“ Plants - Having a Light Lunch”
Understanding The Science of Light

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This curriculum unit is recommended for:
Third Grade Science

Keywords: plants, leaves, chlorophyll, photosynthesis, visible light, reflection, absorption, sun,, solar energy, solar panels, angles, shadows

Teaching Standards: See **Appendix 1** for teaching standards addressed in this unit.

Synopsis:
This curriculum unit provides appropriate level background knowledge for a Third Grade teacher to facilitate students as they explore the ‘big idea’ of “How do plants respond to light?” Students will explore our biggest source of light energy, the sun and some of the properties of light energy in a series of labs. The outcome of this unit is to help students identify and explain the basic properties of solar energy and how it can be used by plants and humans. Students will observe changes in different materials as they interact with light and discuss their observations with their peers and the class in a seminar style discussion. They will learn how light energy is a beam that can be transferred from the sun to a collector - such as a plant. Students will also explore how light can be collected from different angles and study cause and effect scenarios to note differences in how matter will respond to light. Students will experiment with how a solar panel collects light and uses it for energy. Finally, they will use the data and observations collected in the labs to draw conclusions about how the sun’s light can be used for energy.

I plan to teach this unit during the coming year to 18 students in Third Grade.

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Karyn Hays

Introduction

My students usually express interest in the Science topics that we explore in class. I wanted my curriculum unit to address what my students are naturally curious about. Most of my students usually engage in activities and discussions in our Earth Science curriculum. I find a lot of excitement when we talk about the Solar System, plants, and ecosystems. I noticed students open up and talk about these topics naturally when we are at recess, or any time they are outside. They always want to show me bugs, plants, and rocks they have found or if they see an object in the sky- the moon, clouds, the weather etc.

Sustainability, recycling, harnessing energy in a practical way, and protecting the environment are trending in our students' world. Primary school is their first introduction to these concepts, and the students embrace these conversations due to their love of plants and animals. In my experience, when I teach our unit on plant growth and we discuss where our food comes from, students want to know more about gardening, food sources, and how to protect plants. We talk about pollution and keeping the environment healthy for water sources, landforms and soil, which all affect plant growth.

My students are also highly engaged during our Solar System unit. They are fascinated by the facts and illustrations of the objects in the sky. They dive into the topics that discuss the cycles and movements of the planets, the moon and the sun. We have several short lessons focused on solar energy. My plan is to expand this typically short lesson and emphasize the significance in the role of the sun's light as a source of energy. The role of solar energy can easily be expanded during our unit on Plants, their parts and their functions- focusing on leaves and their process of photosynthesis. I think it would be fun to have the students explore the concept of solar power in a lab experience.

With several months spent in remote learning, due to Covid precautions, many students did not experience hands-on inquiry Science at our school as often as they typically would with in-class lab experiences. A goal for this unit is to help give "just in time" learning and offer experiences to catch any students that missed observing plant growth, and hook all my students, as they learn about the process of photosynthesis and using solar power. The responsibility of protecting our ecosystems will be placed in the hands of this generation, as it has passed to ours, so hands-on experiences - even as simple as observing how plants collect sunlight- is a good start to introducing them to this role. This unit will provide Third Grade level vocabulary, and simple explanations of processes and concepts involving the sun's light energy. By the end of this unit students will be able to teach others about the sun's visible light, why it is essential for plant growth, how plants collect light, and solar panels can do this as well.

Demographics

I teach a regular education Third Grade class consisting of 18 English speaking students with diverse abilities and backgrounds. My school is located north of Charlotte in North Carolina. We are part of the Charlotte Mecklenburg School system in the Northwest Learning Community. We are a suburban public school serving grades K-8. We have approximately 1,000 students. Currently, the percentage of students achieving proficiency in Reading/Language Arts is 78%. The percentage of students achieving proficiency in Math is 83% and 89% in Science. Our school makeup includes 78% white, 6% black, and 11% Hispanic, 2.2%Asian, 2% two or more races, less than 1% Pacific Islander, less than 1% American Indian. Thirteen percent of our students are on the Free Lunch program. The majority of our students come from families with parents who have a college education background or higher. We are considered a more affluent school with students who receive a tremendous amount of support with a strong PTO and financial resources from the local community.

Content Research

Light Is Energy

When teaching students about light it is helpful in your explanation to convey the idea that "light is a type of energy"[1] We can see this energy when it is reflected off the surface of a solid object. For example, the moon is a large rocky solid in space. It does not give off any light but it looks white to us. We can only see the color of the moon because the sun's light bounces off the moon and we see the white color reflected back to us.[2] Light can travel through gasses and water. It is measured in waves that have a constant length and frequency. Think of these waves as similar to "waves when dropping a rock in a pond"[3]. The different colors of visible light are determined by the wavelength of the wave and is part of a scale called the electromagnetic spectrum. Light with a shorter wavelength is a bluer/ purple color. Light with a longer wavelength is more of a red color.

The Electromagnetic Spectrum

The electromagnetic spectrum is a scale of seven types of light energy waves as seen in Figure 1. It is a continuous spectrum, but there are seven main categories. The categories of light are organized according to how long the light energy's wavelength is. The light waves are a repeating pattern that can transfer energy. The wavelength is the amount of energy (not matter) that is being moved. In Figure 1, notice that visible light is in the center of the spectrum[4]. Our main source of visible light is from our sun.

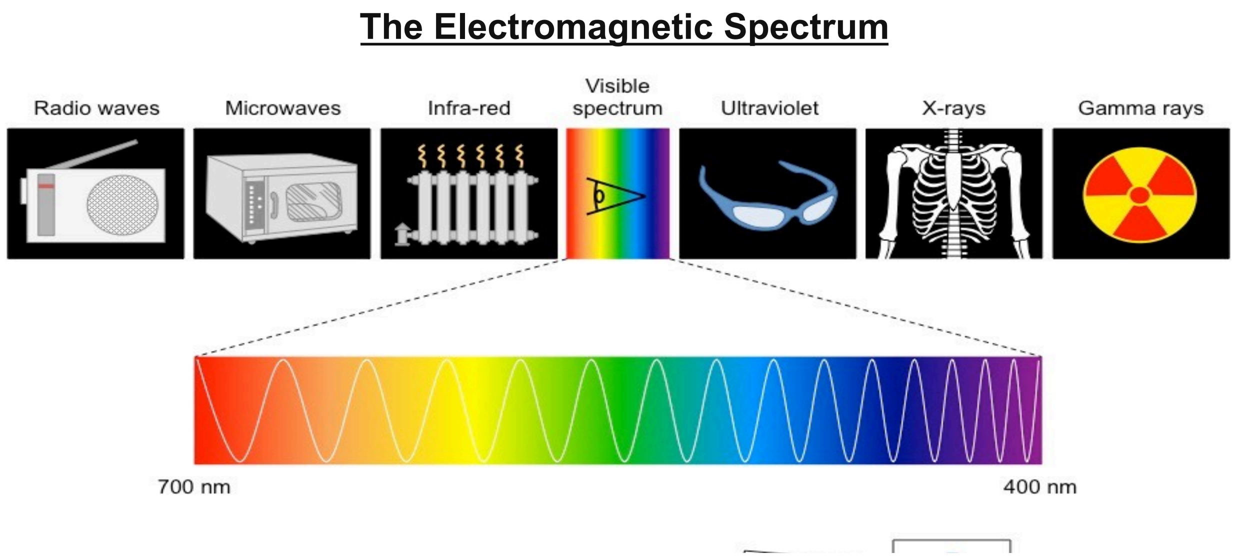

Figure 1 : The Electromagnetic Spectrum[5]

Visible Light

There are many different types of light. Students may have heard of several kinds of light - microwaves, ultraviolet light, infrared light, etc. Visible light is the light we are most familiar with since it gives us " the ability to see".[6] Visible light is the part of " the electromagnetic spectrum that humans can detect". [7] The colors of visible light are the colors that most students who have learned about the rainbow are familiar with- ROY G BIV (Red, Orange, Yellow, Green, Blue, Indigo, Violet). Our sun's brightest color is yellow/green, even though it does give off light in all colors.[8] We can see different colors in the sky because the yellow light from the sun is scattered and other colors are bouncing off different molecules in our Earth's atmosphere. For some examples, think of a sunset with pinks and reds. We can see more of the sun's colors during sunsets when the light is passing through more molecules in our atmosphere.[9] When the sky looks very blue on a clear day (no clouds) it is because more of the molecules in our atmosphere are scattering blue light and are magnifying the blue part of the sun's light.[10] It is this visible light from the sun that is the most valuable to our plants.

The Sun & Light Beams As Energy

The sun is the star that is in the center of our solar system. It is the largest body in our solar system and its energy is what makes life on Earth possible. The sun provides visible light energy for life to grow. Plants collect the sun's visible light in order to make their food during photosynthesis. Sun beams are able to travel through air and water because they are transparent. The sun beam light waves travel quickly from the sun and move in straight lines until they hit matter. When these beams of light come in contact with a solid, such as a plant, the solid absorbs some of the light energy beam. Every place on Earth receives solar energy at least part of the year. "The amount of solar radiation that reaches any one spot on the Earth's surface varies according to: geographic location, time of day, season, local landscape and local weather."[10]

The Sun's Light Hits Earth At Different Angles

It is important to notice the angles at which the sun's light hits our Earth. The higher the sun is in the sky, in other words, its angle, in relation to Earth, the more of its energy is directed at Earth. This affects the growth of plants and life on our planet. The amount of light beams Earth receives changes throughout the hours of the day due to the fact that the Earth is constantly rotating. Earth spins on its axis and, every 24 hours, daytime occurs for the part of the Earth facing the sun, while the opposite side of the planet is in darkness, signaling nighttime. Throughout the day, the sun appears to change its position in the sky. When the sun rises, it has an angle of zero degrees. The angle of the sun increases throughout the day until noon. After noon the sun's angle decreases back towards zero. In the early morning and late afternoon, the sun is low in the sky so the light beams travel further than at noon, when the sun is at its highest point. On a clear day, the greatest amount of solar energy reaches a solar collector around noon.[11]Students can view these changes of sunlight during the day while observing light on a sundial.

The sun's light beams hit the Earth's surface at different angles due to the fact that the Earth is also round. When the sun's rays are directly overhead at 90 degrees, they are concentrated at the Earth's surface and it receives all the light energy beams possible. This is why during the day, at noon, it is typically the hottest part of the day. If the energy beams of the sun are more slanted, the beams become more spread.[12.] The polar regions on Earth always receive sunlight at an angle partly due to the round surface and partly due to the tilt of Earth on its axis. During part of the year, the polar regions receive no solar light at all. In Figure 2 you can see the sun is at a lower angle to the Earth in December compared to June.[12] This greatly impacts how much direct light energy that part of the world will receive.

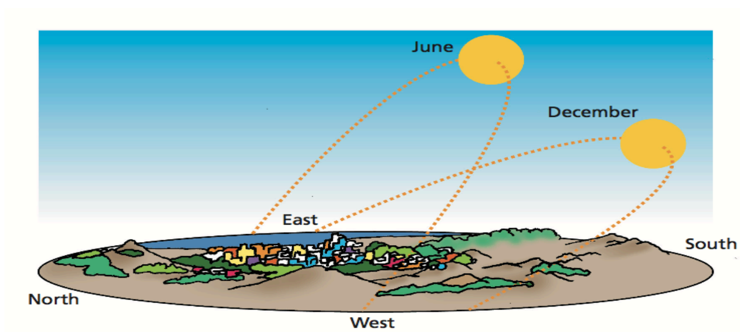

Figure 2 The angle of the Sun above the horizon is much greater in summer than in winter.

Image: Smithsonian Science Education Center Source

The Sun's Relationship to Seasons

The seasons on Earth and the tilt of our Earth also determines the amount of solar energy we receive and how intense the light will be. Earth is in constant orbit around the sun. It completes a full circle every 365 days. Our Earth is also tilted slightly at 23.5 degrees. Earth goes through season changes due to this tilt. "The tilt is always pointed in the same direction in space, toward Polaris (the North Star), even as the planet travels in a circle around the sun".[13] Noted in Figure 3, you can see that over the course of a year our Earth goes through four seasons.

Starting around December 21st, the Northern Hemisphere is tilted farther away from the sun. During this time, our days are shorter, nights are longer, we have less solar heat, and the least amount of sunlight. The sun also looks lower in the sky with the "least angle to Earth". [14] Between March 21 and September 21, the Northern Hemisphere is tilted toward the Sun and has spring and then summer. Around June 21 North America faces toward the sun. During summer, our days are longer, and now our nights are shorter, we have much more solar heat, and more sunlight. The sun looks higher in the sky and at its highest angle to Earth. The higher the sun is, the more sunlight and heat energy the Earth receives. You can visualize these changes using Figure 3, which shows the highlighted parts of the Earth by the sun.

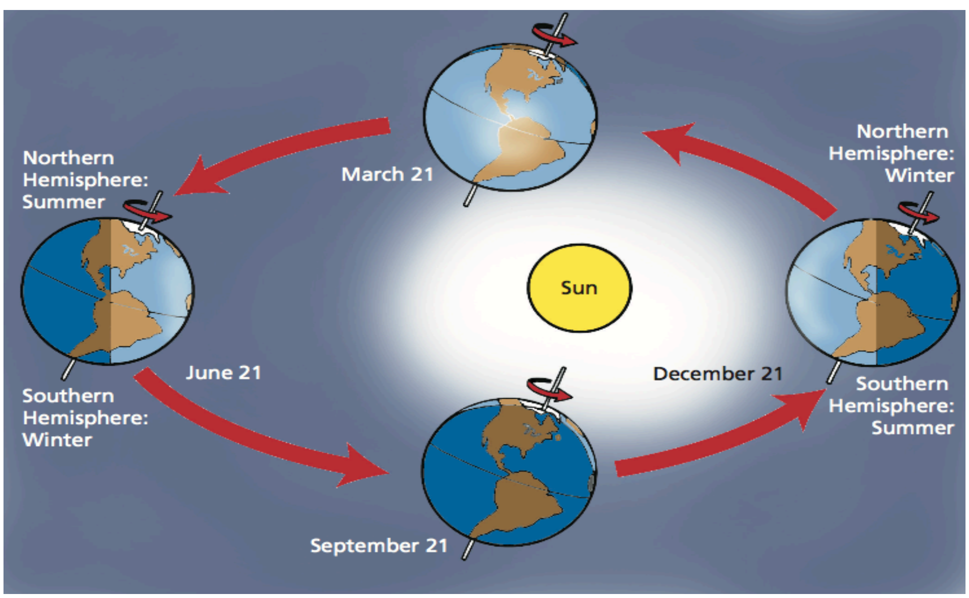

Figure 3. The Earth orbits the sun 365 days a year. The Earth is also tilted on its axis which shows how seasons are created due to the amount of solar energy hitting the Earth's surface. [15]
Image: Smithsonian Science Education Center

Depending on where you are on the planet, days can be longer or shorter in length from season to season. For example, "Cities such as Denver, Colorado receive nearly three times more solar energy in June than they do in December." [16] In contrast, the equator, which is the middle of our Earth, receives about the same amount of solar energy year round.

Plants - using the energy from the sun

Visible light energy is essential for our survival on Earth. This is because it is the number one power source for our food. The whole process of photosynthesis is a transfer of energy from the sun to a plant. During photosynthesis several steps take place. Plants are able to take in carbon dioxide, mix it with water within its cells and create food for itself - sugar. For photosynthesis to occur, it is helpful to remember the different types of light on the Electromagnetic Spectrum. It must be the correct type of light for photosynthesis to take place. If we think back to the Electromagnetic Spectrum, infrared light is not strong enough to fuel this process and ultraviolet light is too strong. Visible light is just the right light for plants to create the process of photosynthesis[17]. This is why the sun is our best source of energy.

During a plant's life, the plant is constantly doing life tasks. The plant is absorbing water from the ground through its roots, at the same time, it is always taking in carbon dioxide from our air. Carbon dioxide is able to enter through tiny microscopic holes in a plant's leaves. These holes are called stomata. When stomata open, they take in carbon dioxide. At the same time, the plant is also collecting the beams of sunlight through the tiny stomata holes. The energy from the sunlight causes a chemical reaction within the plants' cells that break down the small particles of carbon dioxide and water and create sugar and gas. The sugar is called glucose and the gas is oxygen. The plant breaks down the sugar "into energy and uses it for growth and repair". [18] The plant releases the oxygen through the same tiny holes which it took in the carbon dioxide.

What is interesting to note is why visible light is the type of light that plants need. Plants create all this energy in their chloroplast cells. Chloroplasts are located in the plants' leaves and in these cholorplast cells are molecules called chlorophyll. These are the green molecules that make a plant look green. Chlorophyll absorbs all the colors of the sun's white light, including red and blue. The only color that the plant does not absorb is green. This is the color that is reflected back to us so we see the plant as "green." You may notice in the fall, leaves lose their chlorophyll molecule when they start to die. When leaves lose their chlorophyll, their other pigments begin to show more. Carotenoids create the yellowish-orange color, like the pigment in carrots. Anthocyanins are the red and purple pigment in leaves. [18]

Solar Panels- Visible Light Is Not Just For Plants

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To understand how solar panels work, students will have to understand what electrons are and how they can move to generate electricity. Man-made solar panels are similar to plants in that they have specialized cells that collect sunlight and use it for energy. Solar panels are rectangular, flat surfaces covered in an array of solar cells. Solar cells are designed to capture particles of sunlight, or photons, of visible light. Solar panels look smooth on the surface like plastic or glass, but they are primarily made of silicon. “Silicon is a semiconductor material that can absorb the photons from the sun’s visible light.” [19] The atoms of a solar panel contain electrons. Electrons are microscopic charged particles that fly around atoms. When enough sunlight is collected by the solar cell, “electrons, which are in the atoms of the material’s cell, are dislodged and able to move.” [20] The electrons move up towards the surface of the solar cell. The front of the solar cell is made specifically to allow for these electrons to shift up to the surface of the cell. The movement of the electrons creates an electric current similar to a battery. Electric conductors on the cell absorb the electrons and are often connected to a battery that allows the electricity to flow.

Solar panels work best when they are directly facing the sun. However, not all places keep their panels flat and in one place. Places like a power plant, that can afford movable solar panel systems, will install them so they are able to tilt to follow the sunlight, like a plant. This allows for the most sunlight possible to hit the cells. However, this is very expensive. So due to cost, Most businesses and homes must keep solar panels fixed in one position to allow the maximum amount of sunlight beams to hit the panel. In the northern hemisphere they will face south.[21]

Unit Goals

The goal for this unit is for students to understand how the sun’s light is a source of energy and how matter responds to the collection of sunlight.

The lessons are outlined for a progression of understanding.

1. Understand how the sun moves and is positioned to provide plants and humans light energy
2. The parts of a plant, their basic functions, and how leaves collect light, and conduct photosynthesis
3. The response of plants to the amount of sunlight it receives
4. The response of plants to the angle of sunlight it receives
5. How humans can collect sunlight by using solar panels and use the light for energy

Instructional Implementations

Teaching Strategies:

Anchor charts
Anchor charts are noted through the Content Research and in the Guided lessons to help students visualize the key vocabulary and concepts in the lessons. Anchor charts can be located in Appendix 2.

Hands on Lab experiences
Through the use of simple labs for the lessons in this unit, students are able to observe, first hand, the processes that take place when light interacts with matter. The small details that are often missed from reading or watching a video about a concept or process will be highlighted in discussions and journal writing so students can pay careful attention to details. Examples - where is the stomata located on a leaf? Where is the sun located overhead? Is it directly overhead or behind us at an angle?

Academic talk / seminar
Academic conversation and the use of "talk" amongst students is a great tool to help students practice new vocabulary and figure out key concepts being explored in a Science unit. Students can learn from each other as they hear vocabulary, facts, and processes explained in their peer language which is more familiar to them than from a textbook. Before each lab experience, the teacher will give background knowledge and also pose questions that will guide students to think about what possible effects and outcomes can occur. After each lab experience, the class will come together to discuss the causes and effects they noticed during the investigations. The teacher can informally assess that the students understood the contenct of the lesson and that they are using the correct vocabulary introduced or practiced in the lesson.

Journaling/Exit tickets
Writing is essential to help students organize their thinking about a new concept and practice new vocabulary. If a student can write about a concept they often comprehend it and can connect with it better than answering multiple choice questions. Students will need science notebooks or teacher created notebook paper in a folder to create a space for recording work or taking notes. Journaling during this unit will take place after the class has come together to discuss the lab experiences. By giving this pre-writing experience, students will have the opportunity to practice using the vocabulary, and talk out their ideas and possible misconceptions, before writing.

Materials List - See Appendix for links for materials
One for each student:
paper plates
small ball of playdough/modeling clay
Marble composition notebooks to use as Student Science Notebooks

For one lab station or lab stations for each group:
Glass or plastic clear bowls
leaves - collect outside, the larger the better
Grow lights with timers
solar fan kit
or
micro motors
micro fan blades
micro solar panels

small established plants
Or
Bag of dried butter or lima beans to grow plants or Small pots
Small bag of Potting soil

****A few weeks before you begin your unit, plant a few lima bean seeds in pots so they are ready to use or purchase a few small plants for your students to use.

Lesson 1 The Sun's Light Moves - Creating a sundial
Objective ***:*** Students will understand how solar energy can be collected, students need to understand the movement of the Earth and its effect on sunlight. The sunlight changes angles and position as the Earth is rotating for day and night.

Materials needed:
Prepare ahead - *Make a completed sundial to use in the lesson and as a model
Each student will need:
Student Science journal
1 paper plate
1 full size pencil
1 one small ball of molding clay
1 thin marker, colored pencil or *Sharpie* pen

Guided minilesson:

Teacher explains the sundial model while displaying a prepared sundial so students can see what it looks like. Explain to the students the different parts of the sundial. A sundial is a measuring tool similar to a clock that measures time by using the sun. A sundial has numbers around the outside edge, and a gnomon (pronounced *"no-man"*), or a stick, in the center of the dial. The gnomon blocks part of the sun's light when the sun is overhead. You can read what time it is on the sundial because the shadow of the gnomon creates a line over part of the dial. The line will fall on a number (or close to it) so you can 'read' the time. The shadow will move each hour because the Earth is turning and causing the sun to be in a different position in the sky. The Earth is spinning so it appears the sun is moving, however the sun is not actually moving, only we are. Because of the Earth's movement and changing positions in the sky, the light beams from the sun are shining on us at different angles. We receive the sun's energy at different strengths throughout the day. To help the students see these changes, they will observe a sundial for one day.

Lab Procedures - Create and read a sundial :
Students will make a sundial so they can observe how the angle of light from the sun shifts due to the Earth rotating slowly for 24 hours.

1. Students will poke a hole in the center of a plate using a sharpened pencil (or a teacher could do this ahead of time).
2. Using a small ball of clay, students can "hold their pencil" in the center of the plate by molding the clay around it.
3. On a sunny day, have the students place their plates outside. Set the plates on a flat surface in full sunlight. It is best to have the plates in an open area where it can receive full sunlight with no shadows. You may want to place a few rocks on each plate to keep them from moving.
4. Each hour of the day, 9am, 10am, 11am, 12 am, 1pm, 2pm, 3pm - have the students check the shadow line created on the plate. Using another pencil and a ruler, have students trace over the line created by the shadow and mark it with a number. The number should be the current hour.
5. As you go outside, have students stand next to their sundials. Instruct the students to stand still and look up briefly at the sky and note where the sun is in the sky. Make sure students do not stare directly at the sun! The students can use trees, buildings, their sundials, etc. to notice any changes in the sun's location. Have the students observe their sundial before touching it. Next, have the students trace the line created by the shadow on their plate.
6. Repeat these similar activities each hour of your day or as often as possible from morning to afternoon to note changes.

Seminar Discussion points:

Towards the end of the end of the day:

1. At 2pm, when the sun can cast a shadow behind the students, have the students stand in place and pick up their sundial in their hands. Have the students hold their plate in their hands and tell them to stand so the sun is behind them. What do they notice on their plate? The shadow line should be on the 2 digit. Have the students turn slowly in a full circle while standing in the same spot. As the students turn in their spot, they should, watch the shadow on their plate as they spin slowly in place. What do they notice is happening to the shadow moving on their plate? Some students may not understand that the light is not moving, but Earth IS, which affects how the light will hit the surface of the Earth.

2. Pose the question to the students - did the sun, or its light, turn just now, or did something else turn? Guide students to understand that the Earth is actually rotating, not the sun, which will affect the angle of the sun's light hitting matter on Earth, such as the sundial, people and plants - things that are using the sun's light.

3. Let the students discuss changes they notice in the sun's position in the sky and changes in the shadow. Be sure to discuss misconceptions that the sun is moving and re-direct them that the "angle" of the light is changing because the Earth is moving.

4.While outside, and observing the shadows, discuss the shadow created on the plate with the students. Did the shadow move? Did the shadow change shape? What else did they notice about the sun in the sky?

5. Ask the students what caused the changes in the shadow on their plate? What created the shadow on the plate? What did you notice about the sun and the position of the shadow cast on the sundial?

6. Closing question - ask the students what is really happening- Is the sun moving or the Earth moving?

** These discussion points will be expanded upon in the next few lessons.

Lesson 1 Exit Ticket- Journal Questions:

Students should respond to the answers to the following questions in their Science Journals.

Cloze Activity - Use this word bank to complete the statements.

Earth sun different blocked gnomon shadow Sunlight day sky away

Rewrite these sentences and fill in the blanks to make the sentences make sense.

1. As the ______________________ rotates on its axis to lead us from day to night, the position of the ____________________ in the sky will change.

2. The sun's light beam will hit the sundial at a ___________________angle each hour as our part of the Earth turns ________________ from the sun's light.

3. At noon, Earth has turned halfway between ______________ and night because the position of the sun has changed in our ___________________.

4. The _____________________________ of the _____________________________ on the sundial let us know what time of day it is.

5. Only the ____________________ is rotating, the ______________________ is not actually moving.

Lesson 2 The Sun's Light Is Energy

Objectives: Students will know plant vocabulary and understand the function of each part of a plant. This lesson will focus on the function of leaves and their job to collect sunlight and use it as energy to make food.

Materials:

Student Science journals
For each group:
A clear glass or plastic bowl
magnifying glass
One large leaf -picked fresh right after the bowl is placed outside in the sunlight
small pebbles or a few small stones
water

Guided lesson/ minilesson :

1.Display a plant anchor chart for students to view as you briefly discuss the parts of a plant.

2.Explain that each part of a plant has a function, including the leaves. Plants have the ability to collect light. A plant leaf collects sunlight and changes, converts it to food energy.

1. Using the Plant anchor chart, briefly discuss the different parts of the plant and their functions.
2. Focus on how the leaves in particular have an important role in plant growth

3. Using the Leaf anchor chart, focus on the different parts of the leaf.
4. Explore a leaf up close. Explain the parts of a leaf including the chlorophyll
5. Using their Science notebooks, the students can sketch the plant and note its functions in their Science notebook.

Lab procedures - Leaf observations :

1. Place a clear plastic or glass bowl outside in direct sunlight
2. Collect a fresh leaf from a plant or tree (the larger the better!)
3. Place a leaf upside down, in the bowl, and place 2 or 3 small pebbles on it to weigh it down under the water.
4. Let the sunlight hit the bowl directly for an hour.
5. Return outside to make observations about the leaf. The students should notice bubbles.

Seminar Discussion:
After checking on the leaf, ask the students the following questions.
1. What did you notice about the leaf? The students should see the process of photosynthesis taking place as oxygen is leaving the leaf in the form of gas bubbles.
2. Where do you think the bubbles are coming from?
3. What state of matter are bubbles?
4. What gas do you think the bubbles are?

*Exit Ticket Lab questions***:**
1. Describe what you noticed on the plant leaf under the water. Draw a model of the leaf as a visual aid for your sentence.
2. How do you know the leaf was still going through photosynthesis? What could you see?
3. What three things did the plant leaf have so it could create photosynthesis?

Lesson 3 The amount of light - does it matter?
Objective: Students will observe how plants respond to a certain amount of light and how a plant responds to changes in its environment.

Materials :
Create lab stations for your students to use in groups or create a lab station for the whole class to use- depending upon availability of materials.
Student Science journals
Per group :
2 grow lamps with timers
2 boxes
-one box labeled “summer” with grow lamp inside and 14 hour timer set

- one box labeled “winter” with grow lamp inside and 10 hour time set

2 timers set - set one for 10 hours (winter) and one for 14 hours (summer)
2 potted plants- one plant
one plant

Guided minilesson:
Discuss with students why Earth does not receive the same amount of sunlight all year. Sunlight hits the surface of the Earth at different angles at different parts of the year.. The Earth is tilted 23.5° degrees. So, in the summer, the sun’s light hits the Northern hemisphere more directly and gives us longer hours of sunlight, hence a longer day. In the winter, the sun is at a lower angle in the sky, so we receive less hours of direct sunlight, this is why we have a shorter day. Will plants still grow if they receive only 8 hours of sunlight? Plants usually do not grow in the winter due to the cold temperatures and lack of sunlight. But maybe if we controlled the temperature and just looked at the amount of light we could see, would plants still grow on only 8 hours of sunlight in a temperature controlled environment. Or must plants receive a full “summer’s day” of light?

Lab Procedures - Amount of light :
1. Set up one box with a plant inside
2. Secure one grow lamp to the inside top of the box and mark this box as “winter” to act as “sunlight during winter”
3. Set up a second box with a plant inside
4. Secure one grow lamp to the inside top of the box marked “summer” to act as “sunlight during summer”
5. Set the timer for the “winter” box for 10 hours.
6. Set the time for the “summer” box for 14 hours.

Each morning, let the students turn on the lights and set the timer for winter and summer at the same time, as soon as they arrive each morning.

7. Each day, open the boxes to observe changes in the plants responses to the light.
8. Have the students measure the height of each plant to note differences. Students should record their observations in their Science journals.
8. Repeat this procedure for as long as you would like to make observations - 5-10 days.

Seminar Discussion points:
1.Discuss the changes in the plants. Did one plant respond differently than the other?
2.Discuss the differences in height. Did one plant grow more or have a better response with 14 hours of light compared to 10 hours of light?
3. What would you recommend to someone wanting to plant a garden- when should they plant their plants?

Exit Ticket Lab questions:
Observe your plants each day. When you notice changes, begin recording your observations starting on day 1.

Table - have students draw a table to record their daily observations :

Plant Growth Chart

	day 1	day 2	day 3	day 4	day 5
10 hours of light					
14 hours of light					

After day 5 have students answer these questions in their journal :
1..What did you notice about plants growing with 10 hours of sunlight compared to a plant growing with 14 hours of sunlight?
2.Explain the cause and effect relationship between the amount of time a plant receives sunlight and its growth. What did you notice?

Lesson 4 -The angle of the light
Objective: Students will observe how plants respond to the angle in which a plant receives light.

Materials :
Create lab stations for your students to use in groups or create a lab station for the whole class to use- depending upon availability of materials.
Student Science journals
Per group :
2 grow lamps with timers
2 boxes
-one box labeled "summer" with grow lamp inside
- one box labeled "winter" with grow lamp inside
2 plants
2 grow lamps attached inside the boxes
-"summer"/ Light attached to the top of the box so the light will shine on top of the plant
-"winter"/Light attached to the side of the box so the light will shine sideways on the plant

Guided minilesson:

Explain to the students now that they have observed the sun in the sky, how it appears to change positions, and how plants react to different amounts of light - would it affect plants which direction sunlight comes from? Can they still use the light as energy if it comes at an angle like it does in winter compared to in summer? Discuss with students why sunlight is not as strong at all times of the year. Light hits the Earth at an angle, as we have started to observe in the other lessons, but it can do this for long periods of time. This is why we have seasons. Not all parts of the Earth receive sunlight at the same time due to the tilt of the Earth. The Earth is tilted 23.5 degrees. So in the Northern hemisphere (where we live) in the summer, the sun's light hits the Northern hemisphere more directly overhead. The light is concentrated on one area more intensely. In the winter, the sun is lower in the sky so the sun's light energy is spread out. Demonstrate this on a globe. Turn out the lights in the classroom and place a globe on an elevated surface. Point out the tilt of the Earth to the students. Shine the light from a flashlight directly on the Northern Hemisphere to show "summer." Ask the students, what do you think happens to plants when the sun is shining directly on the Earth's surface such as in summer? Next, shift the globe so the flashlight is shining on Australia , such as in winter. What might happen to plants during this time? Will any plants still grow? Will plants still grow if light comes at different angles?

Lab Procedures- Angle of light :

1. Secure one grow lamp to the inside top of a box marked "winter" to act as "sunlight during winter"
2. Secure another grow lamp to the right side of a box marked "summer" to act as "sunlight during summer" The grow light should hit the plant at a 45-degree angle.
3. Place one plant in each box
4. Let the students turn on the grow lights in each box ,at the same time, as soon as they arrive each morning to control the amount of light each plant receives. This allows each plant to receive the same amount of sunlight.
5. Set the timer for 10 hours.
6. Each day, open the boxes to observe changes in the plant growth.
7. Students should measure each plant to note changes in growth and mark it in their Science journals.
8. Repeat this procedure for as long as you would like to make observations.

Seminar/ Discussion points:

1.Discuss the changes in the plants. Did one plant respond differently than the other?
2.Discuss the differences in height. Did one plant grow more or have a better response with sunlight concentrated directly overhead compared to the plant with light coming from the side?

3. What would you recommend to someone wanting to plant a garden- when should they plant their plants to receive the best angles of sunlight?

Exit Ticket/Lab question for Science journaling:
1. What did you notice about the plants in the "summer" light?
2. What did you notice about the plants in the "winter" light?
3. If you were to help someone plant their plants in a garden, what advice would you give them about planting their plants? When should they plant their plants? What direction should their plants face- does this matter?

Lesson 5 - Light as Energy.
Objective : Students will use a solar panel to observe how we can collect sunlight and use it to power a device.

Materials :
Create lab stations for your students to use in groups or create a lab station for the whole class to use- depending upon materials.
Student journals
For each group:
3 or 4 micro solar panels
1micro motors
1micro fans
1grow lamp

Guided Minilesson:
Solar panels collect and use the light from the sun. To create electricity from sunlight we can collect the light and change it to electricity. Sunlight is made up of tiny particles called photons. These photons are tiny particles of light energy. We can collect these light particles like plants do. We need special devices like solar cells to collect these particles. (Show the students a calculator with solar cells). These calculators have solar cells. These cells also have small particles inside them called electrons When light from the sun hits these cells, the light particles attract the electrons that are trapped in this solar cell. When the electrons move inside the cell, an electric circuit (or circle of electricity) is formed. We capture this electrical current so we can have electricity that we can use. Have you noticed that solar panels can move? They can angle themselves to follow the sunlight. Do you think this is necessary?

Lab Procedures- Mini Solar Panels :

1. Hook up one mini solar panel to the motor - red wires connect to red wires, black wires connect to black wires. Twist the wires carefully together to secure the connection.
2. Position the fan on top of the motor
3. Lay the panels on a flat surface
4. Have a student hold the grow light source directly over the solar panel
5. Have the students note what happens to the fan.
6. Have a student hold the light source directly to the side of the solar panel - at a 45 degree angle.
7. Have the students note what happens to the fan.

6. Students should note the changes in their Science journals

8. Have the students hold the panels at a 45 degree angle sideways (teacher may need to demonstrate this so students do this correctly)

Once the students are successful in getting the motor to run and notice the changes in the speed of the fan turning, tell the students to experiment and change how the light is hitting the panels. Suggestions - Try holding the light further away or closer to the panel. Direct students to try holding the light at other angles.

9. Have the students hook up more than one solar panel to the fan to increase the amount of light being collected.

10.. Lastly, have the students try creating partial shadows, partially blocking the light with part of their hand or a piece of paper, and move the panel under part of the shadow.

Exit Ticket Lab question:

1.What happened when the light was positioned directly overhead/ 90 degrees to the solar panel?

2.What happened when the light was positioned sideways at a 45 degree angle to the solar panel?

3. Did the solar panel work better when the light was positioned a different way?
4. Did the solar panel and fan work when the light was partially blocked or in a shadow.

5.What happened when more than one solar panel was being used.

What advice would you give someone who wanted to position solar panels on their house to collect sunlight?

Assessment

Science Journal Exit Ticket Rubric

4 points	The Student mastered fully answered the question using accurate facts, details and key ideas related to the Science discussions. They supported evidence of their thinking by using examples from the lab experiences.
3 points	The Student mastered answered the question using details and facts related to the Science discussion, some of their thinking still lacks support.
2 points	The Student has not mastered, but is progressing toward understanding. The student partially answered the question using some details related to the discussion but did not support their thinking.
1 point	The Student has not mastered and did not demonstrate progressing toward understanding. Possibly did not address the question , is missing supporting evidence or lacks too much detail in their answer to show their thinking.

Student Resources

Photosynthesis Lab - Gizmos
This is a fun lab experience without any mess! The students can practice observing how carbon dioxide, sunlight and water all work together to create photosynthesis and have an output of oxygen.
https://gizmos.explorelearning.com/find-gizmos/lesson-info?resourceId=395

Teacher Resources
"What is Photosynthesis" by Smithsonian Education Center
This website is what I used for my anchor chart in helping students understand the parts of a plant and their functions. It also is a good background source for the basics of photosynthesis.
https://ssec.si.edu/stemvisions-blog/what-photosynthesis

"How Do Solar Cells Work" by Sci Toons
This video is helpful in understanding how solar panels work with visuals on basic information on how electrons move. Helpful for building background knowledge on what is inside a solar cell. https://www.youtube.com/watch?v=UJ8XW9AgUrw

Energy Kids -This website gives great background information about solar energy.
https://www.eia.gov/kids/energy-sources/solar/

"What is the Winter Solstice?" by Smithsonian Education Center
This website has helpful visuals for anchor charts you can draw or display as visual guides to help students comprehend the concepts of how the sun moves.
https://ssec.si.edu/stemvisions-blog/what-winter-solstice

Appendix 1: Teaching Standards

NC Standards

Science

3.L.2.1 Remember the function of the following structures as it relates to the survival of plants in their environments: • Roots – absorb nutrients • Stems – provide support • Leaves – synthesize food • Flowers – attract pollinators and produce seeds for reproduction

3.L.2 Understand how plants survive in their environments.3.L.2.1 Remember the function of the following plant structures as it relates to the survival of plants in their environments: Leaves – synthesize food

3.L.2.2 Explain how environmental conditions determine how well plants survive and grow.

3.E.1 Recognize the major components and patterns observed in the earth/moon/sun system

3.E.1.2 Recognize that changes in the length and direction of an object's shadow indicate the apparent changing position of the Sun during the day, although the patterns of the stars in the sky, to include the Sun, stay the same.

3.P.3 Recognize how energy can be transferred from one object to another.

ELA/Literacy

RI.3.3 Describe the relationship between a series of historical events, **scientific ideas or concepts**, or steps in technical procedures in a text, **using language that pertains** to time, sequence, and **cause/effect**.

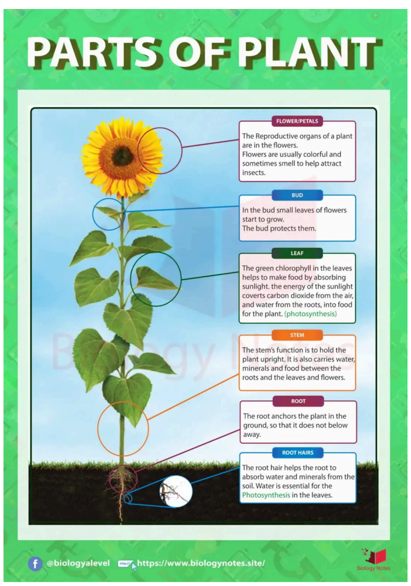
Appendix 2:

Day 1 materials

Example of sundial

Day 2 materials

Anchor chart



Source - Source: https://medium.com/@biologynotes/parts-of-plant-fab7d2442516

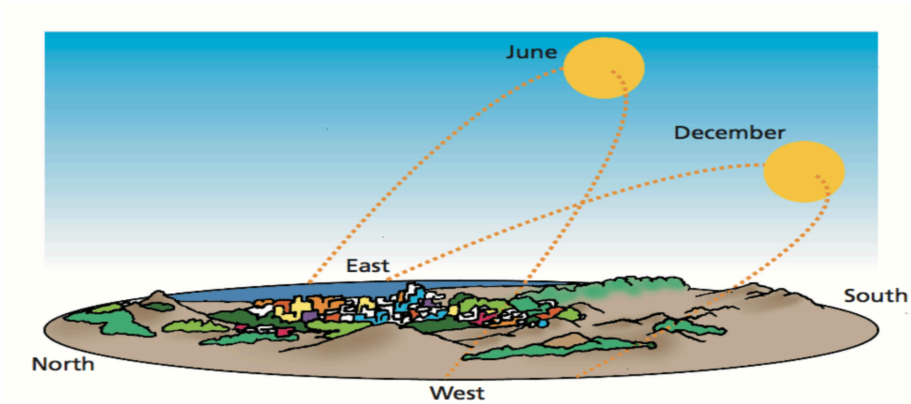
Day 3 materials

Example of a grow light with timer
Grow lights with timers - Amazon link

Day 4 materials

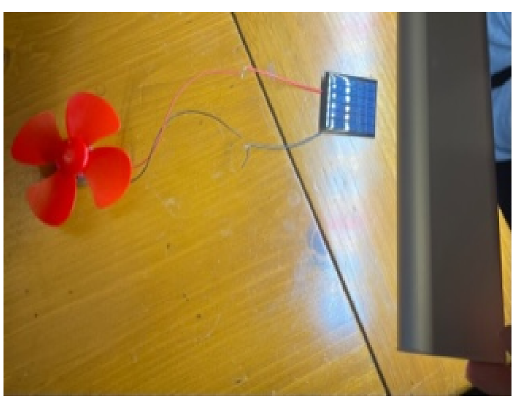
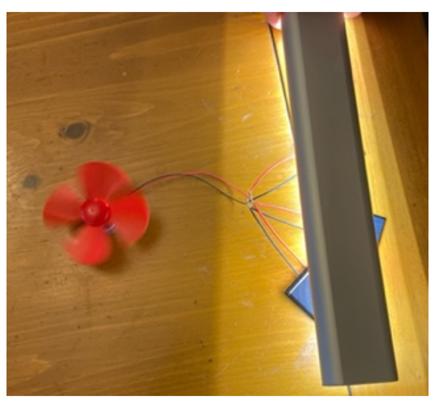
Visual to see with students

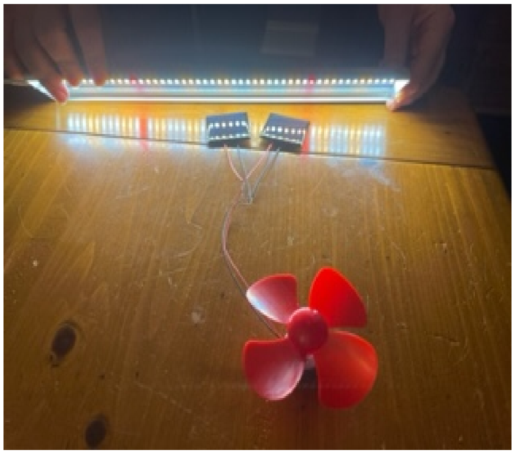
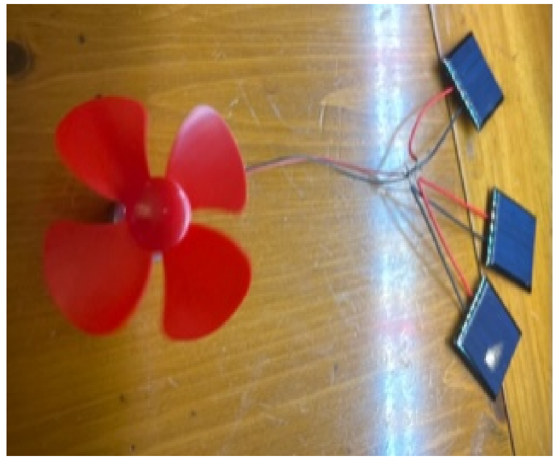


Examples of how to set up lab/boxes with grow lights

Day 5 materials

Ideas for configuration of solar panels
solar fan kit - Amazon link
or
micro motors- Amazon link
micro fan blades- Amazon link
micro solar panels - Amazon link

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