



وزارة التعليم  
Ministry of Education



ABDULLAH BIN SALAM SCHOOL

مدرسة عبد الله بن سلام للتعليم الأساسي (5 - 8)

Search title:

Using recorded student feedback as a guide to choosing more sustainable school flooring

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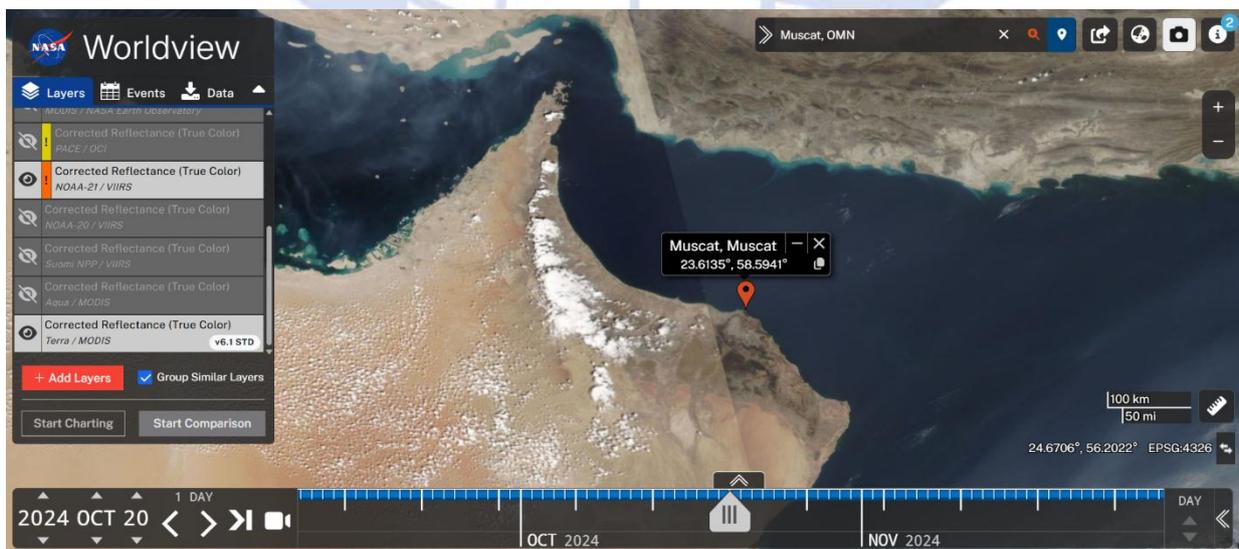
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(A satellite image)



## Research summary :

**This research focuses on how daily observations from the GLOBE program contribute to helping scientists understand climate change and protect the school and community environment. It also examines the impact of extreme surface temperatures on students' use of outdoor spaces during the afternoon. Finally, the research explores how long-term program data can contribute to developing a strategic plan to enhance school sustainability and mitigate the effects of local climate change.**

**The research aims to provide a scientific justification for transitioning to more sustainable school floors using field evidence and to raise environmental awareness within the community. It seeks to integrate expert expertise with student data to achieve the desired environmental sustainability and effectively address community and environmental issues, ensuring a high-quality learning environment.**

**The research methodology was based on citizen science, integrating three research paths: first, field measurements of surface and air temperatures using approved GLOBE protocols; second, the distribution of scientific questionnaires to 42 participants to assess the impact of heat on physical activity; and third, an interview with the project engineer. Historical records were analyzed using artificial intelligence techniques.**

**The results revealed a significant temperature discrepancy exceeding 30.9°C. Concrete surfaces recorded a maximum temperature of 71.1°C in May 2024, compared to 40.2°C for the air. Analysis showed that conventional flooring acts as a heat collector, raising the school's ambient temperature. Participants also confirmed that this high temperature restricts activities and play in the schoolyard.**

**The findings indicate that sustainability is a smart investment that reduces operating costs when adopting a life-cycle costing approach. GLOBE data serves as a comprehensive "health record" for the building, guiding engineering decisions toward the use of highly thermally efficient materials. Light colors, such as white ceramic tiles, were also shown to significantly reduce surface heat compared to colored cement, which absorbs more energy.**

**Recommendations include replacing existing flooring with materials that have a high solar reflectance index and increasing green spaces to reduce heat absorption. The research also suggests adopting "miniature application models" as a first step toward comprehensive development in line with Oman Vision 2040 to ensure a safer learning environment for future generations.**



## Basic terms :

### **Surface Temperature:**

**This is the primary variable in the research, representing the average surface temperature measured directly on the floor. This temperature is measured in degrees Celsius (°C).**

- **Surface Cover Type:**

**This identifies the actual floor material being evaluated. Records indicate that measurements were taken on an interlocking paving stone floor, which is classified as concrete.**

- **Current Temp:**

**This is a parallel measurement compared to the surface temperature. This value is used to assess the extent to which the surface contributes to raising the local temperature in the school's surroundings (the heat island effect).**

- **Date and Time of Measurement (Measured At / Solar Measured At):**

**These are essential for analyzing time patterns and identifying temperature variations throughout the day or across different seasons.**

- **Surface Condition:**

**This is a note recorded to determine the physical condition of the surface at the time of measurement, such as "dry". Visualize Data: A website that uses the GLOBE program to extract data and observations recorded in the program's protocols.**

**Capital Expenditure (CAPEX): This refers to the one-time financial investment made at the start of a project to purchase and install construction materials.**

**Life Cycle Cost Analysis (LCCA): This methodology assesses the total costs a school will incur over the material's lifespan, not just the purchase price.**



## Research questions:

### Research Question 1:

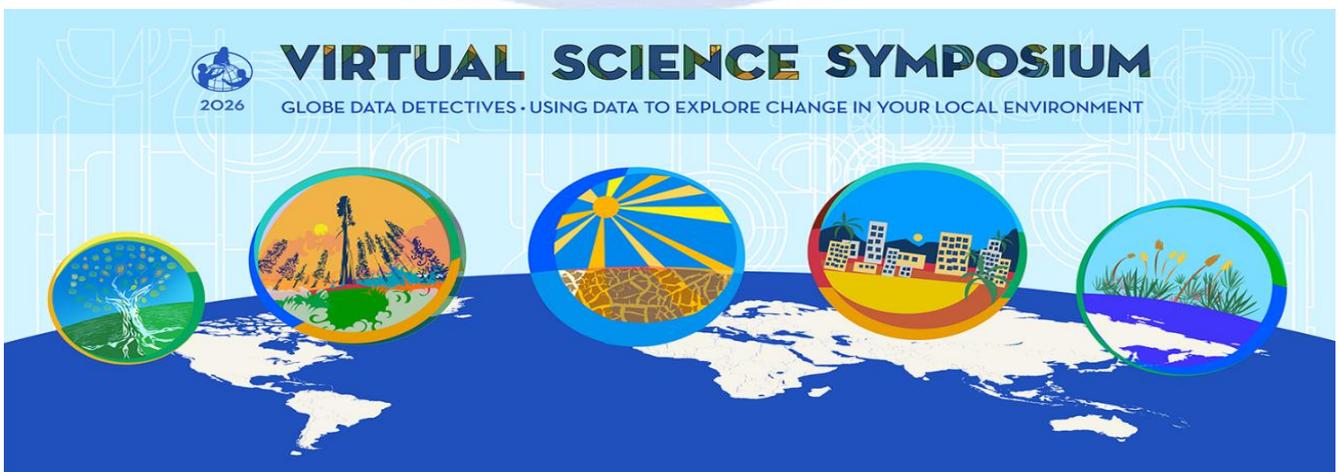
How do our daily observations of surface temperature in the GLOBE program help scientists understand climate change and protect our school and community environment?

### Research Question 2:

How does a significant increase in surface temperature affect students' and teachers' use of outdoor spaces at school during peak temperatures (typically around midday)?

### Research Question 3:

How can long-term GLOBE data (2019–2025) contribute to a school strategic plan to promote environmental sustainability and mitigate the negative impacts of local climate change?





## Introduction and literature review:

This research is based on the methodological and educational framework of the GLOBE program, a global initiative that connects citizen scientists and students to promote environmental awareness and understanding of the Earth as an integrated system. The work focuses on the use of GLOBE-approved protocols, specifically the surface temperature protocol, where extreme local measurements (e.g., 71.1°C on concrete/interlocking tiles) were recorded. These measurements are used as part of a long-term data record spanning from 2019 to 2025. To ensure scientific rigor and the applicability of the findings, the research went beyond simply collecting technical data, integrating three data collection pathways: first, field temperature measurements recorded over six years; second, a survey to assess public perceptions of the impact of soil temperature on the biosphere; third, interviews with school construction engineers; and fourth, the measurements were taken at the Ubaidah Bin Salam School, given that its indoor canopy uses a variety of materials that could be adapted for other schools. This integrated research approach, combining field data, community insights, and expert expertise, aims to justify the transition to more environmentally sustainable school grounds and develop an evidence-based strategic plan. This approach promotes environmental stewardship (raising environmental awareness) and directly benefits both the community and the environment. To ensure the quality of the research, the collected data must be analyzed using the GLOBE information system and advanced data access tools. The final report, submitted as a "Student Research Report," adheres to specific requirements, including the proper citation of references to support the scientific conclusions related to environmental sustainability.

The research also underscores the importance of the data collected by the program's students and its role in addressing local issues. It explores how this data can be used in the future to arrive at relevant scientific conclusions and facts, contributing to the well-being of both the community and the environment. Furthermore, the research encourages students to continuously collect and record information and to regularly document their observations.



## Research plan:

Following the steps of the GLOBE scientific program to justify the shift towards more sustainable school floors, with a focus on using available data on surface heat (interlocking concrete), the following plan was identified:

Timeframe	Goals to be achieved	The mechanism	Implementer
- 501/10/2025 505/10/2025	Defining the research concept and collecting primary data	Choosing a research topic related to temperature comparison - surface temperature	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor
06/10/2025 - 10/10/2025	Collecting daily temperature data for both air temperature and surface temperature in the years between 2015 and 2025	Extract the data from the GLOBE website recorded in Visualize Data, and download the daily tables for all selected months from 2015 to 2025.	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor
11/10/2025 - 15/10/2025	Organizing and presenting data in an organized manner	Tables were prepared that included daily temperatures for both recorded temperature and surface temperature from school data.	Program Supervisor
16/10/2025 - 20/10/2025	Data analysis	Comparing downloaded data and using artificial intelligence to help analyze the data in a logical way	Researcher Yousef Al-Muslihi + Basel Al-Maliki
21/10/2025 - 25/10/2025	Interpretation of results	Studying the effect of Earth's surface temperature and atmospheric temperature through observations recorded from the program's international site	Researcher Yousef Al-Muslihi + Basel Al-Maliki
26/10/2025 - 30/10/2025	Writing a research draft	Formulating the research introduction, objectives, and preliminary results, and analyzing the differences based on the data that was collected and analyzed.	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor
01/11/2025 - 05/11/2025	Preparing tables and graphs	Design the necessary graphs and tables to visually and clearly display the comparison results.	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor
06/11/2025 - 10/11/2025	Research review and editing	Review all parts of the research and ensure the accuracy of the information, the organization, and the coherence between the different parts.	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor
01/12/2025 - 30/02/2025	Preparing the final version of the research	Write the final version of the research in an organized manner and add all the required elements, including references and appendices.	Researcher Yousef Al-Muslihi + Basel Al-Maliki
01/01/2025 - 30/01/2025	Research presentation	Printing, translating, and preparing the research for official submission, and preparing to submit it to the program's international competition and participate with it at the local level.	Researcher Yousef Al-Muslihi + Basel Al-Maliki + Program Supervisor



This plan is a step-by-step guide to working as a "citizen scientist" and applying the scientific research process of the GLOBE program:

Stage	Steps and tasks required	Scientific tools and evidence from GLOBE
<b>Phase 1: Gathering Quantitative Evidence</b>		
<b>Measuring surface and air temperature:</b>	Perform two important measurements using measuring instruments (protocols): 1 - Surface temperature: Measure the temperature of the interlocking pavers/concrete floor directly to determine how hot it is at peak times (e.g., midday). 2 - Air temperature: Measure the normal temperature of the ambient air at approximately the same time.	The soil protocol measures surface temperature, while the atmospheric protocol measures air temperature.
<b>Registering new data:</b>	Enter all recent measurements accurately into the electronic system of the GLOBE program.	Data via GLOBE applications such as GLOBE Observer or through input forms on the website.
<b>Phase Two: Analyzing historical data and documenting the situation</b>		
<b>Researching the historical record:</b>	Traveling through the data "time machine": going back to old GLOBE records (from 2019 to 2025), and extracting surface temperature and air temperature data for our chosen years (from September to December) of each year.	Use the GLOBE (Data Display) data and information system or the Advanced Data Access Tool (ADAT) to load large amounts of data.
<b>Interview with the engineer/official:</b>	Conduct a simple interview with the engineer in charge of school construction or the facilities supervisor to learn about the scientific methods of using (concrete or interlocking tiles) and why they were chosen.	This is an important step in linking scientific data (heat) with engineering decisions (material).
<b>Proof of the problem (justification):</b>	A comparison to demonstrate that the flooring "exerts a thermal effect unevenly": This involves comparing the highest recorded surface temperature (e.g., 71.1°C) with the ambient air temperature. If the difference is significant, it proves that the concrete increases the temperature of the school environment, justifying the need to switch to more sustainable materials.	This analysis aims to justify environmental transformation through evidence.

## Phase Three: Drafting and Publishing the Rules

<b>Writing the final report:</b>	Compile the findings and recommendations into a "Student Research Report." This report should include a school plan outlining how the current area will be replaced with a cooler, more environmentally friendly alternative.	Student research reports can be uploaded to GLOBE databases in any language. However, English has been adopted as the research language for 2026.
<b>Share the discovery:</b>	<b>Publishing the research locally and globally: sharing the results with the school administration (local community), and presenting a report at the International Virtual Scientific Symposium to obtain an evaluation from scientists.</b>	This contributes to GLOBE's mission of increasing scientific understanding of "Earth as a system."
<b>Its connection to GLOBE protocols</b>	Documenting the site's environmental conditions (site details) that affect soil and atmospheric protocol readings.	Physical data (surface temperature) is linked to the biosphere, one of the five spheres of the Earth as a System studied by GLOBE.



### Study location:

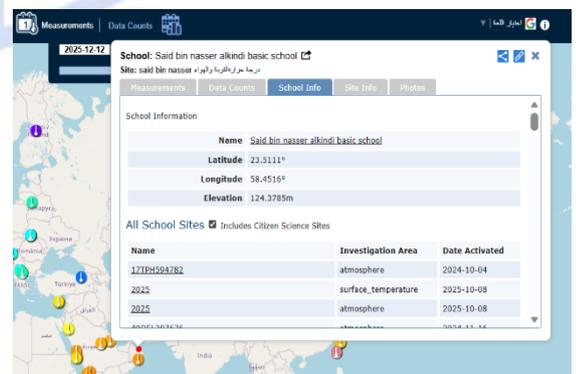
### Three study sites were selected, as follows:

**First:** Said Bin Nasser Al Kindi School, where data were collected over six years (2019-2025). This data is used to monitor surface and air temperatures throughout most of the year. The recorded data was extracted from the GLOBE website using the data visualization tool.

-The school is located in the Muscat Governorate, Al Amerat area, at an elevation of 124 meters, at longitude 23.5111 North and latitude 58.4516 South.

-There are no plants on the studied roofs; instead, there are interlocking tiles. The base of these tiles is made of heat-treated cement.

-Surface temperatures are measured daily near a weather shelter, with measurements taken almost daily around midday.



**Second:** Abdullah bin Salam School also extracted recorded data from the Visualize Data section during the first two months of the study. Because the school is new, the recorded observations of surface temperature and air temperature for a few months were used for comparison with data from Saeed bin Nasser Al Kindi School and Ubaida bint Muslim School.

-The school is located in the Muscat Governorate, Al Amerat Wilayat, at an elevation of 108 meters, at longitude 23.490°N and latitude 58.504°S.

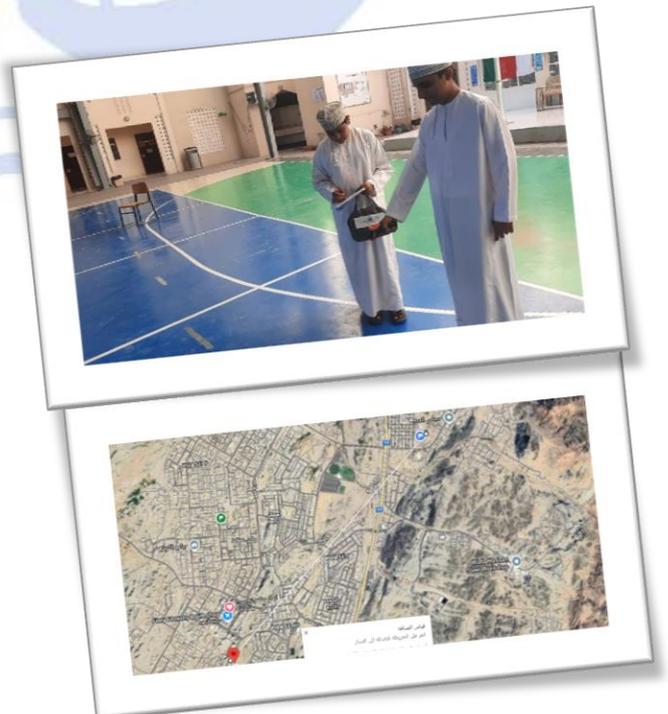
-There is no vegetation in the area where the surface temperature was studied, but the area is covered with soil next to the air shelter.

-Surface temperature readings of the interlocking pavers were also taken in another area of the school to obtain diverse data for the research.

**Third:** Ubaidah Bint Muslim School, surface temperature measurements were taken because the school has various flooring materials, including painted interlocking pavers, cement, and ceramic tiles, in two different locations (in the shade and in the sun). This allowed for a scientific comparison of surface temperature between the three schools.

The school is also located in the same governorate and is 4 kilometers from the study site at longitude 23.465 and latitude 58.477 south.

The school (Ubaida Bint Muslim) is not an organizer of the GLOBE program, but surface temperature measurements were taken for a group of surfaces inside and outside the school in making comparisons that we see as useful in answering the research questions.



# The data collection phase from the three sites:

**First:** Data and observations recorded from Saeed Bin Nasser Al Kindi School during the years 2019 to 2025 through Visualize Data, which were downloaded, as well as new data from Abdullah Bin Salam School:

The image displays three screenshots from the GLOBE Visualization System interface, showing data collection for the 'Said bin nasser alkindi basic school'.

**Top Screenshot: Data Table**

School Name	Site Name	User ID	Latitude	Longitude	Elevation	Measured At	Solar Measured At	Solar Noon At	Average Surface Temperature C	Surface Condition	Average Snow Depth Mm	Snow
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2019-12-16 08:22:00	2019-12-16 08:22:00	2019-12-16 08:41:00	27.0	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2019-12-22 08:43:00	2019-12-22 08:43:00	2019-12-22 08:04:00	28.3	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2019-12-29 08:34:00	2019-12-29 08:34:00	2019-12-29 08:04:00	28.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-01-17 08:27:00	2020-01-17 08:27:00	2020-01-17 08:20:00	41.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-02-19 08:22:00	2020-02-19 08:22:00	2020-02-19 08:20:00	47.7	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-20 08:44:00	2020-03-20 08:44:00	2020-03-20 08:19:00	41.5	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-02-29 08:32:00	2020-02-29 08:32:00	2020-02-29 08:19:00	44.6	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-01 08:33:00	2020-03-01 08:33:00	2020-03-01 08:19:00	37.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-02 08:33:00	2020-03-02 08:33:00	2020-03-02 08:19:00	40.7	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-04 08:42:00	2020-03-04 08:42:00	2020-03-04 08:21:00	44.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-09 08:29:00	2020-03-09 08:29:00	2020-03-09 08:16:00	42.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-11 08:28:00	2020-03-11 08:28:00	2020-03-11 08:19:00	48.7	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-03-12 08:33:00	2020-03-12 08:33:00	2020-03-12 08:19:00	41.9	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-09-14 08:31:00	2020-09-14 08:31:00	2020-09-14 08:01:00	54.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2020-09-24 08:22:00	2020-09-24 08:22:00	2020-09-24 07:58:00	36.3	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-09-26 08:18:00	2023-09-26 08:18:00	2023-09-26 07:57:00	39.3	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-09-27 08:17:00	2023-09-27 08:17:00	2023-09-27 07:57:00	65	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-02 08:30:00	2023-10-02 08:30:00	2023-10-02 07:59:00	61.1	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-03 08:47:00	2023-10-03 08:47:00	2023-10-03 07:58:00	62.3	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-05 08:17:00	2023-10-05 08:17:00	2023-10-05 07:59:00	60.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-09 08:25:00	2023-10-09 08:25:00	2023-10-09 07:53:00	37.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-11 08:15:00	2023-10-11 08:15:00	2023-10-11 07:52:00	61.5	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-13 08:20:00	2023-10-13 08:20:00	2023-10-13 07:51:00	60.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-16 08:25:00	2023-10-16 08:25:00	2023-10-16 07:51:00	37.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-23 08:23:00	2023-10-23 08:23:00	2023-10-23 07:50:00	31	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-23 08:10:00	2023-10-23 08:10:00	2023-10-23 07:50:00	33.3	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-10-26 08:10:00	2023-10-26 08:10:00	2023-10-26 07:49:00	35.2	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-01 08:11:00	2023-11-01 08:11:00	2023-11-01 07:49:00	42.7	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-03 08:47:00	2023-11-03 08:47:00	2023-11-03 07:49:00	41.8	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-09 08:23:00	2023-11-09 08:23:00	2023-11-09 07:49:00	35.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-12 08:24:00	2023-11-12 08:24:00	2023-11-12 07:50:00	43.1	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-14 08:13:00	2023-11-14 08:13:00	2023-11-14 07:50:00	47.4	dry		
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40774	58.4961	5	2023-11-15 08:02:00	2023-11-15 08:02:00	2023-11-15 07:50:00	36.9	dry		

**Middle Screenshot: Site Information**

Site ID: 34072  
 Name: سعيد بن ناسر آل كندى الابتدائية  
 Latitude: 23.407829°  
 Longitude: 58.496231°  
 Elevation: 105.0m  
 Location Source: gps

**Bottom Screenshot: Atmosphere Site**

School Name	Site Name	User ID	Latitude	Longitude	Elevation	Measured At	Solar Measured At	Solar Noon At	Current Temp C
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-04 08:38:00	2019-12-04 12:42:00	2019-12-04 07:56:06	29.3
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-12 08:43:00	2019-12-12 12:36:00	2019-12-12 07:50:09	28.6
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-14 08:25:00	2019-11-14 12:36:00	2019-11-14 07:50:21	29.3
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-15 08:00:00	2019-11-15 12:10:00	2019-11-15 07:50:31	29
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-18 08:26:00	2019-12-18 12:44:00	2019-12-18 07:50:42	31.3
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-17 08:48:00	2019-11-17 12:58:00	2019-11-17 07:50:33	31
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-18 08:11:00	2019-11-18 12:21:00	2019-11-18 07:51:05	28
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-18 08:18:00	2019-11-18 12:44:00	2019-11-18 07:51:18	34.3
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-20 08:38:00	2019-11-20 12:47:00	2019-11-20 07:51:32	32.8
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-03 08:29:00	2019-12-03 12:33:00	2019-12-03 07:50:42	28
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-04 08:32:00	2019-12-04 12:30:00	2019-12-04 07:50:36	27
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-11-26 08:30:00	2019-11-26 12:37:00	2019-11-26 07:51:32	27.1
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-03 08:29:00	2019-12-03 12:33:00	2019-12-03 07:50:42	28
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-08 08:24:00	2019-12-08 12:26:00	2019-12-08 07:50:14	27.2
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-05 08:27:00	2019-12-05 12:31:00	2019-12-05 07:50:31	28.6
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-15 08:19:00	2019-12-15 12:18:00	2019-12-15 07:50:10	30.1
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-16 08:20:00	2019-12-16 12:18:00	2019-12-16 07:50:10	24.5
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-17 08:18:00	2019-12-17 12:20:00	2019-12-17 07:50:10	29.8
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-18 08:24:00	2019-12-18 12:23:00	2019-12-18 07:50:28	29.8
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-18 08:24:00	2019-12-18 12:23:00	2019-12-18 07:50:28	29.8
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-22 08:22:00	2019-12-22 12:18:00	2019-12-22 07:50:26	27.7
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2019-12-22 08:22:00	2019-12-22 12:18:00	2019-12-22 07:50:26	27.7
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-02-18 08:30:00	2020-02-18 12:07:00	2020-02-18 07:49:38	30.9
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-02-19 08:24:00	2020-02-19 12:05:00	2020-02-19 07:49:38	34.4
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-02-20 08:34:00	2020-02-20 12:18:00	2020-02-20 07:49:38	37.1
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-02-25 08:40:00	2020-02-25 12:18:00	2020-02-25 07:49:38	37.1
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-03-01 08:20:00	2020-03-01 11:59:00	2020-03-01 07:48:14	33.6
Said bin nasser alkindi basic school	سعيد بن ناسر آل كندى الابتدائية	13264716	23.40783	58.49623	105	2020-03-02 08:24:00	2020-03-02 12:03:00	2020-03-02 07:48:10	33.2

**Second:** Observations recorded from Ubaidah Bint Muslim School regarding surface temperature, as shown in the following tables:

The comparison between surface temperatures using a thermal gun, taken on 10/12/2025 AD at two different locations in the school (in the shade and in direct sunlight).

Recorded surface temperatures of materials (under shade) at Ubaida Bint Muslim Basic Education School during the afternoon					
Recorded temperature (3) samples	Ceramic material Color: White	A cement floor with a painted finish			Interlocking pavers Cement-colored
		milky color	green	blue	
First sample	19.1	24.9	25.4	26.4	24.9
The second sample	19.9	24.9	25.3	26.6	24.2
Third sample	18.6	24.6	25.3	25.3	24.1

Table(1)

Recorded surface temperatures of materials (under the sun) at Ubaidah Bint Muslim Basic Education School during the afternoon					
Recorded temperature (3) samples	Ceramic material Color: White	A cement floor with a painted finish			Interlocking pavers Cement-colored
		milky color	green	blue	
First sample	35.9	34.6	34.5	36.4	31.1
The second sample	35.8	35.1	32.6	37.3	32.2
Third sample	33.6	33.9	31.6	39.6	35.9

Table(2)



## Analysis of the results:

By using artificial intelligence tools to analyze big data from Excel files, the Notebooklm tool was used, where the tool reads the primary source of the information included without searching for external sources. This allows control over the information that the system reads and it can be analyzed as follows to answer the search questions.

### The first research question:

**How do our daily observations in the GLOBE program about Earth's surface temperature contribute to helping scientists understand climate change and protect our school and community environment?**

**First:** A comparison was made between surface temperatures and ambient air temperatures over the years under study, as follows:

The collected data show a significant discrepancy between surface temperatures (according to the soil protocol) and current ambient air temperatures (according to the atmospheric protocol), highlighting the phenomenon of localized warming in the school environment.

The comparison between the two measurements, based on available data from Saeed Bin Nasser Al Kindi School, can be summarized as follows:

#### 1 - Heat Gap:

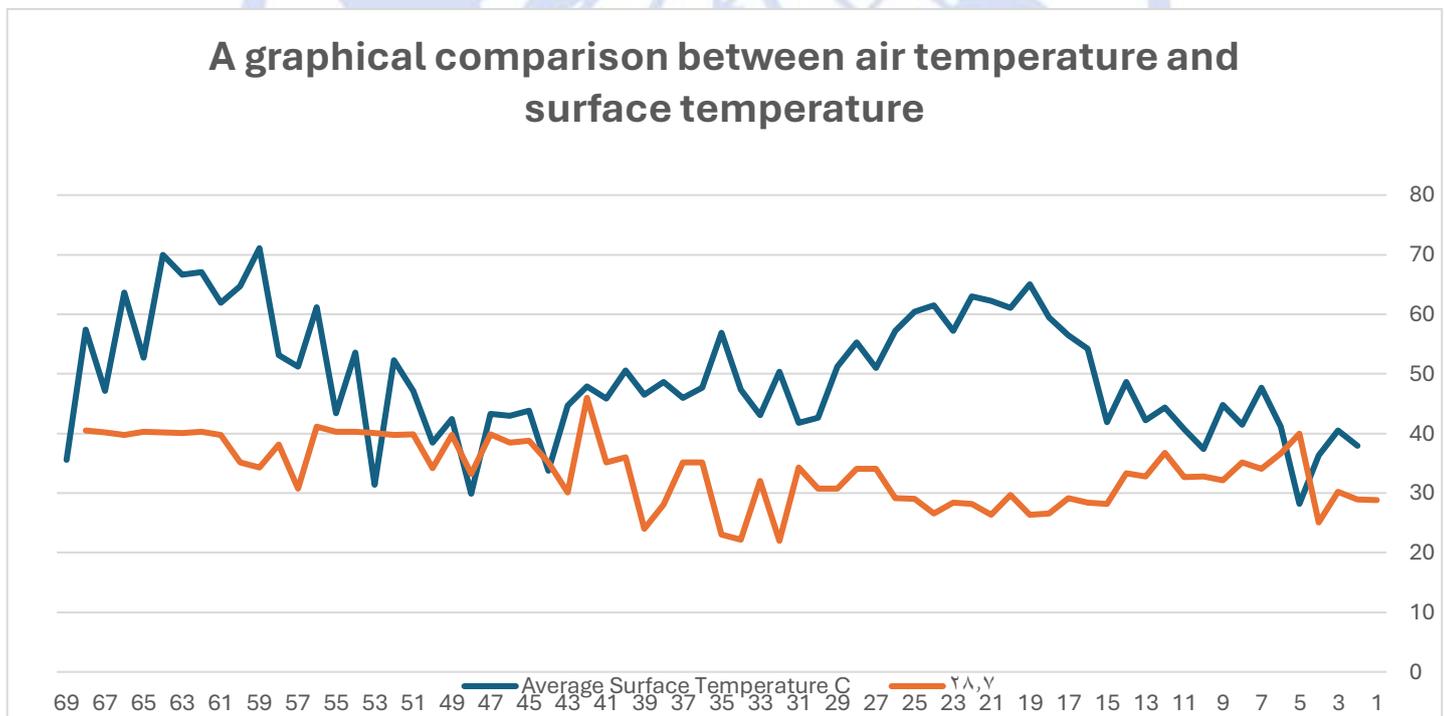
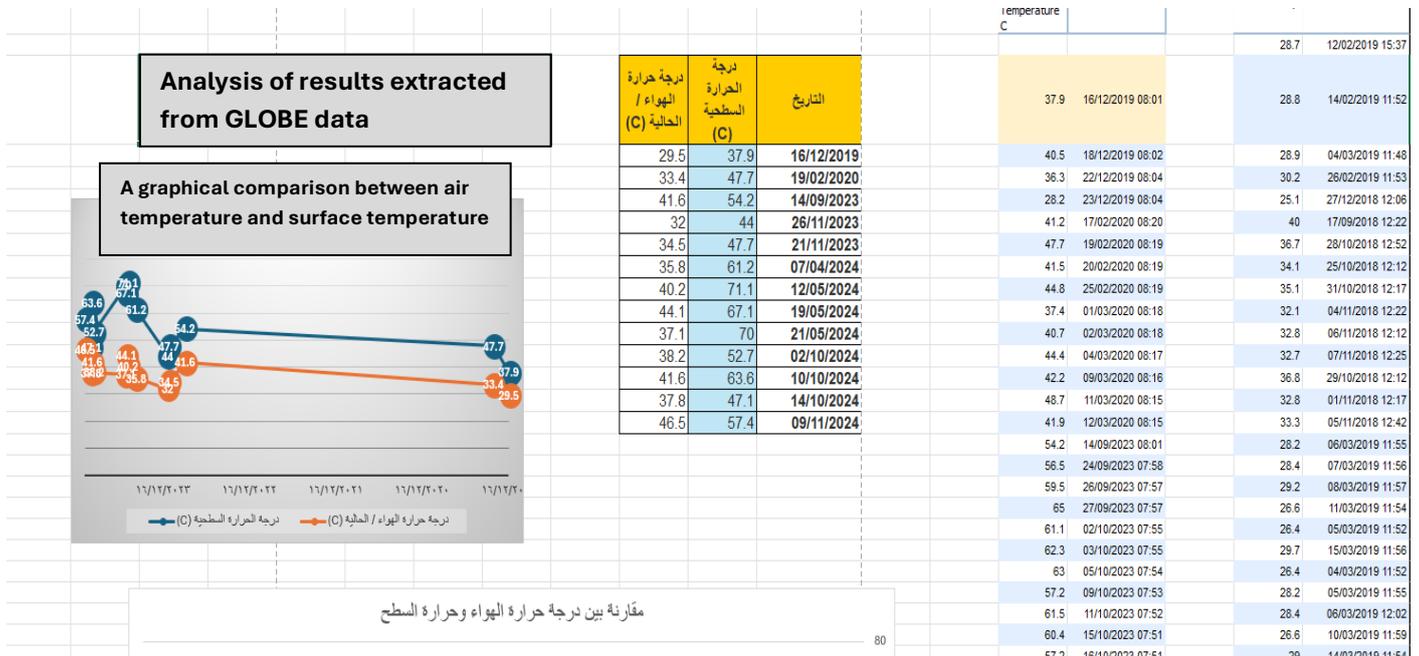
- Significantly High Surface Temperatures: Surfaces not covered with vegetation, and made of concrete/interlocking tiles, register temperatures significantly higher than ambient air temperatures.
- Highest recorded value: The average surface temperature of the concrete reached 71.1°C on May 12, 2024.
- Daily comparison: On the day the surface temperature reached 71.1°C (May 12, 2024), the current temperature recorded at approximately the same time (12:08) was 40.2°C. This indicates that the surface temperature was approximately 30.9°C higher than the ambient air temperature.

Other examples of surface temperature increases:

- On May 21, 2024, a surface temperature of 70°C was recorded on concrete.
- On September 27, 2023, a surface temperature of 65°C was recorded.
- Measurements exceeding sixty or seventy degrees Celsius were taken in the periods immediately preceding or following the peak of the midday sun.

## 2 - Notes on types of construction surfaces:

Surface heat data indicate that surfaces made of concrete or interlocking pavers (which fall under the concrete category in the classification of surface coverings) show this remarkable heat increase, as surface measurements on interlocking pavers were frequently included in the recorded data and observations.



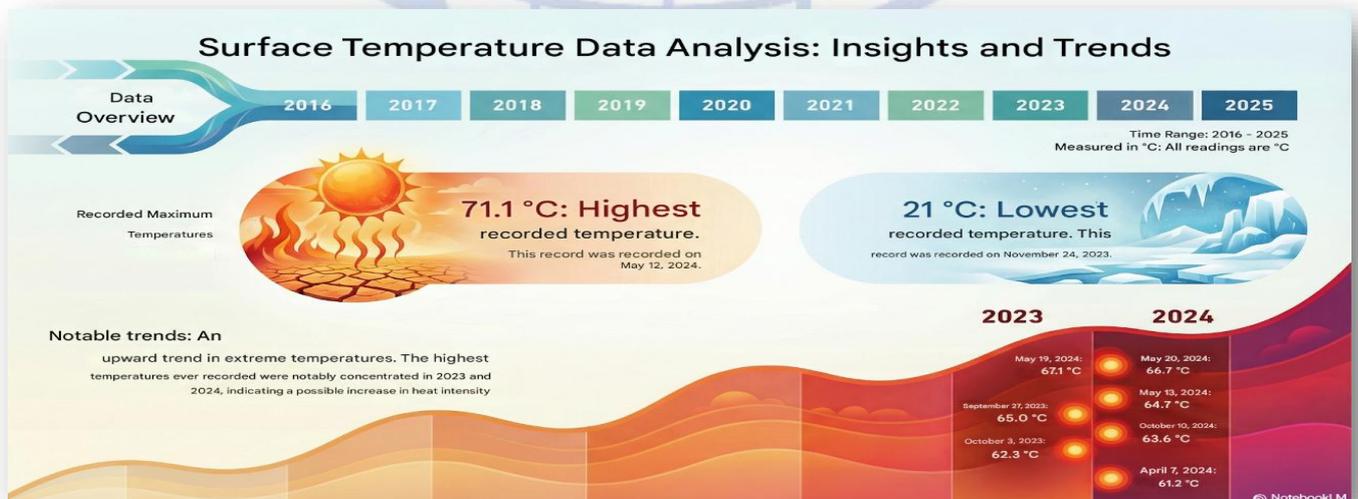
### 3 - Influence of environmental conditions:

•Surface temperature is affected by surface conditions, as many high readings were recorded when the surface condition was classified as (dry).

**Second:** Using the information from Tables (1) and (2) obtained from Ubaidah Bint Muslim School regarding surface types and their relationship to surface temperature, the following observations were made:

The measurements recorded by the research students at Ubaidah Bint Muslim School, taken using a thermal imaging gun during midday, reveal several important observations about the surface temperature behavior of construction materials:

- 1- The acute effect of sun exposure: A significant and immediate increase in the surface temperature of materials is observed when moving from shade to direct sunlight.
- 2- Highest temperatures under sunlight: The painted cement floor recorded the highest single reading under direct sunlight, reaching 39.6°C. Interlocking pavers (blue, green, and milky) and ceramic tiles recorded readings ranging between 31.1°C and 37.3°C under direct sunlight.
3. Lowest Shade Temperatures: The white ceramic material exhibited the lowest recorded surface temperatures in the shade compared to all other tested materials, with readings ranging between 18.6°C and 19.9°C.
4. Effect of Material and Color Variation: Temperatures varied between different material types (ceramic, interlocking pavers, cement flooring) and colors, even under the same conditions of shade or direct sunlight exposure.
- .5Measurement Time: All measurements were taken during the afternoon at the school.



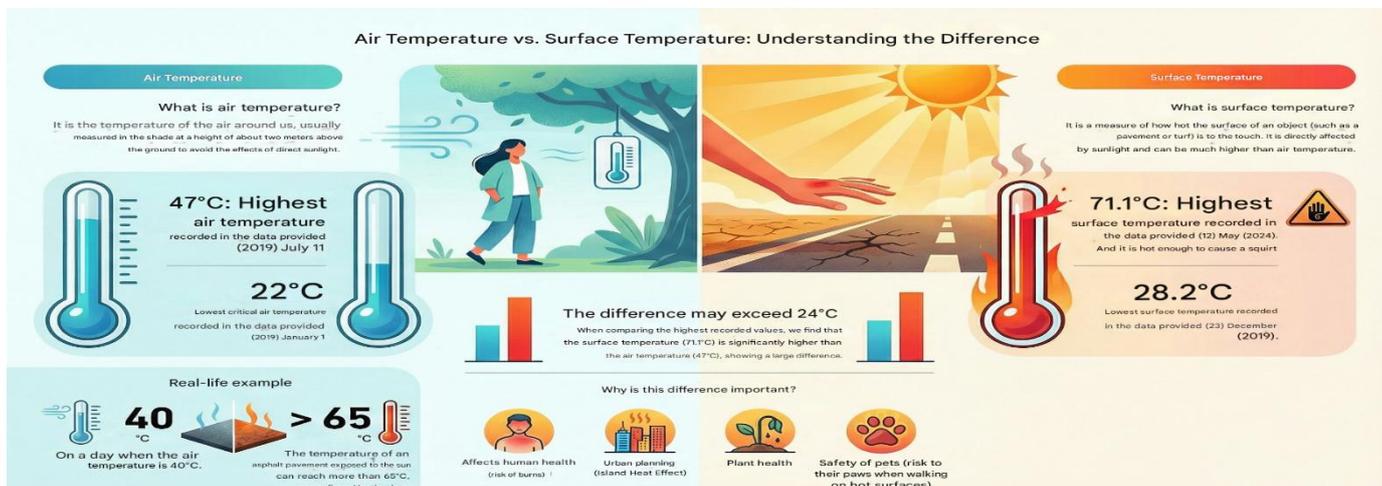
The main conclusion that can be drawn from these measurements is that the type of building material, its color, and its exposure to solar radiation have a direct and decisive effect on determining the surface temperature of school floors during the afternoon.

The conclusions can be summarized as follows:

**1 - Solar Effect and Thermal Hazards:** The significant and immediate rise in surface temperatures upon direct sun exposure indicates that unshaded surfaces (such as the one that recorded 39.6°C on the painted cement floor) absorb and store large amounts of solar energy. This can create an uncomfortable or hazardous environment during the midday heat.

**2 - Importance of Material and Color Selection:** Comparison between different materials reveals significant variations in thermal behavior. Painted cement surfaces recorded the highest readings (39.6°C) under sunlight, while white ceramic tiles under shade showed the lowest recorded surface temperatures (ranging from 18.6 to 19.9°C). This demonstrates that light colors and providing shade are effective strategies for reducing surface heat absorption.

**3 - Variation Among Materials:** The variation in readings recorded between different colored interlocking pavers (blue, green, and milky) confirms that material and color properties directly influence surface temperature behavior, even under the same exposure conditions. In general, the measurements conclude that the variation in surface temperatures is not random but is directly related to the composition and properties of the surfaces, which supports the need to plan for the use of materials with appropriate thermal properties in exposed areas.





To answer the second research question, which is:

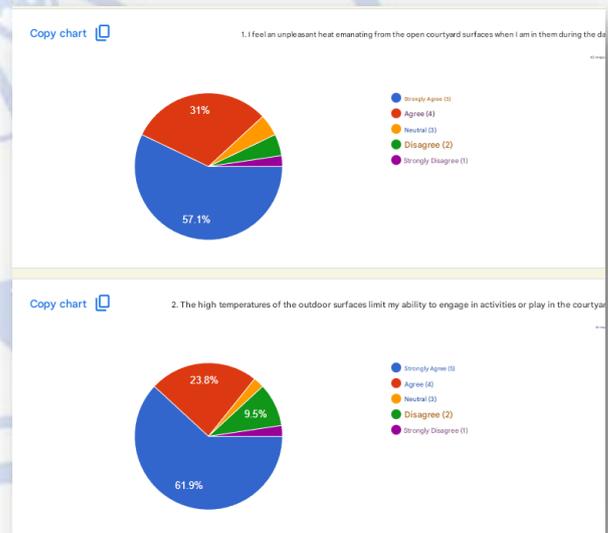
**How does an extreme rise in surface temperature affect students' and teachers' use of outdoor spaces in the school during the period when the highest temperatures are recorded (usually around solar noon)?**

A scientific questionnaire, a type of Likert scale (questions attached), was used and distributed to students and teachers via social media. Forty-two responses were collected, from which we can conclude the following:

1 - Impact on Comfort and Usage: This addresses items one and two, where participants indicated that they "feel uncomfortable heat" emanating from the floors and that "high surface temperatures limit the ability to engage in activities or play in the playground".

2 - Comparison of Surfaces (Manufactured vs. Natural): This is based on item three, which measures participants' perception of "a noticeable and comfortable temperature difference when standing on cultivated areas compared to concrete/asphalt areas".

3 - Role of Material/Color Properties: This integrates the scientific understanding presented in items five and ten, where respondents believe that "dark colors absorb more heat than light colors" and prefer using "light or reflective colors" to reduce heat.



4 - Shift Towards Sustainability: This reflects the overall theme of the questionnaire regarding the contribution of current materials to "increasing local global warming" (item 6), and strong support for replacing flooring with "environmentally friendly materials" (items 8 and 9) .

The main conclusion drawn from the questionnaire responses, which were analyzed using a five-point Likert scale [2, 3, 4, 5, 6], shows that there is a widespread awareness and strong agreement among respondents that the construction materials currently used in schoolyard flooring cause thermal discomfort, limit outdoor activities, and contribute to the local greenhouse effect, necessitating their replacement with environmentally friendly materials and light colors.

**The main conclusion can be further elaborated by the points that received the highest levels of agreement (5 – strongly agree and 4 – agree):**

1- Experiencing heat discomfort and limiting activities: Respondents expressed a feeling of “uncomfortable heat emanating from the open courtyard surfaces” (Item 1), and that “high surface temperatures limit the ability to engage in activities or play in the courtyard” (Item 2).

2- Clear preference for planted areas and awareness of thermal contrast: There is a strong sense of “a clear and comfortable temperature difference when standing on planted areas compared to concrete/asphalt areas” (Item 3).

3- Perception of the negative impact on the indoor environment: Respondents strongly believe that “the heat of the outdoor courtyards negatively affects the temperature of the classrooms overlooking them” (Item 4).

4- Recognition of the contribution of materials to global warming and a desire for change: Respondents believe that “the materials currently used in paving the school contribute to increased local global warming” (Item 6). As a result, there is overwhelming support for replacing flooring with "environmentally friendly" materials, even if they are slightly more expensive (items 8 and 9).

5- Awareness of the Role of Color: The prevailing belief is that "dark-colored flooring (such as asphalt) absorbs more heat than light-colored flooring" (item 5), and respondents prefer "using light or reflective colors in playground flooring to reduce heat" (item 10). In short, the survey underscores the need to address exposed hard flooring as a major cause of high surface temperatures and discomfort in the school environment, with a strong preference for environmental mitigation solutions such as replacement, landscaping, and the use of light colors.

To answer the third question:

### **How can long-term GLOBE data (from 2019 to 2025) contribute to a school's strategic plan to promote environmental sustainability and reduce the negative impacts of local climate change?**

An interview was conducted with Engineer Ehab Al-Halat, a Projects and Maintenance Engineer at the Directorate General of Education in Muscat Governorate, Projects and Maintenance Department. A series of questions were posed (interview questions attached), leading to the following conclusions:

The interview with Engineer Ehab Al-Halat provides essential answers that directly address how to leverage long-term GLOBE program data (2019-2025) in formulating a sustainable school strategic plan. This can be achieved through the following points:

#### **1- Transforming data into a "compass of persuasion" for decision-makers.**

Sources confirm that long-term data (such as the aforementioned six-year data) transcends mere theoretical projections to become empirical evidence. This data acts as a compass, guiding decision-makers to shift their focus from the "CAPEX" (Cost, Inception, Exception) to the "LCCA" (Cost, Lifecycle, Cost, and Allowance). Thus, the data contributes to demonstrating that sustainability is not merely an environmental choice, but a smart investment that reduces the school's operating expenses in the long run.

#### **2- Demonstrating the efficiency of materials in the local climate.**

The data collected by the students helps address structural concerns related to maintenance. By monitoring temperatures over the years, the school can demonstrate the importance of using materials that can replace or enhance current materials, as well as providing shade. This can also contribute to reducing the impact of surface heat transfer in the school building, and demonstrate how green spaces can help mitigate these effects if adopted in future school construction or the development of existing schools.

#### **3- Supporting Thermal Comfort and Academic Achievement Standards.**

The interview indicates that the strategic plan should balance structural efficiency with thermal comfort. Using GLOBE data allows the school to propose modifications to the outdoor flooring using materials with a high Solar Reflectance Index (SRI) to reduce heat absorption. The ultimate goal here is not merely technical, but to improve the learning environment so that students can use school grounds for longer periods without experiencing heat stress.

#### 4- Scientific Reliability and Sound Methodology.

The daily monitoring methodology and the use of periodic calibration devices, as the students did, lend high reliability and credibility to the results when presented to technical authorities. This transforms the research from a mere "casual observation" into a sound engineering study that can be relied upon in developing maintenance plans or new construction projects for the school.

#### 5- Implementation Roadmap (Pilot Areas).

The interview suggests starting with a "Pilot Area" initiative within the school. The strategic plan could adopt the transformation of a small corner of the school into a practical research model. Success in this small area will be the spark that leads to larger projects and aligns with Oman Vision 2040. In short, this data acts as a bridge between the students' scientific observations and the practical engineering and financial applications on the ground, transforming the school into a more humane and sustainable environment for future generations. To illustrate by analogy: Long-term GLOBE data can be likened to a building's "comprehensive health record"; just as a doctor cannot develop a long-term treatment plan for a patient based on a single blood pressure reading, an engineer or school principal cannot build a sustainability strategy without an accurate and comprehensive (health history) (thermal data) that shows how the school body (floors and buildings) reacts to local weather fluctuations over the years.



### Discussion of the results:

The discussion of the results of this research revolves around linking field scientific data, community perception, and engineering vision, in order to answer the research questions and achieve the study's objectives in promoting school sustainability, according to the following sequence:

#### First: The Role of GLOBE Observations in Understanding Local Climate Change (Answer to Question 1)

The results show that daily observations of surface temperatures are a crucial tool for scientists and students to understand the phenomenon of local warming.

- **Thermal Gap:** The data revealed a sharp contrast between surface and air temperatures. In May 2024, concrete surfaces (interlocking pavers) recorded a maximum temperature of 71.1°C, while the air temperature at the same time was 40.2°C. This difference of 30.9°C demonstrates that the existing flooring acts as a heat collector, increasing the temperature of the school's surroundings.
- **Material Behavior:** Measurements showed that non-vegetated, concrete surfaces exhibit a significant increase in heat compared to other materials, justifying the need to transition to more sustainable materials.

### Second: The Impact of High Temperatures on the Use of Outdoor Spaces (Answer to Question 2)

An analysis of a questionnaire completed by 42 participants revealed that the intense heat from rooftops directly and negatively impacts the learning environment and physical activity:

- **Restrictions on Activities:** Participants unanimously agreed that the heat emitted from exposed rooftops is "annoying" and limits their ability to engage in activities or play in the playground, especially during the midday sun.
- **Environmental Preferences:** The results demonstrated a high awareness of thermal contrast; there is a strong sense of a comfortable temperature difference between planted areas and concrete areas, which reinforces the desire for greenery.
- **Impact on Classrooms:** There is a widespread understanding that the heat from outdoor areas negatively affects the cooling of classrooms overlooking them, thus increasing the strain on cooling systems.

### Third: The Contribution of Long-Term Data to the Sustainability Strategic Plan (Answer to Question 3)

According to the interview with Engineer Ehab Al-Hatli, the GLOBE data spanning from 2019 to 2025 provides the school with a "roadmap" towards sustainability.

- **Scientific Persuasion:** This data transforms "casual observations" into a "rigorous engineering study" that convinces decision-makers to focus on the "Life Cycle Cost" (LCCA) rather than solely on the initial construction cost.



- **Improving the Learning Environment:** The data supports proposals to modify the flooring using materials with a high Solar Reflectance Index (SRI) to reduce heat absorption, thus achieving "thermal comfort" for students.

- **Pilot Area Initiative:** The study proposes to begin by converting small sections of the school as a pilot area for research, which aligns with Oman Vision 2040's goal of promoting environmental sustainability.

Overall Conclusion: The research objective is achieved by demonstrating that the use of reliable scientific data is the bridge connecting students' field observations with practical engineering and financial implementation. The shift towards more sustainable school floors is not just an aesthetic choice, but an environmental and health necessity to ensure a safer school environment for future generations.



## The general conclusion from the discussion:

### Research Conclusions

- **First:** Thermal Variation and Material Behavior: The study demonstrated a critical thermal gap between air temperature and solid (concrete) surfaces, exceeding 30°C. This confirms that traditional building materials in schools act as "heat reservoirs," contributing to the exacerbation of the small island urbanization phenomenon.
- **Second:** Environmental and Functional Impact on School Spaces: The results revealed a direct correlation between increased surface temperatures and restricted use of outdoor areas. Radiant heat reduces thermal comfort, hindering students' physical activities and consequently increasing the thermal load on adjacent classrooms.
- **Third:** Scientific Data as a Guide for Engineering Design: The research concluded that long-term GLOBE (2019-2025) data provides a reliable reference for supporting engineering decision-making. The shift towards materials with a high solar reflectance index (SRI) and the expansion of vegetation cover are technological necessities for achieving the sustainability standards adopted in Oman Vision 2040.
- **Fourth:** Economic and Environmental Feasibility: The research emphasizes the importance of moving from assessing "initial construction costs" to assessing "life-cycle costs" (LCCA), as investing in sustainable materials reduces long-term energy consumption and provides a healthier and safer learning environment.



## Research summary :

This study focuses on assessing environmental sustainability in the school environment by linking field data with community perception and engineering perspectives. The results, based on GLOBE program data (for the period 2019-2025), revealed a significant thermal gap of up to 30.9°C between concrete surfaces and air temperature, demonstrating that traditional flooring acts as a thermal collector, exacerbating local warming.

Qualitative and quantitative analysis showed that this thermal increase negatively impacts the quality of the learning environment, limiting students' outdoor activities and increasing the heat load on classrooms. The study concludes that relying on accurate scientific data is fundamental to supporting the shift towards using construction materials with a high Solar Reflectance Index (SRI) and implementing the concept of "Life Cycle Cost" (LCCA). The study recommends adopting pilot projects for developing schoolyards in line with the sustainability goals of Oman Vision 2040, to ensure a healthy and safe learning environment.



## Thanks and appreciation:

### **Acknowledgments:**

**Words of gratitude and appreciation permeate the pages of this research for everyone who contributed, supported, and encouraged us on our scientific journey to discover more about using observations and how to transform them into scientific research supported by recorded evidence over the years. We extend our deepest thanks to:**

- **School Administration and Teachers:** Special thanks to the Principal of Abdullah bin Salam Basic Education School and Mr. Aziz Al-Hadi, the program supervisor, for their support and for providing the optimal environment for completing this research.
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- **Experts and Specialists:** Special thanks to the Projects and Maintenance Department at the Directorate General of Education in Muscat Governorate.

**Friends and Colleagues:** The members of the GLOBE team for their assistance and continuous encouragement in preparing and presenting the research in the appropriate manner.



- Saeed Bin Nasser Al Kindi School. (November 30, 2025). Daily temperature measurements – surface temperature measurements. Al Amerat Governorate – Al Hajer area.
- Abdullah Bin Salam Basic Education School. (November 30, 2025). Daily temperature measurements – surface temperature measurements. Al Amerat Governorate – Al Amerat area.
- GLOBE Program. November 2025. Retrieved from <https://www.globe.gov>

#### **Books and Scientific References:**

- Al-Banna, Ali. (2021). Environmental Problems and the Conservation of Environmental Resources. Dar Al-Fikr Al-Arabi.
- Ghanem, Ali. (2020). Climatology. Dar Al-Masirah.
- Ministry of Higher Education and Scientific Research. (2018). Guide to Measuring Environmental Temperatures.

#### **Scientific Websites:**

- GLOBE Environmental Website, accessed November 15, 2025, [www.globe.gov](http://www.globe.gov)
- Oman Civil Aviation Authority - Meteorology Website, accessed December 20, 2025, [met.caa.gov.om](http://met.caa.gov.om)
- National Aeronautics and Space Administration (NASA). (n.d.). What is an Urban Heat Island? NASA Kids. [Retrieved from the official website on January 1, 2026]: <https://science.nasa.gov/kids/earth/what-is-an-urban-heat-island/>



## Research attachments:

### 1 - The Interview with the Engineer”

**Peace, mercy, and blessings of God be upon you. Dear Engineer...../**

Students Yousef Al-Muslihi and Basil Al-Maliki from Abdullah bin Salam School in Al-Amerat, under the supervision of Mr. Aziz Al-Hadi, Assistant Principal, are conducting scientific research on the impact of exposed school floors and their relationship to surface heat. Data has been collected over five years, and these observations have been recorded on an international website.

The students wish to conduct an interview to gather information on the importance of using materials with a lower environmental impact and to propose alternative materials that reduce surface heat and are sustainable.

The students also wish to learn from the interview the reasons considered when building schools and the reasons that prevent the use of certain materials in the construction or maintenance of new or existing schools.

All information will be used for scientific research purposes only, and the interview will be published in the research after analysis by the students.

Note: The research topic has been chosen to be "The Importance of Recorded Observations by Students and Their Impact on the Environment, School Community, and Local Community." - Question 1: Please introduce yourself first:

Answer: Engineer Ehab Al-Halat, Engineer at the Directorate General of Education, Projects and Maintenance Department.

Question 2: Given that the school's roofing material is concrete/interlocking pavers, what are the basic construction standards applied in the Sultanate of Oman for selecting this specific type of material to cover school exterior spaces?

Answer: The engineer stated that the primary criterion is compressive strength, which varies depending on the location of the interlocking pavers. Thicker interlocking pavers are used for exterior areas (parking lots and bus stops), while thinner pavers are used for interior areas.

Question 3: When setting design standards for school exterior flooring, how is a balance struck between the material's durability and lifespan (a structural property) and its thermal properties (its ability to absorb or reflect heat)?

The engineer responded: As a construction engineer in the Sultanate, I believe that designing school exterior flooring in our desert climate requires a careful balance between structural efficiency and thermal comfort. According to the Oman Building Code and the Ministry of Education's standards, this balance is achieved by selecting materials with a high Solar Reflectance Index (SRI) to minimize heat absorption, while ensuring high mechanical strength capable of withstanding the weight of emergency vehicles. We also focus on textured surfaces to resist slipping and ensure student safety, while using locally sourced materials that are easy to clean and maintain, thus preventing sand and dust buildup. This ensures the material's longevity without compromising the building's cooling capacity.

Question 4: As an engineer, how do you view the importance of long-term data (such as the data we collected over five years) in changing the convictions of designers and decision-makers? Can these figures serve as evidence supporting the shift towards green or sustainable schools?

Long-term data represents "real-world proof" for engineers, exceeding theoretical expectations. It shifts the focus of persuasion from the initial cost of construction (CAPEX) to the cost of lifecycle (LCCA), demonstrating to decision-makers, with concrete figures, that sustainability is a smart investment that reduces operating and maintenance costs in the long run. This data also helps alleviate designers' structural concerns by demonstrating the resilience and thermal efficiency of green materials in Oman's harsh climate over a five-year period. This transforms the "green school" from a mere environmental concept into an evidence-based engineering and economic necessity that ensures student comfort and the sustainability of national resources.

Question 5: When designing new schools, what are the primary criteria governing the selection of outdoor flooring? Is student "thermal comfort" in the schoolyard a fundamental criterion, or are durability and cost the only priorities?

Answer: The engineer stated that durability is considered a primary factor.

Question 6: Are the environmental problems associated with these surfaces, specifically the exposed school floors, considered during construction?

Answer: Some sustainable materials are designed to last a long time without maintenance or offer better weather resistance. To your knowledge, have these materials been used in any schools? If so, what materials are they?

The engineer replied that all materials used are weather-resistant because the cement used is sulfate and alkali resistant. Specifically, SRc cement is used, resulting in superior resistance. Question 7: From a structural perspective, does the continuous rise in surface temperatures affect the lifespan of these pavers or lead to increased maintenance costs?

Answer: The engineer says that interlocking pavers are not affected by high temperatures because of the joints used during installation, which reduce shrinkage and expansion caused by temperature differences.

Question 8: In conclusion, what advice do you have for us as young researchers to spread environmental engineering awareness that will contribute to improving our schools' environment in the future?

As an engineer who sees you as the future of development in the Sultanate, my advice to you is to be "the voice of numbers and the image of reality." Engineering awareness is not spread through construction-related speeches, but through smart solutions that touch people's lives.

Here is a simple roadmap for spreading this awareness effectively:

- Simplify the "language of engineering": Don't just talk about "thermal parameters," but talk about "student comfort." Instead of saying "the temperature dropped 5 degrees," say "students can now play in the playground for longer without fatigue." When you link sustainability to health and activity, you'll find a receptive audience among administrators and parents.

- Make your research "visual": We engineers believe what we see. Photograph the flooring with thermal imaging to show the difference between traditional and sustainable interlocking pavers. These heat-generated "color" images are the most powerful visual persuasion tool for changing old beliefs.

- Focus on "Omani-led solutions": Be proud of your groundbreaking research into our local challenges (sun, dust, etc.). Share your findings on professional networking platforms like LinkedIn and at local tech forums. A recent study suggests that "school-work" is not a luxury, but rather aligns with Oman Vision 2040.

- Start with "evaluation models": Your schools have been approved to transform just a small corner into a model (pilot area) and apply your ideas. Small, tangible successes are the spark that ignites larger projects.

My final piece of advice: Don't stop at collecting data; turn it into a "success story." You're not just looking at "tiles and flooring"; you're looking at how to build a more humane and sustainable economic environment for future generations.

- Please write any comments or feedback that will help us build the research. Note that we use equipment that is calibrated before use. This equipment, the light gun, is also adjusted almost daily for the flooring (interlocking pavers).

As an engineer, I believe your methodology in using instruments, which involves periodic renewal and reliance on public observation for reliable (highly reliable) intelligent research, and the credibility of presenting results to technical samples, is a graduation practice that elevates research from the realm of "casual observation" to that of "rigorous engineering study."

- Thank you very much for your time and effort. Regards, the students of the GLOBE program at Abdullah Bin Salam Basic Education School (Grades 5-8).

## 2 - Information extracted from Excel and the Visualize Data program

### تحليل النتائج المستخرجة من موقع GLOBE



التاريخ	درجة الحرارة السطحية / الهواء (C)	درجة الحرارة السطحية (C)
16/12/2019	37.9	37.9
19/02/2020	47.7	33.4
14/09/2023	54.2	41.6
26/11/2023	44	32
21/11/2023	47.7	34.5
07/04/2024	61.2	35.8
12/05/2024	71.1	40.2
19/05/2024	67.1	44.1
21/05/2024	70	37.1
02/10/2024	52.7	38.2
10/10/2024	63.6	41.6
14/10/2024	47.1	37.8
09/11/2024	57.4	46.5

مقارنة بين درجة حرارة الهواء وحرارة السطح

التاريخ	درجة الحرارة السطحية / الهواء (C)	درجة الحرارة السطحية (C)
16/12/2019 08:01	37.9	28.7
18/12/2019 08:02	40.5	28.9
22/12/2019 08:04	36.3	30.2
23/12/2019 08:04	28.2	25.1
17/02/2020 08:20	41.2	40
19/02/2020 08:19	47.7	36.7
20/02/2020 08:19	41.5	34.1
25/02/2020 08:19	44.8	35.1
01/03/2020 08:18	37.4	32.1
02/03/2020 08:18	40.7	32.8
04/03/2020 08:17	44.4	32.7
09/03/2020 08:16	42.2	36.8
11/03/2020 08:15	48.7	32.8
12/03/2020 08:15	41.9	33.3
14/09/2023 08:01	54.2	28.2
24/09/2023 07:58	56.5	28.4
26/09/2023 07:57	59.5	29.2
27/09/2023 07:57	65	26.6
02/10/2023 07:55	61.1	26.4
03/10/2023 07:55	62.3	29.7
05/10/2023 07:54	63	26.4
09/10/2023 07:53	57.2	28.2
11/10/2023 07:52	61.5	28.4
15/10/2023 07:51	60.4	26.6
16/10/2023 07:51	57.2	29
22/10/2023 07:50	51	29.2

School Name	Site Name	Usrid	Latitude	Longitude	Elevation	Measured At	Solar Measured At	Solar Noon At	Average Surface Temperature C	Surface Condition	Average Snow Depth Mm
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2019-12-16 08:33:00	2019-12-16 12:31:00	2019-12-16 08:01:00	37.9	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2019-12-18 08:23:00	2019-12-18 12:19:00	2019-12-18 08:02:00	40.5	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2019-12-22 08:43:00	2019-12-22 12:38:00	2019-12-22 08:04:00	36.3	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2019-12-23 08:34:00	2019-12-23 12:28:00	2019-12-23 08:04:00	28.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-02-17 08:27:00	2020-02-17 12:04:00	2020-02-17 08:20:00	41.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-02-19 08:32:00	2020-02-19 12:09:00	2020-02-19 08:19:00	47.7	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-02-20 08:44:00	2020-02-20 12:22:00	2020-02-20 08:19:00	41.3	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-02-25 08:52:00	2020-02-25 12:30:00	2020-02-25 08:19:00	44.8	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-01 08:30:00	2020-03-01 12:09:00	2020-03-01 08:18:00	37.4	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-02 08:33:00	2020-03-02 12:12:00	2020-03-02 08:18:00	40.7	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-04 08:45:00	2020-03-04 12:25:00	2020-03-04 08:17:00	44.4	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-09 08:29:00	2020-03-09 12:10:00	2020-03-09 08:16:00	42.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-11 08:28:00	2020-03-11 12:10:00	2020-03-11 08:15:00	48.7	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2020-03-12 08:33:00	2020-03-12 12:15:00	2020-03-12 08:15:00	41.9	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-09-14 08:31:00	2023-09-14 12:30:00	2023-09-14 08:01:00	54.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-09-24 08:13:00	2023-09-24 12:15:00	2023-09-24 07:58:00	56.5	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-09-26 08:18:00	2023-09-26 12:22:00	2023-09-26 07:57:00	59.5	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-09-27 08:17:00	2023-09-27 12:21:00	2023-09-27 07:57:00	65	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-02 08:50:00	2023-10-02 12:56:00	2023-10-02 07:55:00	61.1	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-03 08:47:00	2023-10-03 12:53:00	2023-10-03 07:55:00	62.3	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-05 08:17:00	2023-10-05 12:24:00	2023-10-05 07:54:00	63	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-09 08:25:00	2023-10-09 12:33:00	2023-10-09 07:53:00	57.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-11 08:25:00	2023-10-11 12:24:00	2023-10-11 07:52:00	61.8	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-15 08:20:00	2023-10-15 12:30:00	2023-10-15 07:51:00	60.4	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-16 08:25:00	2023-10-16 12:35:00	2023-10-16 07:51:00	57.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-22 08:23:00	2023-10-22 12:34:00	2023-10-22 07:50:00	51	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-23 08:10:00	2023-10-23 12:21:00	2023-10-23 07:50:00	55.3	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-10-26 08:10:00	2023-10-26 12:22:00	2023-10-26 07:49:00	51.2	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-01 08:11:00	2023-11-01 12:23:00	2023-11-01 07:49:00	42.7	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-05 08:47:00	2023-11-05 12:59:00	2023-11-05 07:49:00	41.8	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-09 08:21:00	2023-11-09 12:23:00	2023-11-09 07:49:00	50.4	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-12 08:24:00	2023-11-12 12:35:00	2023-11-12 07:50:00	43.1	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-14 08:15:00	2023-11-14 12:26:00	2023-11-14 07:50:00	47.4	dry	
Said bin nasser alkindi basic school	حرارة السطح في الابتدائية	1264716	23.40774	58.4961	5	2023-11-15 08:02:00	2023-11-15 12:12:00	2023-11-15 07:50:00	56.9	dry	

Measurements | Data Counts | School Info | Site Info | Photos

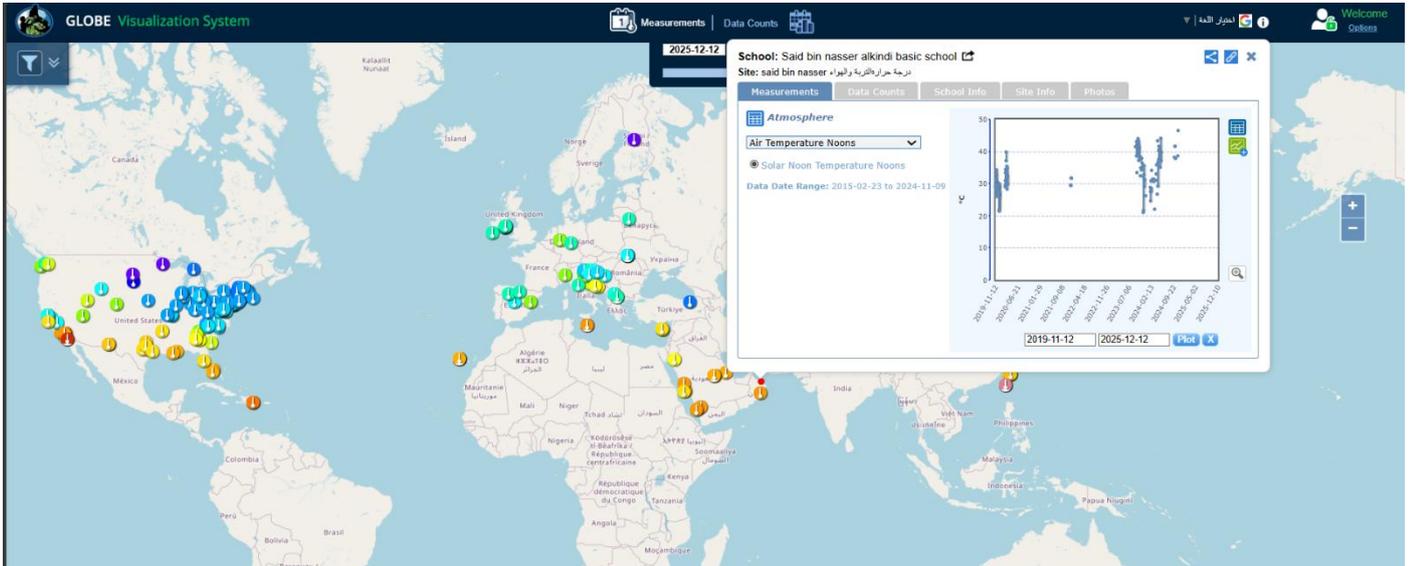
Atmosphere

Surface Temperature Noons

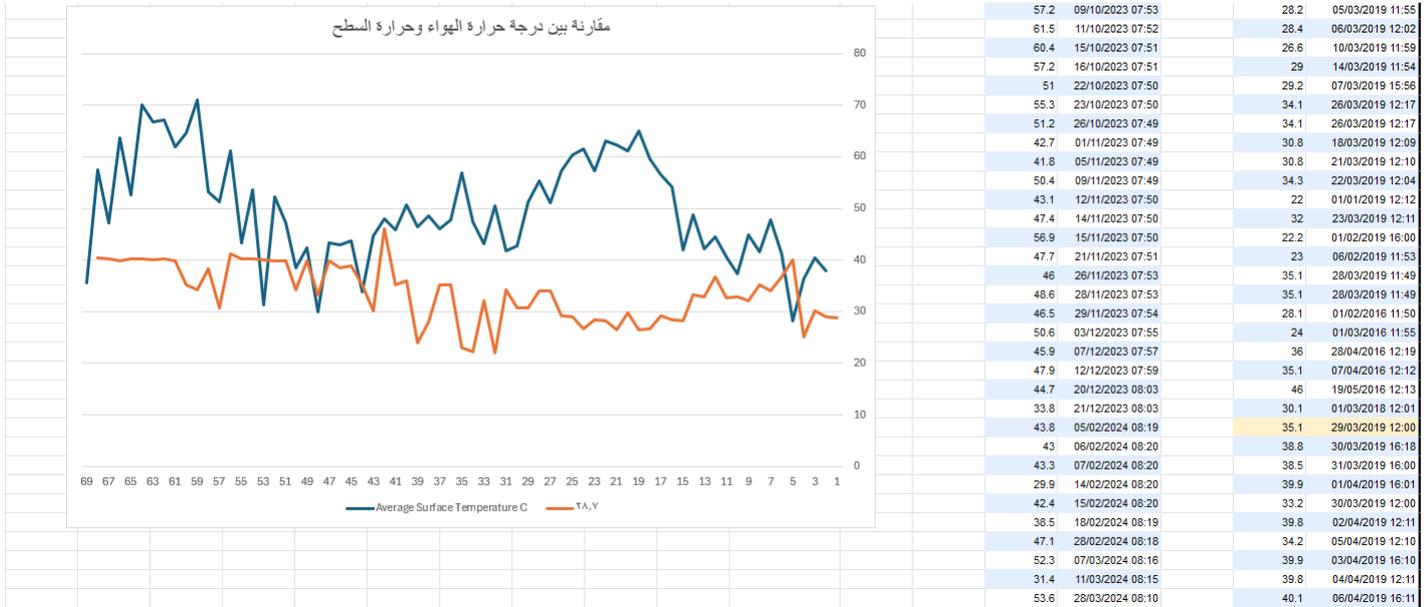
Average Surface Temperature

Data Date Range: 2019-12-16 to 2025-12-01

2019-01-01 | 2025-12-12 | Plot X



		38.5	18/02/2024 08:19		39.8	02/04/2019 12:11
		47.1	28/02/2024 08:18		34.2	05/04/2019 12:10
		52.3	07/03/2024 08:16		39.9	03/04/2019 16:10
		31.4	11/03/2024 08:15		39.8	04/04/2019 12:11
		53.6	28/03/2024 08:10		40.1	06/04/2019 16:11
		43.4	04/04/2024 08:08		40.3	07/04/2019 16:12
		61.2	07/04/2024 08:07		40.3	08/04/2019 16:31
		51.2	21/04/2024 08:04		41.1	09/04/2019 12:01
		53.2	09/05/2024 08:02		30.8	18/03/2019 16:09
		71.1	12/05/2024 08:02		38.2	01/04/2019 16:19
		64.7	13/05/2024 08:02		34.3	21/03/2019 15:57
		61.9	18/05/2024 08:02		35.1	28/03/2019 15:47
		67.1	19/05/2024 08:02		39.8	02/04/2019 16:01
		66.7	20/05/2024 08:02		40.3	07/04/2019 12:31
		70	21/05/2024 08:02		40.1	03/04/2019 12:02
		52.7	02/10/2024 07:55		40.2	04/04/2019 16:08
		63.6	10/10/2024 07:52		40.3	08/04/2019 11:56
		47.1	14/10/2024 07:51		39.8	05/04/2019 12:02
		57.4	09/11/2024 07:49		40.2	06/04/2019 16:04
		35.6	01/12/2025 07:55		40.5	10/04/2019 12:11
					32.2	15/04/2019 12:18
					40.3	09/04/2019 12:12
					40.3	08/04/2019 12:11
					39.1	10/04/2019 12:12
					38.7	11/04/2019 12:12
					34.2	16/04/2019 12:19
					36.5	17/04/2019 12:14
					36	21/04/2019 12:06
					38.6	22/04/2019 12:17
					41.5	23/04/2019 12:17
					41.9	23/04/2019 12:25
					41.9	25/04/2019 12:26



### 3 - Questionnaire questions with images of the answers (some illustrative images only):

**Survey Title: The Impact of Surface Heat on School Floors and General Comfort**

Target Group: School Community (Students, Teachers, Administrators, Parents). Objective: To measure awareness of the impact of building materials on heat and the acceptance of sustainable solutions.

(2) Disagree, (1) Not (Strongly Agree)

Please select the score that best reflects your opinion by placing a checkmark (✓) next to each statement: (5) Strongly Agree, (4) Agree, (3) Neutral, (2) Disagree, (1) Not (Strongly Agree)

1 - I feel an unpleasant heat emanating from the open courtyard floors while I am there during the day.

Strongly Agree (5)

Agree (4)

3. I feel a clear and comfortable temperature difference when standing in grassy areas compared to concrete/asphalt

Strongly Agree (5)

Agree (4)

Neutral (3)

Disagree (2)

Strongly Disagree (1)

4. I believe that the heat of outdoor areas negatively affects the temperature of the surrounding seasons.\*

Strongly Agree (5)

Agree (4)

Neutral (3)

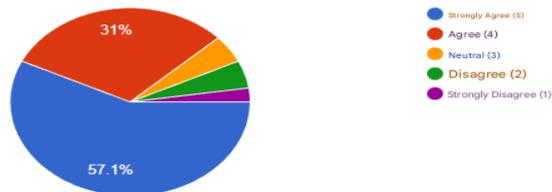
Disagree (2)

Strongly Disagree (1)

Copy chart 

1. I feel an unpleasant heat emanating from the open courtyard surfaces when I am in them during the day.

42 responses



Copy chart 

2. The high temperatures of the outdoor surfaces limit my ability to engage in activities or play in the courtyard.

42 responses

