

Prioritizing Physical Comfort Conditions in Primary School Design: Insights from Teacher Perspectives in Algeria

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Abstract— The design of primary schools has evolved gradually over time, with each period reflecting changes in specific aspects of educational and environmental needs. The current trend emphasizes the integration of computer technology into the school environment, aiming to create a space that supports both traditional and digital methods of teaching. However, in Algeria, these concerns are still not fully addressed. Instead, the focus remains on creating a physical environment that facilitates knowledge transmission and offers a more comfortable space for both students and teachers. In architectural design, achieving an optimal balance of comfort is challenging, often forcing architects to prioritize some aspects over others. Determining which form of comfort should take precedence is therefore crucial. This study aims to identify and prioritize the physical comfort conditions most essential for effective learning environments. To accomplish this, we conducted a thorough theoretical review to identify the key factors influencing physical comfort and potential disruptions to the learning process. Furthermore, we surveyed primary school teachers to rank these conditions based on their perceived importance. The findings provide valuable insights into the challenges teachers encounter in the classroom, offering a foundation for informed decision-making in future school design initiatives.

Keywords— Primary School Design, Physical Comfort, Learning Environment, Teachers' Perspectives.

I. INTRODUCTION

It is universally acknowledged that the primary function of a building is to provide an indoor environment that ensures comfort for its occupants, regardless of external conditions such as weather and acoustics [1]. Architectural quality plays a crucial role in achieving these comfort conditions, as the comfort provided by a building is an inherent aspect of its architectural design [2]. In this sense, architectural design can be seen as a passive solution for ensuring comfort; however, it must also take into account the surrounding environment and be thoughtfully tailored to its various components [3].

In the case of school buildings, the architecture must not only prioritize the comfort of students but also facilitate the learning process for all users. The design should be flexible rather than rigid, allowing it to adapt to the evolution of educational methodologies and pedagogies [4, 5]. Therefore, the design of educational spaces should encourage architects and decision-makers to consider two key factors: first, the student as the primary user of the learning environment, and

second, the creation of a conducive working environment for teachers. A central question in this domain is: "How can school architecture contribute to the success of students?" [6].

To guide architects in their design process, it is essential to understand the impact of each physical comfort parameter on student performance. Knowledge of these impacts enables construction stakeholders to create a specification document that effectively addresses the needs of both students and teachers. This study aims to assist architects and decision-makers in developing these essential specifications, ensuring that the design of school buildings aligns with the comfort and functionality required for optimal learning outcomes.

II. METHODOLOGY OF RESEARCH

The first step of this study involved a bibliographic review to identify the parameters and conditions that influence the well-being of both students and teachers. This step allowed us to categorize the identified needs into two main groups:

- Needs related to the school building itself
- Needs related to the internal environmental conditions or the atmosphere within the building.

The second step in achieving the desired outcomes was the administration of a questionnaire survey. Before proceeding with the questionnaire, it was essential to review existing studies, surveys, and works on similar topics. This preliminary research provided valuable insights and allowed us to learn from both the successes and limitations encountered in previous projects [7]. The successful completion of the questionnaire depended on three key factors: clarity, the avoidance of ambiguity, and the appropriate use of language. To ensure clarity and minimize misunderstanding, we opted for colloquial language, and the questionnaire was therefore written in Arabic. The third consideration was to frame the questions in a way that was as non-confrontational as possible to encourage honest and thoughtful responses. For this study, the questionnaire was designed and then hand-delivered to the teachers of the selected case study schools.

III. CASE STUDY

Our study was conducted in the city of El Harrach, located in the Wilaya of Algiers. To achieve the intended objectives, a simple random sampling survey was carried out, targeting a selection of primary schools with identical architectural designs, situated in different environmental contexts.

A. Conceptual Models of School Buildings in Algeria

Figure 1 illustrates the most common typologies of primary school buildings in the study area.

- 1) **Types 1 and 2:** These are single-row block designs based on a model plan proposed by the Ministry of Education. The layout consists of a row of classrooms, each accessed via a central corridor approximately 2 meters wide. These schools are classified into categories A, B, C, and D. Additionally, this design can be adapted into a U-shaped configuration.
- 2) **Type 3:** This type features classrooms arranged around an internal courtyard and is a legacy of the colonial era. The building typically spans two levels: a ground

floor and a first floor, although in some cases, it may include a ground floor plus two additional floors.

- 3) **Type 4:** Constructed during the 2000s, this model consists of a three-story building (ground floor, first floor, and second floor) housing classrooms. The classrooms are organized in two parallel rows, each opening onto an interior corridor approximately 1.80 meters wide.

It is important to note that our study is focused exclusively on Types 1 and 2, as they represent the majority of primary schools in Algeria. Additionally, while other building types exist, they have not been included in this study due to their limited prevalence.

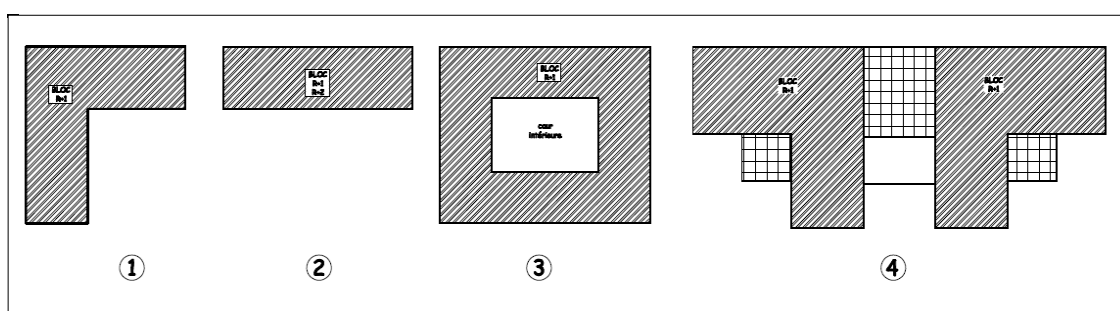


Fig. 1. Proposed Model Architecture

Table 1. Number of Schools According to the Type. (Sourced National Ministry of Education)

Type	Number of classes	Number of schools
Type A	3 salles de classes	2225
Type B	6 salles de classes	4460
Type C	9 salles de classes	1661
Type D	12 salles de classes	2953
Off type	/	6554
Total	/	17853

B. Construction Materials

The review of the specifications for the construction of primary schools provided valuable insight into the technical requirements and materials used in the building process. The key materials identified include:

- Reinforced concrete (post-and-beam structure)
- Semi-prefabricated 16+4 hollow-core concrete floors
- Double hollow brick masonry (30 cm, consisting of 10 cm, 5 cm, and 15 cm layers) for exterior walls
- Simple 10 cm hollow brick masonry for interior partitions
- Cement mortar plastering for interior wall finishes
- Plaster coating on interior walls
- Cement mortar coating on exterior walls
- Solid redwood doors (2.17 x 1.04 meters)
- Wooden windows with 3 mm single glazing.

IV. COMFORT CONDITIONS IN THE SCHOOL

Pedagogy and architectural design are two interdependent factors that must address both the physical and psychological needs of students, facilitating their learning process. Simultaneously, the design must support teachers in effectively carrying out their educational responsibilities. In this study, we aim to classify the comfort needs of students based on their level of importance. The comfort diagram Figure 2 was developed based on responses to a questionnaire administered to primary school teachers. It is important to note that these findings are specific to primary schools in Algeria. Before presenting the priority order of these needs, let us first outline how they were categorized:

A. Conditions Related to the School Building

- Number of students per classroom
- Classroom size
- School site area
- Adequate facilities and accommodation
- Ease of movement and flexibility within spaces
- Hygienic conditions

B. Internal Environmental Conditions

- Thermal comfort
- Visual comfort
- Acoustic comfort
- Air quality

C. Classification of Conditions According to Teachers' Responses

The analysis of the collected responses enabled us to establish the following classification of conditions based on the teachers' feedback:

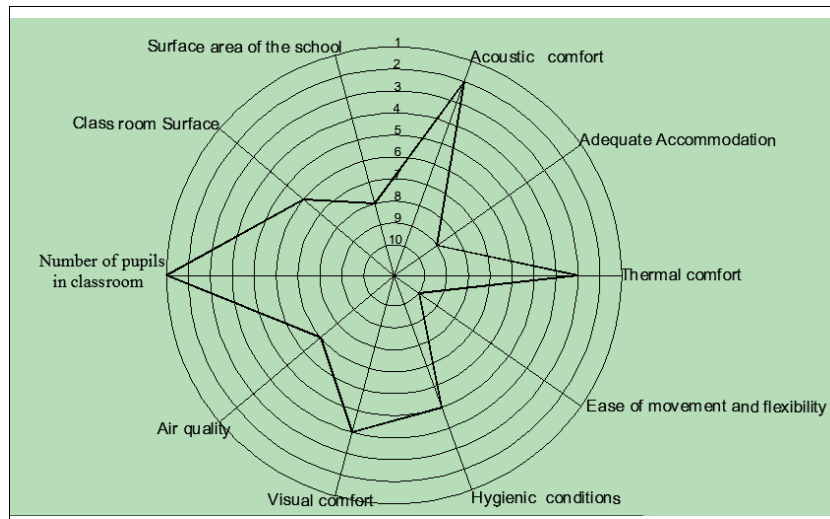


Fig. 2. Comfort conditions in the classroom (comfort rose)

1) *Number of Pupils in the Classroom:* The most important condition according to the answers of teachers is the small number of pupils in the classroom. The most significant condition identified by teachers is the number of pupils in the classroom. Research on the impact of class size on the learning process indicates that while reducing class size may not always yield systemic benefits—given that smaller class sizes require more classrooms and teachers—it has been shown to be particularly beneficial for disadvantaged and younger students [8]. For instance, a smaller class allows the teacher to better address individual students' needs and reduces the time spent managing classroom disruptions [9]. In Algeria, the Ministry of Education has established classroom occupancy standards:

- Primary school: 30 students per classroom
- Middle school: 31 students per classroom
- Secondary school: 31 students per classroom

However, it is important to note that these standards are often not adhered to. Many schools report class sizes exceeding 35 students. Teachers surveyed for this study consistently indicated that larger class sizes require more time and energy to achieve the same educational outcomes as smaller classes.

2) *Acoustic Comfort:* The presence of noise in classrooms significantly disrupts concentration for both students and teachers. The design of school spaces and the selection of materials must account for the reverberation time to minimize noise-related disturbances. Classrooms must be properly isolated

from adjacent rooms, ensuring that sound within the room allows the teacher to be heard clearly without straining their voice. Similarly, the students should be able to hear the message without interference from excessive echoes caused by high reverberation. When the sound source and the receiver are within the same room, sound insulation is achieved through acoustic treatments such as sound absorption. In cases where the sound source and receiver are in separate rooms, sound insulation between rooms is required. Teachers' responses highlight that the introduction of sound insulation is crucial in environments with high noise levels. Therefore, the location of schools should be carefully considered to avoid noise-related issues. Poor acoustics can lead to various problems, including learning difficulties, hearing loss, and demotivated staff.

3) *Thermal Comfort:* Typically, schools are in use only during the day and for four to five days a week, and they are closed during school holidays. As a result, the actual occupancy of the school is partial, and this affects both winter and summer conditions. Despite this, ensuring optimal thermal comfort during both seasons remains a primary concern. The design must incorporate passive solar heating strategies for winter while protecting against excessive solar radiation in the summer. The building's design and construction should ensure comfort in the summer without the need for air conditioning while minimizing the reliance on auxiliary heating in winter. The materials used in construction must be carefully selected to prevent mold growth on the interior surfaces of classrooms [10]. School buildings house a variety of spaces, each with distinct thermal comfort needs. For instance,

circulation areas do not require the same level of thermal control as classrooms. Teachers frequently emphasize thermal discomfort as a major issue, particularly in classrooms where inadequate temperature control can significantly hinder the learning process.

4) *Visual Comfort:*

Visual comfort in a classroom is characterized by the ability to see objects clearly and without strain in a well-lit, pleasant environment. Insufficient or excessive lighting, poor light distribution, or inappropriate light spectra can cause visual fatigue or disturbances over time, leading to discomfort and reduced visual performance. Teaching and learning activities require specific lighting levels to support visual tasks. Both students and teachers should have access to a bright, comfortable, and stimulating environment. The use of natural light combined with high-quality artificial lighting is fundamental to ensuring both visual comfort and efficient energy use in schools. Key parameters for visual comfort, in which the architect plays a leading role, include:

- Appropriate illumination levels for visual tasks
- Accurate color rendering
- Harmonious light distribution throughout the space
- Balanced luminance ratios within the room
- Absence of harsh shadows
- Proper highlighting of objects' relief and shape
- Availability of an outward view
- A pleasant quality of light
- Absence of glare

The required artificial illumination levels, measured one meter from the floor, are as follows [11]:

- General education rooms: 250 lux
- Classrooms for evening classes: 350 lux
- Special rooms (e.g., art, sewing, manual work, science labs): 500 lux
- Corridors and circulation areas: 100 lux

Teachers surveyed reported that students experience visual discomfort due to excessive sunlight entering classrooms on sunny days, causing glare and making it difficult to focus.

5) *Hygienic Conditions:* Hygiene is a critical factor in the school environment and can be defined as the set of individual or collective practices aimed at maintaining health and preventing illness. It must be rigorously implemented on a daily basis by both students and staff across all areas of the school, including classrooms and other spaces frequented by students. Hygiene measures are especially important in schools, which cater to young children—an age group that is more vulnerable to infectious diseases.

6) *Classroom Size:* Classroom size is determined based on the number of students, with a minimum recommended area of 42 m². In Algeria, classrooms

are typically rectangular, and the space is calculated according to the standard of 1.25 m² per student, with a ceiling height no less than 4 meters. These standards may vary between countries. Teachers indicate that the classroom area is generally adequate, provided that the number of students is kept within reasonable limits.

7) *Air Quality:* Indoor air quality in schools is a particular concern. Although the pollutants found in school environments are generally similar to those in other indoor spaces, their concentrations may be higher. This is due to factors such as the greater presence of furniture, the use of school supplies like glues, markers, and paints, and the frequent use of cleaning products [12]. The extended presence of students and teachers in classrooms contributes to the accumulation of odors and toxic pollutants. Proper ventilation is essential to renew the indoor air, reduce pollutant concentrations, and maintain acceptable air quality levels. Ventilation also helps to remove excess heat generated during classroom occupancy. Studies show that air change rates in classrooms can vary depending on the type of activity being conducted. From a hygiene perspective, certain air change rates are required, expressed in cubic meters of air per hour per occupant. Health regulations specify the minimum air renewal rates for both mechanical and natural ventilation in different school spaces:

- Classrooms, study rooms, and workshops: 15 m³/h per occupant
- Offices, reception areas: 18-25 m³/h per occupant
- Canteens and dining rooms: 22 m³/h per occupant
- Sanitary facilities: 30 m³/h plus 15 m³/h per piece of equipment
- Relay offices: 15 m³/h per meal
- Storerooms, archives, circulation areas, and halls: 0.36 m³/h per m² of floor area [13]

8) *School Surface Area:* The surface area of the school refers to the total area of all spaces within the school, including recreational areas, the library, courtyards, and other facilities. For example, according to French standards, the courtyard should have a surface area of 0.7 m² per student. A larger school area allows for a greater diversity of educational spaces and the introduction of new learning environments, which can evolve in response to changing educational needs. For instance, outdoor educational spaces, considered complementary to conventional classrooms, are becoming more common. The dimensions of these spaces vary depending on the grade level and the number of students [14]. Furthermore, the development of digital technologies in schools is influencing the traditional audiovisual sector, particularly with the ongoing shift towards digitalization in image and sound, digital photography, computer image

processing, multimedia, and other advancements. The presence of a variety of spaces within the school promotes a versatile learning environment, motivating students and enhancing their educational experience.

- 9) *Adequate Accommodation:* The effective functioning of teaching requires well-designed furnishings and a layout that is both functional and appealing. Furniture design should be based on clear objectives and established comfort standards, incorporating input from both designers and technicians. Collaboration is essential at this stage, whether it involves school staff, furniture manufacturers, or independent designers [15]. The opposite Figure 3 illustrates a typical classroom layout found in primary schools across Algeria. Teachers have described this arrangement as inadequate, lacking creativity, and not conducive to a stimulating or attractive learning environment.

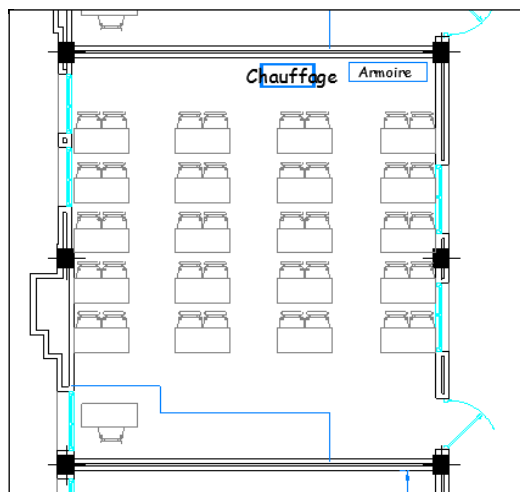


Fig. 3. Typical classroom layout.

- 10) *Ease of Movement and Flexibility:* Flexibility, by definition, refers to the ability to easily adapt to changing circumstances or bend without breaking. In architectural terms, a building is considered flexible if it can seamlessly accommodate changes in function or use. A flexible building evolves to meet new needs rather than remaining static, transforms to support growth rather than restricting it, interacts with its users rather than imposing limitations, and is adaptable rather than rigid [16]. This quality is especially critical in school architecture, given the continuous evolution of teaching methods and learning environments. Facilitating movement within the school building is essential, particularly for younger children who require efficient navigation of the space. Teachers in the schools surveyed highlighted a significant lack of flexibility in the design, pointing out that these buildings are poorly equipped to support shifts in educational practices or adapt to the changing needs of both students and teachers.

V. CONCLUSIONS

This study enabled us to classify the comfort conditions in schools in Algiers based on their relative importance. The aim is to assist decision-makers and architects in selecting the most appropriate architectural designs that cater to students' needs and enhance their learning environment. Our findings indicate that, first and foremost, minimizing the number of students per classroom is essential for better classroom management, both in terms of comprehension and student behavior. The second most important factor, according to teachers, is reducing noise levels, which are seen as critical for fostering effective communication between students and teachers. Thermal comfort ranks third, with teachers expressing significant concern about its impact on students' well-being, particularly during extreme temperatures in winter and summer. These first three parameters—classroom size, acoustic comfort, and thermal comfort—are considered the most important factors by teachers. Other factors such as visual comfort, hygiene conditions, classroom surface area, and air quality were ranked as moderately important. The surface area of the school, layout, and ease of movement received lower priority in the teachers' assessments. It is important to note that each teacher tends to prioritize the factors most lacking in their specific school environment. For instance, teachers in schools that struggle with thermal discomfort but are located in quiet areas may place greater emphasis on thermal comfort over acoustic conditions. This is why, from the outset, we selected schools in varying environmental contexts to ensure a diverse range of responses.

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