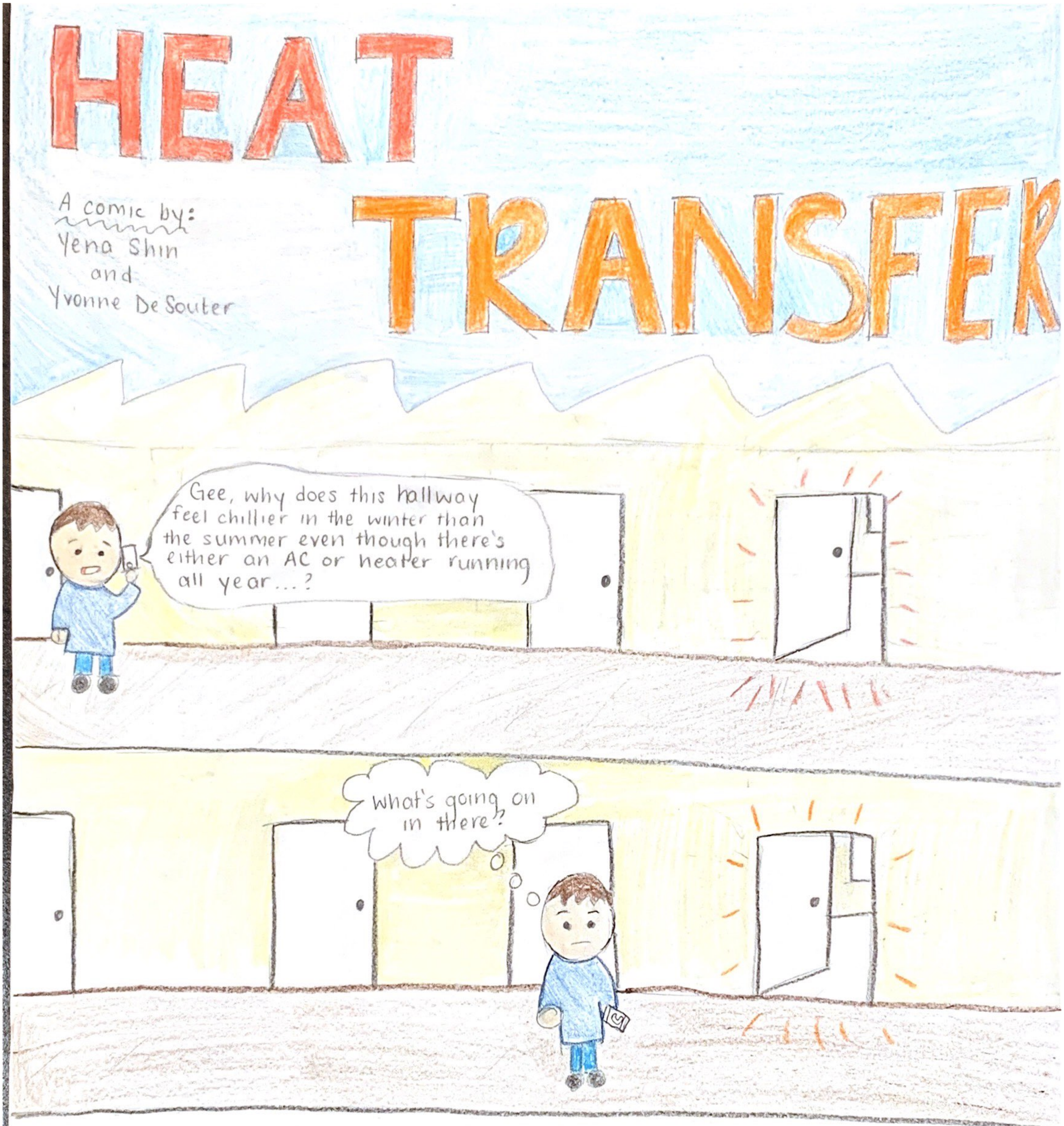


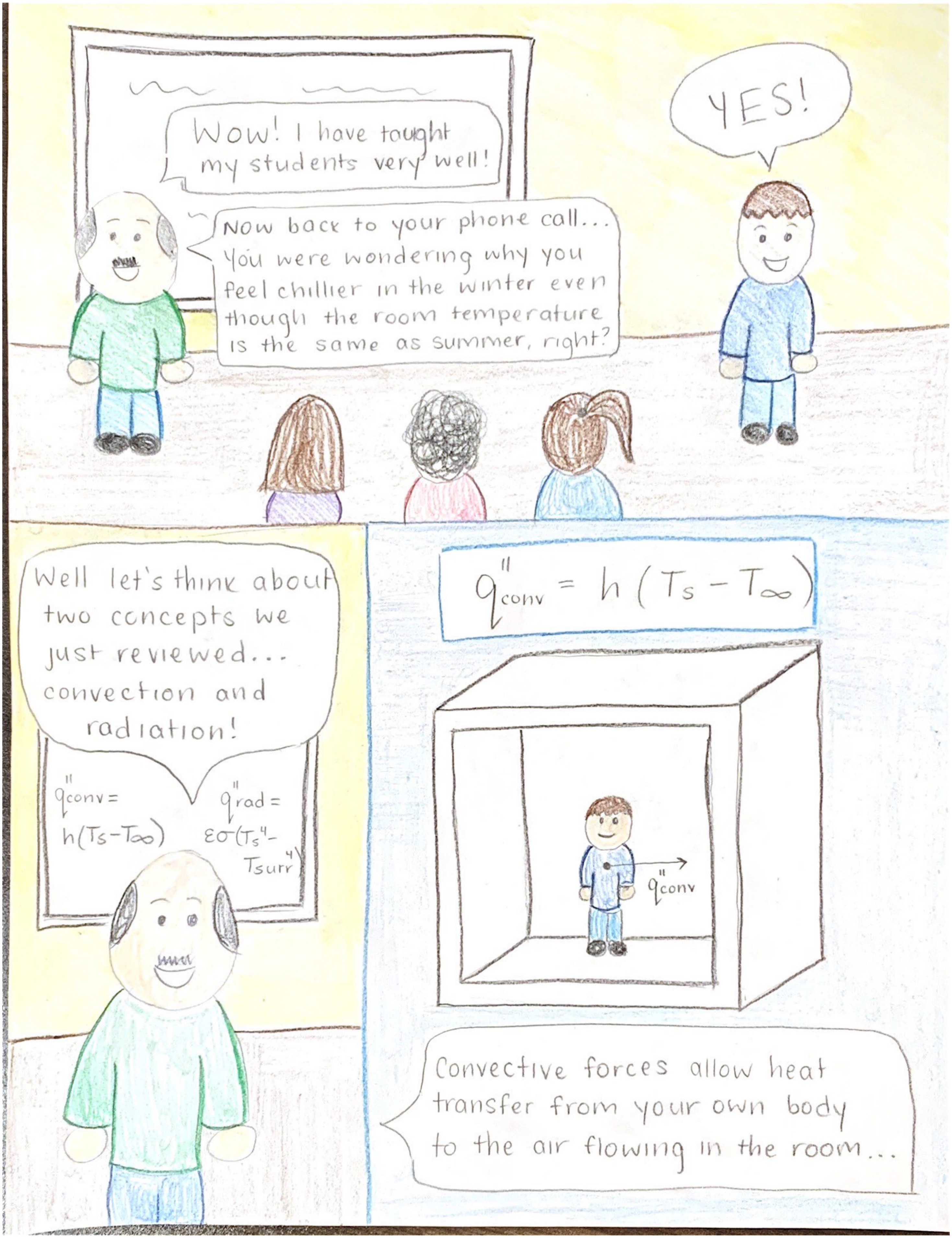
The boy hears loud talking from a nearby classroom and sees bright lights shining from it. Thinking this is a sign that it will answer the question he has about the chilly feeling in the hallway, he enters...

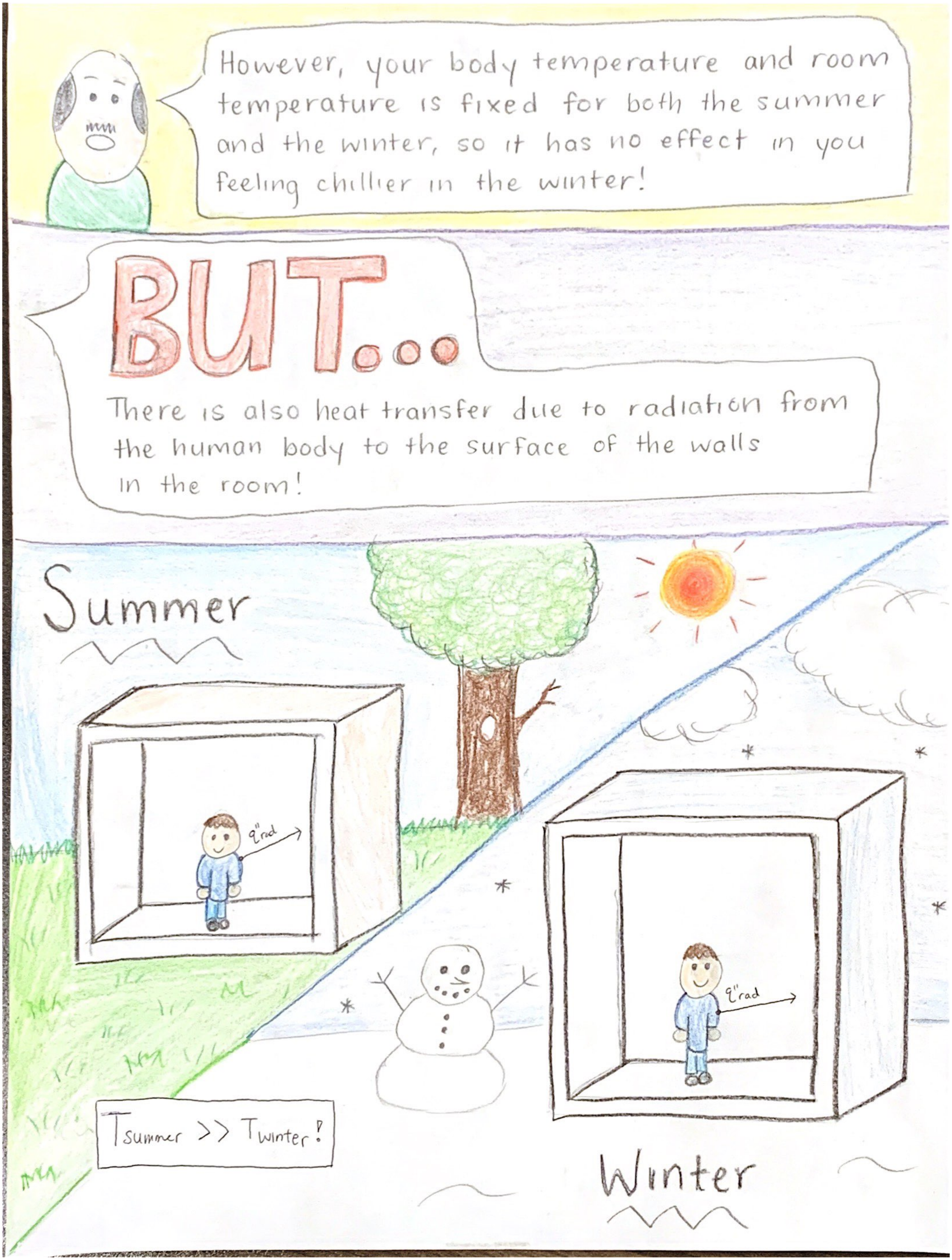

Maybe this Chem E class will help me answer my question...
Fourrer's Law...
Heat transfer is the movement of thermal energy in a system, and the driving force is a temperature gradient! The system always works toward thermal equilibrium...
What are the three types of heat transfer?
CONDUCTION!
CONVECTION!
And don't forget the last one... RADIATION!


The boy enters the classroom and takes a seat...
Now class, who can define conduction?
Conduction is the transfer of heat between one material to another through direct contact, and it has three source types : NUCLEAR, CHEMICAL, and ELECTRICAL heat source
Okay... So would a real life example of conduction be heating water in a pot over a Stove?
YES! Correct! And we can mathematically define conduction by using Fourier's Law...
Fourier's Law gives us heat flux, which is defined as the rate of heat transfer per unit area.
Thermal conductivity (k) impacts how much heat can be transferred. For example, an aluminum pan will conduct heat much better than a steel pan because aluminum has a higher k value!
Fourier's Law:
$q_x'' = \frac{q}{A} = -k \frac{dT}{dx}$
rate
area
heat flux
k: thermal conductivity
$\frac{dT}{dx}$: temperature gradient AKA driving force!
*The negative sign accounts for the heat transferring from a high to low temperature


ALUMINUM
STEEL
VS.
K = 205.0 W/m·K
K = 50.2 W/m·K
K Aluminum > K steel
Therefore, aluminum conducts heat better than steel does!
Let's move onto the next concept... CONVECTION!!! who can define this next type of heat transfer?
Convection is the transfer of heat between bulk motion of fluid and its surroundings...
...There are two types of convection:
① Forced → driven by an external force
② Free → driven by buoyancy forces
Within convection there are two types of heat transfer: sensible and latent heat transfer!
Oh so I guess an example of convection could be heat transfer between a cold wall and a heated room?
Correct!
Convection can be explained by using the general flux equation on the board...
q" = h (Ts − T∞)
flux
* h = K/δ
thermal conductivity
boundary layer
h: convective heat transfer coefficient
Ts: temperature of the surface
T∞: temperature of the bulk fluid


And that's a summary of heat transfer!
No... there's still one more. Radiation!
Let's start by defining what exactly radiation is...
Radiation is the transfer by electromagnetic waves! Unlike conduction + convection, no contact is needed between the heat source + object heated
What would an example of radiation be?
The sun heating up the asphalt is a good example!
There are two types of radiation processes. Emission is when radiant energy or photons are released when a system goes from a high to low energy, and absorption is when the addition of radiant energy causes a system to go from low to high
The general heat flux eq'n for radiation is:
$q'' = \varepsilon \sigma (T_s^4 - T_{surr}^4)$
ε: emissivity coefficient of same object
σ: Boltzmann constant (5.67×10^{-8} W/m²K⁴)
T_s: temperature of the surface
T_{surr}: temperature of the surroundings
Similar to conduction and convection, there is a governing heat flux equation for radiation!


Wow! I have taught my students very well!
YES!
Now back to your phone call... You were wondering why you feel chillier in the winter even though the room temperature is the same as summer, right?
Well let's think about two concepts we just reviewed... convection and radiation!
q''conv = h(Ts−T∞)
q''rad = εσ(Ts4− Tsurr4)
q''conv = h (Ts − T∞)
q''conv
Convective forces allow heat transfer from your own body to the air flowing in the room...


However, your body temperature and room temperature is fixed for both the summer and the winter, so it has no effect in you feeling chillier in the winter!
BUT...
There is also heat transfer due to radiation from the human body to the surface of the walls in the room!
Summer
q"rad
q"rad
Tsummer >> Twinter!
Winter


Recall the heat flux equation for radiation...
$q''_{rad} = \varepsilon\sigma(T_s^4 - T_{surr}^4)$
Because the temperature of the wall is higher in the summer and your body temperature remains constant...
$q''_{rad,summer} < q''_{rad,winter}$
So, there is more heat loss due to radiation in the winter, which explains why you feel chillier in the winter!
Wow okay, I get it now! Thanks so much for helping out!
Maybe I should change my major to chemical engineering...
THE END