THE AMERICAN UNIVERSITY IN CAIRO

RESEARCH AND CREATIVITY CONVENTION

Understanding the Impact of Daylight Access on Home-Schooled Learners' Circadian Rhythm during COVID'19.

The research analyzes the learning environment in the Egyptian residential context, which became imperative following the shift to online and hybrid learning modes during the COVID-19 pandemic. Available literature suggests that daylight access is critical for regulating the children's circadian rhythm and stimulating their alertness. The investigation explores daylight accessibility to children at home in Cairo's new development areas, both qualitatively and quantitatively, to assess the impact of such a shift on the children's learning performance.

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Keywords: *daylight, chronotype, children, home-schooling, learning environment.*

1 Research Hypothesis

Access to daylight is critical for maintaining the circadian rhythm of the body, which is responsible for the performance and alertness of children (LeGates et al., 2014). Previous research has studied daylight accessibility in the fully dense areas of Cairo, showing the inadequacy of daylight distribution in the interior space (Saad, 2016). However. there are no studies on daylight adequacy in interior spaces conducted in new development areas.

- **Hypothesis:** The circadian rhythm type makes a difference in student learning. The lack of access to adequate daylight at home in new development areas disrupts the circadian rhythm of children, shifting it from Morning to Evening type. Simple improvements could be made to address this in most homes.
- **Objective:** To address the potential design treatments for the home setting as the "new study space".

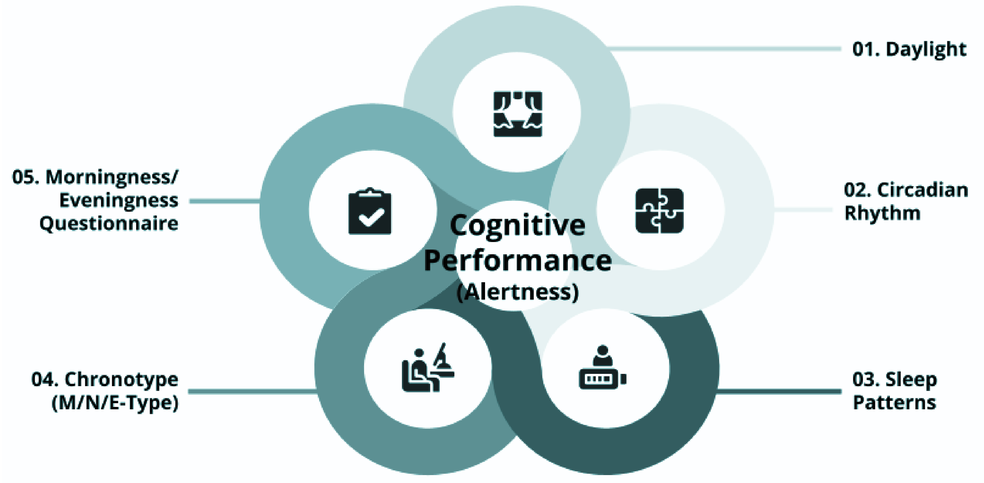
2 Research Question

Since learning shifted from the formal setting to the residential setting post-COVID-19, how do students' access to quality daylight at home compare to those in the formal learning environments?

1. How much daylight (in terms of **quantity**) do children have access to at home in new development areas such as the 5th settlement?
2. How is this affecting their **circadian rhythms** and, accordingly, their educational performance?
3. What are the different scenarios of **learning environments** in the residential setting in terms of access to daylight?
4. What are the **different spatial/architectural conditions** at home that lead to these differences?
5. What are the **daylight characteristics** in the children's study spaces that contribute to effective home learning settings?

3 Literature Review

- The Roggio Emilia Theory mentions that the school physical environment is a "third teacher" (Berti et al., 2019). In comparison to other physical aspects of the learning environment, daylight has the highest effect on the children's overall learning performance (Barrett et al., 2015).
- A minimum of 300 lux levels of daylight on the study plane at school regulates the children's circadian rhythm and, accordingly, modulates their sleeping patterns, which contributes to increased alertness (Fisk et al., 2018).
- A person's chronotype is his/her circadian rhythm typology, whether **E**/**M**/**N**-Type (**M**orning, **E**vening, **N**eutral), which is an indicator of the individual peak performance hours of the day (Duarte et al., 2014).
- To test the chronotype, a standard questionnaire called the "Morningness-Eveningness", or **MEQ** can be used. School children tested are usually M-type, meaning that they are more alert in the **M**orning (Escribano et al., 2012).



4 Methodology

The total random sample (N=33) - school children whose age is between (4-18). Relevant cases (N=12) are invited to submit qualitative data to be analyzed as case studies, of which, 3 are selected as representative samples.

Quantitative Data Collection

- Lux Measurements at the children workplanes
- Testing children chronotype using MEQ Test

Qualitative Data Collection

- Content Analysis of children workspaces pictures at home
- Surveying parents about academic performance of children

Representative Sample

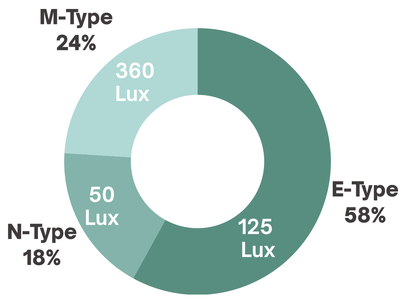
- Selected as focus samples to analyze daylight qualities that contribute to each of the chronotypes

5 Results

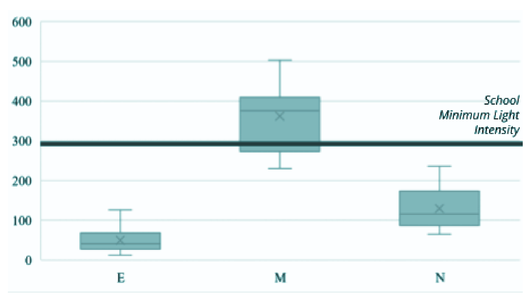
Scan for the case studies

The mean light intensity on the study plane = 140 lux. The confidence interval for E-Type=50 is 95% CI [36, 63] is less than the required 300 lux, showing a significant difference in lighting levels between E-type and non-E-type children.

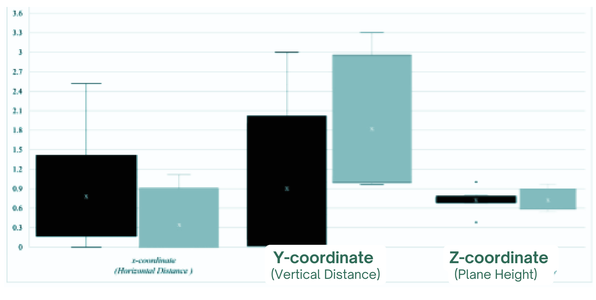
Only 18% of the sample have 300 lux on their study planes at home. The children's circadian rhythm shift, from the expected M-type during school, to a majority of E-type, shows that the residential learning environment affects the children's alertness, altering their circadian rhythms and sleep patterns, and, accordingly, their capacity to learn and develop.



MEQ Test results (%) vs. average lux levels at study plane



B&W plot of chronotypes & lux levels at the study plane



B&W plot of the study plane coordinates (x,y,& z) vs. chronotypes

6 Conclusion

The study spaces in new development areas of home-schooled children are not designed for adequate lighting, which led to a shift in the students' chronotype to E-type (which is usually M-type – based on research conducted in schools). Thus, this shift is affecting the children's alertness and capacity to learn. A list of study-space recommendations has been deduced, as indicated on the right, to propose solutions for home-study spaces with adequate daylight exposure.

Since, in many cases, the main challenge was the location of the study plane, future researchers can use artificial intelligence (AI) in AR-based mobile applications to help parents identify the optimum study location within their children's rooms.

- Optimum window dimensions are 2.00 m x 2.10 m, while the literature review suggests 1.20 m x 2.40 m
- Clear, in case of north orientation, or translucent ,for any other orientation, glass type
- Locate the study plane in the half of the room with the window opening & at a right angle to the window
- The study plane should be more aligned to the window opening but further away from the window plane.
- Cubic room volume

- Avoid high reflectance material for the working plane such as glass or shiny metal
- Use solid plastic, particle-board covered with a laminate or melamine finish, laminated wood, plasterboard, or light oak wood is used as the study-plane materials to satisfy the 30-50% reflectance value
- Light direction is advised to reach the working plane from the left side, avoiding glare

(Heschong & Higgins, 2009)
(Ma'bdeh & Al-Khatatbeh, 2019)
(Designing Quality Learning Spaces: Lighting, 2007)

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