

Do different floors of our school have different average temperatures compared to the outside temperature?

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Abstract

We were curious about the air and surface temperatures around the school. Our hypothesis was that the different floors of the school have different temperatures and that the temperatures increase as you go up. We went to different floors of our school and collected data. Our results concluded that our hypothesis was wrong, because it was getting colder as we went up on each floor. With the help of our GLOBE mentors, Dr. C and Sara, Mrs. Smith, and our maintenance director Mr. Hatfield, we were able to investigate our question and learn about the importance of heating a facility like our school.



Research Question

Our research question is: Do different floors of our school have different average air temperatures and how do those temperatures compare to the outside temperature?

Our hypothesis is that it will be warmer on higher floors of the building and lower floors of the building will be a little cooler. The reason we think this is because warm air heats up near the surface of the earth and rises. Air molecules move faster which creates more space between those molecules.



This photo is of us collecting surface temperatures on the roof

Introduction

Surface temperature is a measurement that can be observed with an IRT or Infrared Thermometer. We were curious about this question because students discuss how different floors feel dramatically warmer or cooler than others throughout the school day. When researching this topic we discovered it is important to keep in mind different types of surfaces absorb heat differently as well as different colors. As stated in our hypothesis heat rises, we learned this from some research we did on my NASA Data.



An interview with Mr. Hatfield, the maintenance instructor, for background research

Are there separate thermostats on each floor of the building?

Answer: Every classroom has its own thermostat on/off master thermostat in the basement.

What is a boiler?

Answer: It's a large heater that uses steam for heat. A water tank [250 gallons] is heated and steam is pushed through pipes up to each floor.

How much does it cost to heat our building?

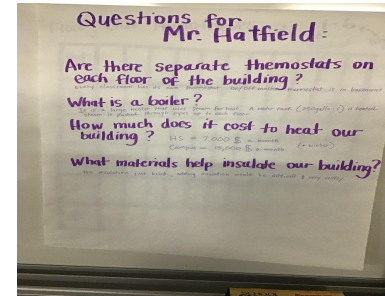
High school=\$7,000 a month, Campus=\$15,000 a month, +winter

What materials help Insulate our building?

Answer: No insulation; just brick. Adding insulation would be different and very costly.

How old is the boiler?

Answer: It was made in 1997 so it is 30 years old.



Research and Experimental Methods

For our experiment we went to all the floors in our school building to take surface temperatures with IRTs. We also took air temperature measurements using a liquid alcohol filled air thermometer. We went to each floor to take measurements in the left, right, and center hallways. We also took measurements in the auditorium and in front of the school outside. There was carpet on the fourth floor but not on the other floors, and some of the hallways didn't have the lights on. When taking measurements outside we used GLOBE protocols and submitted our data through the GLOBE Observer app.



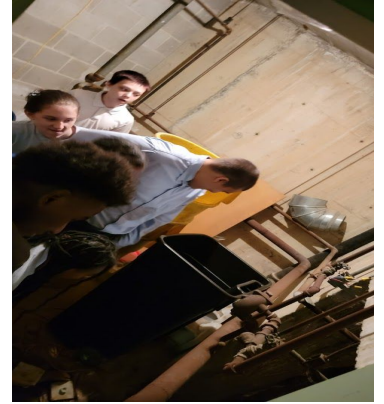
Variables

Independent Variable: the floor levels.

Dependent Variable: the temperature.

Other external variables to consider: types of surface, winter season,

Constants: the IRTs, the thermometer, the general location on each floor.

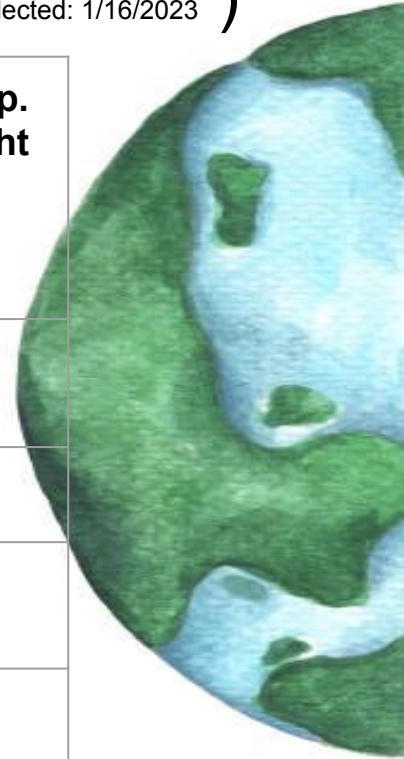


These are photos of us at the tunnels under the school where Mr. Hatfield showed us the water for the boiler comes from.



Our Data Table (all temperatures are celsius Date collected: 1/16/2023)

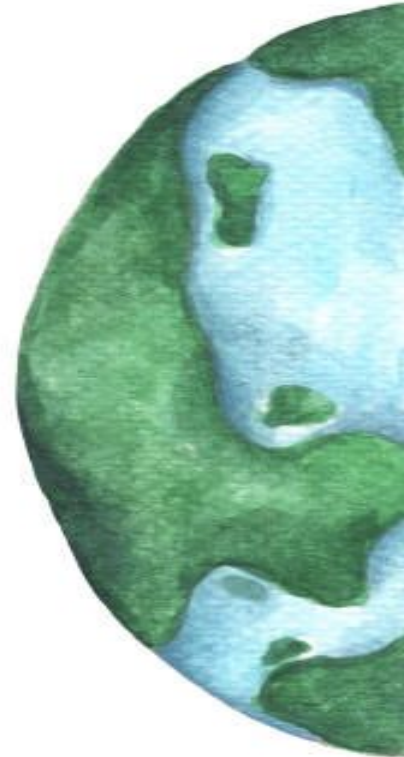
Date 1/17/23	Surface temp. Avg left hall	Air temp. Avg Left hall	Surface Temp. Avg. Center Hall	Air temp. Avg center hall	Surface temp. Avg right hall	Air temp. Avg right hall
Basement	20°	22°	19°	21°	18.5°	21.5°
1st floor	21.5°	21°	22°	20.5°	21.5°	21°
2nd Floor	19°	20.5°	21°	20°	20.5°	20.5°
3rd Floor	21.5°	20°	20.5°	19°	22°	20°
4th Floor	19.5°	19°	19°	18.5°	21°	19°



Our other observations

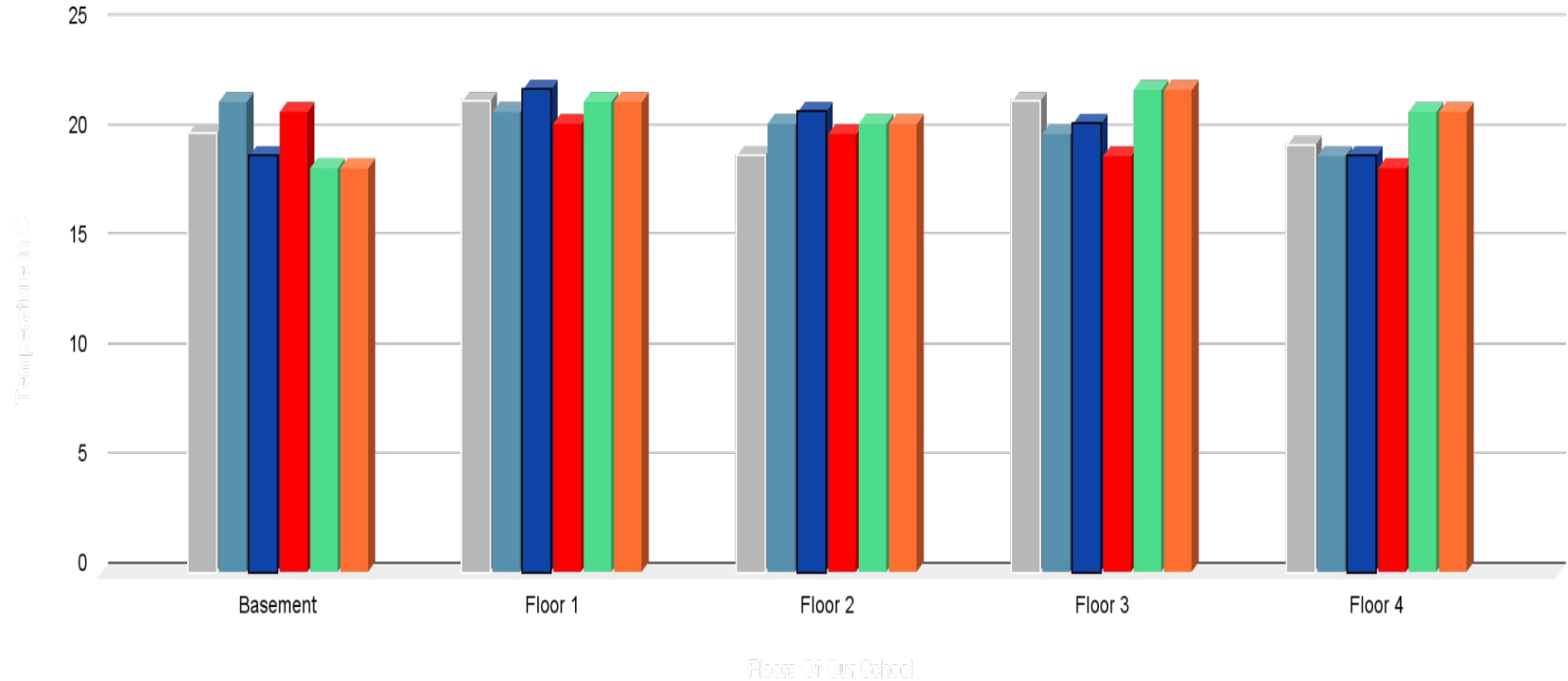
Date collected: 1/16/2023

Places where we took temperatures	Surface Temperature	Air Temperature
Roof	8.5°C	15°C
Outside front entrance sidewalk	10.5°C	13.5°C
Lower level of the Robert Frye Auditorium	18°C	20°C
Upper level of the Robert Frye Auditorium	19.5°C	21.5°C



Date collected: 1/16/2023

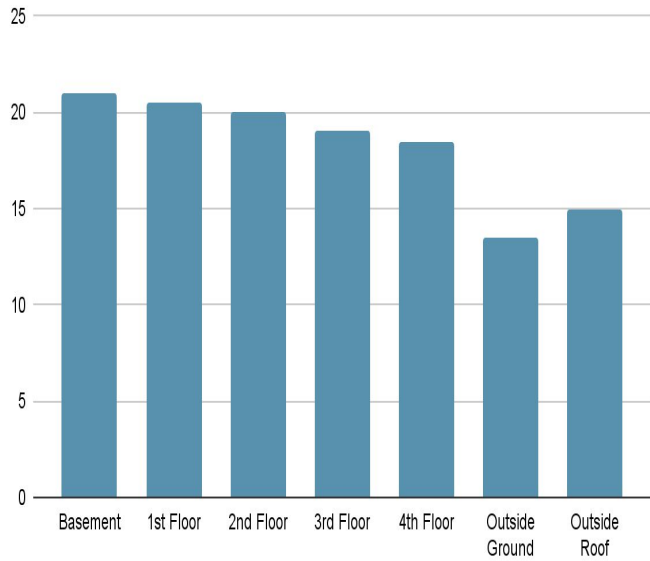
Do different floors of our school have different average air temperatures compared to the outside temperatures



■ Surface temp. avg left hall ■ air temp. avg left hall ■ Surface temp. avg center hall ■ Air temp. avg center hall ■ air temp. avg right hall ■ surface temp. avg right hall

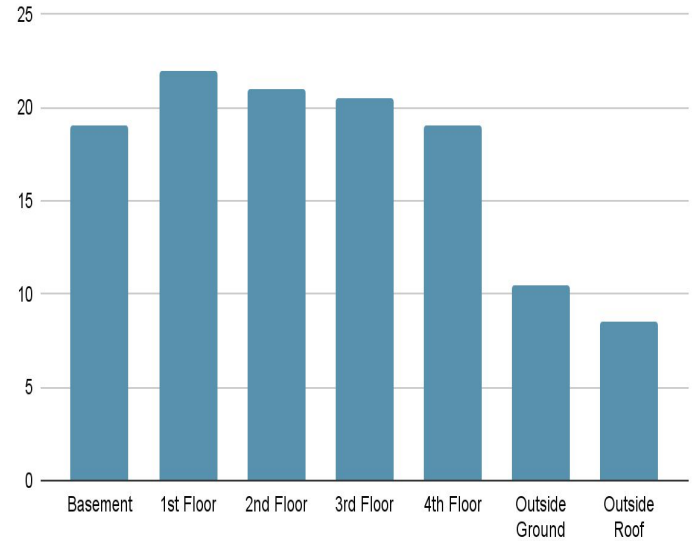
Air Temperatures indoor compared to outdoor

Air Temperatures in Celsius in Center Hallways



Surface Temperatures indoor compared to outdoor

Surface Temperatures in Celsius in Center Hallways



Discussion of Results

The most important observation we took away from this experiment are that the higher we went in the building, each floor got colder. This was a surprise and contradicted our hypothesis. However team members all had different surface temperatures. We noticed that all our classmates got different temperatures on each floor. This means we could do this project again maybe on a larger scale. A possible reason for all the different temperature measurements could be using multiple IRTs. We also discussed the possible effect of the placement of the Sun. In the morning the Sun shines on the right hallway (East) and in the afternoon on the left (West).



Conclusions

What we learned is that there are a lot of variables contributing to our odd results. Another surprising thing we learned was how much it costs to heat our school and that the building doesn't have any insulation. If scientists wanted to copy our experiment we would recommend they only use one IRT and collect data for more than one day, maybe every day for a month.

Although it might be costly at first, we would like our building administration and trustees to consider a more energy and cost efficient plan for heat. A next step could be to discuss this with them and research what other schools in our community do to conserve heat and money.



Sources:

- <https://www.freepik.com/vectors/watercolor-earth> (earth image/slide template)
- <https://www.globe.gov/en/home>
- <https://mynasadata.larc.nasa.gov/>



Credits

Special thanks to Mr. Hatfield, Sara and Dr.C from GLOBE Mission Earth and our teacher Mrs. Smith.

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