SCIENCE INQUIRY PROTOCOL
5E LEARNING PLAN[1*]

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General Lesson Topic: Light

Course Section: EDEE-273-001/02

Part I. Background :

1. Overview and Context

Overview of Science Inquiry: This lesson teaches students about how light allows them to see in the dark. Specifically the students will use pre-made light boxes to study how light interacts with different materials and influences an individual's visual perception in the dark. By the end of the lesson, the students will understand that light travels in straight lines, reflects off objects, and allows individuals to see in the dark. However, students will also discover how cardboard (opaque), wax paper (translucent), and cellophane paper (transparent) materials influence light's pathway and an individual's ability to see in the dark. Since light travels from a source, reflects off objects, making them visible, rather than going around/avoiding objects, it's understood that light travels in straight lines. This would also explain how different mediums/materials influence light's pathway. For instance, light gets absorbed by opaque mediums, interrupting its pathways, however it transmits through transparent mediums. Translucent mediums, like wax paper, influence the speed of light; causing it to slow down. In turn, light will refract and less of its energy will pass through the medium (although still more than in the opaque medium) (MAD GARDEN Science, 2024). This lesson is part of a larger unit on transmission of energy. The unit will discuss the components of light waves, and its role in visual perception/allowing individuals to see. The unit can extend to study the reflection of light in the outdoor settings. This lesson will be divided into six sections: 1. Eliciting questions and reflections through an interpretive activity: counting the number of lines visible in a sketch depending on the type of blindfold the student is wearing. 2. Regroup to discuss their findings and hypotheses for how light travels.	**Intended Audience:** Grade 5, Cycle 3

[1*] *Adapted from Teaching Works instructional template*

3. The students will model their hypotheses on a teacher-provided template.
4. The students will then use the lightbox to explore their ideas, alternating between the three different material dividers.
5. After completing this activity, the students will select light's pathway through one of the given mediums and revise their model to represent one sequence.
6. The students will then regroup, discuss the driving question, and extrapolate explanations from their models.

This will respond to the phenomenon of how material impacts a student's ability to see in the dark. This lesson aligns itself with big ideas of science 2 (objects can affect other objects at a distance) because the object visibility is impacted by the material barrier which influences the light's ability to travel through the medium. This lesson also fits into a big idea about science number 12 (Scientific explanations, theories and models are those that best fit the evidence available at a particular time) as it uses student created models to engage thinking and extrapolate explanations.

Our teaching philosophies are grounded in student inquiry, sense making and intrinsic will to explore; therefore students will have the opportunity to engage with ideas through building and editing their models. This lesson aligns with STEAM education as the students will analyze artwork, specifically shading and lines to elicit thinking about the relationship between visibility and light. This adds an artistic side to science lessons which often gets repressed. The students will be engaging in engineering practices (in prior lessons) as they are building their own lightboxes, and dividers. When building these light boxes (in prior lessons) and orienting the light towards the object in the lightbox the students will use their visual-spatial skills, which develop through mathematical reasoning. In terms of science and technology, the students will be inquiring on how light travels and using the lightbox (technology) to learn about its pathway. This lesson can lead to further lessons on light absorption, reflection and refraction in nature.

ENGAGE:

- The students will discuss the required conditions to perceive items visually (i.e. light). To elicit thinking/reflection the teachers administer a different material blind fold to each group; the students will share their perceptions and question why some students were able to see more through the blind fold than others. Teachers will record student answers on the board which will be revised at the end of a lesson. The students will hypothesize how different materials impact a light's pathway from the source to the eye; they will demonstrate their ideas by filling in the teacher provided template.

EXPLORE:

- The students will use their premade lightboxes to explore how visibility is impacted by different materials. The divider window will be replaced by a translucent, transparent, and opaque material to explore how light travels through different mediums and create visual perceptions.

EXPLAIN:

- The students will explain their revised scientific models and how their perception of objects were influenced by each material.
- The students will co-construct (alongside the teacher) a "gotta have" checklist to summarize the big ideas of the lesson

EXTEND:

- In proceeding classes the students will explore how natural sunlight rays travel; the students will explore absorption (transforming sunlight to heat). The students will also study reflection from sunlight to the eye and how protective wear like Inuit snow goggles work as protection from the sun . The students will create models for these phenomena.

EVALUATE:

- The revised model will be collected as a formative assessment, the students will receive feedback which they will use to build their 3D/digital models for the museum exhibition and other proceeding lesson activities.
- The students will create 3D or digital models for how light travels. They will use a combination of art materials, music, audio, movement, math and science to represent their learning. The students will work in groups of 3-4, and present this in a museum exhibition style.
- The students will also complete a teacher-created self-assessment checklist so they can assess their own learning experience.

Anchoring Phenomenon
Students will discover how light travels from the source in straight lines, reflects off objects, and reaches the eye to make it visible. Simultaneously, the students will explore how different materials (cardboard, wax paper, and cellophane paper) influence light's pathway.

Driving Question:
How do light's pathways influence how we see in the dark?

This is linked to the larger idea of how light travels/transmits energy from the sun to Earth, making humans able to perceive visuals daily. Light also influences weather, timing, and seasonal change, and sleep; think about the material of the curtains in your room! Hence, it is an important phenomenon to discuss. This lesson is inspired by a common "sneaky practice" that young children engage in: reading under the covers.	

2. Resources and Materials

Source Lessons:

- OpenSciEd. (n.d.) 1.1. *Waves & Light*. OpenSciEd. Retrieved January 27, 2025, from https://openscied.org/instructional-materials/1-1-waves-light
    - We were intrigued by the activity presented in this lesson plan. Therefore, we chose to adapt it and incorporate it into our engaging part of our lesson. We found it interesting to test out with the students what it is like looking around in darkness, vs. light. For our lesson plan, we will focus on how different materials let light pass through. The diverse materials used were inspired by this lesson plan; while maintaining student engagement by connecting to a relatable phenomenon of reading in the dark.
    - The engage phase of our lesson inspired by one of the earlier light lessons discussed in this topic, however it was adapted to include art; embracing diverse interests in the classroom.
    - The explore phase adapted the previously discussed notion of the light box to include diverse materials which impact the way light travels within the box, in turn influencing our visual perception of the objects.
    - This lesson provides insight to the scientific principles and concepts discussed through the lesson (and unit per extension); however, the majority of the unit was only used as inspiration for this lesson due to the time constraints.
    - This unit plan was intended towards grade 1, however we have adapted this lesson to fit into a 30-45 minute grade 5 class activity.
    - To scaffold opportunities for students to engage in explanations, the teachers will be using diverse talk moves, such as orienting students thinking or pressing students thinking. The purpose of these talk moves are for students to remain curious, build a sense of confidence and love for scientific investigations.

- *McGill University . (2024). What do we need to see objects? Student Guide. Lab Manual . Montreal.*
    - This source had a big unit designed to explore how we can see in the dark. We chose to mainly focus on the third and fourth lesson plan that talks about the different materials that light passes through. Therefore, the rest of the lesson plans in this unit resource will be left behind.
    - The explain phase of our lesson was adapted through inspiration of the lightbox model used in activity two of this lesson plan.
    - To improve our lesson we have studied all the Lab manual light related activities. All activities in this unit are beneficial contributions to developing a unit on light; however, to ensure that the lesson is developmentally appropriate, students will use tools such as a light box. This tool

was chosen as it can foster a sense of student-led inquiry as the students can engage in building scientific materials. Often, in traditional science curriculum, students are handed a series of materials and instructions and expected to robotically follow them. This lesson aims to shift away from this, rather foster scientific inquiry which embraces the student as a co-constructor of their learning.

Lesson Resources & Science References

OpenSciEd. (n.d.). 1.1 Lesson 2 Community Connection out-of-school light. https://openscied-uploads-production.s3.amazonaws.com/temp-materials-pdf/cc/1.1%20Lesson%202%20Community%20Connection%20Out-of-School%20Light%20Source.pdf

- The style of this worksheet is potential inspiration for maintaining a public record or student thinking or helping students organize data from their experiment. The students can use this chart system to discuss the analysis of their models.

The Association for Science Education. (n.d.). Exploring that we need light to see things year. https://static1.squarespace.com/static/5b0e74d775f9eefeadca6f6e/t/5ed8f5fadf72c14cdc715c58/1591277061931/light+lesson+1.pdf

- This source provides insight into scientific concepts around light and conditions for seeing in the dark. It also demonstrated an example of how students may organize information (in charts) after experimenting

Peekaboo Kidz. (2017). *Light | The Dr. Binocs Show | Learn Videos For Kids*. YouTube. **https://www.youtube.com/watch?v=d7yTlp4gBT**

- This video was used to understand how light waves travel, and use simple terminology that resonates with the students in our classrooms. Having students understand key terms is crucial to building their confidence to ask questions and explore key concepts.

MAD GARDEN Science. (2024). *Behavior of Light | Reflection, Refraction, Absorption*. YouTube. https://www.youtube.com/watch?v=H7ztkEofaaM

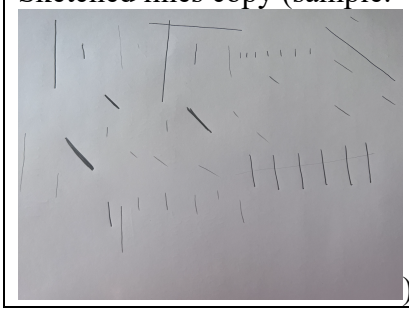
- This video was used to understand how light transmission, refraction, absorption, and refraction works and occurs when light interacts with different mediums.The extension activity was also inspired by this video.

Fay, A. (2017). *Inuit snow goggles*. Inuit Snow Goggles - Canada's History. https://www.canadashistory.ca/explore/first-nations-inuit-metis/inuit-snow-goggles

- This resource was used to learn about the purpose of Inuit snow goggles and the materials used to create them. This aligns with the larger idea of light reflection and absorption discussed in the extension activities.

Éducation, Loisir et Sport Québec. (2009, August 24). *Progression of learning - science and technology* . Gouvernement du Québec. https://www.quebec.ca/en/education/preschool-elementary-and-secondary-schools/quebec-education-program/elementary

Materials:

Items	**Quantity**	**For student or teachers?**	**Providing own supply**	**Need to borrow from lab supplies**
Lightbox with Cardboard divider	1 (per group)	For students	X	
Light box with Wax paper divider	1 (per group)	For students	X	
Lightbox with Cellophane paper divider	1 (per group)	For students	X	
Flashlight	1 (per group)	For students	X	
Blindfold	3	For students	X	
Light Model Template Worksheet https://www.canva.com/design/DAGe2tz_1dI/NkmSH8MYiqNh2IOiJsmpIg/edit?utm_content=DAGe2tz_1dI&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton - link edited	1	For students	X	
Sketched lines copy (sample: )	3	For students	X	

3. Learning Goals

HEAD
Students will know:

- What is light
- What path light travels
- What are sources of light
- What conditions people need to see

- What blocks light
- New vocabulary: reflection, refraction, transmission, absorption

Students will understand:
- Why we need light to see
- How light interacts with objects to make them visible.
- How light travels (in straight lines)
- How different materials impact ability to see certain objects
- Why different materials make objects visually perceivable to different agreements

HANDS
Students will do:
- Use flashlights to investigate light properties and document their findings.
- Demonstrate how light reflects off an object
- Explain how light bounces off objects and travels through a medium; students will build a visual/ verbal representation to represent this.
- Explain light transmission/refraction/reflection
- Work collaboratively, discussing their observations and explaining the role of light in helping us see in the dark.
- Create models for the light's path in relation to the material used
- Count the lines in a drawing while wearing a blindfold
- Draft hypothesis about light's pathway and its interaction with different materials.

HEART
Students will be able to:
- Recognize connections between their curiosity and real-world applications (e.g., understanding how light impacts daily life, safety, and learning).
- Build confidence in exploring scientific questions
- Work as a team to extrapolate explanations from scientific models
- Connect phenomenon to their everyday lives

QEP Connections.

❑ **Material World**

❑ Earth and Space

❑ Living Thing

Essential knowledges (Progression of learning):

B. Energy	1	2	3	4	5	6
1. Forms of energy						

f. Describes the behaviour of light rays (reflection, refraction)					→	★

For lesson extension: specifically focusing on transformation of light to heat (point 3.d/e.)

3. Transformation of energy						
a. Describes situations in which human beings consume energy (e.g. heating, transportation, food consumption, recreation)			→	→	→	★
b. Names means used by human beings to limit their energy consumption (e.g. fluorescent light bulbs, timers) and to conserve energy (e.g. insulation)			→	★		
c. Explains the insulating properties of various substances (e.g. polystyrene, mineral wool, straw)					→	★
d. **Describes the transformations of energy from one form to another**			→	★		
e. **Recognizes the transformations of energy from one form to another in various devices** (e.g. flashlight: chemical to light; electric kettle: electrical to heat)					→	★

Competencies:

1. To propose explanations for or solutions to scientific or technological problem
    a) To use a variety of exploration strategies
        i) The students will explore how light works to make humans perceive objects visually. The students will also use their pre-made lightboxes to explore how different materials impact visual perception of objects. The students will understand the pathway light takes and how different materials cause light to reflect, refract, transmit or absorb.

3. To communicate in the languages used in science and technology.
    a) To make effective use of everyday and symbolic language to formulate a question, explain a point of view or give an explanation.
        i) The students will practice scientific language such as hypothesis, observation, inference, data, analysis and more. The students will also use key terms related to the properties of light waves to extrapolate explanations from their scientific models.

Strategies:

- Putting forward hypotheses (e.g. individually, as a team, as a class)
- Using technical design to illustrate a solution (e.g. diagrams, sketches, technical drawings)
- Comparing different possible explanations for or solutions to a problem in order to assess them (e.g. full-group discussion)

Scientific model - Ideal

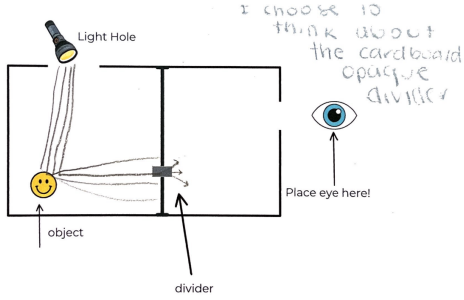
Ideal model for opaque/cardboard divider:

Name:_____ Date:_____

HOW DOES LIGHT TRAVEL?

Before looking into the Lightbox, draw your hypothesis for light's pathway.
How do you think light travels?
Next, Place the flashlight in the light hole and see for your self.
Then, with another colour pen/pencil or crayon draw your model for how light travels through one of the selected mediums (cardboard, wax paper, or cellophane paper) Lastly, answer the question at the bottom of the page!

I choose to think about the cardboard opaque activity



What do you think is happening with light? How does light travel? Which divider did you represent? Does light reflect, refract, transmit or absorb?

I think light travels in straight lines. I choose to show how light travels through the cardboard medium it gets absorbed they the cardboard so only a very very small amount goes through.

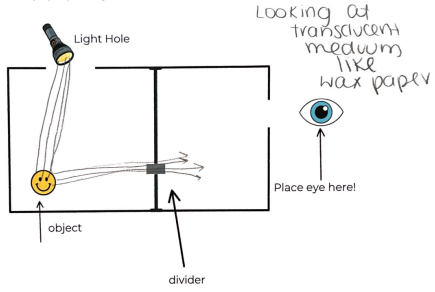
Ideal model for translucent/wax paper divider:

Name:_____ Date:_____

HOW DOES LIGHT TRAVEL?

Before looking into the Lightbox, draw your hypothesis for light's pathway.
How do you think light travels?
Next, Place the flashlight in the light hole and see for your self.
Then, with another colour pen/pencil or crayon draw your model for how light travels through one of the selected mediums (cardboard, wax paper, or cellophane paper) Lastly, answer the question at the bottom of the page!

Looking at translucent medium like wax paper



What do you think is happening with light? How does light travel? Which divider did you represent? Does light reflect, refract, transmit or absorb?

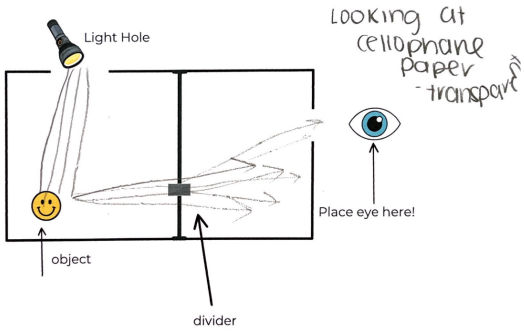
I choose to look at how light travels through wax paper. I travels in straight lines but refracts when it hits the wax paper. The wax paper adds resistance which means that the change and direction of light changes when hitting the material

Ideal model for transparent/cellophane paper divider:

Name:_____ Date:_____

HOW DOES LIGHT TRAVEL?

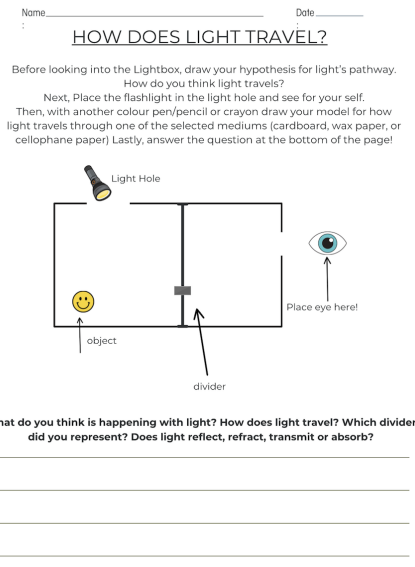
Before looking into the Lightbox, draw your hypothesis for light's pathway.
How do you think light travels?
Next, Place the flashlight in the light hole and see for your self.
Then, with another colour pen/pencil or crayon draw your model for how light travels through one of the selected mediums (cardboard, wax paper, or cellophane paper) Lastly, answer the question at the bottom of the page!



What do you think is happening with light? How does light travel? Which divider did you represent? Does light reflect, refract, transmit or absorb?

I choose to look at how light travels in straight lines through a transparent material like cellophane paper. The light energy gets transmitted to the eye because nothing is blocking it'

Scientific model - template


Name_____ Date_____

HOW DOES LIGHT TRAVEL?

Before looking into the Lightbox, draw your hypothesis for light's pathway.
How do you think light travels?
Next, Place the flashlight in the light hole and see for your self.
Then, with another colour pen/pencil or crayon draw your model for how light travels through one of the selected mediums (cardboard, wax paper, or cellophane paper) Lastly, answer the question at the bottom of the page!

What do you think is happening with light? How does light travel? Which divider did you represent? Does light reflect, refract, transmit or absorb?

This model will be handed out to students as a worksheet: they will portray their initial ideas. The students will then explore how light interacts with three different materials and they will revise their models after observing the inside of the lightbox. The students will respond to the bottom question to extrapolate explanations from their models.

Evidence-based explanation - teachers

Light travels in straight lines, however when encountering diverse materials light interacts differently. When looking at the lightbox, there is a small window on the side for the light source (ie. the flashlight). This window allows light to reach the object. Inside the box, there is a divider, each box is made of a different material which influences light's pathway; thereby impacting how humans see in the dark. Behind the divider, there is a window for the eye, therefore there isn't a direct line between the light source and the eye. This design demonstrates how light travels from the source, reflects off objects in a straight line and makes it perceivable to the human eye. However, the different material dividers show how light's pathway may be interrupted and make objects imperceivable in the dark. For instance, when light is flashed into the lightbox, it bounces off the object and interacts with cardboard (an opaque material) it is absorbed. Therefore, there is a transformation of energy, and little-to–no light is transmitted through the medium. For example, an opaque object/material could be metal, ceramic, a door, or a school binder. When light enters the light box, it reflects/bounces off the object and interacts with a translucent medium like wax paper, some light penetrates the medium through refraction. For example, something translucent would be a frosted window, paper, curtains, or oil. The object is more visible through a translucent medium compared to an opaque medium, however best visibility occurs when light interacts with a transparent medium. Lastly, transparency means that there is no light absorption and an individual can completely see through the material or object. Lights transmits directly through a transparent medium. An example of this would be water, cellophane paper, glass, clear plastic like a water bottle, or glasses.

Evidence-based explanation - students

I think that light can pass through transparent materials easily because there is nothing to block it from passing through. Light travels in rays or straight lines because it goes from a flashlight, it bounces off an object and then we can see it. It doesn't avoid or go around the object, but bounces off it. I think that light can still pass easily through translucent materials but I will be able to see less clearly on the other side. I also think that light cannot pass through opaque materials because the material blocks the light, absorbing it from passing through.

I think this because I've looked through the lightbox using the three different materials and I could see the object clear, less clear, and not at all. I also think this because I used a blindfold with my group and I saw how much of a difference it made to have different material blindfold when looking at the drawing. I think this because of the discussion I had with the class. Everyone's answers, the teacher's explanations, and the drawings on the board helped me with my understanding.

The science principle or idea that helps me explain this is light travels in straight lines and interacts differently with different kinds of materials. Some materials let light pass through easily, some materials let light pass through but not clearly, and some materials do not let light pass through, I know this because of absorption and what it does to light when it hits a material.

This principle or idea helps me use my evidence to support my claim because I have explored how light does not travel through all materials and I have understood the reasoning why, which is light absorption and how it affects different materials.

4. Anticipating Students Ideas

Student everyday experiences and ideas related to this phenomenon:
We are choosing to begin with the conversation of seeing in the dark and how sometimes we can see objects in the dark and sometimes we cannot. Beginning the lesson like this will allow students to connect and have intrigue in the coming lesson. Students will be able to share their experiences, for example closing the curtains in their room, hiding under a fort, closing their eyes, and putting sunglasses on. Also, our Engage activity will include putting blindfolds of different materials over their eyes. This activity is extremely simple and accessible so students will be able to have a correct understanding of what they need to be thinking of and asking questions about.

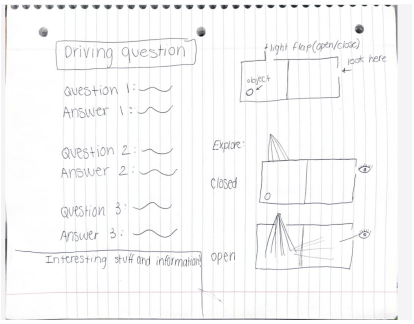
We are choosing to do an activity that includes different material blindfolds to show students a real representation of our phenomenon and for them to actually experience the difference of seeing light and dark. Doing this will allow the students to connect with the lesson and the phenomenon because it is an experience most students have at home. We can also talk about building forts, shutting the curtains when it is bedtime, the sunshade in the car if they have a young sibling, etc. We hope that mentioning these activities will prompt a class discussion where students can talk together and come up with different ideas of how they see in the dark and what covers it.

We anticipate that students might not know the answer before the lesson and we might get some inaccurate claims such as; “because it covers it, the sun gets less strong, reflection and refractions are the same because I can see through both, opaque objects are black”.

We think that prior to our lesson, students will understand that transparent materials do not block light and the opaque materials do block light. It is not expected for students to know the terms but they will be able to explain the phenomenon in the language that they know because the phenomenon is something they encounter every day. Our goal is to help the students understand the “why” and the “how” the three materials let light pass through; through refraction, transmission, absorption or reflection. Some challenges our students might face is associating the type of material to its interactive pathway (ex: how wax paper causes light to refract). We acknowledge that visuals are crucial to modelling light’s pathway. Also, students might struggle with knowing if something is transparent or translucent, reflective, refractive, transmissive or absorptive because technically we can see through both. We plan to work with this challenge by checking student understanding and walking around the classroom while students are exploring to see if we can help students show the difference between both materials.

Public record of student thinking

At the beginning of the lesson, during the engage phase, we will write the driving question on the board so students can be constantly reminded of the goal of the lesson. Next, we will write down the questions pertaining to the Engage phase on the board as well as the answers to those questions. We will keep the answers on the board so that students can revisit their hypotheses and initial answers at the end of the lesson and activities. We will draw a diagram of the lightbox on the whiteboard to help students understand how it works and what to do to be able to see the light (lightbox door open and closed). We will also use the diagram of the lightbox to explain our activity to students, identifying the different parts of the lightbox, how they work, and what to do. Next, during the explain phase, we will add student answers and our own explanations of how light travels using lines directed towards the lightbox and an eyeball to demonstrate that that is where light is being received. Finally, if a student asks an important and insightful question that we believe adds to the lesson and the students' understanding, we will keep a space on the board to record the student's thinking.



Part 2. 5E Inquiry Protocol

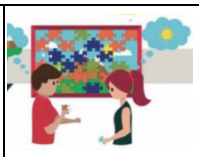
5. Instructional Sequence

Describe the activities that you will do with your students. Provide enough specificity that someone else could teach from your plan. This includes scripting the key talk moves you plan to ask. In each phase of the lesson, highlight at least 2 questions to use at specific points during the lesson that will foster students' scientific sense-making. For each question, list at least 5 possible ideas that students may include in their answers/explanations.
For each phase, specify what you will be expecting to observe as the students engage in the lesson (any observable behaviors that you will see and hear).
NOTE: Your lesson should engage with real-world, hands-on materials and demonstrable phenomena rather than relying on audiovisual recordings or virtual simulations. To encourage active engagement and teacher-student discourse, use of slideshows and videos is strongly **dis**couraged. You may use a whiteboard and handouts interactively with students to generate models and record student thinking.

Management considerations:
The lesson will begin in the dark, while the teacher speaks with a flashlight by her face (campfire style!). The teacher will ask students to look around, seconds later she will open the lights. Once the teacher opens the lights she will prompt students to reflect on how seeing in the light and dark differ.
The Engage part of the lesson will ask students to put blindfolds on their eyes. ~~Since we will be four teachers~~ The teacher will split the class in three for that portion and they will each receive an opaque, translucent, or

transparent blindfold. Each group will have to share in between themselves and rotate with the different materials blindfolds. ~~Three teachers will be with each team and the fourth teacher who is leading the Engage phase will supervise.~~ The teacher will supervise, help, and go around the classroom to ensure that the lesson objective is being met (5 minutes). While the teacher is leading the Engage phase, she will write on the board the answers of her students and ~~the three other teachers~~ will be helping students and making sure they are listening. After having completed the blindfold activity, the teacher will listen to every student's answer after asking what they experienced during the activity (2 minutes). This will lead the teacher to ask: "how does the way light travels (through different materials) influence how we see in the dark?" The teacher will ask the students to discuss with their partners and jot their hypotheses on the board. Then, the teacher leading the explore phase will step in and end their discussion. The teacher will record student answers and begin the Explore phase of the lesson.

Engage phase duration: 10 minutes

The teacher will:	 **The students will:**
The lesson will begin with the lights in the classroom closed and the curtains or blinds closed. The teacher will ask the students…	Students will ask …
"Is it light or dark in the classroom right now?"	Students will say: "It is dark right now."
The teacher will answer: "Why do you think it is dark right now?"	Students will respond: Because the lights are closed and the curtains are closed."
The teacher will: Open the curtains or the blinds	
The teacher will say: "Now that I have opened the curtains, what is different about the light in this room?"	Students will answer: "It is brighter in the room."
The teacher will respond: "Yes, exactly! Can someone tell me why the room got brighter when I opened the curtains?"	Students will give many answers: ● "You opened the curtains" ● "You unblocked the sun" ● "The sun stopped when you closed the curtains but now it has turned back on" ● "The curtain was blocking the sun" ● "I don't know"
The teacher will write down the student's answers on the board The teacher will say: "Those are awesome answers, let's find out more!" The teacher will say: "Now, let's think about this question: Why do you think some materials let light through while others don't?" Discuss with your peers!	Students will think and discuss with their peers.

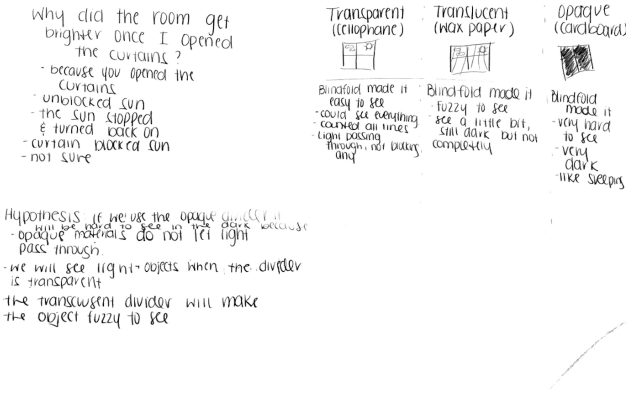
The teacher will say: “Would anyone like to share what they discussed with their groups?”	
	Students will share their answers with the teacher.
The teacher will hold up three different materials (opaque, transparent, translucent) and ask the class to observe. After 30 seconds, the teacher will ask students: “What do you notice is different about each of these materials?”	
	The student will say: “One is transparent, the other one is a bit less transparent, and the other is completely dark.”
The teacher will say: “That’s a great observation! So, transparent ~~looks like this (draws a window with nothing in the glass), it~~ allows light to pass through clearly. Would anyone like to give me an example of a transparent material?”	
	Student will say: “A window”
The teacher will say: "Yes, that is an example of a transparent material”.	
Translucent, which is the material you can kind of see through ~~it like this (draws a window with the glass a bit frosted)~~ it scatters the light partially. Does anyone have an idea of what a translucent material could be?”	
	Student will say: “ Sunglasses or tissue paper”
This material that is completely dark is opaque ~~(draws a window with completely darked out glass)~~ it blocks light completely. Does anyone have an idea of what an opaque material could be?”	
“Would anyone like to add something or ask a question about these types of materials?”	Student will say: “Curtain or wall”
The teacher will say: “Now, so we can explore this mystery together, let’s try to see for ourselves how light passes through different materials.”	
“Now it is very important that you listen closely because you’ll be the scientists conducting this experiment! Can everyone show me a thumbs up to tell me you are ready and listening? Awesome!”	

"You will be splitting into three groups, when I give you the number go see teacher 1, teacher 2, or teacher 3. Once you are split up, your teacher will give you a transparent blindfold, a translucent blindfold, or an opaque blindfold". "Next, you will share with your teammates and each have a turn of putting on the blindfold and you will be given a paper with lines on it to observe only once you have put on the blindfold. You will then take off your blindfold and share with your teammates how many lines you saw. It is important that you only keep the blindfold on your eyes and not close to your mouth or your nose." Note: Teachers assigned to each team will closely watch students while they use the blindfold to ensure safety. "Does anyone have any questions?" "Great, let's begin!" Moments later… The teacher will say: "Okay class, let's come back together to discuss our observations!" The teacher will say:"Can someone tell me what they saw when they put on the transparent blindfold?" (*eliciting students thinking*)	The student will answer: "I was able to count all my lines, it was really easy".
The teacher will ask: "So you were able to see everything with your transparent blindfold and count all your lines? Why do you think that is?" (*eliciting/pressing on students thinking*)	The student will answer: "Because my blindfold was not blocking any light, I could see right through it".
The teacher will write on the board what the student said: Transparent: Could see everything Counted all the lines Light passing through Not blocking any light	

The teacher will ask: “Great observation, now can someone tell me about their experience with the translucent blindfold, remember it is this one (points to the diagram of windows on the board), what were you able to observe?”	The student will answer: “With my translucent blindfold, I was able to count some of the lines but some of them were a little bit fuzzy. I could see only a little bit but it was not completely dark”.
The teacher will say: “That’s a great explanation. So, with your translucent blindfold, you were only able to see a few lines but it was not completely dark, is that correct? Did any other students have the same experience?” (*orienting students thinking*)	The students will answer: ● “I did” ● “Me too”
The teacher will ask: “Lastly, who can tell me what they saw when they used the opaque blindfold, remember that is the one that is completely dark (points to the window diagram on board)?”	The student will answer: “When I put on my opaque blindfold, I couldn’t see anything, it was like I closed my eyes really hard or when I go to sleep, it was very dark”.
The teacher will answer: “That is a really good way of explaining what you saw. Did anyone have the same experience as this student?” (*orienting student thinking*)	The students will answer: “I did!”
The teacher will say: “Thank you for your answers, they were all very interesting. Now, I want you to think about this question: How do light’s pathways influence how we can see in the dark? Discuss with your partners or your peers who are sitting close to you”. The teacher writes the question on the board	

END OF ENGAGE

Picture of white board at the end of the engage phase:



Management considerations:
In this phase, students will explore how light travels in the dark through different materials. The teacher will begin by providing a template for students to fill out their hypotheses individually after the discussion they just had with their peers. The students will model how they believe light travels through the 3 different dividers.~~Throughout the experiment, the students will each have the chance to look at a lightbox with 3 dividers made out of different materials (cellophane paper- transparent, wax paper- translucent, Cardboard- opaque).~~ Throughout the experiment, the students will each have the chance to look at three different light boxes made out of different materials (cellophane paper-transparent, wax paper-translucent, Cardboard-opaque). Each box will be labeled by the type of material the divider is made out of. (Transparent, Translucent, Opaque). The students will also explore the difference between turning the flashlight on and off. Their objective is to determine how light passes through the three different dividers. Once every student has had the chance to look at all three lightboxes, they now have to look back at their template they first filled out and try to remodel the phenomenon they just explored. During this activity, the students will be in groups of 3-4, the lightbox will be placed right in front of them and the teacher will announce when it is time for students to take a look one by one. All students will have the chance to get through 1 material divider before switching to the next material.

Explanation of Activity (2 mins): The teacher will explain to the students what the experiment of this lesson will be. All expectations and objectives of this lesson will be discussed. The students are expected to actively participate and observe carefully what is happening, while respecting their peers around them. Instructions on the procedures of this activity will be given as well. The teacher will explain how first they are going to have to fill out their initial hypothesis, then look in a lightbox with different dividers one by one. Additionally, the teacher will draw on the board what the students are supposed to observe in the lightbox and remember. Afterwards, they will look back at their initial hypothesis and create a new model based on what they observed. The rest of this lesson, discussing their evidence-based explanation, will be carried out in the following explanation phase.

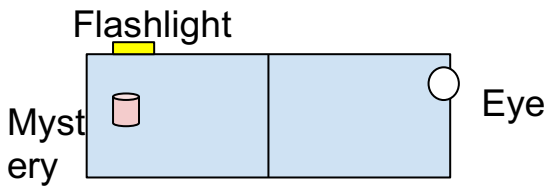
Modeling Hypotheses (3 mins): The teacher will hand out a worksheet to students to fill out their initial hypothesis. The students will have to complete 1 diagram to show how they think each divider will allow the light to pass through. Additionally, on the same worksheet, students will write out one sentence to explain their model. For instance one student might say: “The light fully travels through a transparent divider in a straight line.”

Experiment (5 min): Once every student has completed the first part of their worksheet, we will carry on with the experiment. One by one they will observe the first ~~divider in the~~ lightbox and see how light travels through. Once each student has had the chance to look at the first material, we will switch the box and follow the same procedure for the second box. The same will follow for the third lightbox. If needed the teacher will allow students to go back to the first or second lightbox to allow them to compare and contrast them.

Modeling Evidence-Based Explanation (5min)- this will segway into the explain phase: Now that all students have looked at all three material dividers and compared them one to another, they will have to look back at their initial model. On the same worksheet, they will have a revised model demonstrating what they observed. Once all students have the chance to finish all three models representing how light travels through the three different dividers, the next part of this lesson will be carried out, to discuss their findings.
Phase Duration: 15 minutes

The teacher will:	 **The students will:**
To begin with the activity, the teacher will hand out the worksheet for each student and give out clear expectations.	*Students will actively listen and follow the teacher's instructions. They will also get the chance to ask questions if further explanation is needed.*
The teacher will come back as a group and let students express their thoughts based on what the previous teacher asked them to do. T: What do you guys think? How do light's pathways influence how we can see in the dark?	The students might answer: S: With the opaque material we can't see anything but with the transparent material we can see the light pass through. S: Yes, I agree! I could not barely see with the translucent material.
T: Thank you guys for sharing those answers!	
T: Now we are going to explore how light travels through different materials like cellophane paper, wax paper, and cardboard. We'll use three different lightboxes to see how each material affects the way light passes through.	~~S: What do I need to write on these lines under my model?~~
T: Before we start our observations, I will give each of you a worksheet. For now, I want you to complete only the first part. Your task is to draw a model predicting how light will travel through one of the lightboxes. Use lines to show how you think the light will move, and feel free to add notes explaining your ideas. So for example, you can draw how you think the light will pass through a transparent box?	

T: Before we begin, does anyone have any questions concerning the worksheet? T: I will give you 3 minutes to complete this task. *While the students are completing the worksheet, the teacher will walk around the classroom and while whispering, ask some students to explain what they drew.* ~~The teacher will reply by saying:~~ ~~T: You can write down some of your thoughts on how you think light will travel. But we'll go back to this after our experiment.~~ ~~*Give students 5 minutes to complete their models.*~~ T: Give me a silent thumbs if you are done completing the part you had to do. T: Now that everyone has their hypotheses, you guys will have the chance to experience it with Miss Lorie. So enjoy! _____ T: Good, so now that everyone has completed their hypotheses, we can begin observing what is going to happen in the lightbox. T: For this activity, we have three different light boxes made out of different materials. Each type of material is written on the box. Your goal is to carefully observe in each box with a flashlight, and identify what is at the other end of the box. Make sure to compare one box to another and see how different they are! I will show on the board what the inside of the box will look like, and what you are supposed to identify. *The teacher will begin to do a small drawing on the board.* *The drawing will look something like this:*	*The students have 3 minutes to complete their worksheet.* *The students will give a thumbs up once they finish.*

 T: Before we begin observing, are there any questions?	
T: We will start with our first box, which is made out of an opaque material; cardboard, as we can see, it's written on it.	*Students will ask questions if there are any.*
T: Student 1 when you are done observing pass the lightbox to the person on your right side. (*pressing for descriptions and observations*)	*The students will all get the chance to look through the first lightbox.*
Once every student has had the chance to observe the first box, they can turn to their peers and do a quick think-pair-share of what they observed. *As teacher circulates* T: Could anyone tell me what they saw in the first box?	S1: I could not see anything. S2: Nothing S3: I only saw darkness.
The teacher will record the student's first round of observations on the board. In order to have visuals for students.	S1: I think we might see the object now because we couldn't see in the first box. S2: I think we won't see anything because the first box had nothing.
T: In that case, let's move on to our next lightbox. This is made out of translucent material. Can anyone guess how they think light will interact with this material?	*The students will look through the lightbox one by one.* *As students are looking through the box, they might answer the teacher's questions this way:* S1: I only see a little thing, but I can't tell what it is.

Students will all have the chance to look through the box. As they are looking through, the teacher will ask questions like: T: Can you see something? T: Do you want to share what you are observing? T: How is this box different from the first one?	S2: I see the shape of the object, but it's hard to tell the object. S3: In this box, I can see a bit more than the first one, but it's still not clear. S1: I think I saw something at the end of the box, but I couldn't really tell what it was. S2: No, it was hard. S3: I saw something shaped like a circle maybe but it was not super clear.
T: Good observations students, who wants to share with the class what they observed?	
T: Was anyone able to identify what was at the end of the box?	S1: I did not check in a different angle. S2: Me neither.
T: Was anyone able to see the object differently when you changed the position of the flashlight?	*The students will all take a look inside.*
T: In that case, we can go back to the first box and look at the second one again while moving around our flashlight to see if we might see something different in the first and second box from our initial observations.	~~S1: I think so~~ S1: In the first box, the object was not there. But in the second box, I could see a little bit better if I moved around my flashlight.
T: Who wants to share with the class if they saw something different.	S2: I mean, I don't think so because when we changed the boxes with different materials, I saw the objects differently.
T: I see student 1, so do you think that the flashlight's position is the only factor that impacts the way you can see an object? (*challenging students' thinking)*	
Before moving on to the next lightbox, the teacher will once again record all student observations on the board.	*Students will take a good look inside as the teacher asks them questions to allow students to express their observations.*

T: We will now look at the last lightbox that has transparent material. *The teacher will ask once again questions while students observe:* T: What makes this box different from others? T: S2, can you tell me what you are looking at? ~~T: Who was able to identify what was in the box?~~ T: Who wants to share what they observed? *The teacher will record student's observations on the board one last time.* T: Those are great observations! I now want you guys to pair up and share together how each box was different, and why you think it was different. _____ T: Great job, everyone! You made some really thoughtful observations. Now, I'd like you to take out the worksheets we worked on earlier. Using a different colored pencil, update your initial models to show what you actually observed—how did the light travel? T: Next, take a moment to answer the question at the bottom of the page, explaining the pathway of light. Don't worry about writing perfect answers! Just jot down some ideas you'd feel comfortable sharing. We'll go over our findings together and refine our understanding. T: I'll give you three minutes to complete your worksheet." *The teacher will once again walk around the classroom, look at students' answers and answer some questions.*	S1: I can see the object way better now. S2: I now know that the object is a rock. S3:: I saw a small rock. S1: Me too I could see a rock. S2: I saw the same thing. I was right, the object was shaped like a circle. *The students will have a moment to discuss together before moving to the final part of the worksheet.* *The students will have 3 minutes to work on their worksheet.*

T: Can you give me a silent thumbs up when you are done? T: Wow! I can see that a lot of the models have changed from the before and after. Now, with Miss Stefania, you'll have a chance to discuss your findings together. You'll explain how light traveled through the three different lightboxes and compare your observations. Let's see what we discovered!"	*The students will give a thumbs up once they have completed their second models.*

Management considerations:

This phase of the lesson aims for students to understand and explain how light travels in straight lines and interacts with different objects through reflection/refraction/transmission/absorption. The teacher will have students regroup and support students through a large group discussion. The purpose of the discussion is for students to make connections between their activity, models and everyday experiences. This phase will be divided into three aspects outlined below.

The key points to be discussed in this phase include:

- The lesson will begin with a discussion of light's pathway by sharing student hypotheses and data (3 minutes).
- The data will connect to a review of how light interacts with different materials, specifically focusing on reflection/refraction/transmission/absorption (5 minutes).
- the question of: Does light's interaction with materials in the lightbox present itself in the natural world (i.e. through sunlight) to elicit student thinking about extension exercises (2 minutes).

To organize students' ideas a public record of their thinking will be maintained on the white board. The teacher will add new findings to their initial ideas presented on the whiteboard. The teacher will create a chart, organized by each material, where students can pin their models on the white board after sharing ideas under the specific category.

Phase duration: 10 minutes

The teacher will:	 **The students will:** Students will ask … Students may respond… Students will do…
T: I love how we are adding to our models, filling them with rich new ideas. I'll give you one more minute to finish up your ideas, don't worry – we will have more time to add to our models and explanations. Let's go back to our original question: how did light's path through different materials influence the way we see in the dark?	
	S1: Light travels in waves but it didn't look curvy or wavy S2: It seemed to travel in rays, like the sun
T: Interesting. I like this connection to the sun you have made. Does this mean that to see objects we have to point light straight in our eyes?	
	S1: I do that with my dad's flashlight sometimes S2: No it just has to be in the air
T: Thank you for sharing. Can you add a little bit more to that, what do you mean it has to be in the air? *(pressing on students thinking)*	
	S2: For us to see there has to be light. Like at the beginning of the class we started in the dark and I couldn't really see until the lights were on.
T: interesting, so since we claim that light travels in rays now, let's find some evidence for this. Do you think when light points towards an object these rays go around it? Do they try to avoid it?	
T: Let's say you're walking in a crowd of people, do you want to bump into them so you walk around and try to avoid people. Do you think light does that with objects?	S3: I'm not sure what do you mean avoid it
	S1: yes, or else we would never see anything because the objects would take all the light so it has to go around S2: I disagree, I think light bounces off objects.
T: Thank you all for sharing, let's put on our detective hats and solve this question, does light bounce off	

objects or go around them? Let's find some evidence through our light box experiment. T:Is there a part of the box where you saw more light or less light?	
	S3: I feel like there was more light in the corner where the flashlight was pointing to then on my side of the box. When I turned it off, I couldn't see anything in any of the boxes. Maybe the flashlight and eye window should be closer
T: Thank you for sharing. Did anyone else feel like they saw something different than what student 3 said?	
	S1: I think it was different depending on the divider we used.
T: ah-ha! I think I see where you're going? Can you elaborate on that point? What was different? (*prompting student for further participation*)	
T: was anything else different?	
	S1: The amount of light in the box
	S2: Seeing the object was different. It was easier to see through the cellophane paper compared to the cardboard. To answer S3, light bounces off objects so the windows don't need to be closer, see the light from the flashlight hits the objects, it bounces off the object, light travels through the window well not in all the boxes but some and then reaches our eye so we can see
Teacher lists observations on the white board under the driving questions and hypotheses. To the right is a chart with model templates for each material. T: Let's discuss light's pathway friends! How did light travel throughout all materials?	
	S3: I think I remember seeing on TV that it travels in waves. S1: Actually I think it's in straight lines.
T: Thank you for sharing. Light does travel in straight lines. But does that mean that the same amount of light comes through in each divider? Was the object equally visible when all dividers were present?	

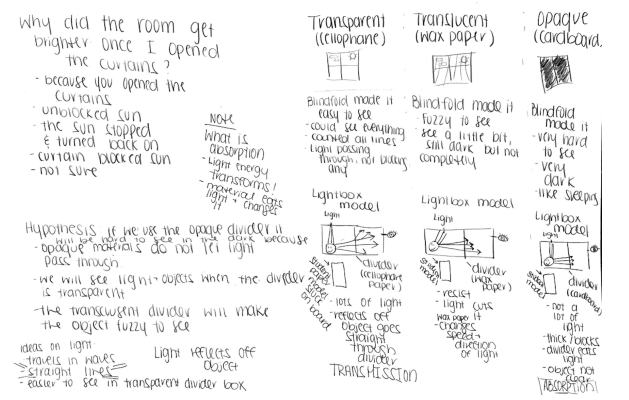
T: Really. How do you know it's not true? Did anyone else have the same idea? (*pressing for student ideas*)	S1: At first, I thought that some light was going to still come through the opaque cardboard because I thought only black items were considered opaque but it wasn't true.
T: I see. So student 1, you're saying that you were not able to see the object at all with the cardboard even though it is not a black material and student two you said not as much light traveled through the medium than you expected. What is one thing that these two materials have in common? Does anyone have any ideas? (*pressing for student thinking*)	S2: I did, but I also thought a lot more light was going to travel through the translucent medium than it really did. S1: I know it's not true because I wasn't able to see the object at all.
T: Why do you think the object wasn't so clear? (*pressing for student thinking*)	S3: all the light didn't come through for both of them S1: the object wasn't that clear
T: How did you know student 3? What made you hypothesize this? (*pressing for student thinking)*	S3: Well with the cellophane paper it was really clear but I knew that it was going to happen.
T: did it have something to do with the quality of the flashlight, type of paper, shoe box or the way you held the flashlight?	S3: I just knew.
T: I see. Now let's review our suggestions: student one, you said that when using the cardboard opaque material you couldn't see the end of the light box at all.	S3: I think it's because I knew it was transparent.
T: Oh, the box remained dark. Thank you for sharing. Now student two you said despite your original thoughts, you still couldn't completely see the object.	S1: Right and the box was still super dark even though I was holding the flashlight.

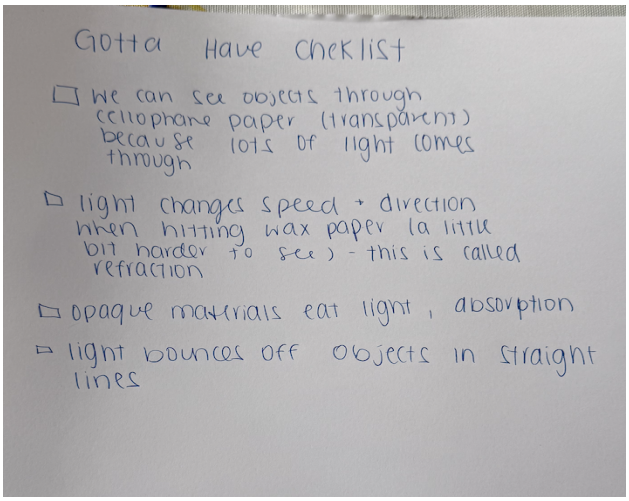
But student three you said you saw the object clearly through the transparent/cellophane paper. Does any one have any other results?	
T: Now what kind of pattern or relationship do we see here?	*Students unanimously agree*
T: Thank you. Can anyone add to this or discuss the relationship between light and material? (*orienting students thinking*)	S1: that light travels through transparent materials but not opaque ones like cardboard.
T: Thank you for sharing. Does anyone have some evidence for this relationship? (*challenging students to bring in evidence from explore phase)*	S2: I think the less transparent a material is the harder it is for those straight lines of light to travel through.
T: Nice sharing. Can you please add that model on the board, under the cardboard line! Does anyone know why this might be? (*orienting students thinking)*	S1: Well I chose to model the opaque material, like how light interacts with the cardboard and I erased my light lines from my first model because less light came through.
T: So I hear that the divider is thick and blocking the light. Can anyone add to that? (*revoicing*)	S2: because it's thick S3: because it gets blocked
T: I like this idea! So the divider is absorbing the light. Can someone tell me how light is travelling by telling me how I should draw my light rays?	S1: the divider eats the light!
Teacher models this on the template T: Thank you, good sharing but we are missing one small step!	S2: You should draw lines from the light hole straight to the divider

T: I see. What about the object?	
T: Right! So in all of these light boxes, no matter the dividing material the light is always going from the source, the flashlight, and bouncing off the object towards the divider. But in opaque materials like cardboard what happens? (*prompting students for further participation*)	S3: the object S1: The light touches it
T: Thank you for sharing. Can someone tell me if this was the same or different for the other materials.	S2: We have to draw less light lines because the light bounces off the object and gets absorbed by the divider so it doesn't pass through it and you can't see the object well.
Teacher models light pathway T: please come put your model on the board under the transparent, cellophane paper section! Can anyone repeat what student 3 said in their own words? (*orienting students thinking*)	S3: For the cellophane paper, I saw the object really well. I drew a lot of lines after the divider. So it bounced off the object and went straight through the divider.
T: Thank you for sharing. This process is called light transmission. How about for the translucent paper? The wax paper. Was this any different?	S1: The object was really easy to see with the cellophane paper divider. We should draw a lot of lines after the divider. So the light goes from the flashlight, reflects or like bounces off the object and then goes through the divider.
T: Please come put your model on the board. Why might this be? T: what does the divider do to the light?	S2: the object wasn't as clear but I still saw it. We should draw less light than the cellophane paper model but more than in the cardboard model. S3: because of the divider

T: Okay. Now this material is pushing back the light and changing its speed.	S1: causes it to resist
T: It's pushing back on the light, changing its speed which causes it to refract. It's almost like you were trying to hold your hat down on a windy day, the hat can't fly off at the same speed but it can still move a little bit. The same way the speed of light slowed down so it refracts but light can still pass through. Now this change in speed also causes something else to change. Any ideas?	S2: So it cuts the light?
T: Close let's think about the positioning?	
T: yes, the direction.	
	S3: The size S2: the temperature
Teacher models these results on the board below the corresponding material title	
	S1: like the place the light is going to
T: Let's review! I want to create a checklist that brings together all the important ideas we discussed today, but I need your help. What are some ideas we "Gotta Have"	S2: Oh, that's why it's a bit harder to see.
T: Thank you, so we can say when light interacts with transparent mediums, light cellophane paper we can see objects clearly. Lots of light is transmitted through the material.	S3: Light transmit easily like it goes straight through transparent mediums, like in the the one with the clear paper I saw the object so clear
T: What else can we add?	
Teachers lists these ideas on the board	

T: Does anyone want to talk about what happened in the box with the cardboard divider, the opaque material.	S1: we can say in the wax paper, light doesn't travel a lot it refracts, it changes speed and place or direction
T: great, can we say that light gets absorbed by the opaque material it doesn't transmit light making objects hard to see	S3: It's when a material eats the light, like the cardboard ate the light so it couldn't pass through the divider.
T: Yes, let's add that point!	S3: yes, but don't forget to say that light travels in rays and bounces off objects it doesn't go around them.
T: That's interesting, does anyone have anything to add?	S2: Remember how we learned that wind can make things move. Do you think light can change into anything? Like sun is light and when I'm in the sun I get hot because the sun rays are hot
T: That's an interesting idea to explore.	S1: if you leave ice cream in the sun it melts
T: Interesting. Think about this for next class. We will review some ideas. Picture of white board at the end of the lesson:	S1: Thinking about the sun, if you said light doesn't go directly into our eyes to make us see. Why do people wear sunglasses then?


Why did the room get brighter once I opened the curtains?
- because you opened the curtains
- unblocked sun
- the sun stopped & turned back on
- curtain blocked sun
- not sure
NOTE
What is absorption
- Light energy transforms / transferred
Hypothesis: If we use the opaque divider it will be hard to see in the dark because
- opaque materials do not let light pass through
- we will see light-colors when the divider is transparent
- the transclusent divider will make the object fuzzy to see
Ideas on light:
- travels in waves
- Straight lines
- easier to see in transparent divider box
Light reflects off object
Transparent (cellophane)
Translucent (wax paper)
Opaque (cardboard)
Blindfold made it easy to see
- could see everything
- counted all times
Light passing through not blocking any
Blindfold made it
- fuzzy to see
- see a little bit, still dark but not completely
Blindfold made it
- very hard to see
- very dark
- like sleeping
Lightbox model
Light
divider (cellophane paper)
- lots of light
- reflects off
Object goes straight through divider
TRANSMISSION
Lightbox model
Light
divider (wax paper)
- resist
- light curs wax paper it
- changes speed→ direction of light
Lightbox model
Light
divider (cardboard)
- not a lot of light
- thick / opaque
- divider eats light
- objects not clear
ABSORPTION


Gotta Have Checklist
We can see objects through cellophane paper (transparent) because lots of light comes through
light changes speed + direction when hitting wax paper (a little bit harder to see) - this is called refraction
opaque materials eat light, absorption
light bounces off objects in straight lines

Management considerations:
This phase connects to the original, abovementioned driving question. The extension activity will take place over three hours. The students will use the two hours to explore light reflection. The day will be structured to have two hours of science activity back to back. We acknowledge that students have set schedules, however for this activity the schedule will be reworked. This lesson will specifically focus on developing students' understanding of reflection of sunlight; connecting the lightbox activity to real-world phenomena. After this activity, the next two science periods in coming days will be dedicated to building student models. The students will then work in groups of 3-4, to use this experience to create a model for how light interacts with a given chosen medium. The students will be required to use music, song, movement, sport, drawing and STEAM practices to make their models come to life. These models will be displayed in the class museum exhibition. Families will be invited to explore the museum along with other members of the school community (student and faculty). The students will circulate, discuss and reflect on their experiences. These activities connect to the evaluation phase as they give students an opportunity to build on their thinking, and reflect on their learning. The students can then use self-assessments to situate themselves in the context of their learning. Our teaching philosophies value self-assessments as they give students an opportunity to reflect on their learning, develop interests and recognize their strengths. We chose this model-making exercise as it values differentiated instruction, students have the freedom to develop their learning beyond the structure of worksheets, rather using their interests and preferred methods of expression.

This lesson draws on student understanding of reflection (or light bouncing off an object in straight lines) when using the light box. However, it aims to incorporate real-life connections so students remain interested and curious. Below is an outline for the extension exercise:

Activity sequence (1 hours):
The students will explore the reflection of sunlight. The purpose of this activity is to integrate indigenous ingenuity into the classroom, while connecting the previous lightbox activity to real-world phenomena. The students will explore how light reflects off certain surfaces, like aluminum foil, white paper, a mirror or construction paper. The students will wear Inuit snowgoggles to assess how light reflects off different materials, but the goggles will protect their eyes. We recognize that not all schools have access to these goggles, but they can be purchased. Prior to the lesson, students will learn about the cultural values of Indigenous snowgoggles, their role, and origins.

The students will align the different materials in sunlight and see which materials reflect sunlight the most. They will then put in the snow goggles and explain their protective role. Here students will make connections to other protective wear like sunglasses, ski goggles, caps and visors.
Sample hypothesis – Testing a new hypothesis: If a surface is light in colour and smooth then more light will reflect off of it.

Model-building lessons (2 hours):
After completing this period-long activity, students will use the following two classes to develop their models. These students will pick one of light's pathways: absorption, reflection, refraction, or transmission. In a team of three to four the students will build models for this pathway. They will connect the model to a real- life phenomenon. Their models should include an audio recording, live performance, song, movement exercise to explain light's pathway. The goal is for students to recognize patterns for light's pathway when faced with different materials along with the relationship between light and material. The models should include reflection about 1-2 of the given exercises completed, explaining their phenomena: blindfold, light box,

sunlight. The teacher will give students diverse art materials: clay, paper rolls, markers, paint, playdough, foil, cellophane paper, wax paper, construction paper, tissue paper, cardboard. Creativity and discussion are encouraged, the teacher will circulate and guide student learning. The students will be in self-selected groups, thereby likely making them heterogeneous groups. However, advanced students will be encouraged to create protective sun wear and explain how it works to interfere with light's pathway from the source to the eye. These models will be used as a tool to assess student learning, while students will also complete self-assessments based on them. The teacher will provide guiding/probing questions to guide/facilitate students in their model creations.	
The teacher will:	**The student(s) :**
I will…. T: Okay class, welcome! Let's review some of the key ideas we've explored over the last few classes.	S1: We looked at light absorption
T: Can someone tell me how light absorption occurs in your own words? What is light absorption?	S2: The opaque cardboard ate the light and didn't come through. I think there's also an energy transformation that happens.
T: great! hold on to that thought! What else happened in our last experiment?	S3: The light went straight through, it was transmission in the cellophane divider because nothing was blocking it. It's like when we had the clear blindfold I saw everything the object was clear to see.
T: Can anyone add to what student 3 said? (*orienting student thinking*)	S1: well I can talk about the wax paper divider, it was translucent only a bit of light came through the object was a bit more difficult to see.
T: Close but it's not quite a reflection let's build on that! Reflection is when light bounces off an object like a mirror, or like we see light bounces off the item towards the divider, the object doesn't have reflective properties like the mirror. But here when the light	

bounces off the object and hits the divider what do we have here?	S2: its reflection!
T: Wonderful! Let's review so when light bounces off the object it reflects onto the divider. The cardboard absorbs light, and there is an energy transformation. The wax paper refracts light and the cellophane paper transmits light. What does this mean?	S1: the light changes speed and direction S2: refraction
T: These are all great points.	
T: Now I want to show you these, does anyone know what these are?	S1: they look like sunglasses S2: or ski goggles
T: They are Inuit snow goggles. These are created by Inuit communities and used when hunting to prevent snow blindness. What do you think they are made of?	S1: wood?
T: Does anyone have any other ideas?	S2: glass? But what is snow blindness
T: Good question. Does anyone have the answer?	S3: I think you mean sun blindness. S1: maybe it's when snow becomes so bright that it makes you not able to see.
T: How would that happen?	S2: because of sunlight
T: Yes, more specifically because of the sunlight's reflection off the snow.	
T: Now let's think about our opaque materials, which material do you think will absorb light most?	S3: like wood.

T: These are made from wood and sometimes animal bone. In indigenous science there's a strong connection between keeping a harmonious relationship with the land. So you see we should treat the animals well, help them during their life and they will nourish and protect us in return. Now when we go outside, we will have you lined up and record the temperature of your construction paper. You will have the opportunity to try these out.	
T: You will see how sunlight reflects differently off aluminum foil, white paper and a mirror. Since there is no snow outside, rather than seeing how sunlight reflects off the snow onto our eyes we will look at the different materials. Let's create a chart for this, begin with your hypothesis?	
	S1: I think when it bounces off the mirror it'll make us not be able to see so the goggles will help.
T: Nice hypotheses! That's a great idea. Let's open our science journals note down our hypothesis and create a table	
T: here we will list our three materials in the first column and then create a second column where you can describe how light reflects off the material and how the snow goggles have helped you!	
T: Form a line and let's make our way outside!	
Teacher and students head outside	
Teacher circulates and observes student word outdoors, we discuss findings.	
T: Let's review! What did the experiment reveal about the role of Indigenous snowgoggles?	
	S1: Before putting on the glasses we see that the mirror made the sun's light reflect the most. I've done this at home before with flashlights and mirrors.
T: Can you add a little bit more to that? *(pressing on students thinking)*	S1:The goggles made us able to stare at the light. Since they were made of wood it make it easy to see because it was absorbing light
T: Did anyone experience anything different? *(orienting students thinking)*	

	S2: like the light bounced off the mirror it was super refractive
T: Was it refractive or reflective? Remember reflective allows light to bounce off the mirror refractive changes the speed and direction of light, do you think the mirror changes the speed and direction?	
	S2: Oh so it was reflective. The white paper wasn't but the foil was also reflective, I actually didn't think the foil would be this reflective.
T: Did anyone else think the foil would be reflective? Did anyone find anything surprising?	
	S3: Neither did I but it makes sense it's sort of shiny like a mirror.
T: Very good observations friends! Let's build on these ideas	
Returns to class (45 minutes later).	
T: In your same working groups I have a fun project for you! Now I want you to think back to the original question: how do different materials influence light's pathway allowing us to see in the dark? In these groups you will use all your creativity to create a model for light's path. I want to see parts of your personality reflected in the model. You can create a dance, song or movie about lights pathway, you can also create a poster and present it to your peers. The model has to be representative of one of light's interactions. What are they again	
	S1: transmission or transformation through absorption S2: and reflection and refraction S3 I think I want to create an upbeat dance to show how light transmits from the flashlight through a transparent medium.
T: Good! You will have two class periods to work on this, and at the end we will create a museum of all your work- half the class will exhibit their work in one period and the other half the next!	
Here are some questions/ideas for you to think about when creating your models:	

· Am I explaining the light pathway? Does light travel in straight lines? · Have I clearly identified the material light is interacting with? · Can you see my interests and strengths and those of my group members in my presentation? · Why am I choosing to create models using these materials? · How does the material relate to the light pathway? · How would I teach this to my younger sibling, friend, parent or family member? · How does this model connect to my daily activities?	

At the end of the main lesson, the teacher will collect students' revised models and provide feedback to improve the students' learning experiences.

This phase will take place in two parts: a museum exhibit where students show their models and a self-assessment. Our teaching philosophies stem in equitable practices; students should not feel anxious and pressured for perfection when completing assessments. However, it is important that students express their learning as they will develop social, cognitive, reflective, and information skills. The model museum will take place in two 45 minute periods. In the first part, half the groups will demonstrate their models, while in the second part the rest of the groups will present their models. The groups who are not presenting will circulate and give constructive feedback, express connections and ask questions to their peers. For instance, if a group created a dance about reflection, they will show a video or the dance and explain their reasoning. The purpose of this assessment is to build student knowledge through diverse learning styles.

Proceeding these two activities a 15-minute period will be dedicated to a self-assessment. This will give students the opportunity to review their own learning, and reflect on new skills they developed. They will reflect on their ideas based on the driving question; and the depth and connections they've made to lessons will be used as assessment tools.

The teacher will:	**The student(s) will:**
Collect students models and give feedback ● Potential feedback ○ Excellent revisions! Think about how light bounces off the object. ○ Good work, don't forget that light travels in rays, it doesn't go around objects! Keep up those straight lines. ○ Good effort, scientist! remember that different materials impact how much light goes through the divider	
<u>Prompt Question to let student review their own learning</u> The teacher will ask: T: What is one thing you learned today about seeing in the dark?	The students will respond: S: Light rays have to reach our eyes for us to see, so even in the dark, we need some kind of light, like from the moon or a flashlight. S: Reflection helps us see in the dark because light bounces off objects and into our eyes. That's why shiny surfaces, like mirrors or water, can help us see better at night. S: Some materials block light completely, so they make shadows or dark areas where we can't see well. S: Refraction can change how things look in the dark. If light bends through something like water or glass, it might make objects look distorted or different.
<u>Discussion Question to reflect students on their new understandings, skills and ideas</u> The teacher will ask:	

T: What is refraction, and how does it affect the way we see? **1st 45 minute period** In the first part of the class, half the groups will demonstrate their models. The teacher will say: T: I will divide the classroom in half, for those who are walking around the museum exhibit, think about how light behaves in dim or dark conditions. What helps us see in the dark, and what makes it harder? T: Try to give constructive feedback to your peers! **2nd 45 minute period** In the second part of the class, the rest of the groups will present their models. The teacher will say: T: Now let's do the opposite, those who were walking around the classroom it is your time to show your model to your peers! T: Remember to ask questions if you have some and express your thoughts to your peers! **A 15-minute period will be dedicated to a self-assessment** Teacher will say: T: Before we finish today's lesson, I want you to take a few minutes to think about what you have learned. This self-assessment checklist will help you reflect on your understanding, the new vocabulary we used, and how confident you feel about today's topic. It is not a test, it is just a way for you to see what you have learned and what you might need more practice with.	S: Even in the dark, some objects reflect light better than others. That's why wearing bright or reflective clothes makes people more visible at night. The students will respond: S: Refraction is when light bends through things like water or glass. It helps us see in the dark because it makes light spread out and helps us see better. S: When light refracts, objects can look bent or in a different place than they really are. S: Refraction happens because light travels at different speeds in different materials. S: When light bends, it can make objects look closer or farther away than they really are. S: When light bends, it's called refraction. It helps us see better in the dark by changing the direction of light so it reaches our eyes.

T: Let's look at the first question together. It asks if you can explain what refraction is and how it affects the way we see. If you feel like you fully understand and could explain it to a friend, check 'Yes.' If you kind of understand but still have some questions, check 'Somewhat.' If you're not sure at all yet, check 'Not yet.' T: Now it is your turn! You have 15 minutes to complete this work. 1. *Understanding the Lesson* I can explain what refraction is and how it affects how we see. ☐ Yes ☐ Somewhat ☐ Not yet I understand how light behaves in dark or dim conditions. ☐ Yes ☐ Somewhat ☐ Not yet 2. *Using New Vocabulary* I can explain the terms reflection, refraction, and light rays in my own words. ☐ Yes ☐ Somewhat ☐ Not yet 3. *Applying What I Learned* I can give an example of how refraction happens in real life (e.g., in water or glass). ☐ Yes ☐ Somewhat ☐ Not yet I can explain how light helps us see in the dark. ☐ Yes ☐ Somewhat ☐ Not yet 4. *Self-Reflection* I feel confident in my ability to explain refraction and light's behavior after today's lesson.	

☐ Very confident ☐ Somewhat confident ☐ Not confident I was able to stay focused and engaged during today's lesson. ☐ Yes ☐ Sometimes ☐ No *5. Next Steps* I need to work more on understanding: ☐ Refraction and light bending ☐ How light helps us see in the dark ☐ Other: _____ I can improve by: ☐ Asking more questions in class ☐ Reviewing notes and vocabulary at home ☐ Practicing examples of refraction ☐ Other: _____ *6. Rate Your Overall Learning Today* How would you rate your overall understanding of the lesson today? ☐ Great ☐ Good ☐ Okay ☐ Needs improvement *7. Working Collaboratively* In my team I played the role of a ☐ leader ☐ organizer ☐ discussion manager ☐ time management keeper ☐ Other: _____ To conclude the lesson, the teacher will ask: T: Would anyone like to share one thing they feel really confident about from today's lesson?	

T: Is there something on the checklist that you realized you still need help with?	