Hot or cold? But why? Really?! Hmmm ...

GLOBE students

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Summary

This study investigates how different surfaces at our school absorb heat and why their temperatures vary. Students measured surface temperatures in three areas: concrete, synthetic turf, and an orchard, using GLOBE protocols and infrared thermometers. Data was collected over two weeks at the same time each day. Our pupils' everyday observations are that certain parts of our school feel warm, or at times even hot while others remain relatively cold. It seems that this trend is persistent throughout the year, though to various degrees, depending on the season. These findings highlight the importance of green spaces in reducing temperature and improving comfort. Students shared their results with local councils, advocating for more greenery in urban areas. They also explored the link between rising temperatures and reduced rainfall.

Keywords: surface temperature, cement, artificial turf, soil, GLOBE protocols

Research questions

The main research question seeks to explain the temperature difference over a large swathe of land, constituting our school's whole area. Some pertinent questions include the following:

- Why do surfaces have different temperatures at the same time of day or year?
- What causes such a difference in temperature?
- What can one do differently to avoid the extreme temperatures?
- What lessons can we draw from these observations?
- Are our observations similar or different from those of other places on earth? And if so, why?

Objectives set

- To measure three surfaces of different texture for two weeks with a time interval in between
- To compare the temperatures of the various selected surfaces
- To draw conclusions and projections based on such conclusions
- To compare these conclusions, if possible, with other observations done in different countries

The above research questions and objectives are important to understand, discuss, and further improve on them. Measuring the temperature of various bodies means that one needs to plan to avoid problems later. For example, knowing which surfaces absorb the most heat energy in a specific time, will help the industry design houses capable of keeping a steady internal temperature without the need for an air conditioner, thus reducing the electricity consumption which will in turn help to reduce global warming. One can also study the impact of variables on surfaces that contribute to a lowering or increase in temperature. Small changes by everyone mean bigger changes on a larger scale.

Gaining ground information will help address pupils' concern about the Earth's environment which will in turn empower them to make, adjust and own decisions in favour of a more environment friendly world. One must cross the bridge between excessive consumption (hoarding) versus responsible consumption.

Research Methods

The suspicion of our pupils, that is, that different surfaces absorb heat differently and coupled with other conditions were reinforced after a discussion with the teacher of science. During the lesson, they measured the temperature of white, black and green surfaces in the sun. From the observations, they noted that black surfaces absorb more heat than the other surfaces for a given time in the sun. This was further 'complicated' and made more interesting if there was the presence of shade in the form of clouds or trees. Actual readings of the surfaces, later, confirmed our pupils' research questions.

Three sites on the school grounds (see Figure 1) were chosen for this study as follows:

- Site A had a concrete surface.
- Site B had an artificial turf surface.
- Site C was in the school's orchard.

Figure 1 Study sites on an aerial view of the school

Materials used

- Infrared Thermometer
- Data logger
- 3 Datasheets, one for each study site
- Clipboard and pen

Data collection

All the pupils were trained in the GLOBE protocols. They were shown how to hold the infrared thermometer in relation to their outstretched hands. They were also instructed on how to use the data logger to measure the humidity, the air temperature, and the air pressure. These seem to be trivial things, but in reality, one has to be as quick as it is possible to gather the corresponding data within the shortest possible time. This procedure also helped our pupils to remain focused and alert during this time.

Two sets of reading sessions were done, spread over two weeks with a few days' span between them. Readings were carefully taken during approximately the same time of the day, usually at around 12.30pm to take into consideration the length of sunlight and the position of the sun as the latter varies along the day. The climatic conditions could also play a significant role.

It was felt necessary to adopt this approach because lately, the atmospheric conditions have become quite uniform. Taking two similar samples in two different time spans might give one a better opportunity to study different situations.

Week 1	Monday	16th December 2024
	Friday	20th December 2024
Time Interval		
Week 2	Monday	27th January 2025
	Friday	31st January 2025

Nine surface temperature readings were taken at each area for each day (see Figures 2, 3 and 4). This means that 90 different readings were taken for each area. This totalled 270 readings

for the three areas over two weeks. Moreover, atmosphere parameters including air temperature, humidity, and air pressure were measured from one of the sites (see Figure 5). One must remember that all data was collected during their break time from the lessons. This shows the pupils' determination to complete this project.

Figure 2 Data collection from study site A – cement surface

Figure 3 Data collection from study site B – artificial turf

Figure 4 Data collection from study site C – school orchard

Figure 5 Measuring weather parameters using data logger

After the observation period, all data was uploaded to the GLOBE database base. The screenshots below show data uploaded on the GLOBE website during the observation period (Figures 6, 7, 8, 9, 10 and 11). The data presented was quite impressive and interesting.

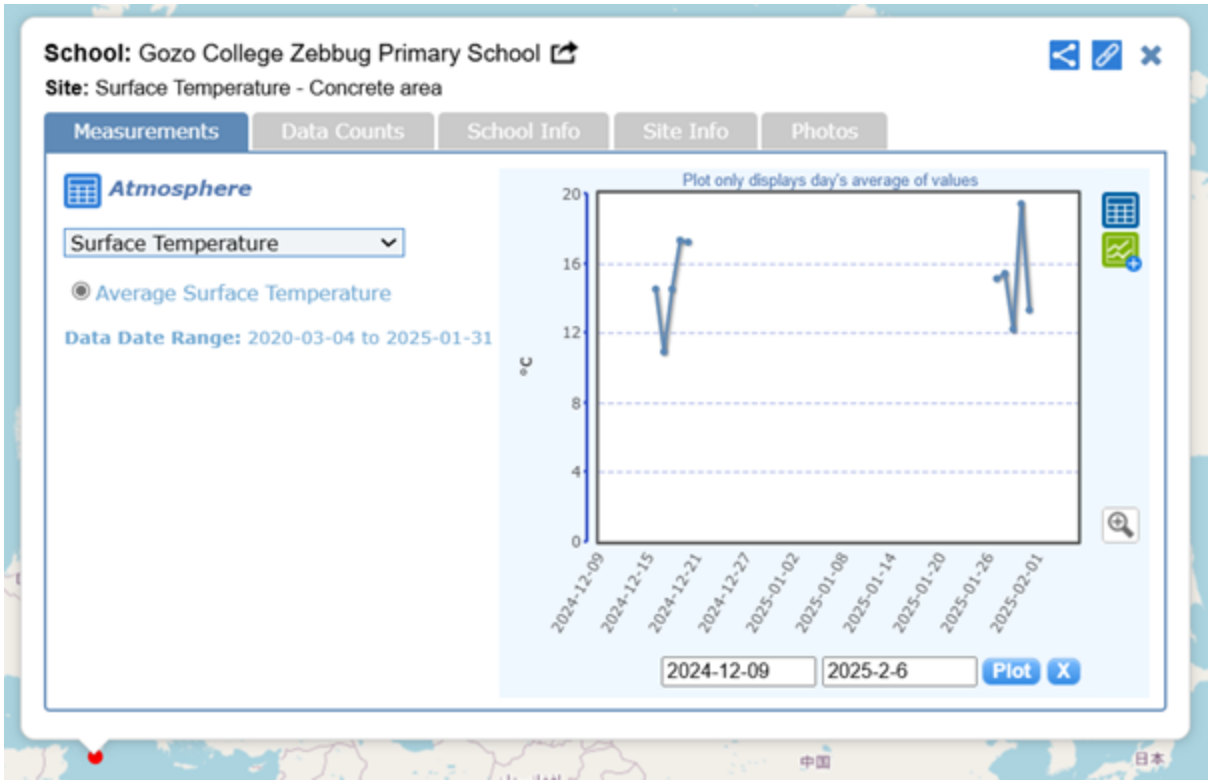

Figure 6 Surface Temperature (Concrete) plot of VIZ GLOBE

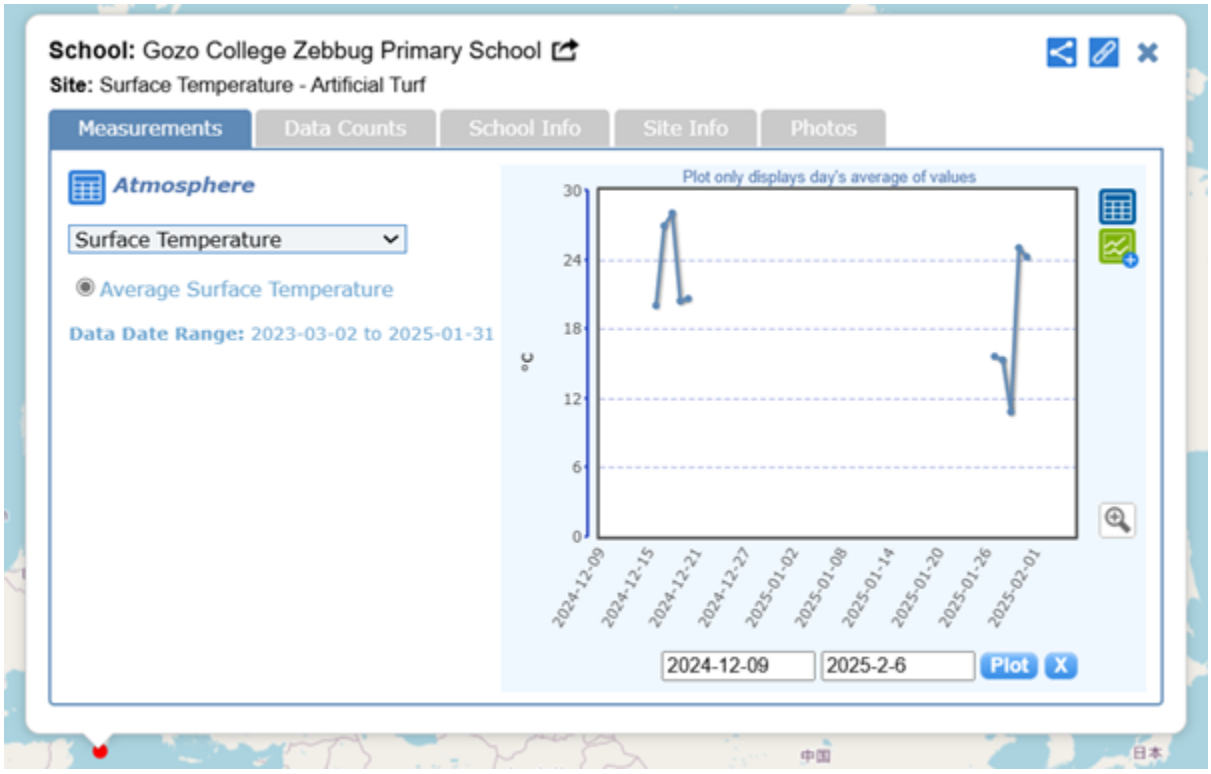

Figure 7 Surface Temperature (Artificial Turf) plot of VIZ GLOBE

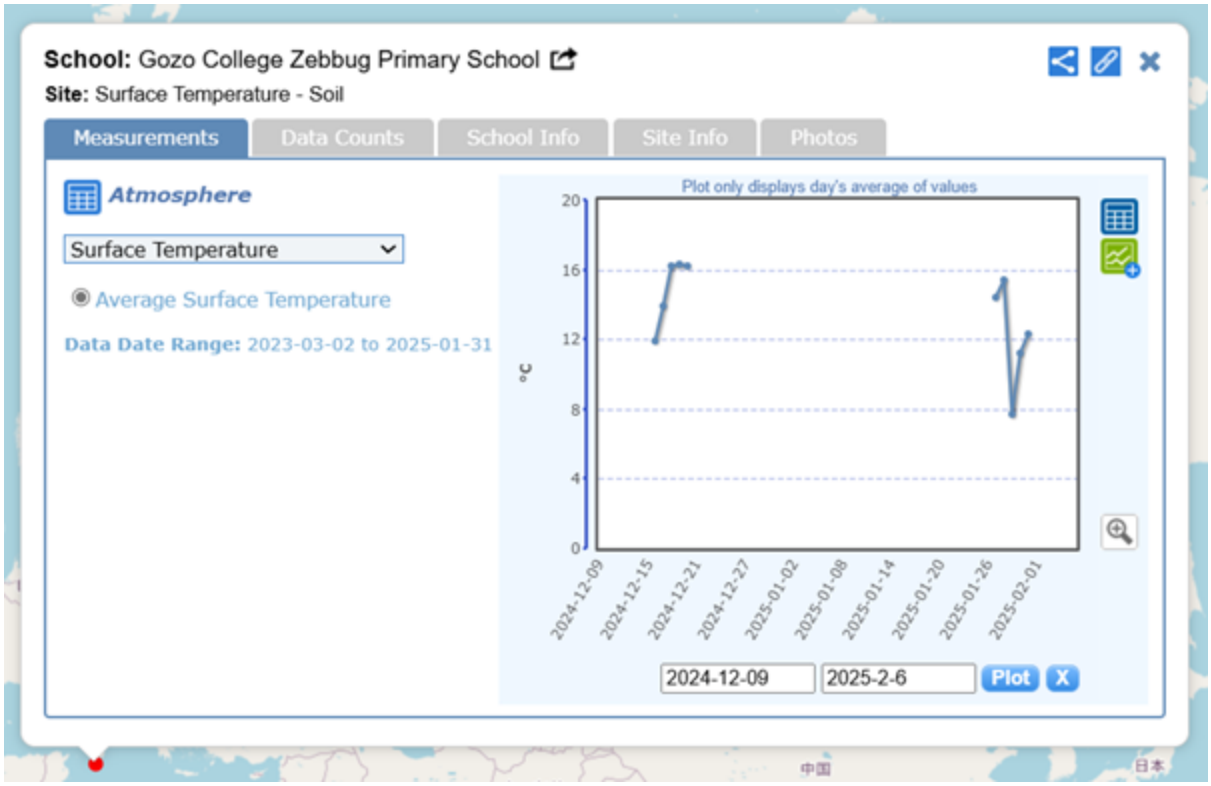

Figure 8 Surface Temperature (Soil) plot of VIZ GLOBE

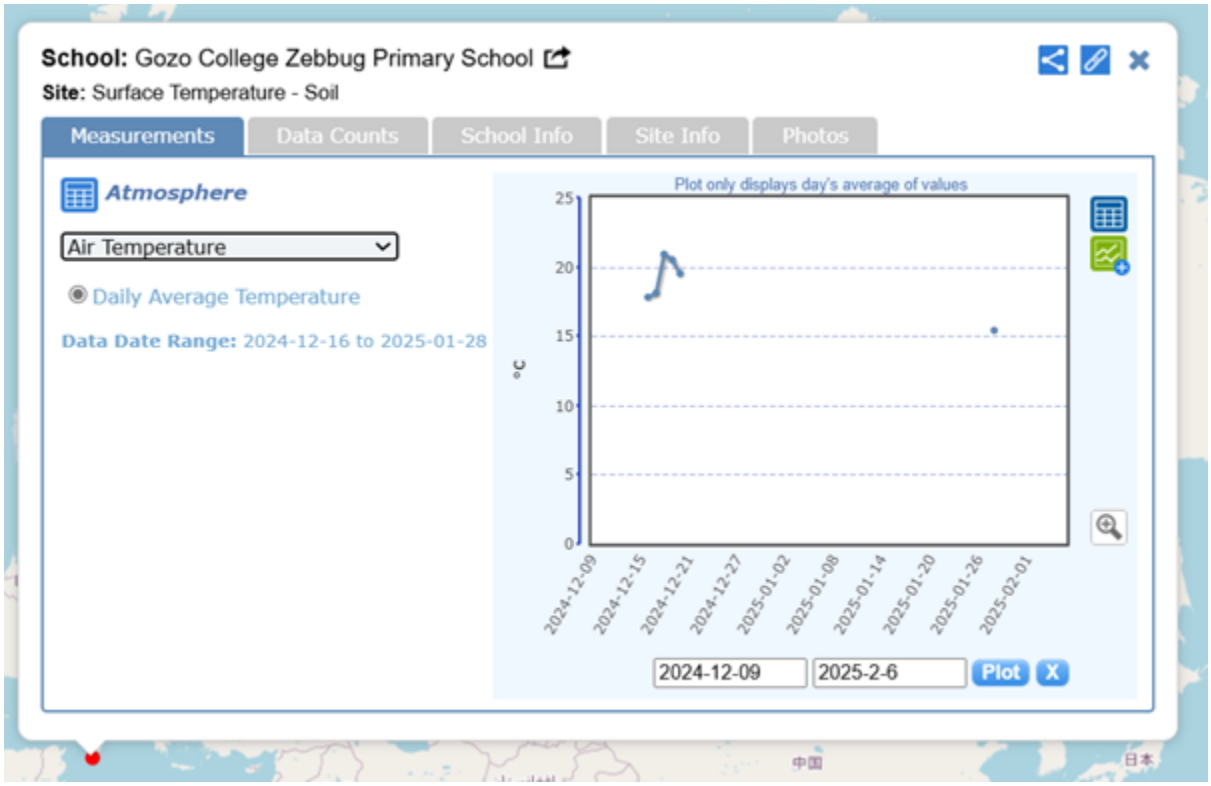

Figure 9 Air Temperature plot of VIZ GLOBE

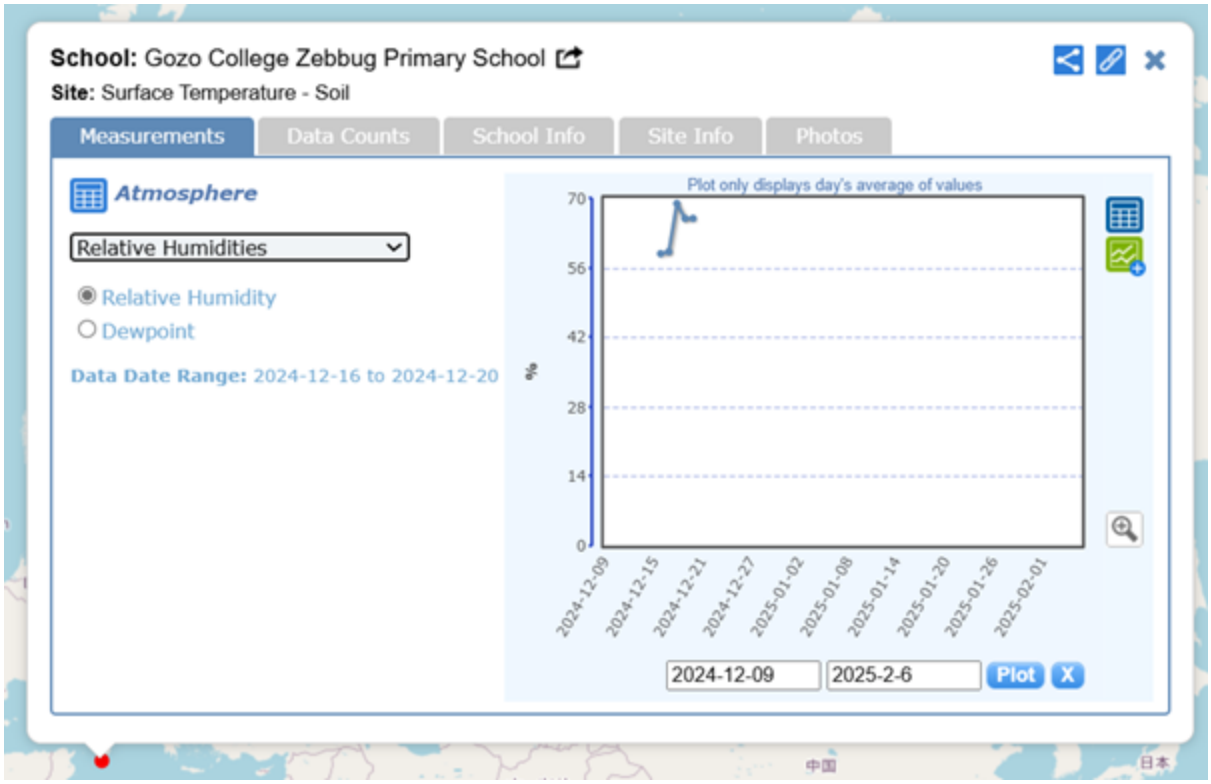

Figure 10 Humidity plot of VIZ GLOBE

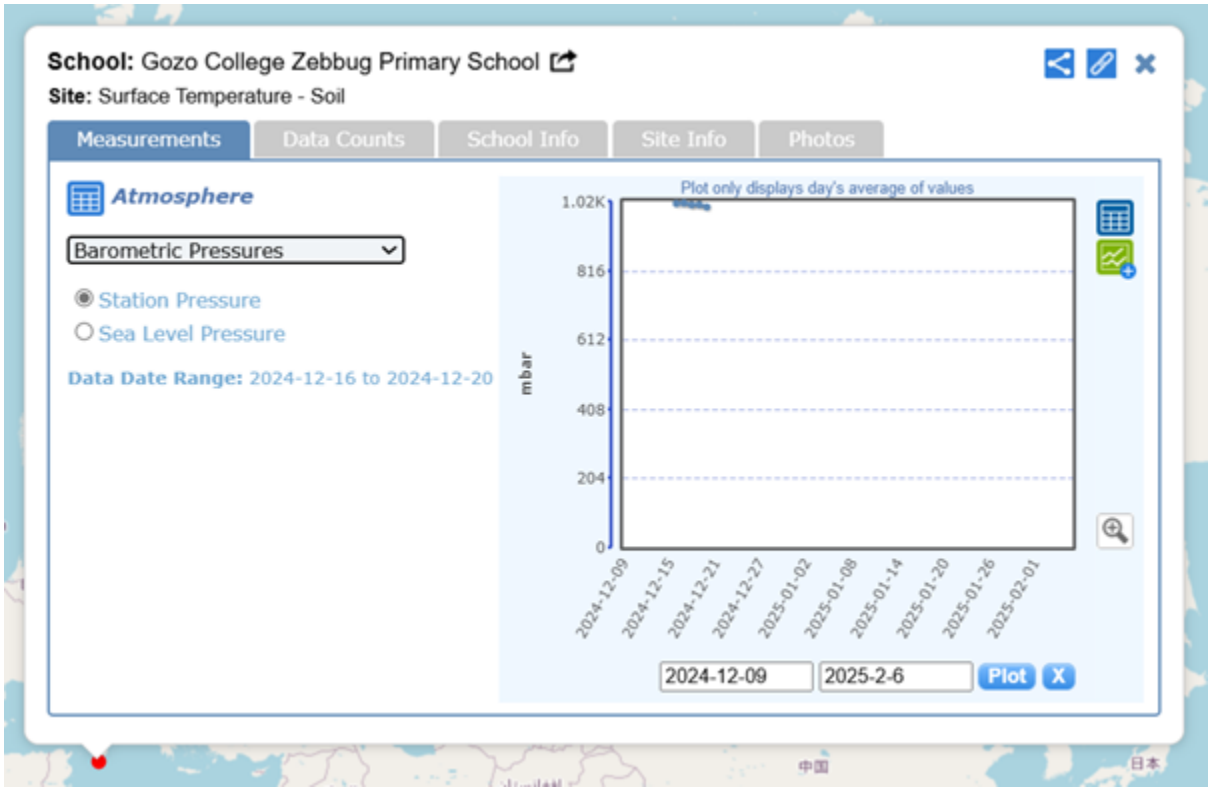

Figure 11 Air Pressure plot of VIZ GLOBE

Conclusion

From the observations of the temperatures of the various surfaces as taken by themselves, the pupils came to the following conclusions.

- Surface Temperature – Concrete

It was noticed that when the concrete surface was wet, the temperature varied a little but, when the surface was dry, the temperature could vary as happened on the 17th December and 30th January but not on the 29th January

- Surface Temperature - Soil

It was noticed that the temperature remained relatively uniform along the surface whether it was dry or wet. This was the coolest surface from the other two.

- Surface Temperature – Artificial Turf

It was noticed that the temperature was the same along the surface but was higher where there was a larger concentration of black rubber granules. Overall, this area maintained a highest temperature compared to the other two surfaces even in cold and wet conditions. This means that black surfaces absorb most heat in a set time over other surfaces.

These findings are important because, as deduced by the pupils themselves, they give an insight of how mankind should handle global warming. 'Much said – little done' and 'Walk the talk' were common anecdotes used by the pupils while surveying the results of the surface temperature.

The pupils noticed the breeze and cool atmosphere which surrounded Area C and proposed that more green breathing spaces should be earmarked in the local community to help people relax and at the same time they will keep the temperature low. To this end, the pupils involved in this study will be sending an email to the Zebbug Local Council and to the Pupils Local Council

(The Foundation for the Well-being of Society) sharing with them the results and telling them to include green areas among built-up areas to keep the temperature low which is good for the inhabitants and for Mother Earth.

Pupils also realised why they enjoyed learning outside the classroom as there was greener spaces, fresh air, and cooler temperatures.

This study was also combined with another study 'Rain and Flooding'. It was found that rain in our country has become scarce and the land dry – which in turn contributes to even higher temperatures. One needs to further study this connection.

Follow-on research and actions

A practical result even on a small scale is the glacier-ripple effect. This consists of installing small-sized mirrors on the soil so that heat is reflected in the atmosphere. Hence, this helps cool down the earth, offsetting the greenhouse effect generated by the Carbon Dioxide in the atmosphere. We will be replicating the effect glaciers have in contributing to a lowering of the earth's temperature. Sadly enough, glaciers are retreating due to global warming and this will be a small contribution to the whole world. We hope that this movement gains momentum so that other people join in and the little of the many, will result in big changes.

Impact of working with a project mentor

This proved to be critical to the conclusion of this project. Ms Ramona Mercieca was supportive throughout the project in terms of advice and practical solutions.

References

GLOBE teacher guide https://www.globe.gov/ (Accessed October 2024)

GLOBE Science Data Visualization https://vis.globe.gov/GLOBE/ (Accessed February 2025)

Badge Descriptions/Justifications:

I am a Data Scientist

Students analysed their own data (from their measurements). They were able to analyse graphs to interpret the data. From the data analysis, the students answered their research questions and made suggestions for future research.

I make an Impact

The students shared their research with the local community and decided to take part in The GLOBE Bloom and Buzz project organised by GLOBE Malta. The project involved planting shrubs and plants to attract bees and increase vegetation in the school garden and community (Figure 12). Once the shrubs and plants grow, they will help reduce the Urban Heat Island Effect.

I am a STEM storyteller

The research was shared on social media, school Facebook page, and with the local council of Zebbug (Figure 13).