by our brain and nervous system and that is impact of environments. Neuroscience explains on how **physical environment affects our cognition**, problem solving ability and moods.

Architecture plays important role in helping to design built environment by serving better spatial orientation, reinforcing cognitive abilities and minimizing negative effect in emotions and motivation.

Another definition of neuroarchitecture is designing efficient environments based not only on technical parameters of legislation, ergonomics and environmental comfort, but also on subjective indices such as emotion, happiness and well-being.

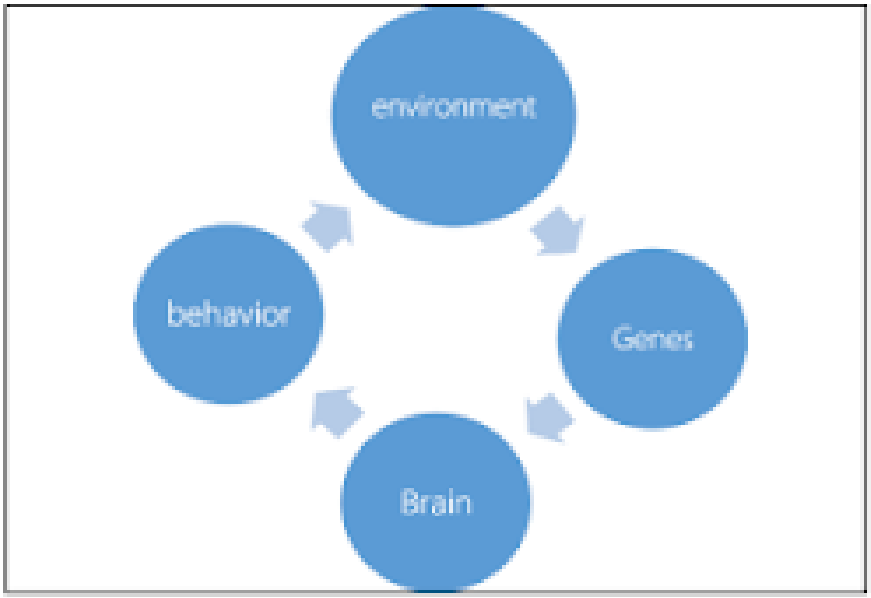


Figure: Neuroarchitecture

4.1.2 Neuroscience and learning and school environments

Our behaviour is influenced by how we perceive the environment. In order to design environments with **beneficial environmental qualities** that would lessen the adverse **physiological, emotional, and cognitive effects**, designing educational buildings have psychological impact on how a student learns. Neuroscience is helping merge the gap between **the physical build environment and human perception and behaviour**.

Hence, using a building's architecture to activate learning can further enhance the learning experience in schools.

4.1.3 Human Brain Overview

There are two types of brain system,

System I (Fast thinking): Operates at an unconscious level

System II (Slow thinking): Operates at a conscious level

The environmental stimulus affects the brain's system (I) by 99% relative to the brain's system (II), (Fig.1), which means that the **built environment can impact the unconscious mind without even the awareness of the conscious mind**.

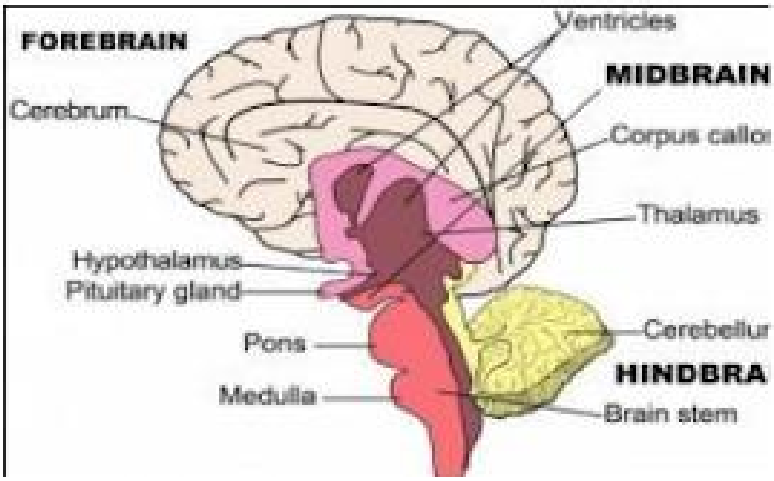


Figure: Illustration of brain

4.1.4 Environmental psychology + neuroscience

What is environmental psychology?

Studies the **relationship between the environment and human behaviour**, wayfinding in complex environments, and the effects of environmental stress on human performance.

Environmental psychology is a subfield of psychology that, as the definition above suggests, deals with how people interact and engage with their surroundings. Its roots reach far back, but as an established field it is relatively young (Spencer & Gee, 2009).

Recent research on the relationship between the physical environment of educational facilities and its *impact on students* has shown that design can definitely affect learning.

4.1.5 Impact of built-environment design on cognitive processes

What are cognitive processes?

Cognitive processes are the **mental operations the brain** performs to process information. Through these operations, the brain interacts with the information around it, stores it and analyses it in order to make the relevant decisions.

What are the cognitive processes involved in the learning environment?

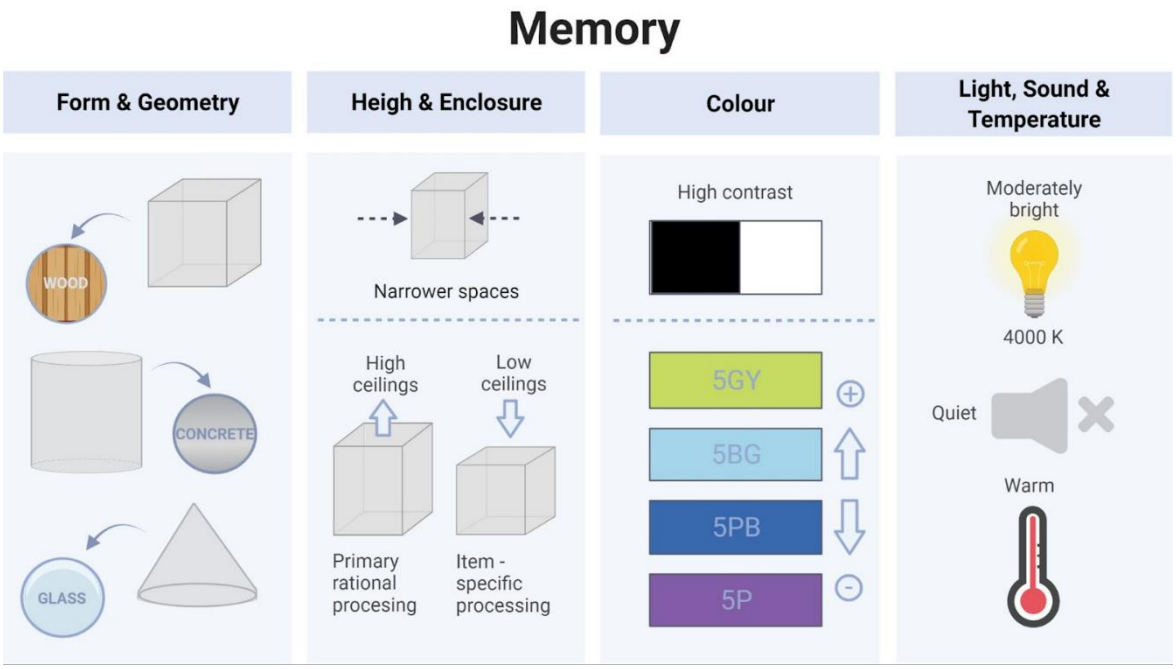
Cognitive processes may include *attention, perception, reasoning, emoting*, learning, synthesizing, rearrangement and manipulation of stored information, memory storage, retrieval, and metacognition.

Attention and Memory are considered to be the mainstays that impact the learning environment.

- Memory

Several studies show that certain architectural aspects can impact the memory process, depending on **colours, lighting, height and sound**.

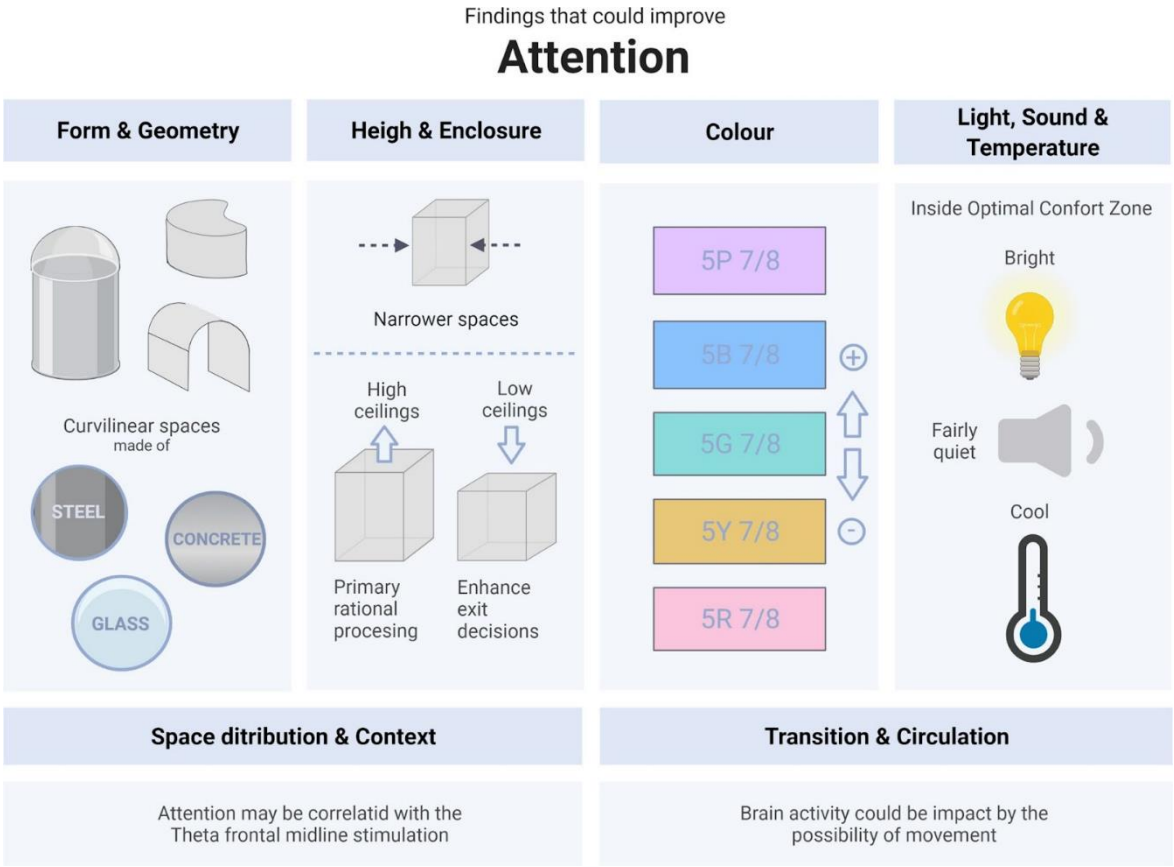
Below are the findings based on the research how memory is affected by architectural elements.



For example, cold-hued classroom walls and narrower classrooms are associated with superior memory performance.

- Attention

Ross (1951) has defined it as “the process of getting an object or thought clearly before the mind”. Whereas, according to William James, “attention is focusing of consciousness on a particular object. It implies withdrawal from some things in order to deal effectively with others. It is taking possession of one, out of several simultaneous objects or trains of thought by the mind, in clear and vivid form”.



Few tests like Bourdon Attention Test, Stroop test were applied on people to survey the positive and the negative effects on the mind due to architectural elements.

5 The Architectural Elements.

Determining the architectural features that can affect users on short-term level, and mostly impacts the nature of the built environment. And hence, **analysing these elements** with reference to neuroscientific architectural research.

The most important elements affecting a student's behaviour in a classroom as analysed are-

- Light
- Sound
- Colour
- Forms and shapes
- Ceiling height
- Nature integration
- Flexibility
- Finishing materials (textures)

5.1 Light

Christopher Alexander - mentions the fact that **low light levels in classrooms** affect students' ability to regulate the body's natural cycle of sleep and arousal.

the presence of large openings in the wall coupled with the presence of a raised roof, which in addition to providing ventilation also allows the classrooms to be light-filled, inviting spaces. Lighting intensity can have different impacts.

Low light intensity shows more stressful behaviours in students while high light intensity brings out the excitement in behaviours. The working memory is considerably affected by correlated colour temperature and illuminance.

5.2 Sound

Reduce background noise: Chronic background noise is associated with several auditory and learning problems. It contributes to neural noise where brain neurons fire spontaneously and distracts the student from learning. This helps in grabbing attention of students.

Silence is necessary to ensure greatest level of **understanding in student's environment**. The best is the balance between the presence and absence of sound. **The sound out of comfort zone** affects listening tasks **negatively** but has no impact on reading tasks.

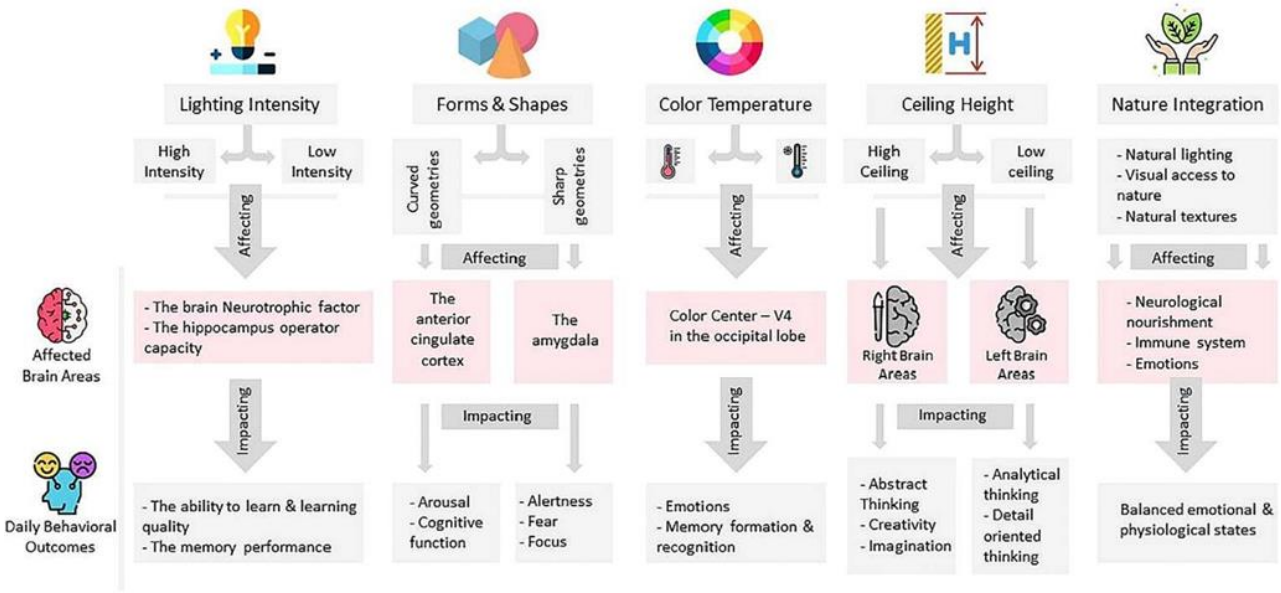


Figure: Dina Ezzat Ahmed Shaaban, Shaimaa Kamel, Laila Khodeir, Exploring the architectural design powers with the aid of neuroscience (little architect's adventure)

5.3 Colour

When exposed to the warm colours, in comparison to the cool colours one, confirming the studied **role of the warm colours** in creating **strong stimulation and boosting the adrenaline** release in the brain.

Warm colours show **energetic behaviour** in the user. This is better for the purpose of subjects which require high intensity energy and participation. It can be incorporated, architecturally, like adding colours like yellow, red and orange to the flooring, walls or ceiling.

Cool colours prove to make people using the **space more relaxed**. An excellent example of this is hospitals using cool colours to project calmness and peace. These can be incorporated into rooms like studying spaces or reading zones.

Specific colours sometimes make space seem larger than they actually are, though others can also create spaces that appear smaller.

Student's **attention** tasks have higher results in classrooms with **cold-hued colours**.

Student's **memory** tasks have higher results in classrooms with **cold-hued colours**. (Linares et al., 2021b)

Research shows that students in cold hued colours classrooms have better mental shift during the studies.'

Little architect's adventure

1

Energetic

Relaxed

2

Energetic

Relaxed

5.4 Forms and shapes

The wise choice of always picking **smooth curved elements** starting from a circular layout of the space, if possible. The heart rates records supported the multiple studies caring about the **effect of the smooth and curved lines in boosting more activity** in some specific brain areas, which by its turn activates the body's sympathetic system, and causes increased heart rates.

Smooth curved shaped forms encourage creativity while sharp edges have proven to be helpful for focused learning environment.

5.5 Ceiling height

Low ceiling heights impact in:

- In analytical thinking
- Detailed focused thinking.

High ceiling helps in-

- Abstract thinking, brings out creativity and imagination.
- Which in turn also brings a lot more natural light
- Rooms with high ceilings enable learners to pay more attention and facilitate a better learning environment than with enclosed spaces - which can increase the stress hormone.

5.6 Furniture

Spaces that can be changed to create new environments are stimulating to students. Mobile furniture and storage systems can be used to provide environmental changes. Furniture in a classroom should be flexible to allow for various uses and configurations. Furniture placement in a classroom affects the interaction and communication levels. Central seats are associated with significantly more verbalization than seats in other areas. **Spatially arranged classrooms** are good example for **logical based learning** while random arranged classrooms have **scope of imagination**.

5.7 Flexibility

As with coworking spaces, students also benefit from **open, fluid classroom layouts**. Multiple flexible seating options in the same learning space, giving a s**ense of independence within the pre-planned order**, e.g., comfy casual floor seating.

The ability to move furniture around and create spaces that accommodate different types of learning provides a flexible environment to suit the needs of various students at various times.

5.8 Sizes of spaces

The **classroom width** significantly impacts on **psychological and neurophysiological attention metrics**. **Wider classrooms** are associated with **poorer performance and lower emotional arousal**. Large spaces, small group spaces and individual spaces fulfil different functional needs in education. Different types of spaces lend a different ambition to the student and teacher and allow for different emotional and physiological responses.

Studies show larger spaces are good for presentations and lectures, physically active learning, and large-group activities. On the other hand, **small group spaces** are important to help in group interaction, to allow for **more discussion and participation**. Individual spaces allow for the student to have some privacy and to work independently from others.

5.9 Nature Integration

Nature integration can mean **visual access to natural lands** and elements. While designing a space, it is import to take into consideration a **multi-sensorial experience of natural elements** and not only visual accessibility.

Nature seen from windows activates students' mood, and helps to keep wellbeing. The mental health of any individual is impacted when the **senses are not connected to the outdoors**. This helps in a balanced emotional and physiological state of the individual.

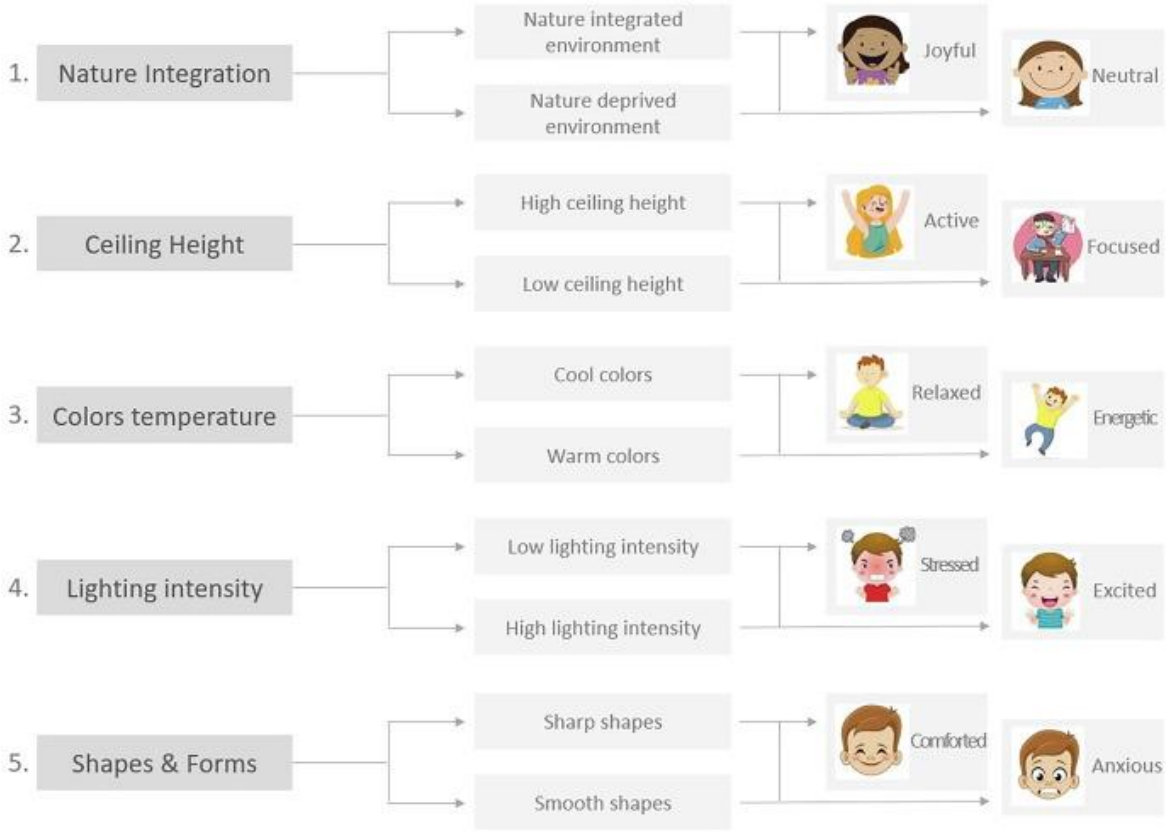
5.10 Form and Geometry

The newest studies show **attention** is enhanced in an indoor space built of steel, concrete, or glass and **memory** can be enhanced in a square or cylinder space built of concrete.

Conical, glass spaces and square, wooden spaces are better for concentrating and retaining information. Curvilinear interior spaces cause higher cognitive and emotional levels whereas rectilinear interior spaces contribute to lower satisfaction and excitement in participants. (Elbaiuomy et al., 2018)

Researchers showed that using a **minimum of 25% of wall space for windows** was acceptable but students prefer a third or more of the wall space should be used for windows.

Sharp edges and straight lines translate into discipline and focus while smooth surface and flowing lines allow for mind wandering and creativity.



6 Inferences

Based on our research, these are the final architectural elements affecting students mind, and encouraging or discouraging for learning environment.

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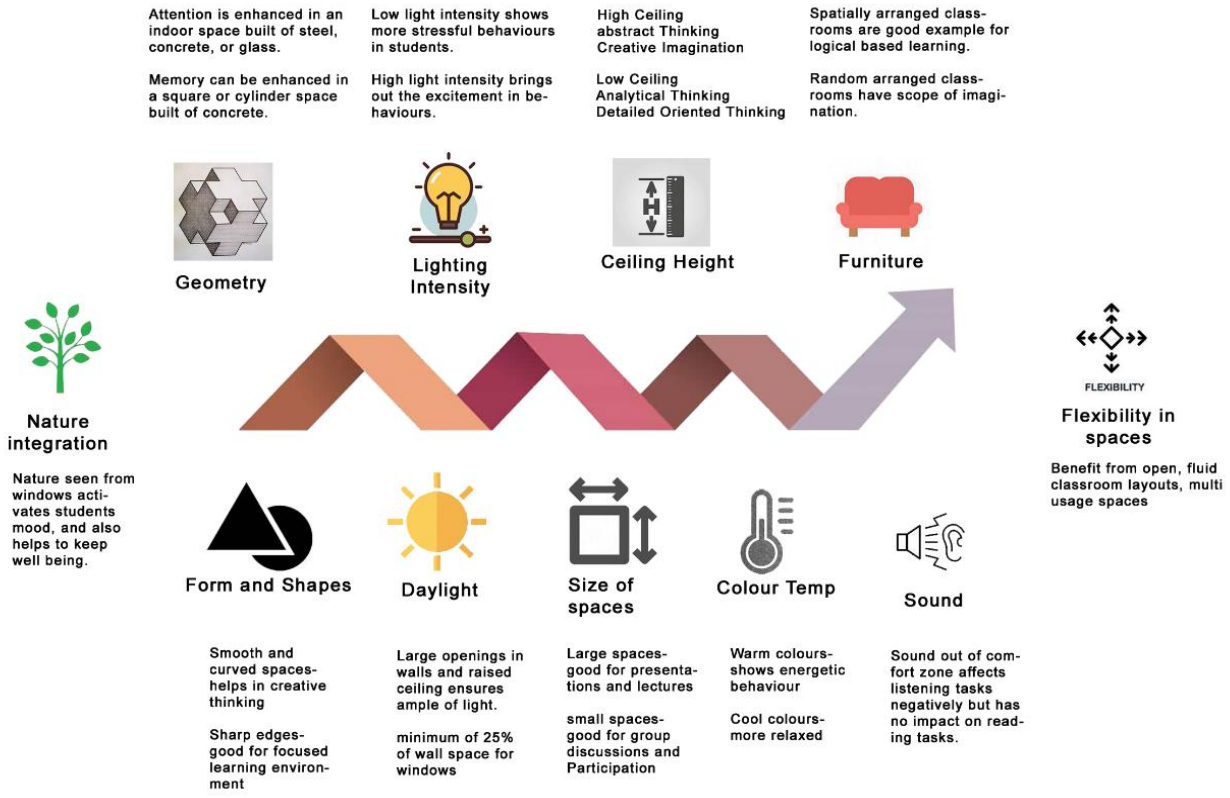
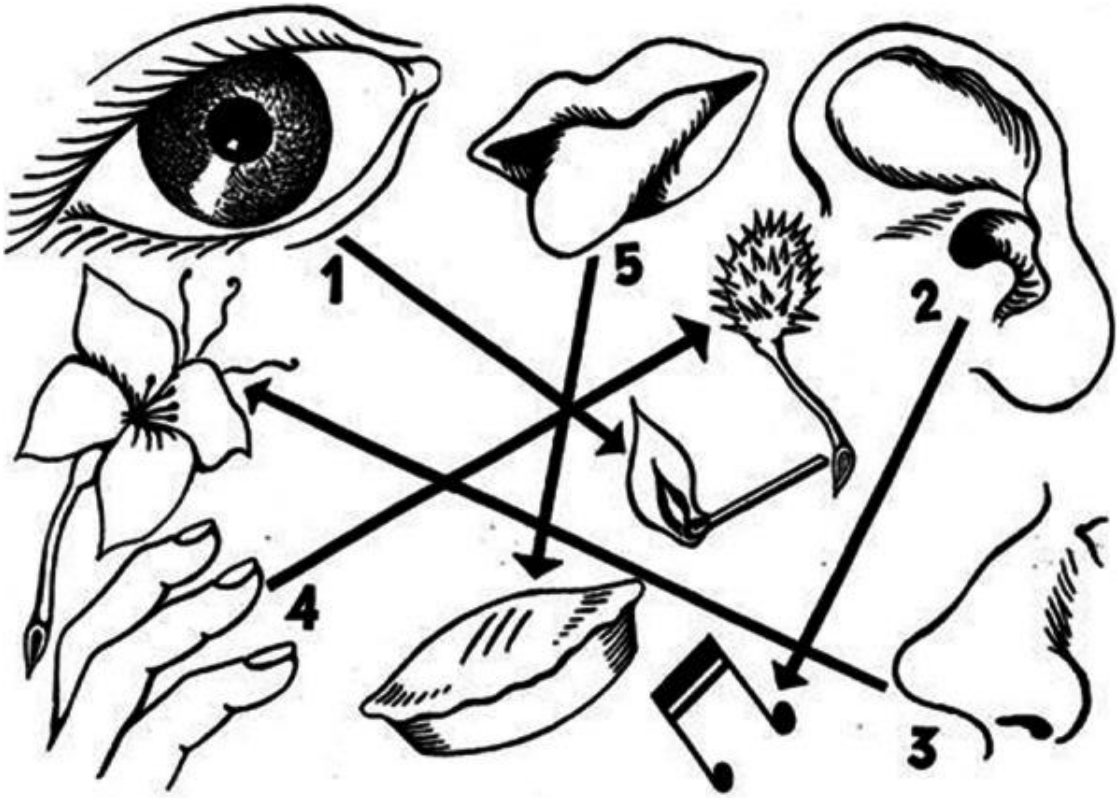


7 The role of the human senses in architectural design



Traditionally, **architects prioritise eye/sight as the primary sense** whilst designing. Increasingly, to include differently able people, other senses have started to being considered as well. Their way of life means relying on other senses more. This has led to incorporation of architectural elements which are focused on touch, taste and smell.

Such **visual dominance** makes sense or, at the very least, can be explained or accounted in neuroscience. After all, it turns out that far **more of our brains** are given over to the processing of what we see than to dealing with the information from any of our other senses.

This figure compares to something like just **12% of the cortex primarily dedicated to touch**, around 3% to hearing, and less than 1% given over to the processing of the chemical senses of smell and taste

8 Design Overview from a Neurological Perspective

It has been written in several journals and papers that the research on Neuroarchitecture has not yielded clear and direct results. Which is why some general theoretical guidelines have been created.

Well-designed classroom may contribute to a release of pleasure by enhancing neurochemicals release in the brain (Opioids & Dopamine); which will result in **automatic seeking out to this specific space**.

Strong identity of each zone can anchor the learning processes in long-term memory.

The use of **colours, shapes, and materials** in creating positive emotional responses to spaces can make the classroom a tool incorporated in lesson planning, and used to **improve the educational experience** for students and teachers.

8.1.1 Designing

Senses that are considered whilst designing the project of this thesis.

- Sight
- Touch
- Hearing

Concept:

- To design each space and classroom based on the **purpose of the room**. Considering enclosure of space in terms of **height, different levels, flooring, texture, colours and furniture**.
- To **connect the learning environment of the outdoor and indoor**, making it a seamless transition.
- **Flexible learning spaces** - Create spatial layouts that support multiple modalities of learning.

9 Inferences from Research

9.1 Types of spaces

The different types of spaces that are required in an architecture school can be classified as:

- Design studio
- Theoretical subject studios
- Technical subject studio
- Examination rooms
- Self-study spaces
- Interactive spaces
- Library and canteen
- Maker spaces
- Presentation / Jury spaces

9.2 Spaces and their guidelines

1. Design Studio

The space is for atelier subjects which need **collaborative and individual spaces** both. The subject needs for students to be able to tap into their **imagination and creativity** and foster team work.

Requires:

- Creativity
- Flexibility
- Energetic
- Attention

Architectural aspects to enhance the room:

- High ceiling
- Smoothened edges
- Good lighting
- Nature integration
- Flexibility is spaces for discussions and collaboration.

2. Theoretical Studio

The 'Theoretical Studio' will host subjects that are mor theory and less practical in the pedagogy sense. The student would have to be **focus and disciplined** to concentrate. A few examples of the subject that can be taught here are **structural design, building material and climatology**.

Requires:

- Calm energy
- Focus
- Memory

Architectural aspects to enhance the room:

- Small and narrow classroom- width of the room will be less than the depth
- Low ceiling
- Sharp edges
- Straight cooperative learning arrangement
- Low sound levels/ good acoustic treatment
- Perfect balance of light to shadow ratio

3. Technical Studio

The 'Technical Studio' needs to host at least **2 different types of cooperative learning arrangement**. Since technical subjects like construction technology and graphics require drafting tables, one space has to be dedicated to that. The other space that needs to be incorporated is a collaborating zone and a **theoretical zone** for teachers to teach the subject in a disciplined way.

Requires:

- Focus the centre of the activity and fixing your mind on a specific task
- Attention notice taken of something
- Memory
- Energetic

Architectural aspects to enhance the room:

- Separate learning environments
- Nature integration
- Sharp edges
- High ceiling for activity a and Low ceiling for activity b
- Good lighting

4. Library

Requires:

- Attention
- Memory
- Student interaction and collaboration
- Relaxed environment
- Nature] Integration

Architectural aspects to enhance the room:

- Building placed on the rear end to keep it away from the main active areas.
- High ceiling and low ceiling heights depending on flexible usage of spaces
- Nature integration in form of inner courtyard surrounded by study furniture arrangements. And also maintaining buffer space in form of outdoor study areas.
- Sharp edges
- Good lighting intensity
- Ample of Daylight
- Floor and wall finish to differentiate multiple spaces present in the multiple usage of space.

5. Self-Study and Seminar Studios

Requires:

- Discussions and collaboration space
- Flexibility in furniture and multi usage of space
- Attention

Architectural aspects to enhance the room:

- High ceiling and low ceiling heights depending on usage of spaces.
- Sharp Edges for self-study spaces and curvilinear edges to seminar and other public spaces.
- Good lighting intensity for self - study areas.
- Nature Integration for public areas.
- Visual contact maintained in spaces.
- Good acoustic solutions and colour added to rooms.

6. Presentation and outdoor Collaboration spaces

Requires:

- Interaction
- Flexibility
- Attention

Architectural aspects to enhance the room:

- Smooth edges to encourage discussions and creativity.
- Nature Integration
- Visual contact maintained in spaces.
- Flexible furniture
- Ample space for sit outs and active interaction.
- Semi closed spaces and closed spaces yet maintaining the visual contact.
- Also acts as social space.

10. References

Figure: Render used as reference for high ceiling walls

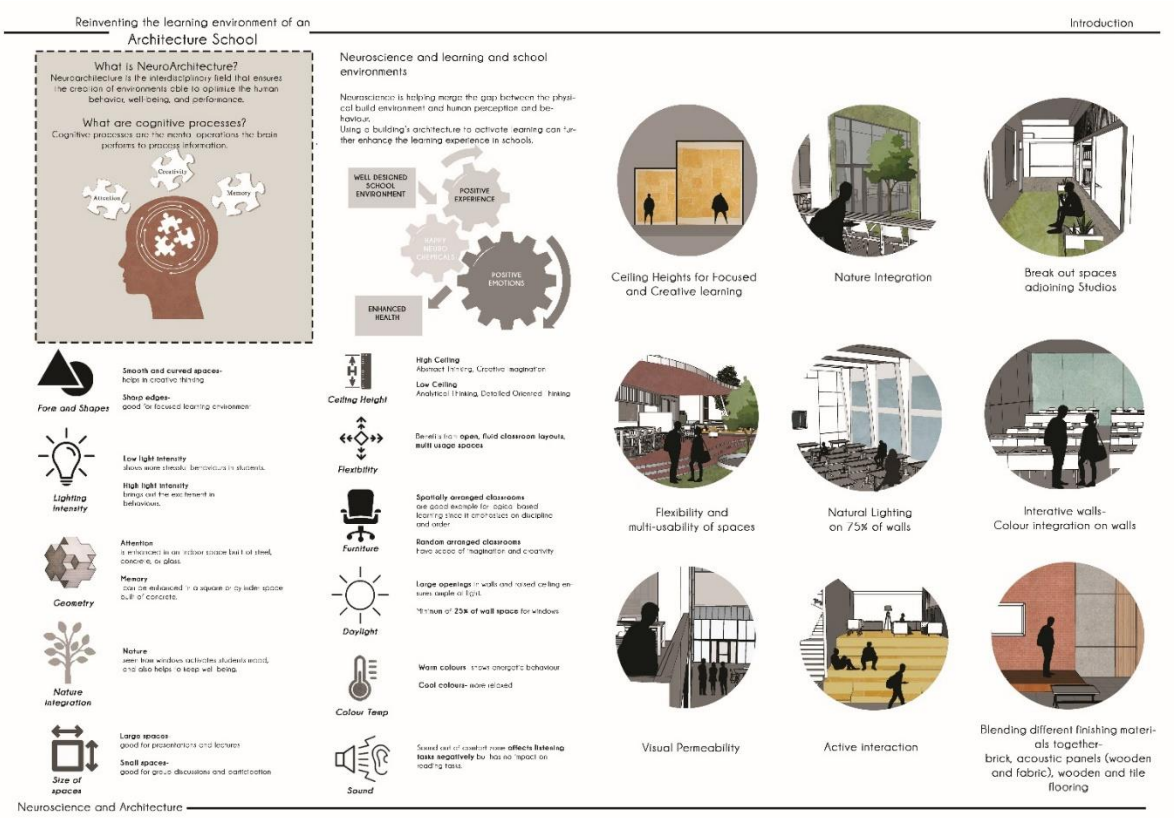
Figure: Clemson University by Sasaki architects

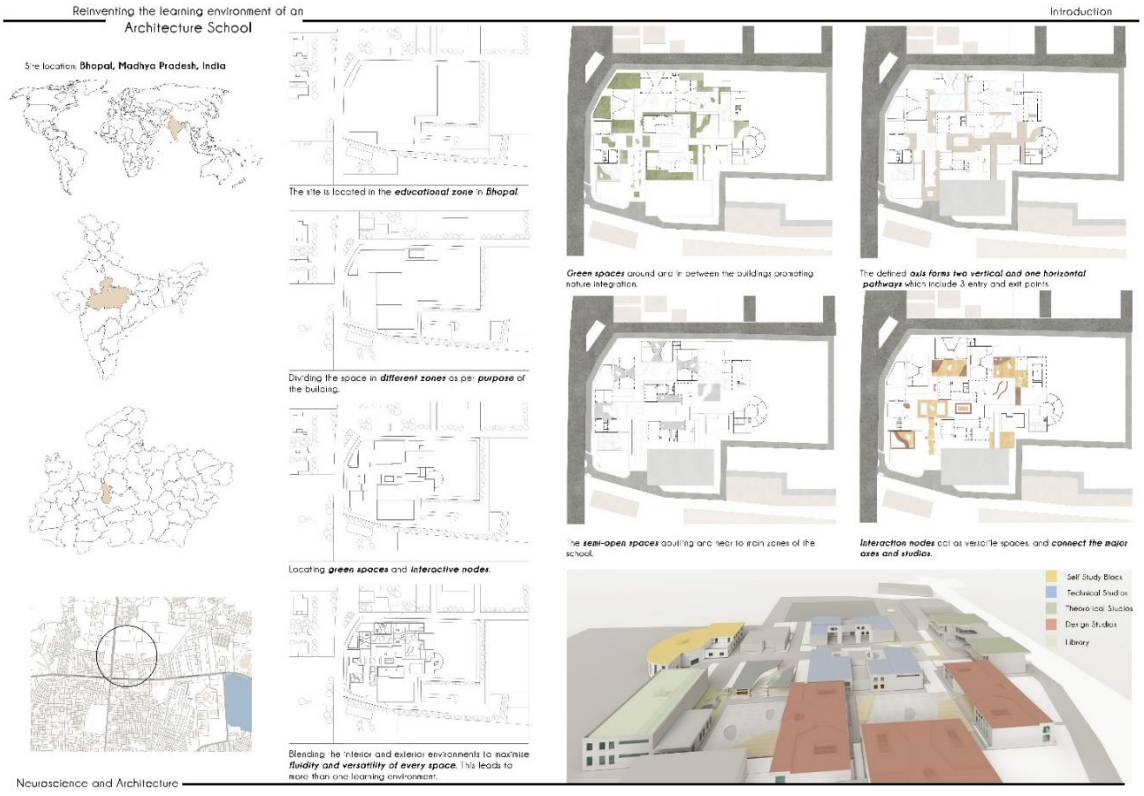
Figure 1Ayer Shirley Regional High School by SMMA.

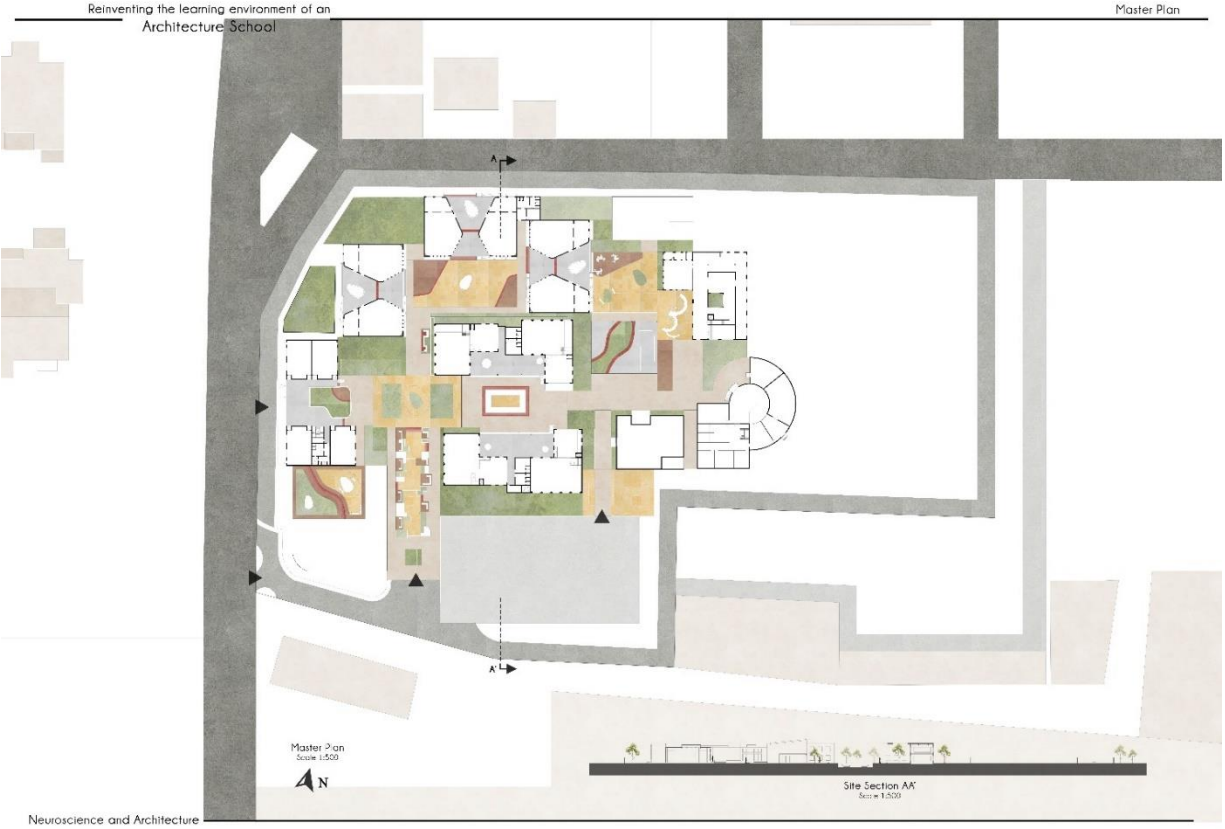
Figure: Exhibition area, by 1c Studio

Figure 2Indian Mountain School Student Center by Flansburgh Architects

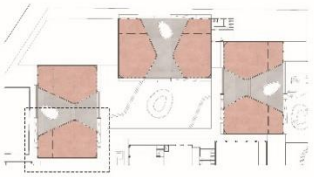
11. Final Drawings



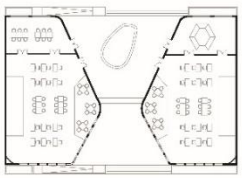




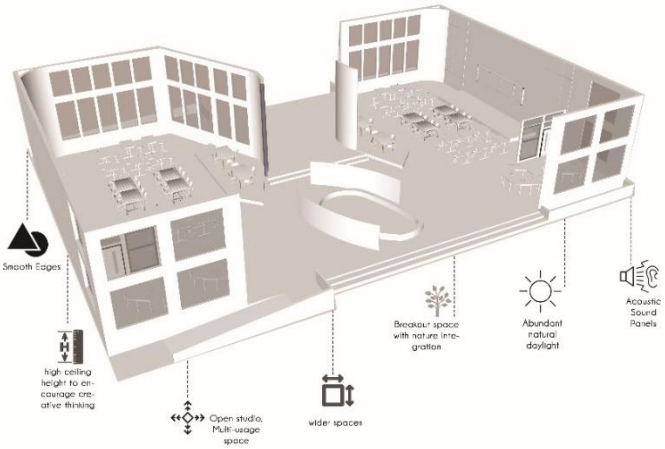
Key Plan
(nts)

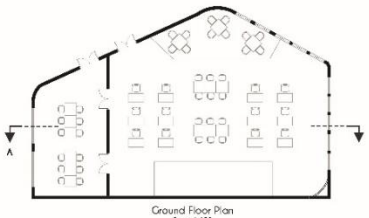


Floor Plan with context
Scale 1:500

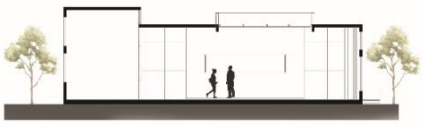


Typical studio layout
Scale 1:200

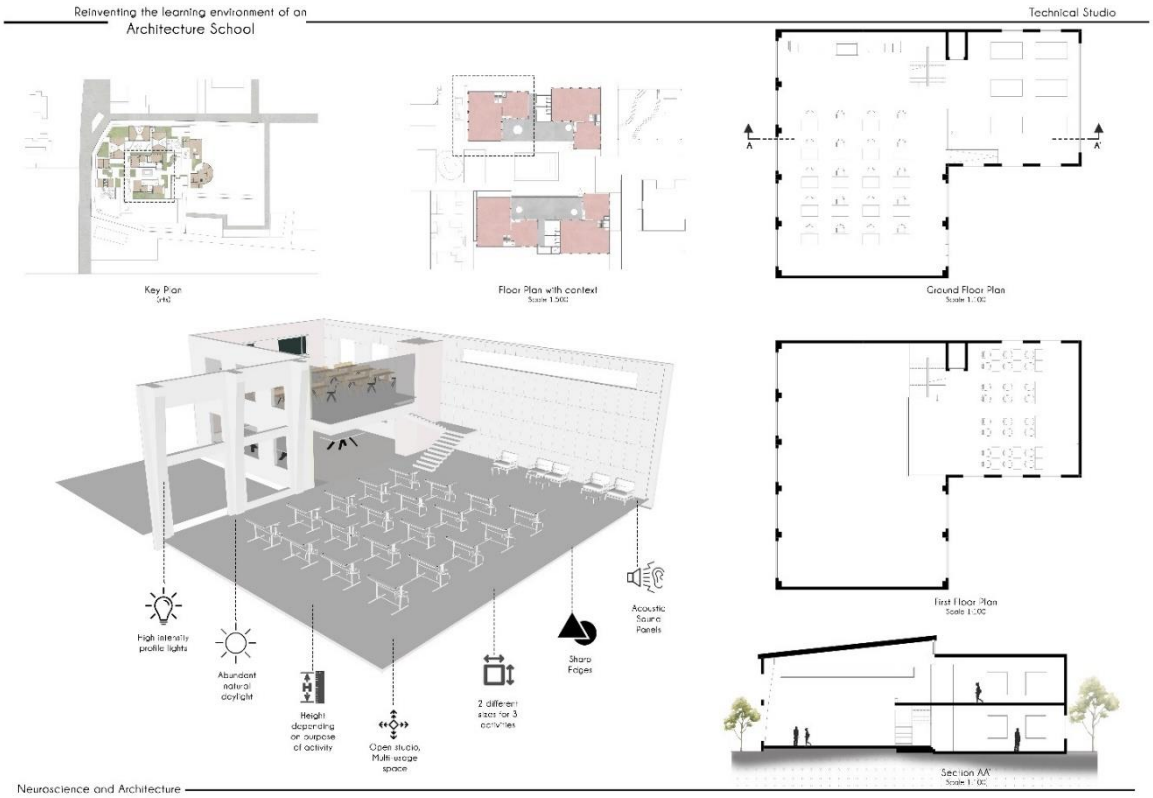


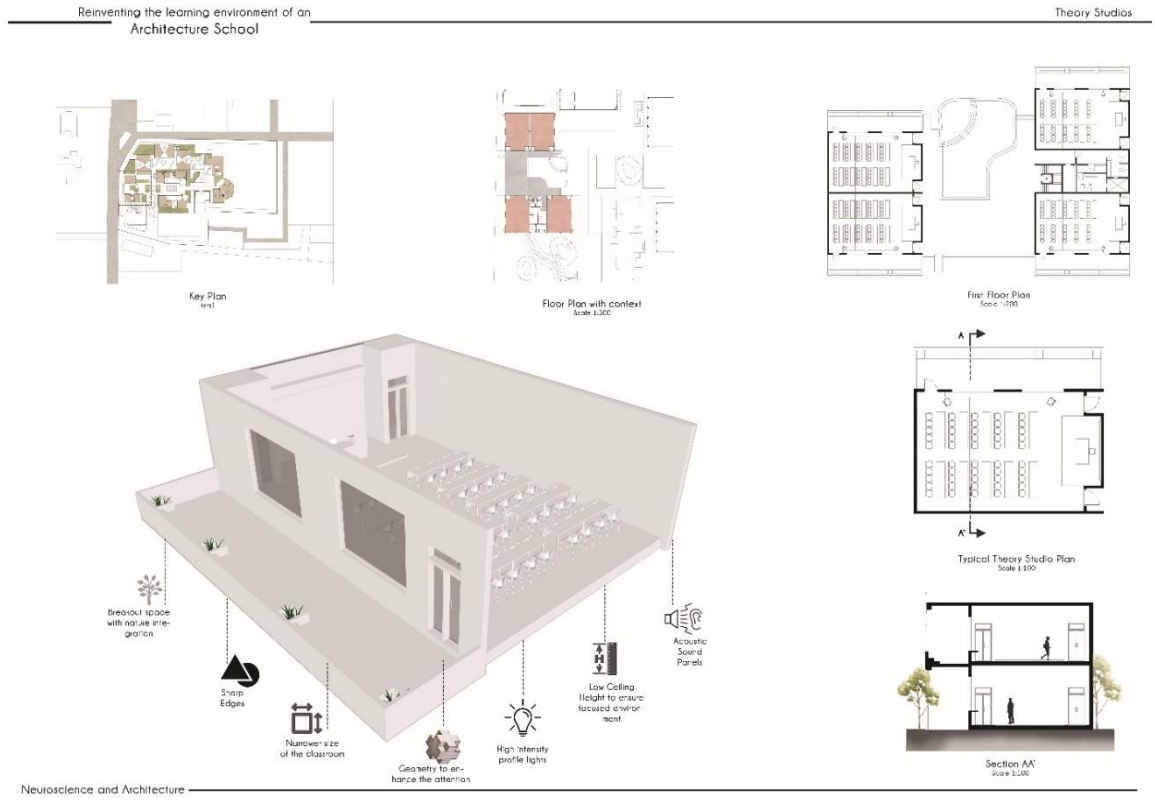


Ground Floor Plan
Scale 1:100



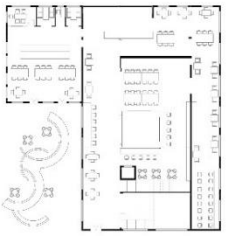
Section AA'
Scale 1:100


Reinventing the learning environment of an
Architecture School
Technical Studio
Key Plan
Floor Plan with context
Ground Floor Plan
First Floor Plan
Section AA'
High intensity profile lights
Abundant natural daylight
Height depending on purpose of activity
Open studio, Multi usage space
2 different sizes for 3 activities
Sharp Edges
Acoustic Sound Panels
Neuroscience and Architecture

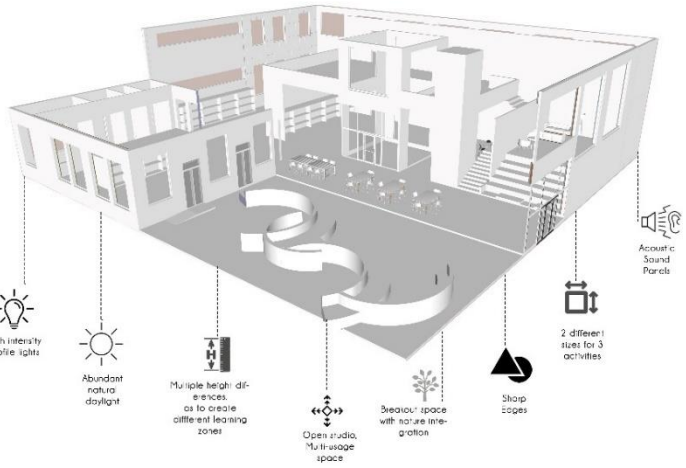

Reinventing the learning environment of an
Architecture School
Theory Studios
Key Plan
Floor Plan with context
First Floor Plan
Typical Theory Studio Plan
Section AA'
Breakout space with nature integration
Sharp Edges
Narrower size of the classroom
Geometry to enhance the attention
High intensity profile lights
Low Ceiling Height to ensure focused environment
Acoustic Sound Panels
Neuroscience and Architecture

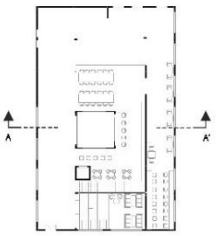
Key Plan
Not to scale

Floor Plan with context
Scale 1:500



Ground Floor Plan
Scale 1:200

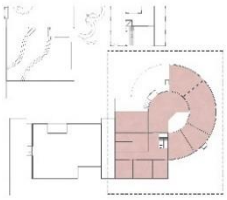




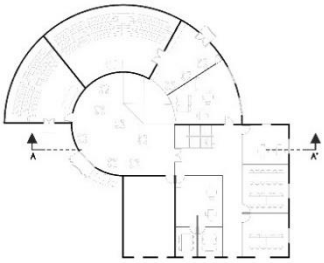
First Floor Plan
Scale 1:200

Section AA'
Scale 1:200

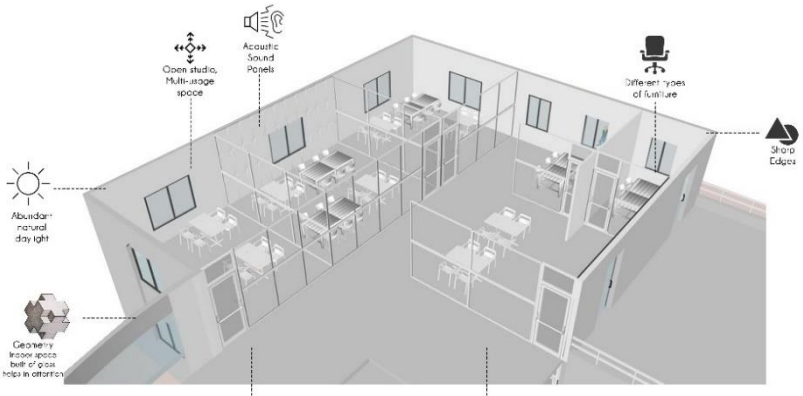
Key Plan
Not to scale

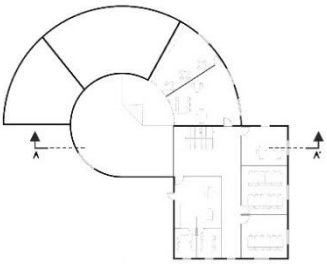


Floor Plan with context
Scale 1:500

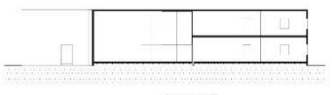


Ground Floor Plan
Scale 1:200

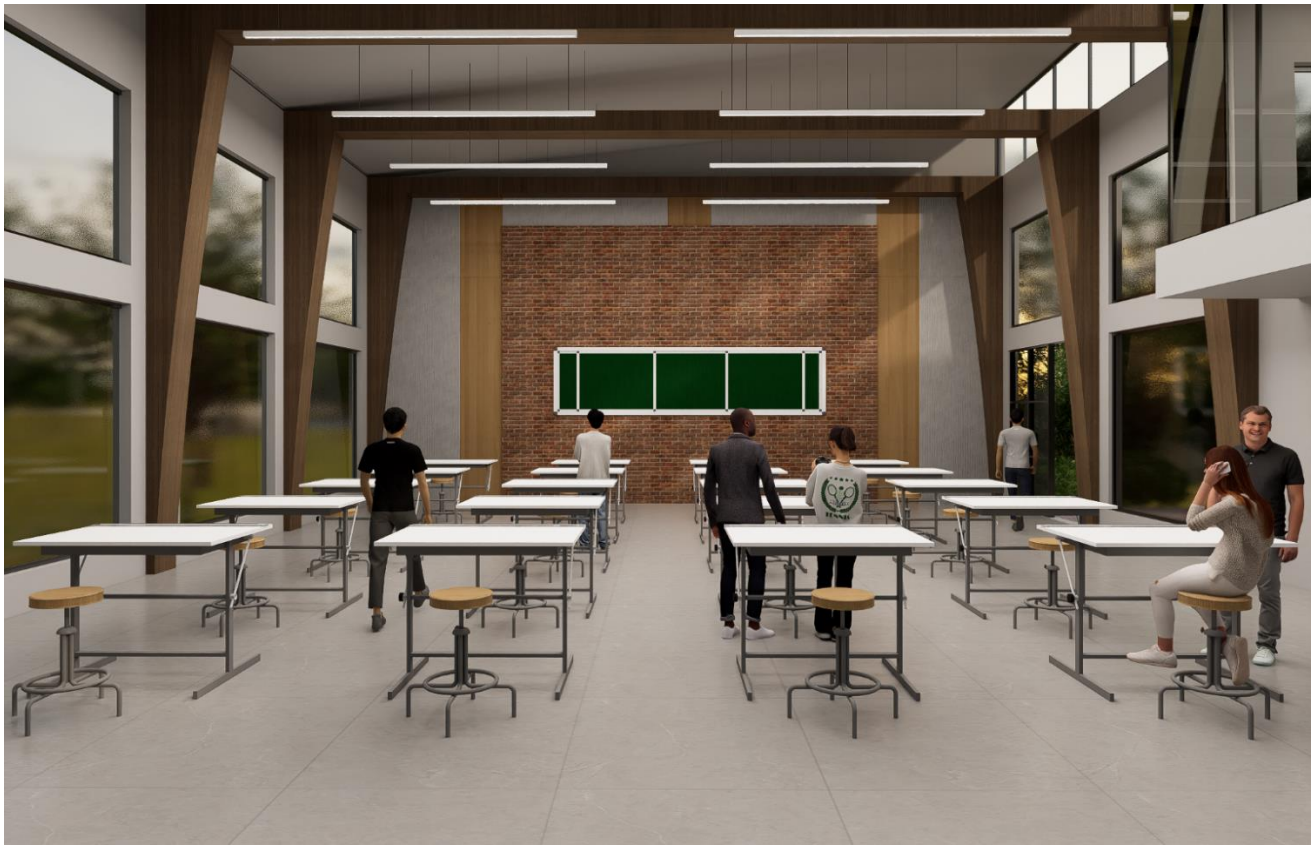


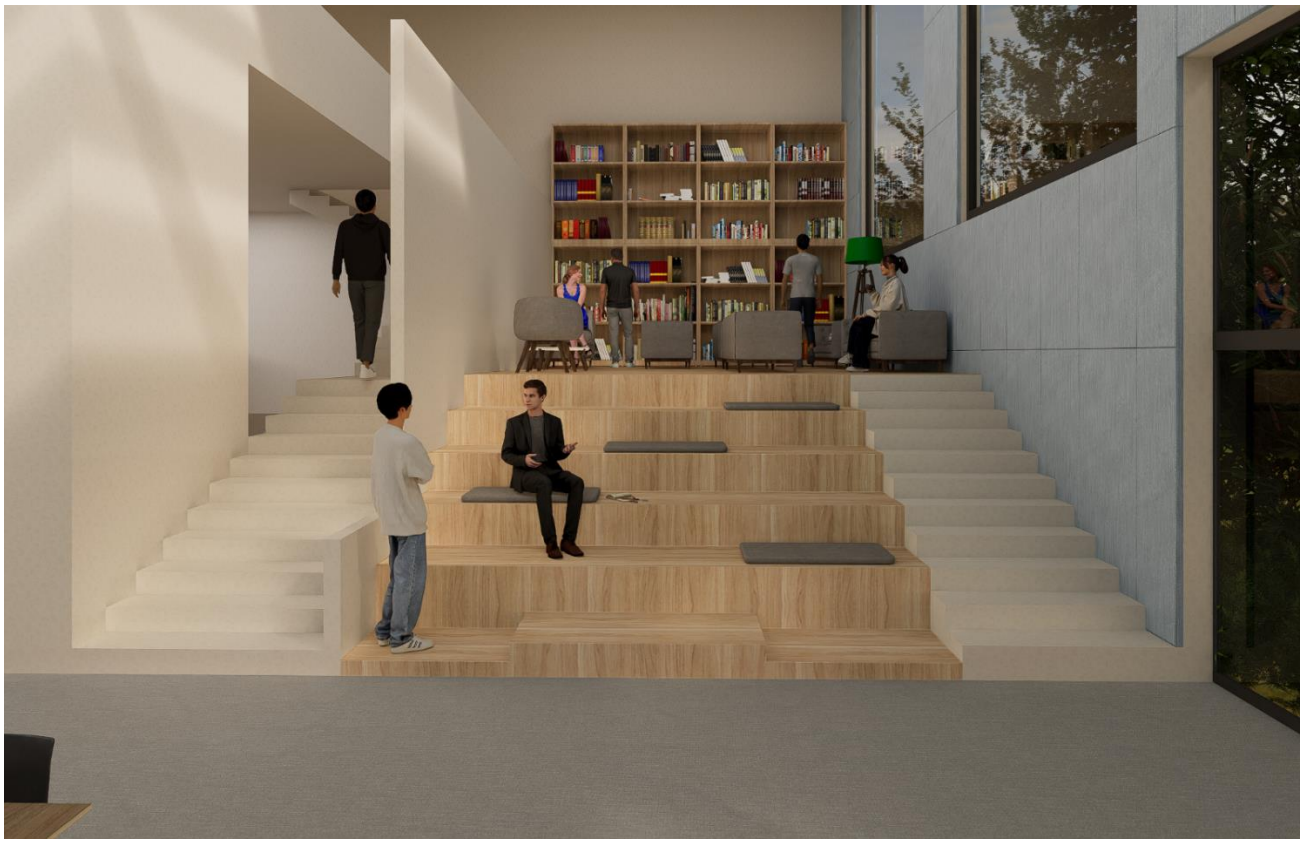


First Floor Plan
Scale 1:200



Section AA'
Scale 1:200





10. Bibliography

Andréa de Paiva. (2018, February 28). Neuroscience for Architecture: How Building Design Can Influence Behaviours and Performance. *Journal of Civil Engineering and Architecture*, *12*(2). https://doi.org/10.17265/1934-7359/2018.02.007

Ezzat Ahmed, D., Kamel, S., & Khodeir, L. (2021, June 1). Exploring the contribution of Neuroarchitecture in learning environments design "A review." *International Journal of Architectural Engineering and Urban Research*, *4*(1), 67–94. https://doi.org/10.21608/ijaeur.2021.215924

Llorens-Gámez, M., Higuera-Trujillo, J.L., Omarrementeria, C.S., & Llinares, C. (2021). The impact of the design of learning spaces on attention and memory from a neuroarchitectural approach: A systematic review. *Frontiers of Architectural Research*.

Ahmed Shaaban, D.E., Kamel, S.M., & Khodeir, L.M. (2023). Exploring the architectural design powers with the aid of neuroscience (little architect's adventure). *Ain Shams Engineering Journal*.

Banaei, M., Hatami, J., Yazdanfar, A., & Gramann, K. (2017). Walking through Architectural Spaces: The Impact of Interior Forms on Human Brain Dynamics. *Frontiers in human neuroscience*, *11*, 477. https://doi.org/10.3389/fnhum.2017.00477

Elbaiuomy, E., Hegazy, I., & Sheta, S. (2017, December 18). The impact of architectural spaces' geometric forms and construction materials on the users' brainwaves and consciousness status. *International Journal of Low-Carbon Technologies*, *14*(3), 326–334. https://doi.org/10.1093/ijlct/ctx018

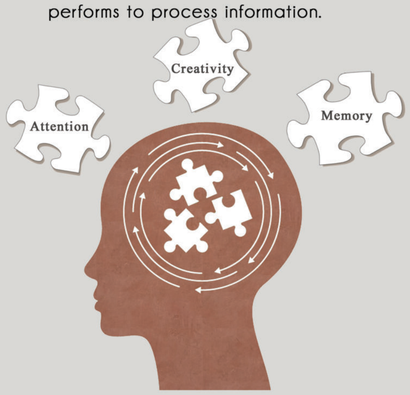
Spence, C. (2020, September 18). Senses of place: architectural design for the multisensory mind. *Cognitive Research: Principles and Implications*, *5*(1). https://doi.org/10.1186/s41235-020-00243-4

What is NeuroArchitecture?

Neuroarchitecture is the interdisciplinary field that ensures the creation of environments able to optimize the human behavior, well-being, and performance.

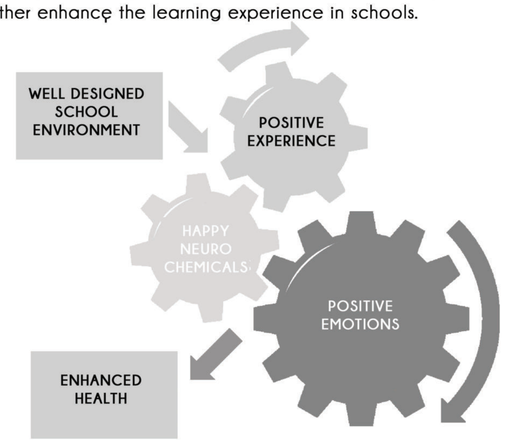
What are cognitive processes?

Cognitive processes are the mental operations the brain performs to process information.



Neuroscience and learning and school environments

Neuroscience is helping merge the gap between the physical build environment and human perception and behaviour.
Using a building's architecture to activate learning can further enhance the learning experience in schools.



Form and Shapes

Smooth and curved spaces-
helps in creative thinking

Sharp edges-
good for focused learning environment

Lighting Intensity

Low light intensity
shows more stressful behaviours in students.

High light intensity
brings out the excitement in behaviours.

Geometry

Attention
is enhanced in an indoor space built of steel, concrete, or glass.

Memory
can be enhanced in a square or cylinder space built of concrete.

Nature integration

Nature
seen from windows activates students mood, and also helps to keep well being.

Size of spaces

Large spaces-
good for presentations and lectures

Small spaces-
good for group discussions and participation

Ceiling Height

High Ceiling
Abstract Thinking, Creative Imagination

Low Ceiling
Analytical Thinking, Detailed Oriented Thinking

Flexibility

Benefits from **open, fluid classroom layouts, multi usage spaces**

Furniture

Spatially arranged classrooms
are good example for logical based learning since it emphasizes on discipline and order

Random arranged classrooms
have scope of imagination and creativity

Daylight

Large openings in walls and raised ceiling ensures ample of light.

Minimum of **25% of wall space** for windows

Colour Temp

Warm colours- shows energetic behaviour

Cool colours- more relaxed

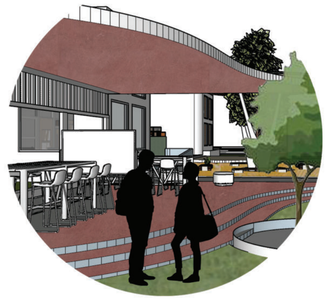
Sound

Sound out of comfort zone **affects listening tasks negatively** but has no impact on reading tasks.

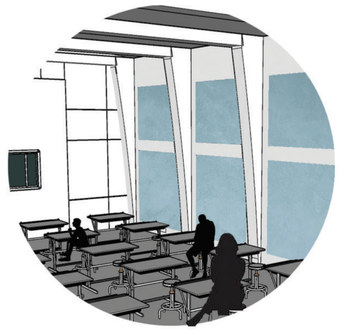
Ceiling Heights for Focused and Creative learning

Nature Integration

Break out spaces adjoining Studios



Flexibility and multi-usability of spaces

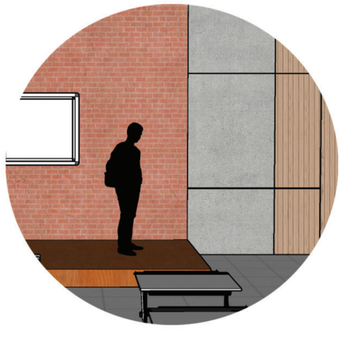


Natural Lighting on 75% of walls

Interative walls-
Colour integration on walls

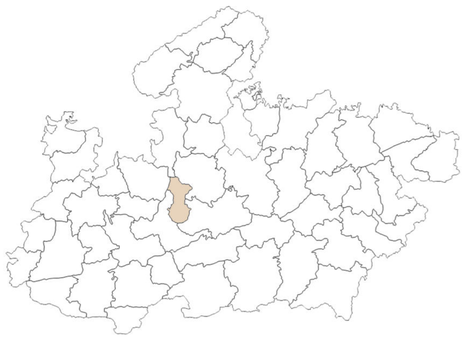
Visual Permeability

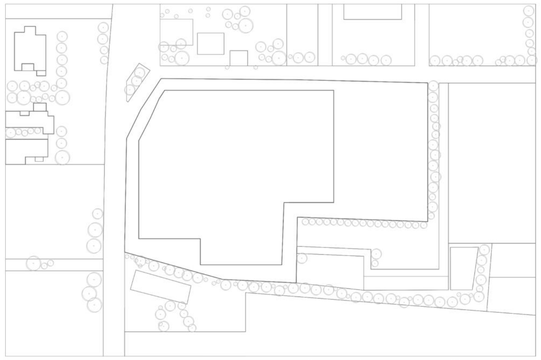
Active interaction



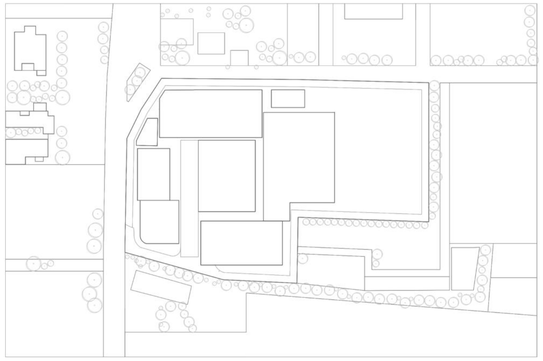
Blending different finishing materials together-
brick, acoustic panels (wooden and fabric), wooden and tile flooring

Site location: **Bhopal, Madhya Pradesh, India**

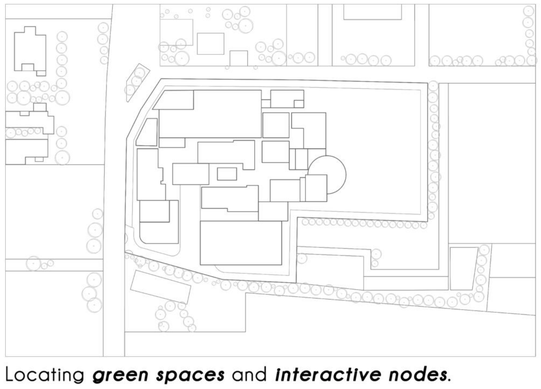




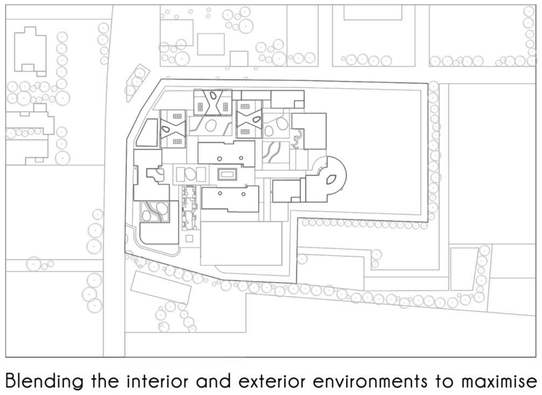
The site is located in the ***educational zone*** in ***Bhopal***.



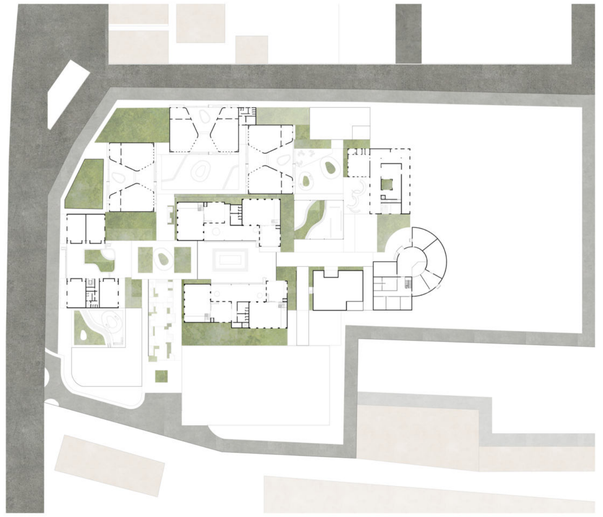
Dividing the space in ***different zones*** as per ***purpose*** of the building.



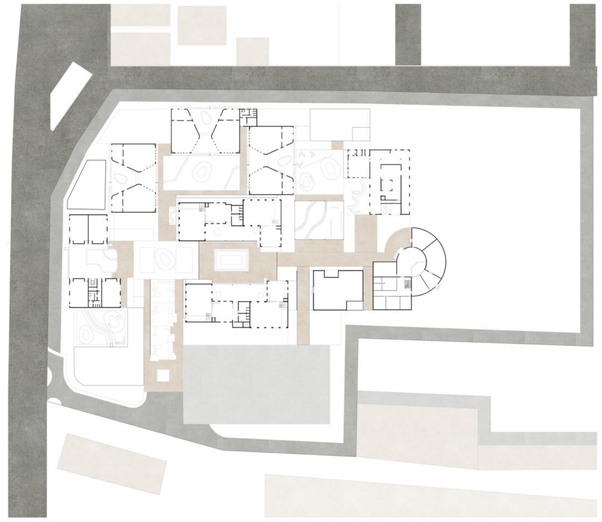
Locating ***green spaces*** and ***interactive nodes***.



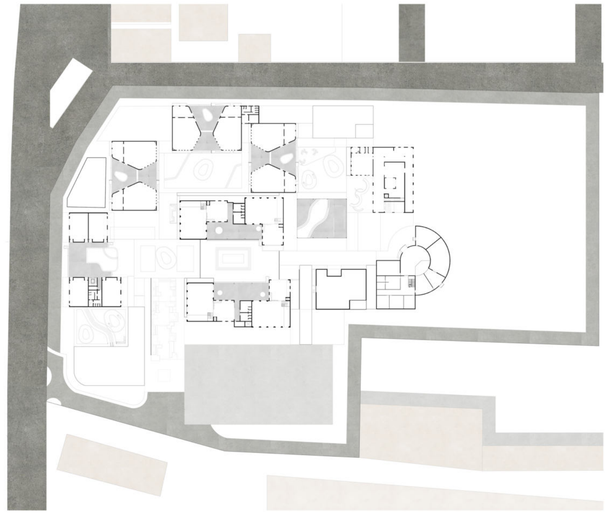
Blending the interior and exterior environments to maximise ***fluidity and versatility of every space***. This leads to more than one learning environment.



Green spaces around and in between the buildings promoting nature integration.

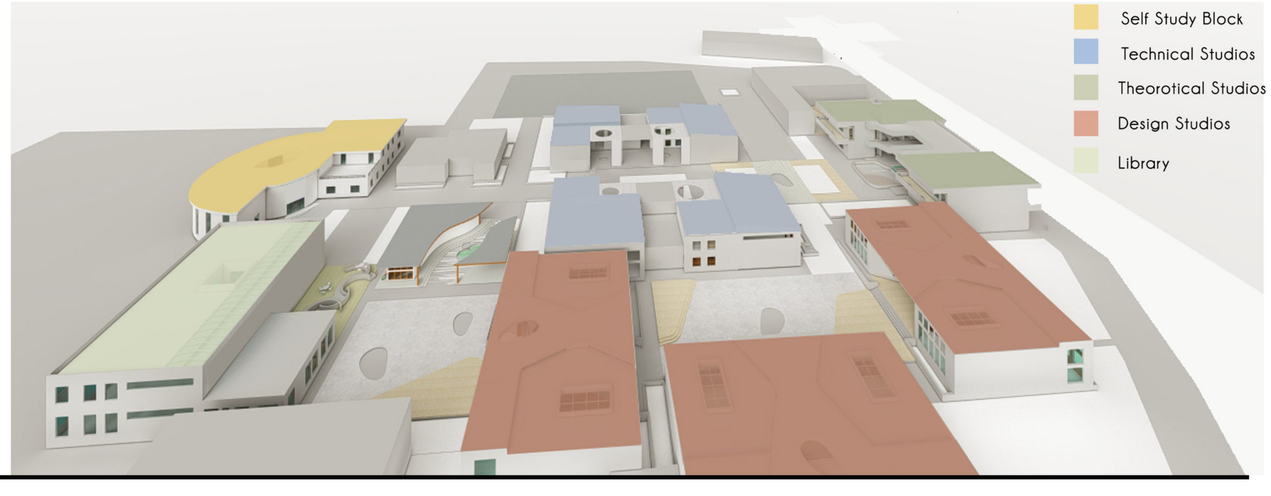


The defined ***axis forms two vertical and one horizontal pathways*** which include 3 entry and exit points.



The ***semi-open spaces*** abutting and near to main zones of the school.

Interaction nodes act as versatile spaces, and ***connect the major axes and studios***.

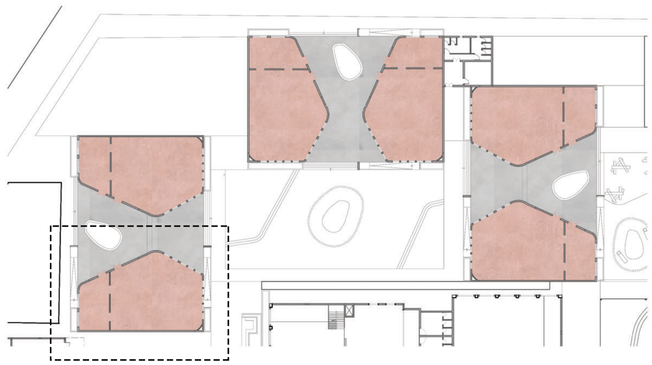


Master Plan
Scale 1:500

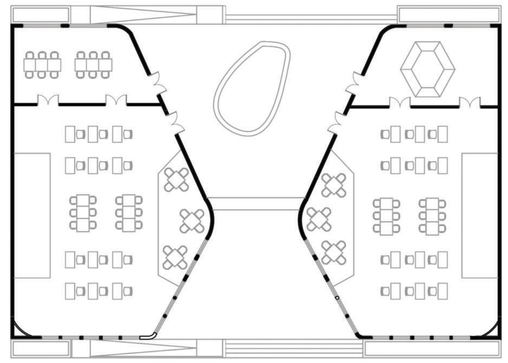
N

Site Section AA'
Scale 1:500

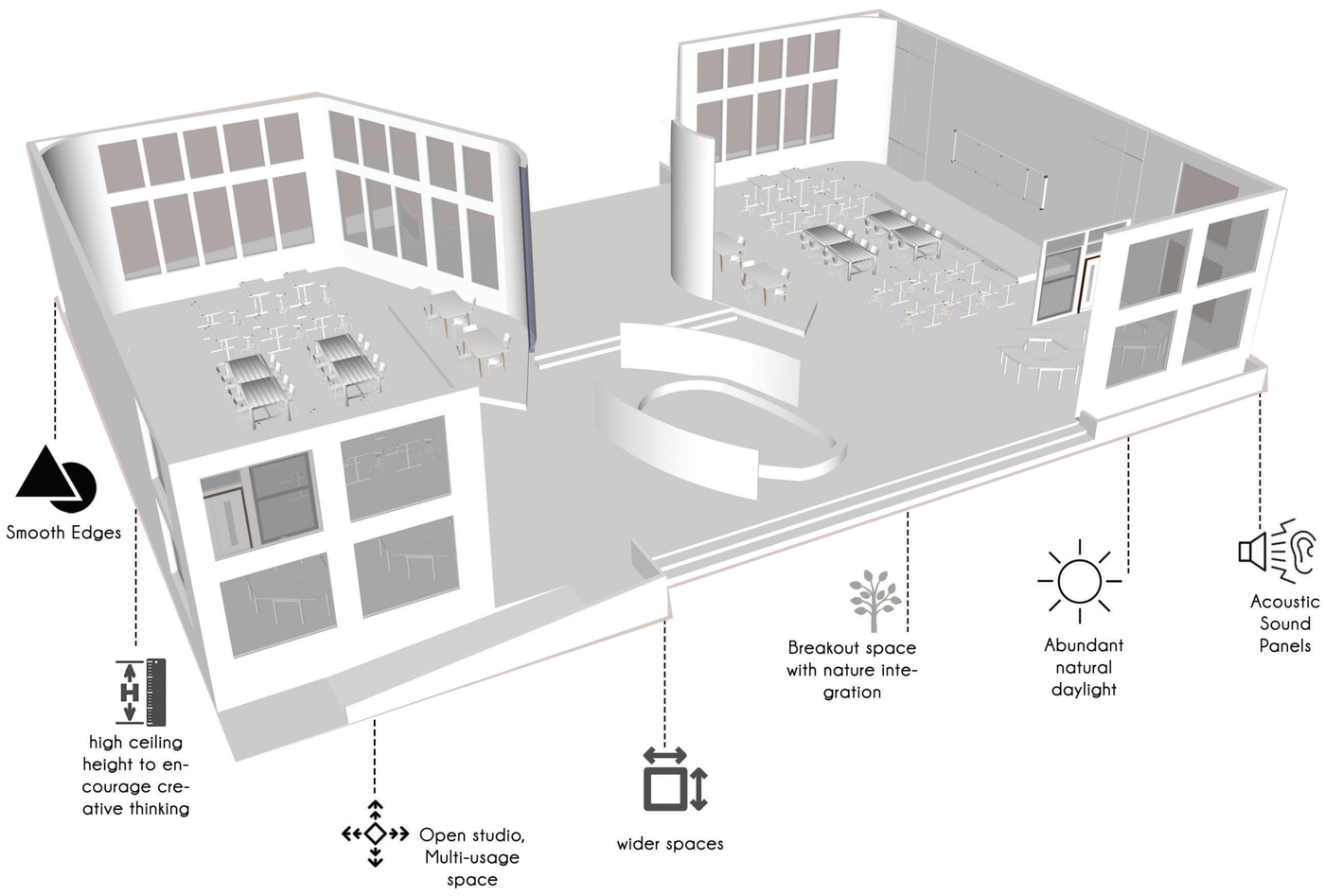
Key Plan
(nts)

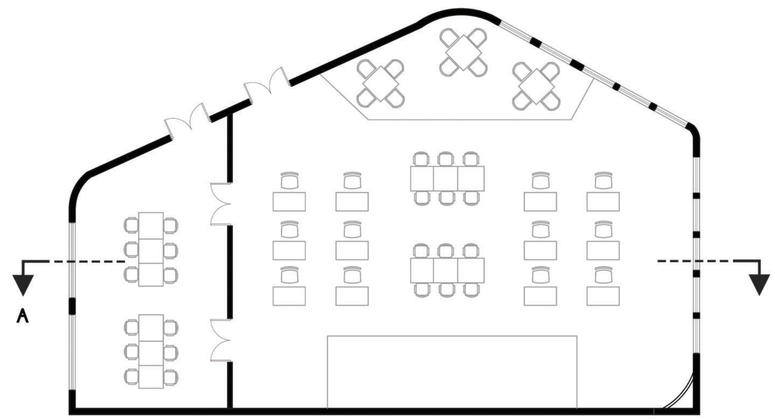


Floor Plan with context
Scale 1:500

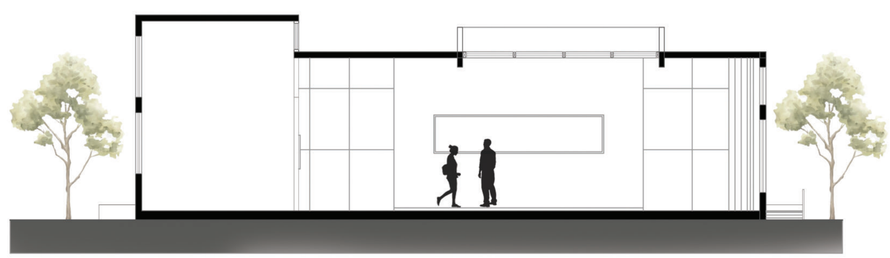


Typical studio layout
Scale 1:200

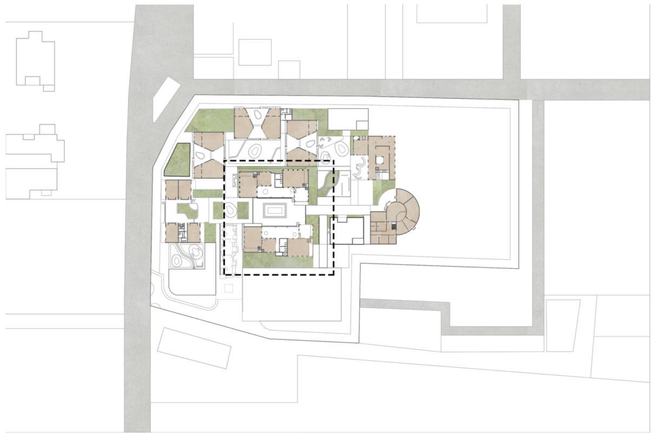




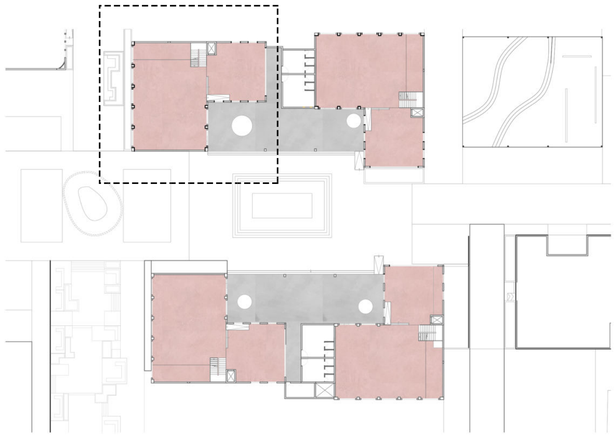
Ground Floor Plan
Scale 1:100



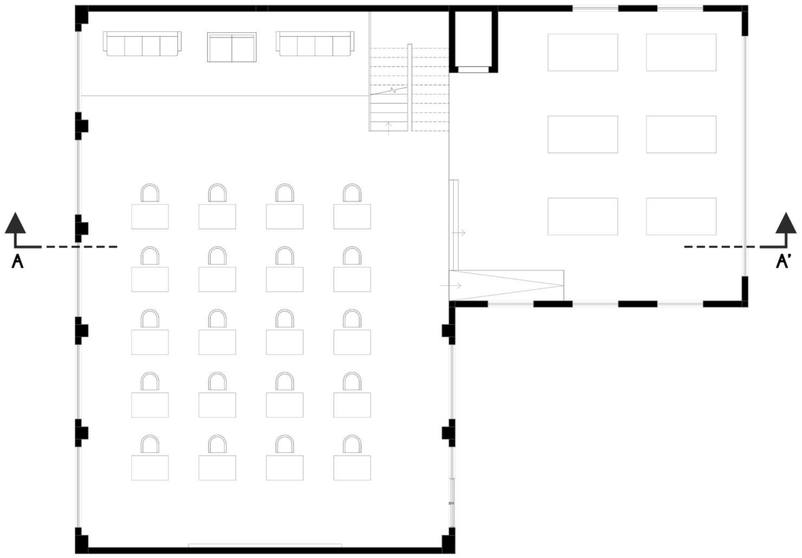
Section AA'
Scale 1:100



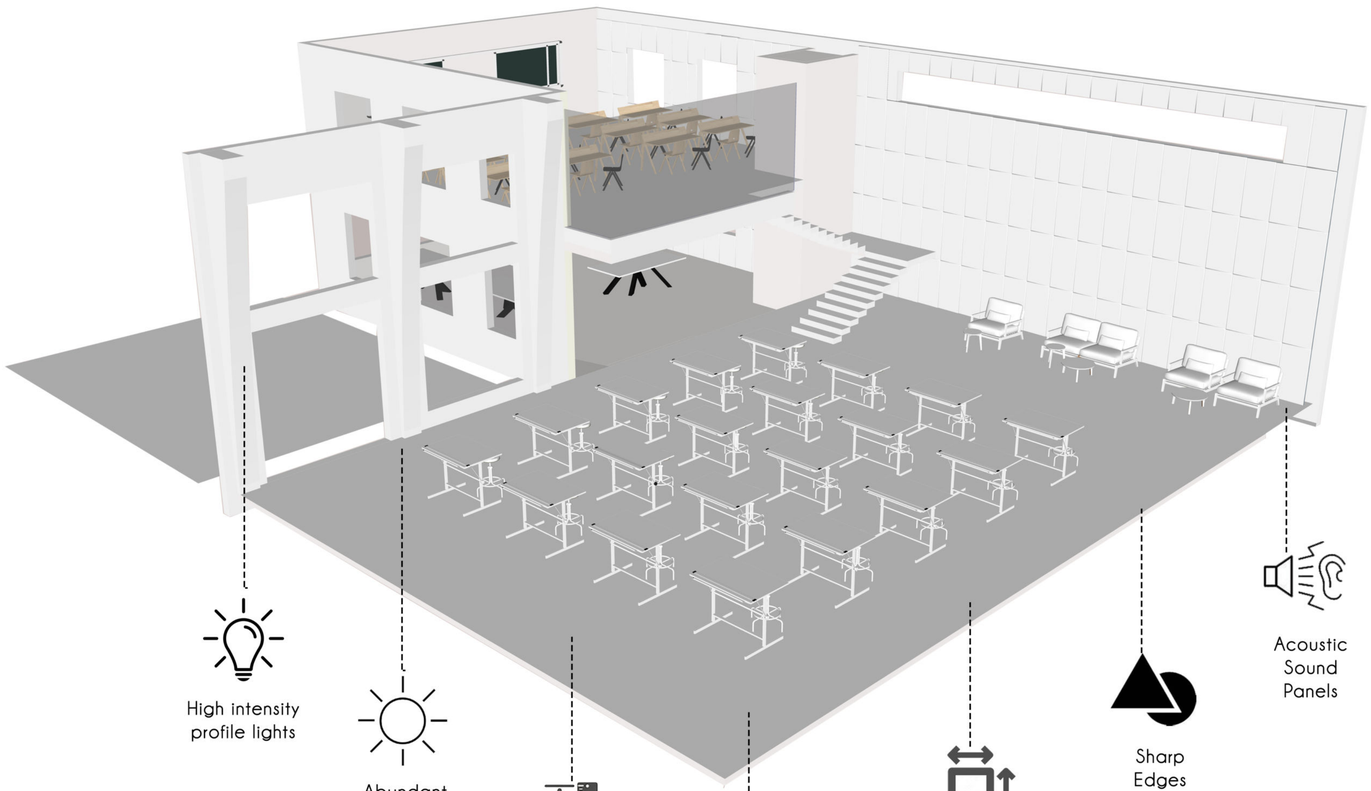
Key Plan
(nts)

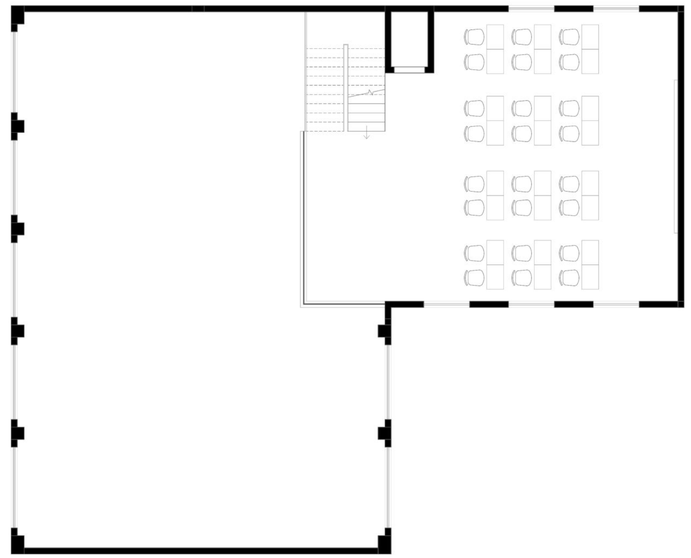


Floor Plan with context
Scale 1:500

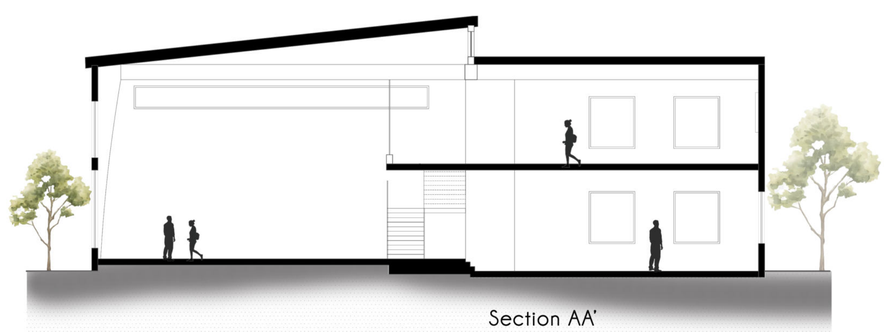


Ground Floor Plan
Scale 1:100



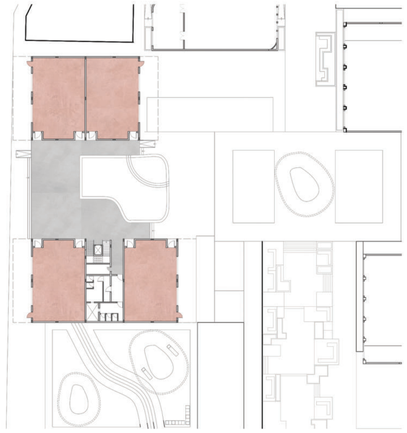


First Floor Plan
Scale 1:100

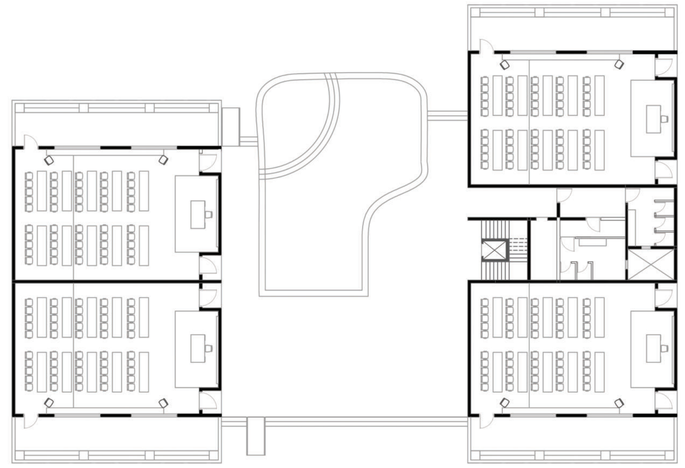


Section AA'
Scale 1:100

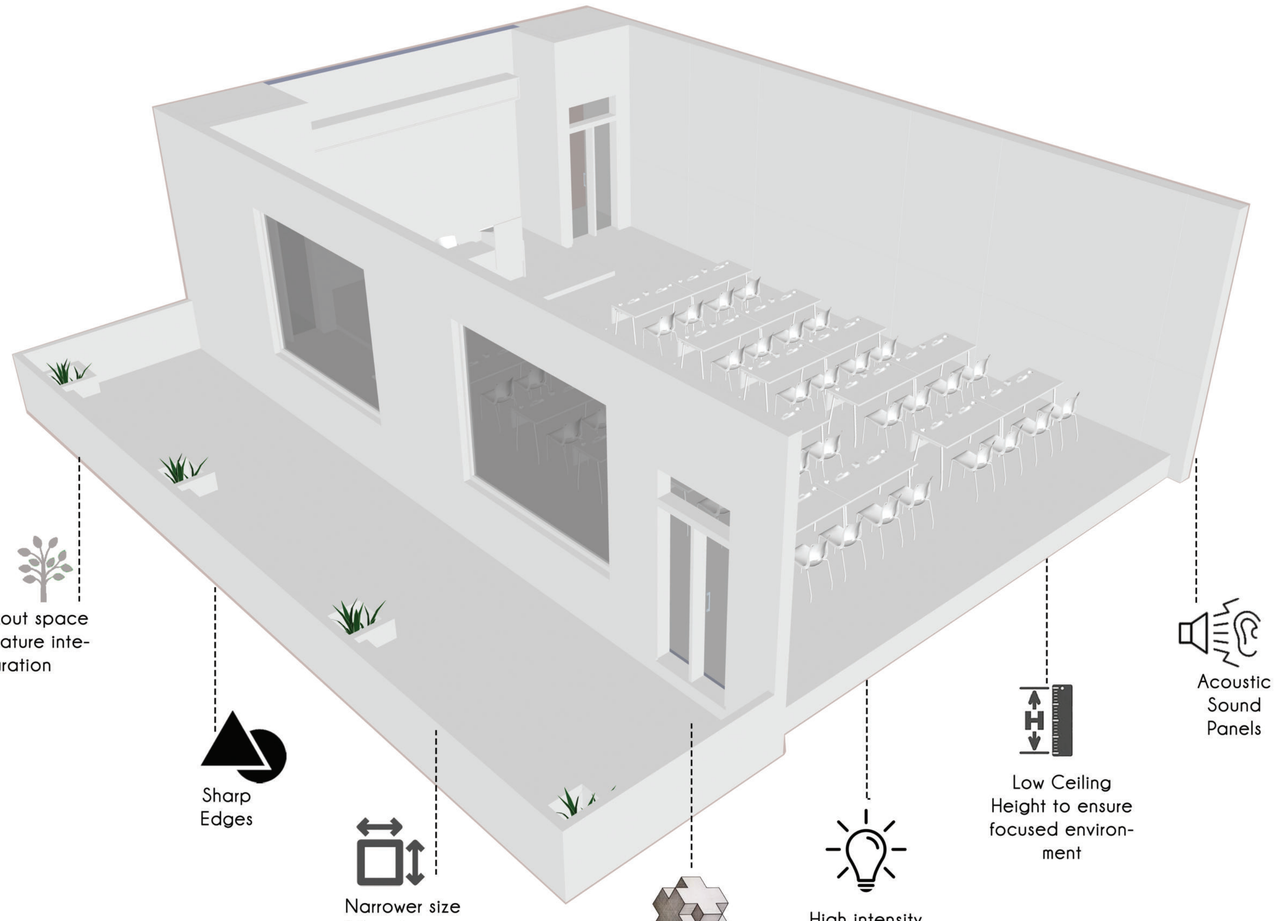
Key Plan
(nts)

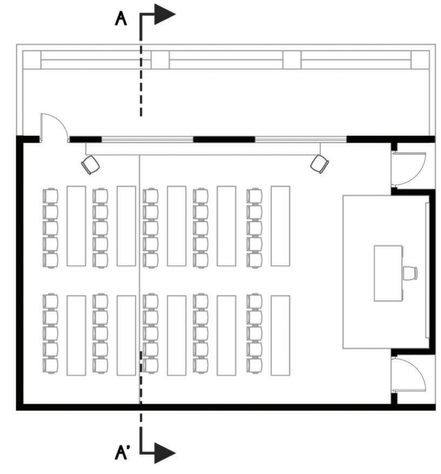


Floor Plan with context
Scale 1:500



First Floor Plan
Scale 1:200

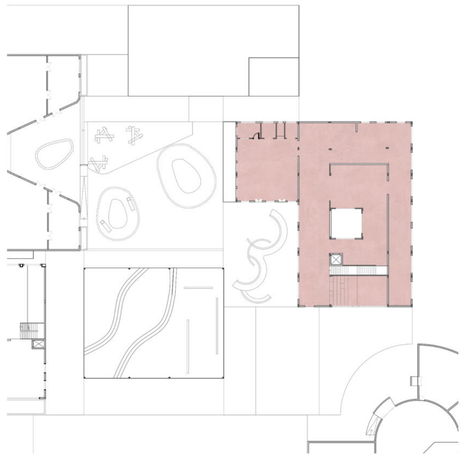




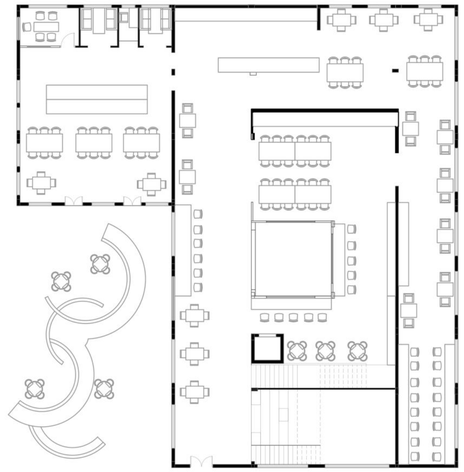
Typical Theory Studio Plan
Scale 1:100

Section AA'
Scale 1:100

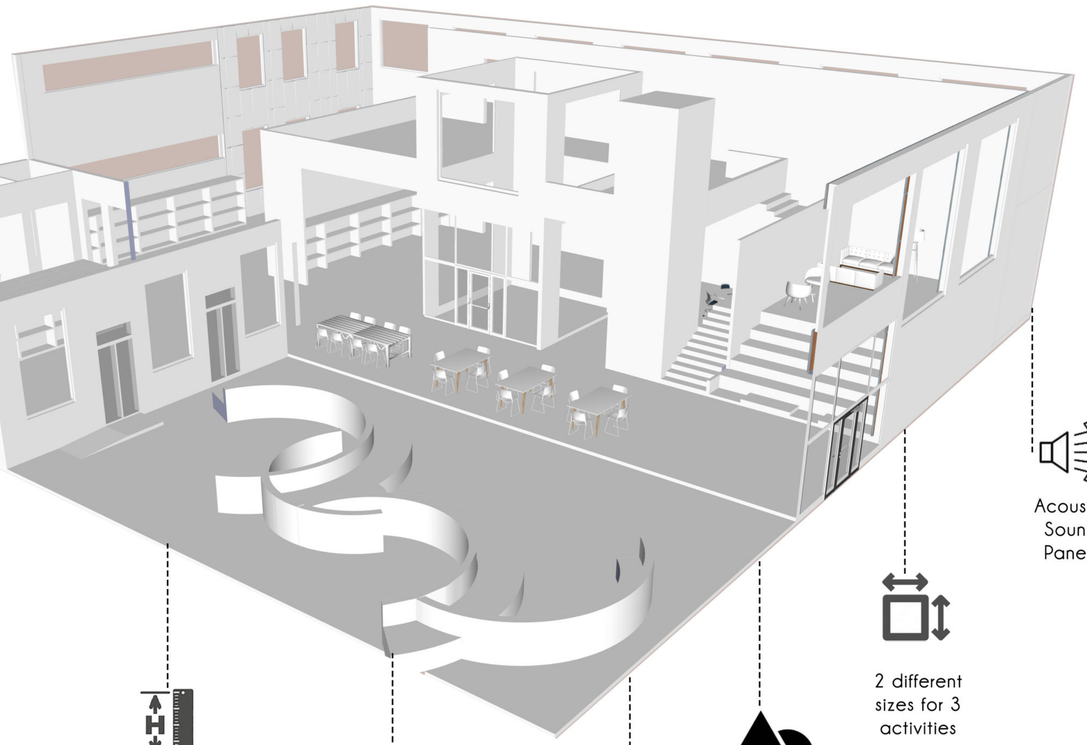
Key Plan
(nts)

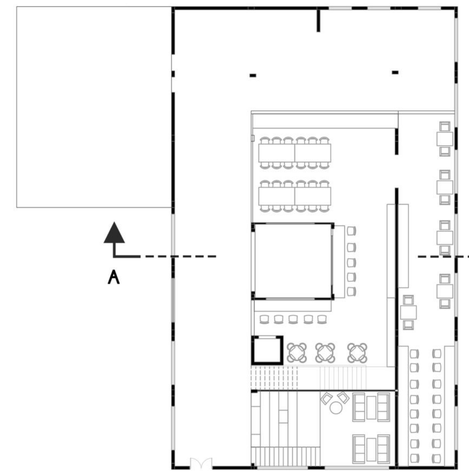


Floor Plan with context
Scale 1:500

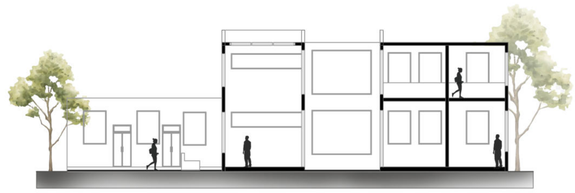


Ground Floor Plan
Scale 1:200



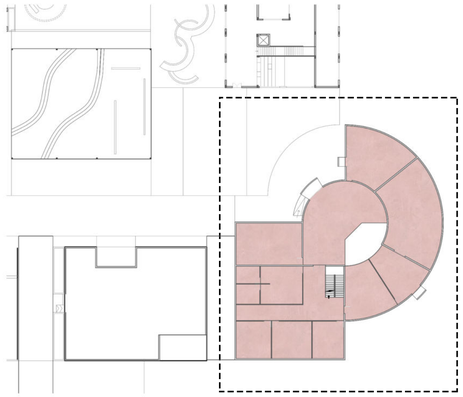


First Floor Plan
Scale 1:200

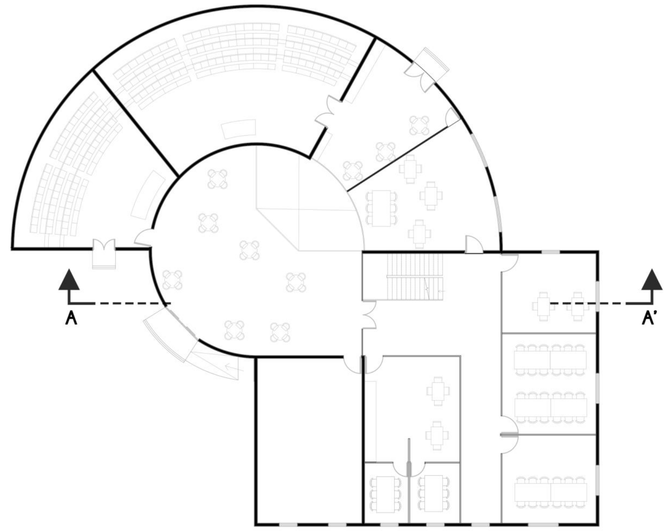


Section AA'
Scale 1:200

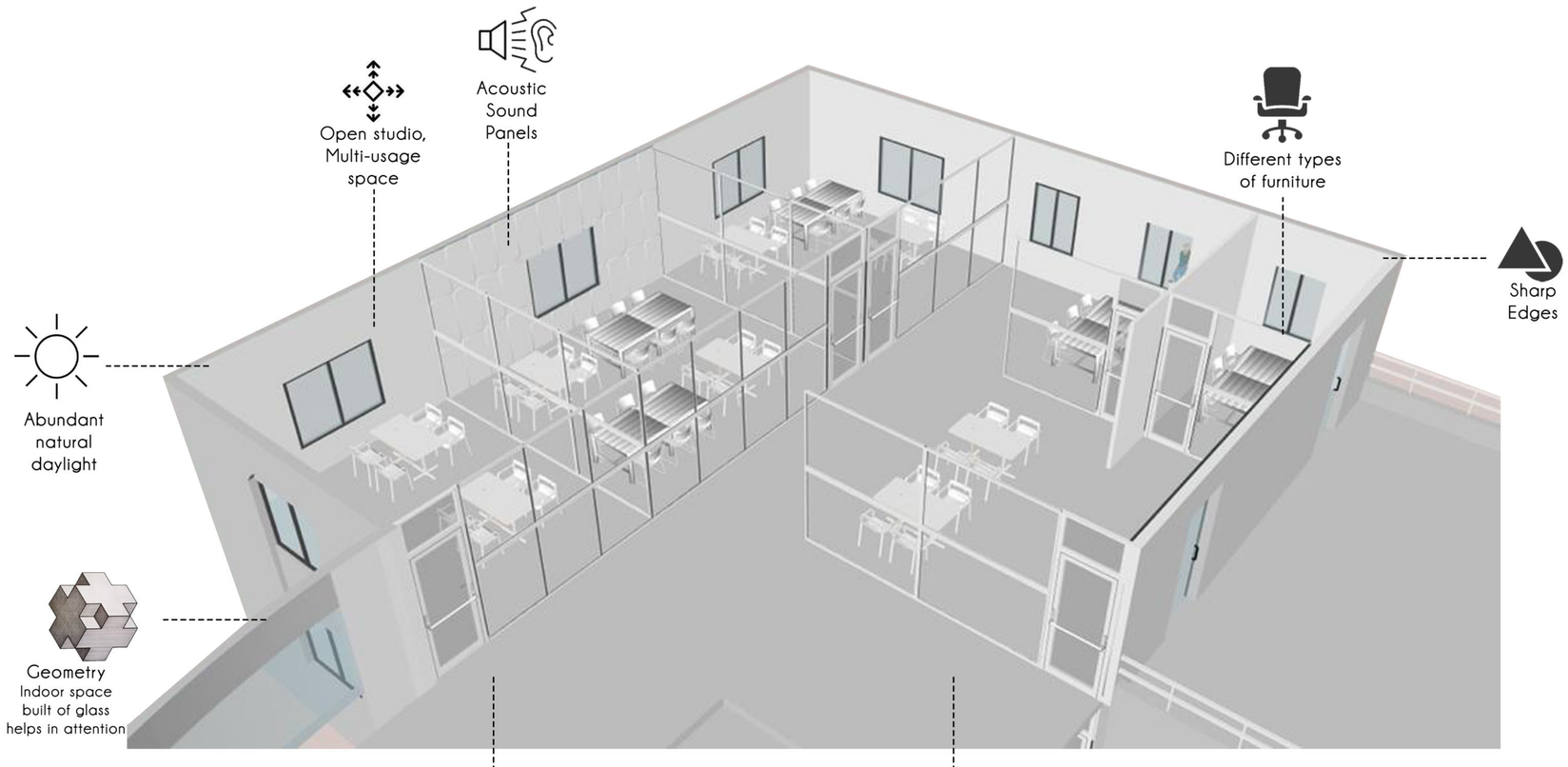
Key Plan
(nts)

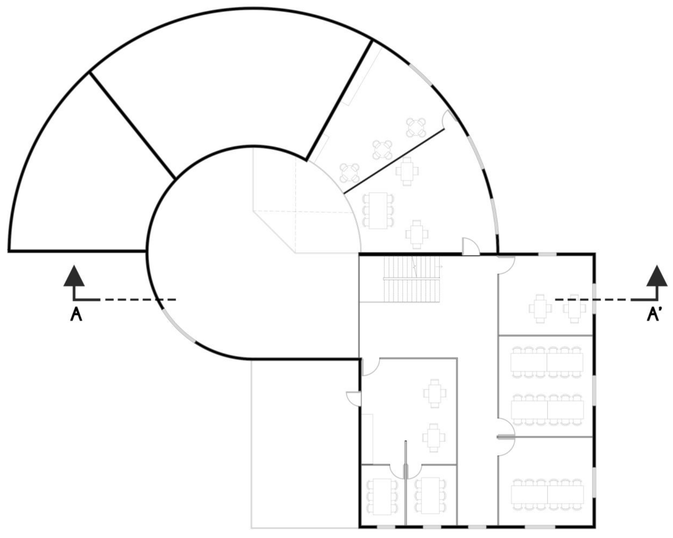


Floor Plan with context
Scale 1:500

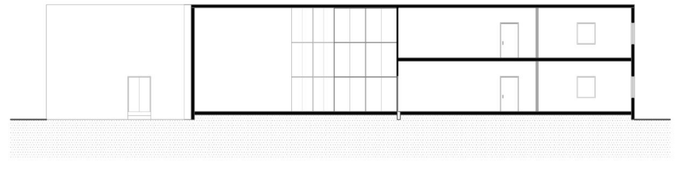


Ground Floor Plan
Scale 1:200





First Floor Plan
Scale 1:200



Section AA'
Scale 1:100

Different spaces are defined by different types of material to enhance purpose of the zone.

The studio has plenteous amount of lighting in the form of; natural daylight from skylight and windows and artificial light.

Technical studio view showcasing the ground level, which is kept for drafting hence, the high ceiling with materials like wood, concrete floor block glass.

The theorotical learning has been put on the first floor above the maker space, maintaining low ceiling height to ensure attention.

The theorotical block has 2 types of seating and learning environment.

Accoustic pnels are placed on 2 walls to minimise external noise which helps with students' focus.

Library view showcases ample daylight and an inner courtyard to integrate nature with the inside of the building.

Interaction space inside the library.

Self-Study studios have various types of spaces partitioned with glass walls. They are integrated with different textures and colours to differentiate between spaces.

Reinventing the learning environment of an architecture school

Architecture and Neuroscience

Diksha Kumar (s301533)
Nehul Khilnani (s301787)

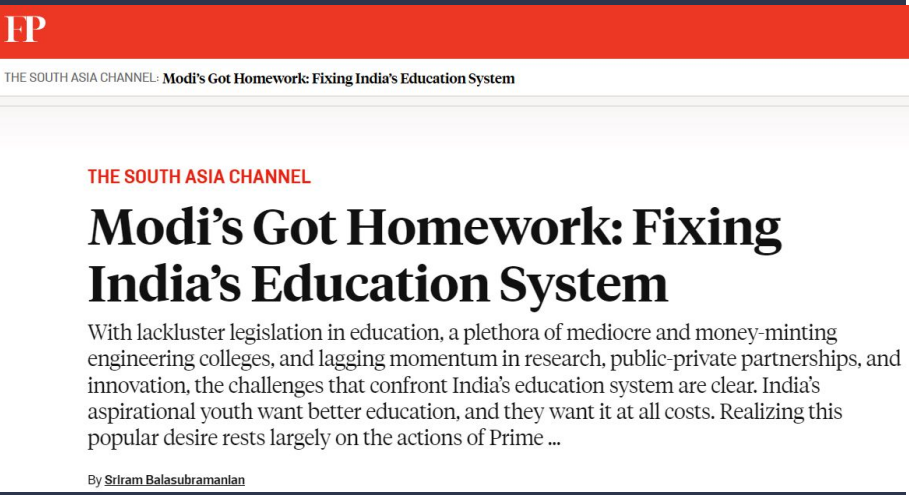
Politecnico di Torino

Introduction to the topic

Introduction: Political

India is a country which is striving to **educate its young population up to the international standards**. Currently, **millions of Indians** go to the **USA, Canada, United Kingdom and Europe** to study in their prestigious universities and world-class campuses. The recent government of India has made s**everal tie-ups with Ivy-league** colleges to fill a necessary gap for students who cannot afford to go to international campuses.

Introduction: Political



FP

THE SOUTH ASIA CHANNEL: Modi's Got Homework: Fixing India's Education System

THE SOUTH ASIA CHANNEL

Modi's Got Homework: Fixing India's Education System

With lackluster legislation in education, a plethora of mediocre and money-minting engineering colleges, and lagging momentum in research, public-private partnerships, and innovation, the challenges that confront India's education system are clear. India's aspirational youth want better education, and they want it at all costs. Realizing this popular desire rests largely on the actions of Prime ...

By Sriram Balasubramanian

How many Indians go abroad for studies every year?

In the first three months of 2022, **133,135 students** left India for academic pursuits, **an increase from 2020** when 259,655 students studied abroad. In **2021**, there were **4,44,553 Indians** – an **overall increase of 41%** in just one year.

What are the **reasons** behind Indians going abroad for further studies?

Attractive salary packages (44%)

High quality of education (33%)

Pursue niche courses (17%)

Gain international exposure (6%)

Introduction: Social

What are the **problems in the current learning environment** of India colleges?

Unsuitable **ventilation** and conditioning

Inflexible cooperative learning arrangement

Generic and **non-personalisation of classroom** as per the subject being taught.

No **acoustical treatments** (to balance incoming noise from traffic and surroundings)

Absence of different kinds of **space** (which limits the freedom of movement)

Introduction: Climate

The climate of India can broadly be classified as a tropical monsoon one. The Indian Meteorological Department (IMD) designates four official seasons:

Winter, from December to early April

Summer or pre-monsoon, from April to June (April to July in north-western India)

Monsoon or rainy, from June to September

Post-monsoon, from October to December

Why choose this topic?

There are over **860 architecture colleges in India** where **30k to 40k students** pass out each year. Only about **10-15 are suited to the needs of architecture** students, the others are designed in a generalised way so that students of any field can be taught there. The **learning environment** plays a very **important role** in educating and academic success.

So, the design of an architecture college mandates an emphasis on the learning environment.

Example:
National Institute of Technology Raipur
(64th ranking by NIRF)

There are no collaborative spaces for students and teachers alike which makes it difficult for the students to work or present their work.

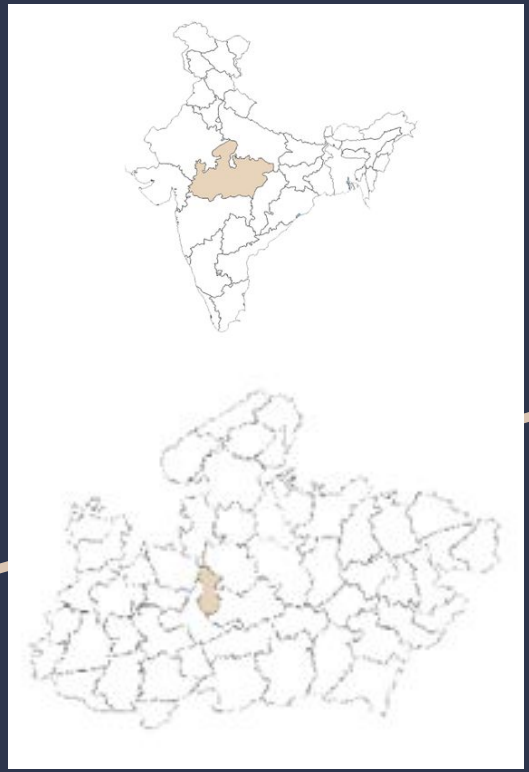
There are no collaborative spaces for students and teachers alike which makes it difficult for the students to work or present their work.

Example:
CEPT University, Ahmedabad
(15th ranking by NIRF)

The **classrooms are very flexible**. **Outdoor classrooms** and **jury areas are** very active. Outdoor courtyards play as **interactive break out spaces**, bringing vibrancy and fostering learning activities.

These spaces help in creating good learning environment, which hence fosters creative minds.

SITE:



Location- Bhopal, Madhya Pradesh

Climate-

Winter, from october to march with temperatures 8°c - 25°c

Summer or pre-monsoon, from April to June 24°c - 45° c

Monsoon or rainy, from June to September 19°c - 23°c

SITE-

Area- 7.43 Acres

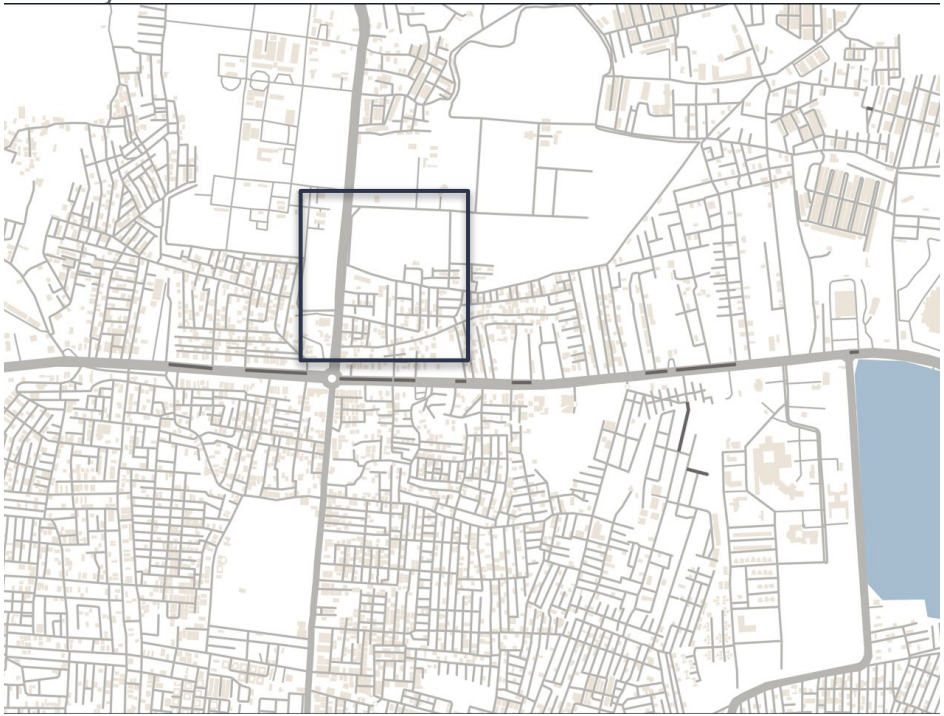
Landmarks- Indian Institute of Soil Sciences, central institute of agricultural engineering. Agricultural land around the site

Site Selection

Area- 7.43 Acres

Zone- Educational\

Easy accessibility through public transport, peaceful and far from the chaotic areas of the city.



Site Surroundings

9M road adjoining the site.

Indian institute of soil sciences

Central Institute of Agricultural Engineering.

Agriculture land surrounding the building

By-laws of an educational building in Bhopal, India

1. Minimum area required: 4-6 hectares
2. Open space: The open spaces around the building not to be less than 6 metres.
3. F.A.R for educational building= 1
4. Ceiling height: 3.6 meters minimum for all regions, 3 meters for cold regions.
5. Minimum width of staircase:
   - upto 24 meters height = 1.5 m
   - More than 24 meters height = 2 m
6. Arrangement of Exit: Travel distance on each floor shall not be more than 22.5 meters.
7. Occupant load gross area in square meters per person= 4

Neuroarchitecture

What is neuroarchitecture?

(n.d.). Exploring the contribution of neuroarchitecture in learning environments design “A review.” International Journal of Architectural Engineering and Urban Research, 4(1).

(2022). The effect of integrating the design of the built environment with neuroscience on designing learning environment for children in early childhood. Journal of Art & Architecture Research Studies, 3(5), 5.

Neuroarchitecture is the interdisciplinary field that ensures the **creation of environments** able to **optimize the human behavior**, well-being, and performance.

Neuroarchitecture is located where **neurology, psychology and architecture intersect to provide an empirical framework** to create better environments that leads to **improve human behavior**, overall health and leisure. Architects realize that their designs for **spaces directly affects users of these spaces** as well as knowing the effects of light, color on users’ spatial perception. As a result, neuroarchitecture takes a step further in explaining how architecture-designed environments **affects** our **overall behavior** in order to optimize the **design process** and providing high quality experiences for users.

Neuroscience and architecture

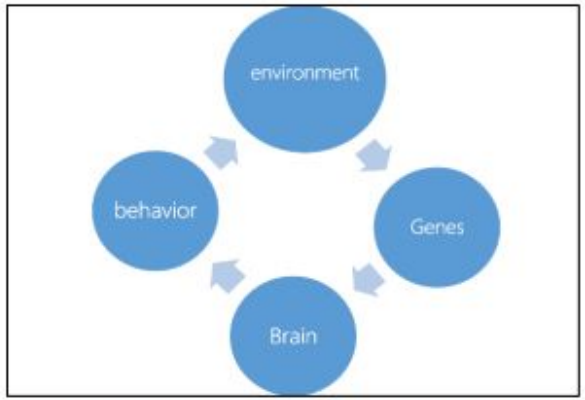


Figure 2 : The mutual effect between the built environment and neuroscience (source: Author, 2021)

Neuroscience explains the **relationship** between the **environment** and the **behaviours** which is - perception to impulse, how neurons in our brains build and store information.

Everything we **'think' and 'feel'** are formed by our brain and nervous system and that is **impact of environments**. Neuroscience explains on how **physical environment affects our cognition**, problem solving ability and moods.

Architecture plays important role in helping to design **built environment** by serving better **spatial orientation**, reinforcing cognitive abilities and **minimizing negative effect** in emotions and motivation.

Neuroscience and learning and school environments

de Paiva A. Neuroscience for architecture: how building design can influence behaviors and performance. J Civ Eng Architect 2018;12(2). doi: 10.17265/1934-7359/2018.02.007.

Our behavior is influenced by how we perceive the environment. In order to design **environments with beneficial environmental qualities** that would lessen the adverse physiological, emotional, and cognitive effects, designing educational buildings have psychological impact on how a student learns.

Neuroscience is helping **merge the gap** between the physical **build environment** and **human perception** and behaviour.

Hence, using a building's **architecture** to **activate learning** can further **enhance the learning experience** in schools.

Human Brain Overview

Ezzat Ahmed, D., Kamel, S., & Khodeir, L. (2021). Exploring the contribution of neuroarchitecture in Learning Environments Design “A review.” International Journal of Architectural Engineering and Urban Research, 4(1), 67–94. https://doi.org/10.21608/ijaeur.2021.215924

1. System I (Fast thinking): Operates at an **unconscious level**
2. System II (Slow thinking): Operates at a **conscious level**

The environmental stimulus affects the brain‟s system (I) by 99% relative to the brain‟s system (II), (Fig.1), which means that the built environment can impact the **unconscious mind without even the awareness of the conscious mind**.

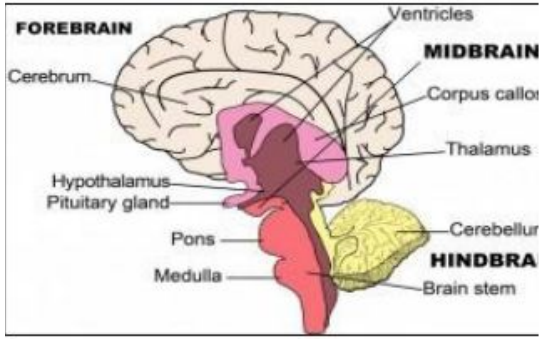


Figure 1: The structure of the human brain (source: Sushil Humagain, 2018)

Environmental psychology + neuroscience

What is environmental psychology?

Studies the relationship between the **environment and human behavior**, wayfinding in complex environments, and the effects of environmental stress on human performance.

Recent research on the relationship between the physical environment of educational facilities and its impact on students has shown that **design can definitely affect learning**.

Impact of built-environment design on cognitive processes

What are cognitive processes?

Cognitive processes are the **mental operations the brain performs to process information**. Through these operations, the brain interacts with the **information around it, stores it and analyses it** in order to make the relevant decisions.

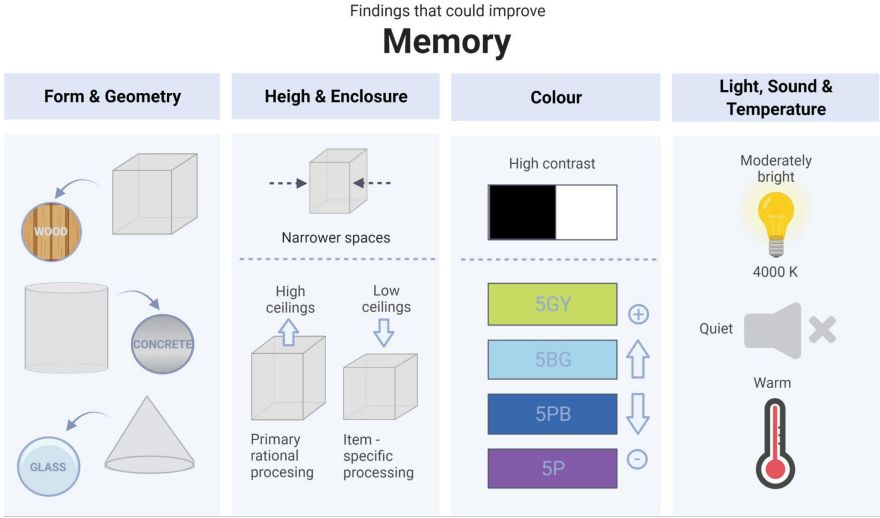
What are the cognitive processes involved in the learning environment?

Cognitive processes may include **attention, perception, reasoning, emoting, learning, synthesizing, rearrangement** and **manipulation of stored information**, memory storage, retrieval, and metacognition.

Attention and Memory are considered to be the mainstays that impact the learning environment.

Cognitive processes: Memory

Llorens-Gámez, M., Higuera-Trujillo, J. L., Omarrementeria, C. S., & Llinares, C. (2021). The impact of the design of learning spaces on attention and memory from a neuroarchitectural approach: A systematic review. Frontiers of Architectural Research, 11(3), 542–560. https://doi.org/10.1016/j.foar.2021.12.002

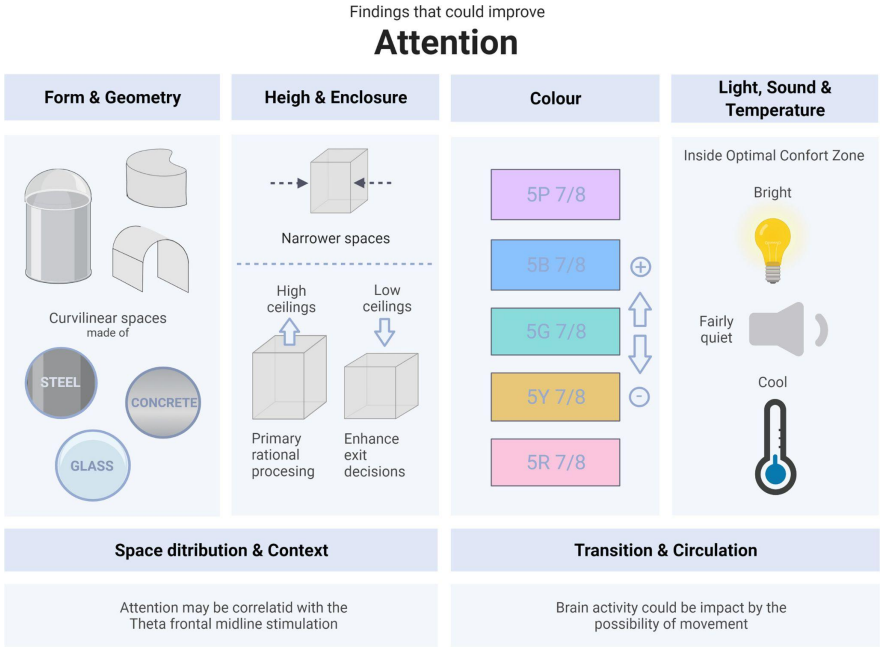


Several studies show that certain architectural aspects can impact the memory process, depending on colours, lighting, height and sound.

For example, **cold-hued classroom walls and narrower classrooms** are associated with **superior memory performance**.

Cognitive processes: Attention

Llorens-Gámez, M., Higuera-Trujillo, J. L., Omarrementeria, C. S., & Llinares, C. (2021). The impact of the design of learning spaces on attention and memory from a neuroarchitectural approach: A systematic review. Frontiers of Architectural Research, 11(3), 542–560. https://doi.org/10.1016/j.foar.2021.12.002



Bourdon Attention Test showed red walls negatively affect students' attention; in comparison, high scores were achieved with purple walls.

Stroop test showed the authors found that the attention of participants is comparable in different environments, but the potential differences in EEG were not explained.

The Architectural Elements.

Ahmed Shaaban, D., Kamel, S., & Khodeir, L. (2023). Exploring the architectural design powers with the aid of neuroscience (little architect's adventure). *Ain Shams Engineering Journal*, *14*(6), 102107. https://doi.org/10.1016/j.asej.2022.102107

Determining the **architectural features** that can **affect users on short-term level**, and mostly impacts the nature of the built environment.

And hence, analysing these elements with reference to neuroscientific architectural research.

The most important **elements affecting a student's behaviour** in a classroom as analysed are -

- Light
- sound
- Colour
- Forms and shapes
- Ceiling height
- Nature integration
- Flexibility
- Finishing materials (textures)

Light

Christopher Alexander - mentions the fact that low light levels in classrooms affect students' ability to regulate the body's natural cycle of sleep and arousal.

the presence of **large openings** in the wall coupled with the presence of a raised roof, which in addition to providing ventilation also allows the classrooms to be **light-filled, inviting spaces**.

Lighting intensity-

Low light intensity shows more stressful behaviours in students.

High light intensity brings out the excitement in behaviours.

that working memory is considerably affected by correlated color temperature and illuminance.

Sound

Reduce background noise: Chronic background noise is associated with several auditory and learning problems. It contributes to neural noise where brain neurons fire spontaneously and distracts the student from learning.

This helps in grabbing attention of students.

Silence is necessary to ensure greatest level of understanding in student’s environment.

The best is the **balance between the presence and absence of sound.**

Sound out of comfort zone affects listening tasks negatively but has no impact on reading tasks.

Colour

When exposed to the warm colors, in comparison to the cool colors one, confirming the studied role of the **warm colors in creating strong stimulation** and boosting the adrenaline release in the brain.

Warm colours- shows **energetic** behaviour

Cool colours- more **relaxed**

Specific colors sometimes make **space seem larger** than they actually are, though others can also create spaces that **appear smaller**.

Student's attention tasks have higher results in classrooms with cold-hued colors.

Student's memory tasks have higher results in classrooms with cold-hued colors.(Llinares et al., 2021b)

Forms and shapes

M. Banaei, J. Hatami, A. Yazdanfar, K. Gramann
Walking through architectural spaces: the impact of interior forms on human brain dynamics
Front Hum Neurosci, 11 (2017), 10.3389/fnhum.2017.00477

The wise choice of always picking smooth curved elements starting from a **circular layout of the space, if possible.**

The heart rates records supported the multiple studies caring about the effect of the **smooth and curved lines in boosting more activity in some specific brain areas,** which by its turn activates the body's sympathetic system, and causes increased heart rates

Ceiling height

Dina Ezzat Ahmed Shaaban, Shaimaa Kamel, Laila Khodeir,Exploring the architectural design powers with the aid of neuroscience (little architect's adventure), Ain Shams Engineering Journal, Volume 14, Issue 6, 2023,

Low ceiling heights impact-

- In analytical thinking
- Detailed focused thinking.

High ceiling helps in-

- Abstract thinking, brings out creativity and imagination.
- Which in turn also brings a lot more natural light

Rooms with high ceilings enable learners to pay more **attention** and facilitate a better learning environment than with enclosed spaces - which can increase the stress hormone.

Furniture

Spaces that can be changed to create new environments are **stimulating to students**. Mobile furniture and storage systems can be used to provide environmental changes.

Furniture in a classroom should be **flexible** to allow for various uses and configurations.

Furniture **placement** in a classroom **affects the interaction** and communication levels.

Central seats are associated with significantly **more verbalization** than seats in other areas.

Spatially arranged classrooms are good example for **logical based learning**. Random arranged classrooms have scope of imagination.

Flexibility

As with coworking spaces, **students also benefit from open, fluid classroom layouts.**

Multiple flexible seating options in the same learning space, giving a **sense of independence** within the pre-planned order, e.g., comfy casual floor seating.

The ability to move furniture around and create spaces that accommodate different types of learning provides a flexible environment to suit the needs of various students at various times.

Sizes of spaces

The classroom width significantly impacts on psychological and neurophysiological **attention metrics. Wider classrooms are associated with poorer performance and lower emotional arousal.**

Large spaces, small group and individual spaces fulfill different functional needs in education.

Larger spaces are good for **presentations and lectures**, physically active learning, and l**arge-group activities.**

Small group spaces are important to help in group interaction, to allow for more **discussion and participation.**

Individual spaces allow for the student to have some **privacy** and to work **independently** from others.

Nature Integration

Nature integration, taking into consideration a **multi-sensorial experience** of natural elements, not only visual accessibility.

Nature seen from windows activates students **mood**, and also helps to keep **well being**.

Helps in balanced emotional and physiological state.

Form and Geometry

E. Elbaiuomy, I. Hegazy, S. Sheta
The impact of architectural spaces' geometric forms and construction materials on the users' brainwaves and consciousness status
Int. J. Low Carbon Technol., 13 (1) (2018), pp. 43-51

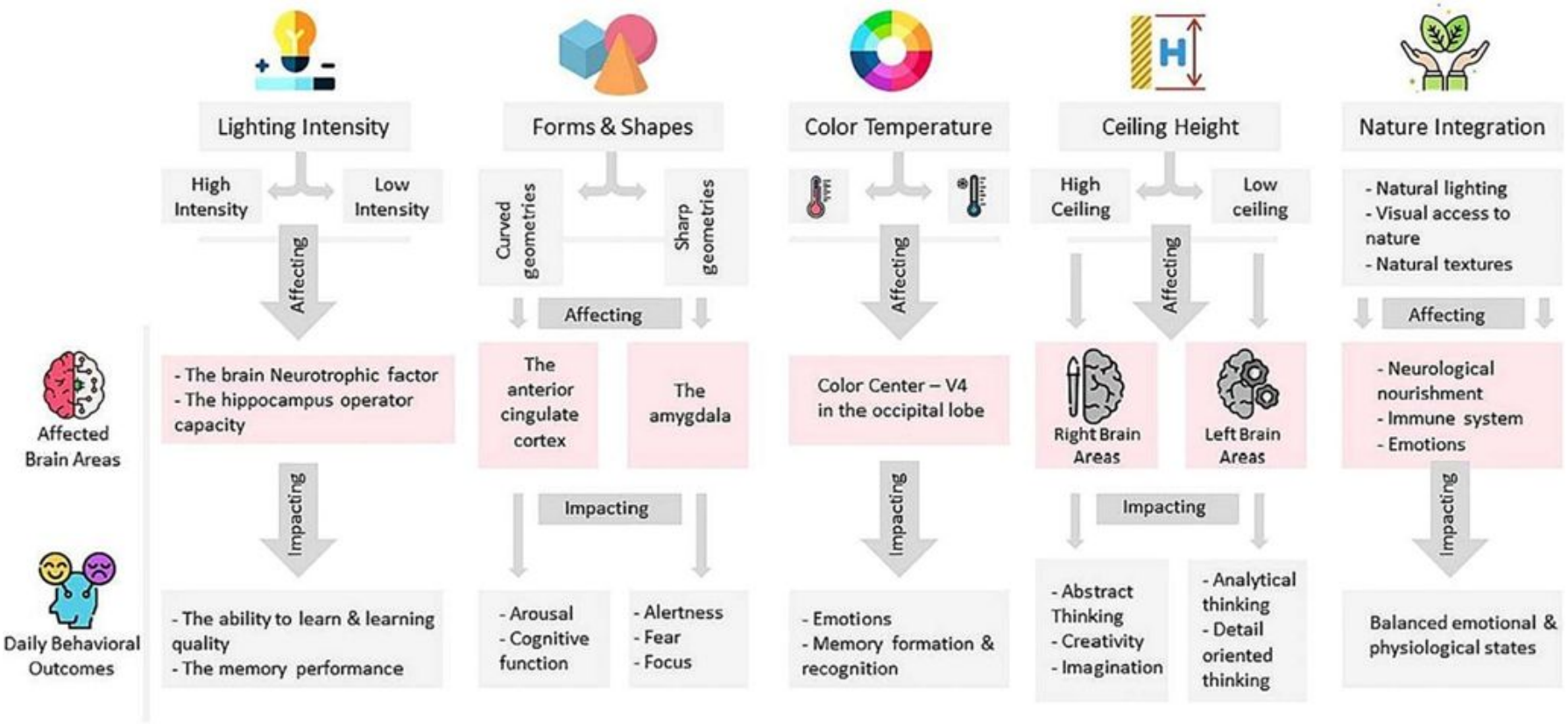
Attention is enhanced in an indoor space built of **steel, concrete, or glass.**

Memory can be enhanced in a s**quare or cylinder space built of concrete.**

Conical, glass spaces and square, wooden spaces are better for concentrating and retaining information. (Elbaiuomy et al., 2018)

Curvilinear interior spaces cause higher cognitive and emotional levels whereas rectilinear interior spaces contribute to lower satisfaction and excitement in participants.

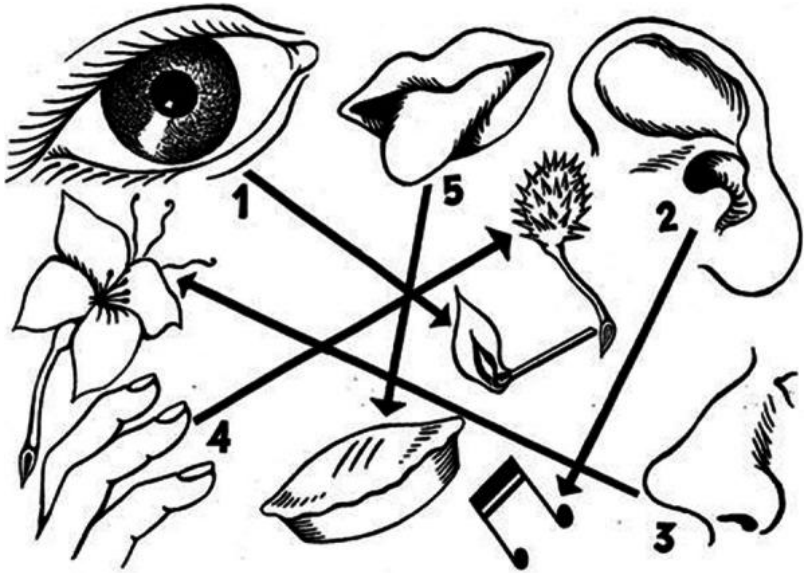
Researchers showed that using a **minimum of 25% of wall space for windows was acceptable** but students prefer **a third or more of the wall space should be used for windows.**



Dina Ezzat Ahmed Shaaban, Shaimaa Kamel, Laila Khodeir,Exploring the architectural design powers with the aid of neuroscience (little architect's adventure), Ain Shams Engineering Journal, Volume 14, Issue 6, 2023,

The role of the human senses in architectural design

Spence C. (2020). Senses of place: architectural design for the multisensory mind. Cognitive research: principles and implications, 5(1), 46. https://doi.org/10.1186/s41235-020-00243-4



Traditionally, architects prioritise eye/sight as the primary sense whilst designing. Increasingly, other senses have started to being considered as well.

Such visual dominance makes sense or, at the very least, can be explained or accounted for neuroscientifically. After all, it turns out that far more of our brains are given over to the processing of what we see than to dealing with the information from any of our other senses.

This figure compares to something like just **12% of the cortex** primarily dedicated to **touch**, around **3% to hearing**, and less than **1% given over** to the processing of the chemical senses of **smell and taste**.

Spence C. (2020). Senses of place: architectural design for the multisensory mind. Cognitive research: principles and implications, 5(1), 46. https://doi.org/10.1186/s41235-020-00243-4

Design Overview from a Neurological Perspective

Ezzat Ahmed, D., Kamel, S., & Khodeir, L. (2021). Exploring the contribution of neuroarchitecture in Learning Environments Design “A review.” International Journal of Architectural Engineering and Urban Research, 4(1), 67–94. https://doi.org/10.21608/ijaeur.2021.215924

It has been written in several journals and papers that the research on Neuroarchitecture has **not yielded clear and direct results**. Which is why some **general theoretical guidelines** have been created.

1. **Well-designed classroom** may contribute to a **release of pleasure** by enhancing neurochemicals release in the brain (Opioids & Dopamine); which will result in **automatic seeking** out to this specific space.
2. **Strong identity of each zone** can anchor the learning processes in **long-term memory**.
3. **Use of colors, shapes, and materials** in creating positive emotional responses to spaces can make the classroom a tool incorporated in lesson planning, and used **to improve the educational experience** for students and teachers.

Designing

Senses considered

1. Sight
2. Touch
3. Hearing

Concept: To design each space and classroom based on the purpose of the room. Considering enclosure of space in terms of **height, different levels, flooring, texture, colours and furniture**.

To connect the learning environment of the **outdoor and indoor**, making it a seamless transition.

Flexible learning spaces - Create spatial layouts that support multiple modalities of learning.

Spaces and their guidelines

Types of spaces required in an architecture school

1. Design studio
2. Theoretical subject studios
3. Technical subject studio
4. Examination rooms
5. Self-study spaces
6. Interactive spaces* -exhibition spaces, auditorium, open air theatre, jury space, multipurpose hall.
7. Library and canteen
8. Maker spaces
9. Presentation / Jury spaces

Inferences from the research

Design Studio

Requires:

- Creativity
- Flexibility
- Energetic
- Attention

Architectural aspects to enhance the room:

- High ceiling
- Smoothened edges
- Good lighting
- Nature integration
- Floor and wall finishes to differentiate multiple spaces present in the block

Theoretical Studio

Requires:

- Calm energy
- Focus
- Memory

Architectural aspects to enhance the room:

- Narrow (small)classroom- size and height of ceiling less compared to the creative studios
- Low ceiling
- Sharp edges
- Straight cooperative learning arrangement
- Low sound levels/ good acoustic treatment
- Perfect balance of light to shadow ratio

Technical Studio

Requires:

- Focus the centre of the activity and fixing your mind on a specific task
- Attention notice taken of something
- Memory
- Energetic
- Acoustic solution

Architectural aspects to enhance the room:

- 2 separate learning environments
- Nature integration
- Sharp edges
- High ceiling for activity a and Low ceiling for activity b
- Good lighting
- Acoustics with colour integration.

Library

Requires:

- Interaction
- Flexibility
- Memory
- Attention

Architectural aspects to enhance the room:

- High ceiling and low ceiling heights depending on flexible usage of spaces
- Sharp Edges
- Good lighting intensity
- Ample of daylight , skylights
- Nature integration
- Floor and wall finishes to differentiate multiple spaces present in the multiple usage of space.
- Good acoustic solutions

Self-study and seminars studios

Requires:

- Interaction
- Flexibility
- Attention

Architectural aspects to enhance the room:

- High ceiling and low ceiling heights depending on usage of spaces.
- Sharp Edges for self study spaces and curvilinear edges to seminar and other public spaces.
- Good lighting intensity for self study areas.
- Nature Integration for public areas.
- Visual contact maintained in spaces.
- Good acoustic solutions and colour added to rooms.

Presentation and outdoor Collaboration spaces

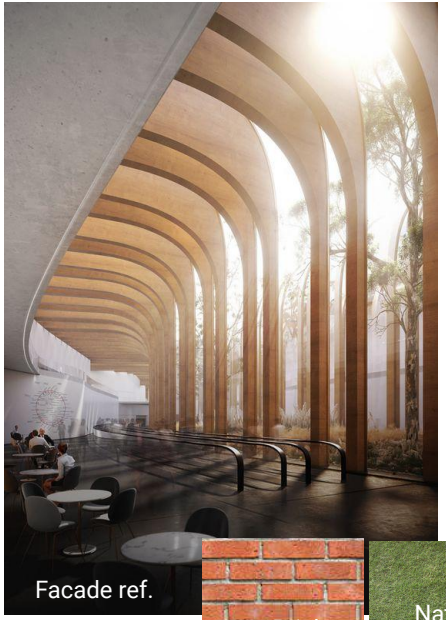
Requires:

- Interaction
- Flexibility
- Attention

Architectural aspects to enhance the room:

- Smooth edges to encourage discussions and creativity.
- Nature Integration
- Visual contact maintained in spaces.
- Flexible furniture
- Ample space for sit outs and.
- Semi closed spaces and closed spaces yet maintaining the visual contact.

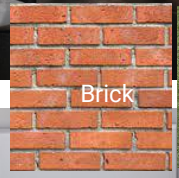
References/ Mood Board

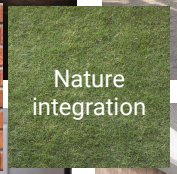

Facade ref.

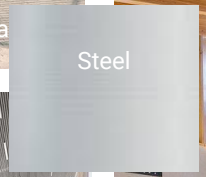

Casa Uc, Mexico by Da
bucio Sistos


Clemson University by Sasaki
architects

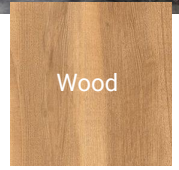

Ayer Shirley Regional High School by SMMA.

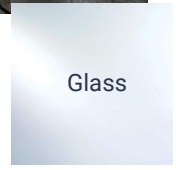

Brick

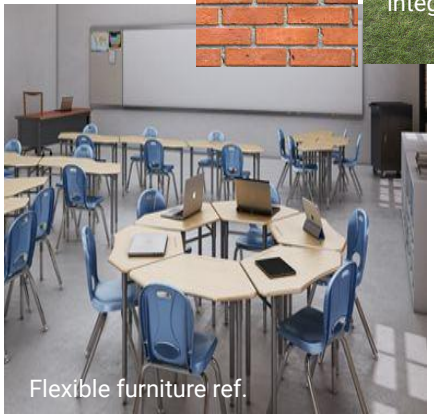

Nature
integration

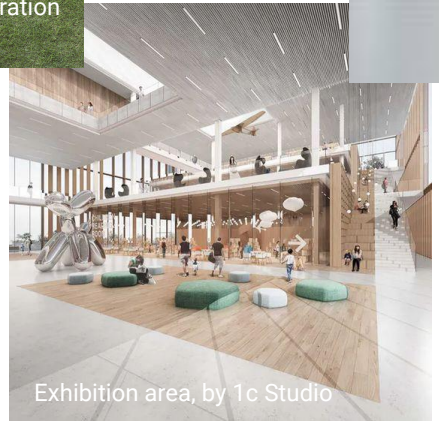

Steel


Concrete


Wood


Glass


Flexible furniture ref.


Exhibition area, by 1c Studio


Indian Mountain School Student
Center by Flansburgh Architects

Bibliography

10. Bibliography

Andréa de Paiva. (2018, February 28). Neuroscience for Architecture: How Building Design Can Influence Behaviors and Performance. *Journal of Civil Engineering and Architecture*, *12*(2). https://doi.org/10.17265/1934-7359/2018.02.007

Ezzat Ahmed, D., Kamel, S., & Khodeir, L. (2021, June 1). Exploring the contribution of Neuroarchitecture in learning environments design “A review.” *International Journal of Architectural Engineering and Urban Research*, *4*(1), 67–94. https://doi.org/10.21608/ijaeur.2021.215924

Llorens-Gámez, M., Higuera-Trujillo, J.L., Omarrementeria, C.S., & Llinares, C. (2021). The impact of the design of learning spaces on attention and memory from a neuroarchitectural approach: A systematic review. *Frontiers of Architectural Research*.

Ahmed Shaaban, D.E., Kamel, S.M., & Khodeir, L.M. (2023). Exploring the architectural design powers with the aid of neuroscience (little architect’s adventure). *Ain Shams Engineering Journal*.

Bibliography

Banaei, M., Hatami, J., Yazdanfar, A., & Gramann, K. (2017). Walking through Architectural Spaces: The Impact of Interior Forms on Human Brain Dynamics. *Frontiers in human neuroscience*, *11*, 477. https://doi.org/10.3389/fnhum.2017.00477

Elbaiuomy, E., Hegazy, I., & Sheta, S. (2017, December 18). The impact of architectural spaces' geometric forms and construction materials on the users' brainwaves and consciousness status. *International Journal of Low-Carbon Technologies*, *14*(3), 326–334. https://doi.org/10.1093/ijlct/ctx018

Spence, C. (2020, September 18). Senses of place: architectural design for the multisensory mind. *Cognitive Research: Principles and Implications*, *5*(1). https://doi.org/10.1186/s41235-020-00243-4

Thank you