

iwonder...

Rediscovering School Science

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THINKING ABOUT LIGHT: USING A DRAWING- BASED ASSESSMENT



Editorial Team:

Chitra Ravi
(Chief Editor)

Email: chitra.ravi@apu.edu.in

Radha Gopalan
(Consulting Editor)

Email: radha.gopalan@azimpremjifoundation.org

Madhukara S Putty
(Web Editor)

Email: madhukara.putty@apu.edu.in

Amol Anandrao Kate

Email: amol.kate@azimpremjifoundation.org

Rakesh Tewary (Advisory Editor)

Email: rakesh.tewary@azimpremjifoundation.org

Venkata Naga Vinay Suram

Email: vinay.suram@azimpremjifoundation.org

Anand Narayanan

Email: anand@iist.ac.in

Saurav Shome

Email: saurav.shome@apu.edu.in

Yasmin Jayathirtha

Email: yasmin.cfl@gmail.com

Anish Mokashi

Email: anish.mokashi@apu.edu.in

Shiv Pandey

Email: shiv.pandey@azimpremjifoundation.org

Hridaykant Dewan

Email: hardy@azimpremjifoundation.org

Sushil Joshi

Email: rusushil@yahoo.com

Chief Communications Officer and Managing Editor: Sudheesh Venkatesh.

Publications Team: Meera Prabhu, Shahanaz Begum, Lokram V G, and Sambit Mahapatra.

Translations Editors: Madhukara S Putty (Kannada) and Rajesh Utsahi (Hindi).

Illustrations and Artwork: Vidya Kamalesh.

Student intern: Samvedh CS.

Designers: MAP Systems, Bengaluru, Karnataka.

Printers: Repromen, Bengaluru, Karnataka.

Editorial Office: Azim Premji University, Survey No. 66, Burugunte Village, Bikkannahalli Main Road, Sarjapura, Bengaluru 562125.

Email: publications@apu.edu.in | Website: <https://azimprejiuniversity.edu.in/iwonder...>

About us: i wonder... is an Azim Premji University publication focused on preparatory-stage (Grades III–V) EVS and middle-stage (Grades VI–VIII) science teaching. Our aim is to publish articles and resources (such as activity sheets, teacher's guides, posters, and field guides) that support classroom instruction in government schools. We present critical perspectives and pedagogical approaches aligned with the broader curricular goals and competencies recommended by the National Curriculum Framework for School Education (NCF–SE) 2023.

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Editorial

Our students are formally introduced to 'light' in the chapter titled 'Light: Shadows and Reflections' in the Grade VII science curriculum. Light is a fascinating area of science—many everyday phenomena, from seeing objects to casting shadows and observing reflections, depend on how light travels and interacts with materials. Making sense of these observations requires students to form mental models of things they cannot directly see, such as the path light takes. As teachers, we need to understand how students interpret what they observe and how their ideas evolve as they learn. This captures the spirit of formative assessment: discovering what students are thinking so we can guide their learning effectively. But how can we help students express their emerging ideas as they learn about light? This issue of *i wonder...* features two articles that address this question.

How can we find out what students are thinking if they do not always express their understanding through spoken or written answers? In her article titled 'Thinking About Light: Using a Drawing-Based Assessment', Deepa invites us to consider drawing as a tool for expressing these ideas. She recognises that students may find it difficult to put their understanding into words, particularly when they are unfamiliar with scientific terms. To help them overcome this barrier, she developed an assessment that engages students with how light travels from a source and how this leads to the formation of shadows and reflections. Students are invited to sketch what they predict will appear on a screen when a shadow or image is formed. The drawings allow students to express their ideas more freely, which is particularly useful for a topic such as light, where understanding involves visualising the paths of light rays. Deepa shows that discussing typical responses can help teachers identify the ideas students are using and decide how to nudge them towards more scientifically accurate ones. Depicting the path of light through diagrams has a long history: more than two thousand years ago, the mathematician Euclid introduced a geometrical way of representing light by drawing rays. Later scientists developed this idea into ray optics, a powerful field that enables the design of everything from camera lenses, telescopes and microscopes to endoscopes, lighting systems and solar cookers. In fact, much of the global internet relies on fibre-optic cables running along the ocean floor.

In his article, 'Thinking About Light: Using a Sequence of Connected Investigations', Nirmal Kumar Neoliya reframes textbook activities into a sequence of explorations based on questions that emerge from students' everyday experiences of light. This approach encourages learners to articulate their ideas and then test them through group activities. Following each activity, the author encourages the groups to discuss their observations and compare possible explanations. This process highlights how continuous guidance is crucial for students to make sense of what they learn from activities. It also supports students in connecting concepts across activities to build a coherent understanding of light—much as scientists themselves came to understand light. Our scientific understanding of the nature of light itself has gone through several twists and turns over the last few centuries. Early theories proposed that light was made up of particles or behaved as a wave. Then came the measurement of its tremendous speed and the recognition that light is a wave of oscillating electric and magnetic fields. Eventually, as scientists examined new observations and compared competing explanations, evidence took us back to the idea of light as a particle. This led to quantum mechanics and the understanding that light can behave both like a wave and like a particle.

Both articles offer distinct yet complementary pedagogical approaches, shaped by ideas and tools that the authors have carefully tested with different groups of students. While these insights are shared in the context of teaching light, I feel that they invite us to think beyond this theme: Could we use drawing-based activities and assessments to help students express their thinking in other science topics? How might we structure guided discussions so that students can connect their learning across activities to build a coherent understanding of other concepts?

Anish Mokashi
Editorial Committee Member



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THINKING ABOUT LIGHT: USING A DRAWING-BASED ASSESSMENT



DEEPA

Grade VII students are encouraged to observe how light behaves in their everyday world. How can a drawing-based assessment tool reveal how these observations shape their understanding of light?

Students are formally introduced to the concept of light in Grade VII.¹ Based on the curricular goals and learning outcomes for this unit, they are expected to observe, interpret, and explain how light behaves in the world around them.^{2,3} Assessments aligned with these goals should help teachers understand how students are making sense of light. However, many conventional assessments focus mainly on what students remember or can communicate through writing. They tell us little about the observations, ideas, or reasoning that shape students' understanding. Also, in the contexts I work in, many students struggle to express their thinking through formal written responses. This does not necessarily mean that they lack conceptual understanding. Often, they can reason carefully about a phenomenon, but find it difficult to communicate their ideas in words. This raises an important question: Can assessments make students' thinking about light visible?

Designing an assessment tool

To address this question, I designed a diagnostic assessment tool that asks students to represent their thinking through drawings (see the **Concept Builder**). Research suggests that representing

scientific ideas visually can help students actively build their understanding. It can also support their ability to move from concrete observations to abstract ideas without relying heavily on written language.^{4,5} Three teachers used this tool with 248 government school students. Here is an analysis of student responses:

(a) What happens when torchlight hits a wall?

This question shows a torch facing a screen or wall. Students are asked to draw what they think will appear on the screen if the torch is switched on (see Fig. 1).

This may appear to be a very simple question—most students have observed torchlight falling on a wall. I included this question to see how closely students observe this everyday phenomenon. A scientifically accurate response would show a cone of light hitting the screen. But a torch does not illuminate a wall uniformly. In most torches, the light source (like an LED or bulb) is placed inside a curved, silver reflector cup. This directs most of the light into a bright central spot (called the 'hot spot'). Some light also spills

around the reflector, creating a wider, dimmer ring (called the 'spill'). Even if a torch emitted a uniform cone of light, the wall would still not appear equally bright everywhere. Light travelling straight from the torch to the wall covers the shortest distance and strikes the wall at 90°. In contrast, light reaching the outer edges of the cone travels farther and strikes the wall at an angle. Because light spreads out as it travels, its intensity decreases. Striking the wall at an angle also spreads the light over a larger surface area, making these regions appear dimmer.

Some students drew a bright central region and a dimmer outer region on the screen. Although they did not necessarily use scientific terminology, these students appeared to be drawing from close observation of how torchlight behaves in real situations. Other students offered a range of responses:

- No light on the screen: Some students drew the torch and the light coming out of it, but left the screen empty. This suggests that they may have struggled to separate the light source from the

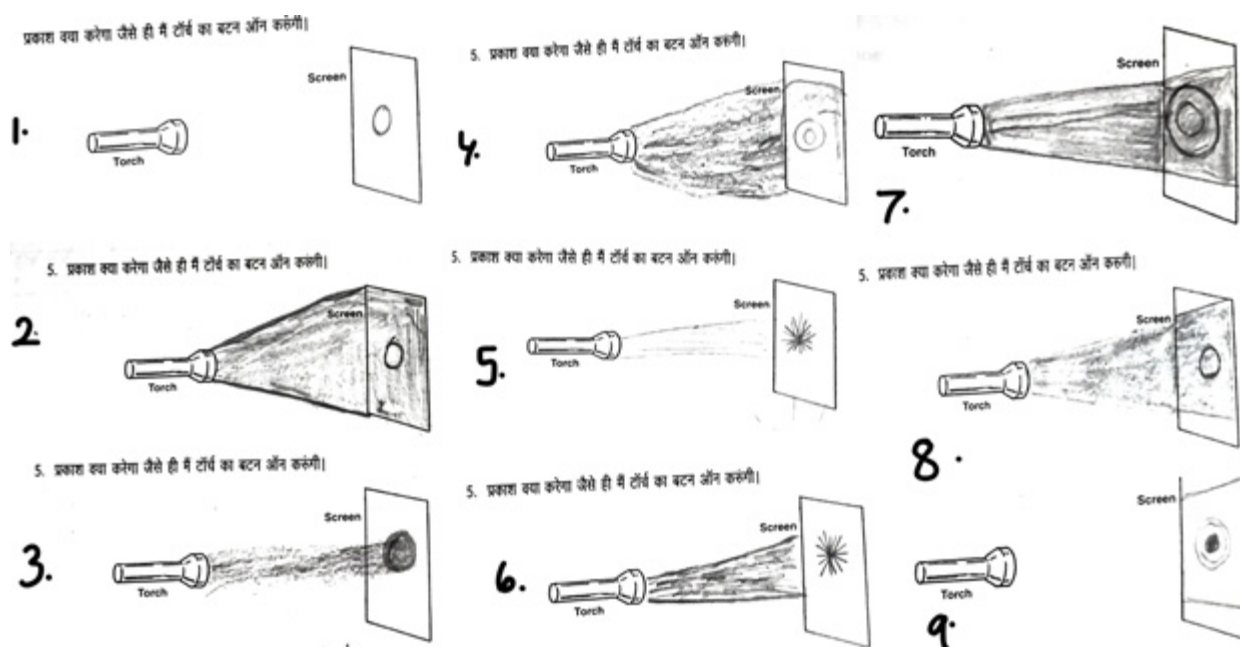


Fig. 1. Some samples of students' representations of torchlight falling on a screen.

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surface on which it falls, or did not know how to represent 'brightness' landing on an object.

- The wall as a see-through cloth: Several students drew a cone of light emanating from the torch, hitting the screen, and then continuing through to the other side, lighting up the space behind the wall. This suggests that they did not understand that a solid wall blocks light from passing through it.
- The scattering of light: Some other students showed light hitting the screen and then bouncing off in many different directions. This suggests that they might understand that a wall does not absorb all the light that falls on it.
- The wall as a mirror: A few students drew a reflection of the torch on the wall. This suggests that they expected the wall to behave like polished glass—bouncing the light cleanly back rather than softly scattering it.
- Inventing a shadow of the torch: Some students drew the torch, the light coming out of it, and a shadow of the torch itself on the wall. This suggests that they view a shadow less as 'light being blocked by a solid object' and more as a separate thing that a torch simply produces, just as it produces light. This could also be related to how strongly these students associated torchlight with 'seeing shadows' (of hand puppets, for example) in dark rooms or during power cuts.

(b) Can light move through a small opening?

This question shows a bulb placed opposite two screens that are positioned one behind the other in a straight line. The first screen, which is closest to the bulb, has a small hole at its centre. Students are asked to draw what they think will appear on the second screen when the bulb is switched on.

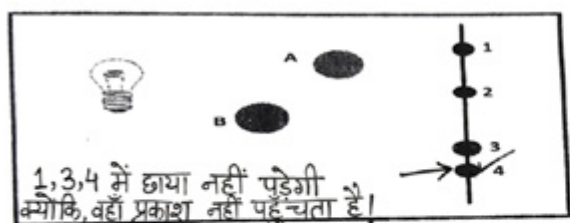
In Activity 11.2 in Chapter 11 ('Light: Shadows and Reflections') of the Grade VII science textbook (NCERT, Reprint 2026-27), students are encouraged to verify the rectilinear propagation of light by tracing its path through holes made in the lower trays of matchboxes that are lined up one behind the other.¹ I included this question to

explore whether students can apply this concept to a different setup. The opening in the first screen would allow straight beams of light from the bulb to pass through, while its solid parts would block the remaining light. Therefore, in a scientifically accurate response, the second screen would be shaded except for a bright central patch with dimensions matching the hole in the first screen. Again, students showed a range of responses:

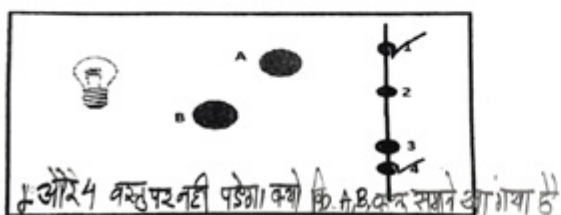
- Replicating the opening: Some students drew the outline of a circle on the second screen. Others drew a shaded circle. In both cases, students focused on reproducing the geometry of the opening on the first screen. But they failed to show that the area within the circle was the illuminated part.
- Incorrectly estimating the size of the illuminated region: Some students shrank the illuminated region by shading most of the second screen except a small part in the centre. Others shaded just the edges of the second screen, leaving a large hole-shaped part of it unshaded. In these cases, students had either underestimated or overestimated the extent of illumination. Interestingly, one student compared this situation with their observation of how sunlight entered their home through a small window, but then 'widened' to fill a dark room. This is incorrect—sunlight continues to travel in straight lines after entering through the window. What appears to be a widening beam is actually the combined effect of light entering through different parts of the window and being scattered by other surfaces and dust particles in the room. However, the student's response showed that they were drawing on an everyday observation to make sense of a new situation.

(c) Where will a shadow not be formed?

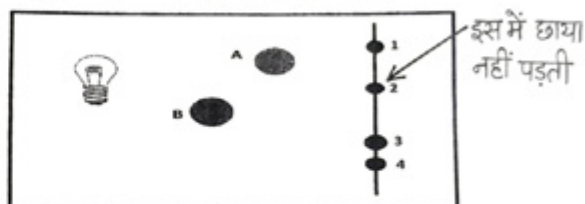
In this question, two balls of equal size are placed between a bulb and a screen. Four points are marked on the screen and students are asked to predict which ones will not show a shadow when the bulb is turned on (see Fig. 2).



7. किस बिन्दु [1,2,3 या 4] पर छाया नहीं पड़ेगी और क्यों, चित्र बना कर बताइये?



7. किस बिन्दु [1,2,3 या 4] पर छाया नहीं पड़ेगी और क्यों, चित्र बना कर बताइये।



7. किस बिन्दु [1,2,3 या 4] पर छाया नहीं पड़ेगी और क्यों, चित्र बना कर बताइये?

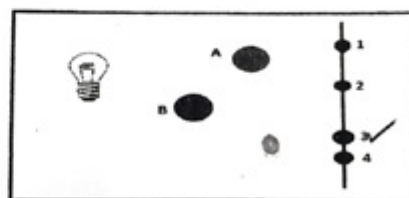


Fig. 2. Some samples of students' predictions of where shadows would not be formed on a screen.

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The purpose of this question is to explore whether students can use straight lines to mentally trace light paths from the bulb and past the edges of the balls to identify the illuminated regions on the screen. Therefore, a scientifically accurate response would be to predict that shadows will not be formed at points 1 and 4 on the screen.

Some students deduced the correct answer by sketching ray-tracing lines. Many others, however, shared predictions (such as the claim that shadows would not form at "points 3 and 4", "only point 2", or "only point 4") without attempting this geometric reasoning. Interestingly, some students revised their thinking after discussion with peers who had used geometry to answer this question.

(d) Where is a shadow formed? This question shows a tree with the Sun shining on it. Four possible positions for the tree's shadow are marked around it. Students are asked to label the source of light, the object, and the correct shadow.

In Chapter 11 of the Grade VII science textbook, students read that: "...when an opaque object is placed in its path, light is blocked. The dark patch, where light does not reach, is the shadow." This

question explores whether students can apply this understanding to a diagram. In many science classrooms, students interpret diagrams only after the underlying ideas have been explained by the teacher or presented in the textbook. Here, students are asked to interpret the relationships between these three elements on their own.

Students' responses showed wide variation. Only some of them labelled the three components correctly. Many students did not comprehend the question. Some students drew their own shadow for the tree rather than identifying one of the possible shadows shown. A few students selected more than one shadow from the given options. This revealed that they had not yet grasped that a single light source at a fixed position can produce only one unique shadow for an object. Some students selected a shadow that lay between the Sun and the tree. This suggests that they may not yet understand that a shadow forms on the side of an object away from the light source.

(e) What does a shadow look like? This question shows a bulb, an opaque rod, and a screen placed in a line. Students are asked to draw what they will see on the screen when the bulb is switched on.

In Activity 11.4 in Chapter 11 of the Grade VII science textbook (NCERT, Reprint 2026-27), students are encouraged to observe the shadows that opaque objects of different shapes and sizes form on a screen (like a wall, the floor, or the ground).¹ Also, shadows are direct evidence that light travels in straight lines. They would not form if light could bend around opaque objects like water flowing around a rock. The purpose of this question is to explore whether students can apply this understanding to a physical situation. A scientifically accurate response would show a shaded, rod-shaped patch on the screen. This is because light from the bulb reaches all parts of the screen except where the rod blocks it. However, student responses revealed a range of alternative ways of thinking:

- Confusing shadows with reflections: Many students drew an exact and detailed replica of the rod on the screen, but did not darken it. This suggests that they were treating the screen like a mirror that shows a reflection of the object rather than a surface on which a shadow is formed.
- Confusing shadows with images: Some students drew an upside-down version of the rod on the screen. This suggests that they are confusing the formation of a shadow with the formation

of an image (by a pinhole camera or lens, for example).

- Drawing the shadow on the object: Other students darkened the rod itself or wrote the word 'shadow' inside it. This suggests that they do not yet understand that the shadow is formed on the screen behind the object.

(f) How do we see objects? Students are asked to draw how they think we see a bottle kept in the Sun, marking the specific path light takes (see Fig. 3).

Among all the questions in the assessment, this is perhaps the most revealing. Students can often recall this textbook statement: *"When light from a source falls on an object and the reflected light reaches our eyes, we are able to see the object."* This question is designed to explore whether they can represent this idea visually. A scientifically accurate response would show the path of light from a source falling on the bottle, being reflected, and reaching the eyes. Only a fraction of the students shared this response. Other responses included:

- Outward projection: Many students drew arrows that emerged from the eyes and reached

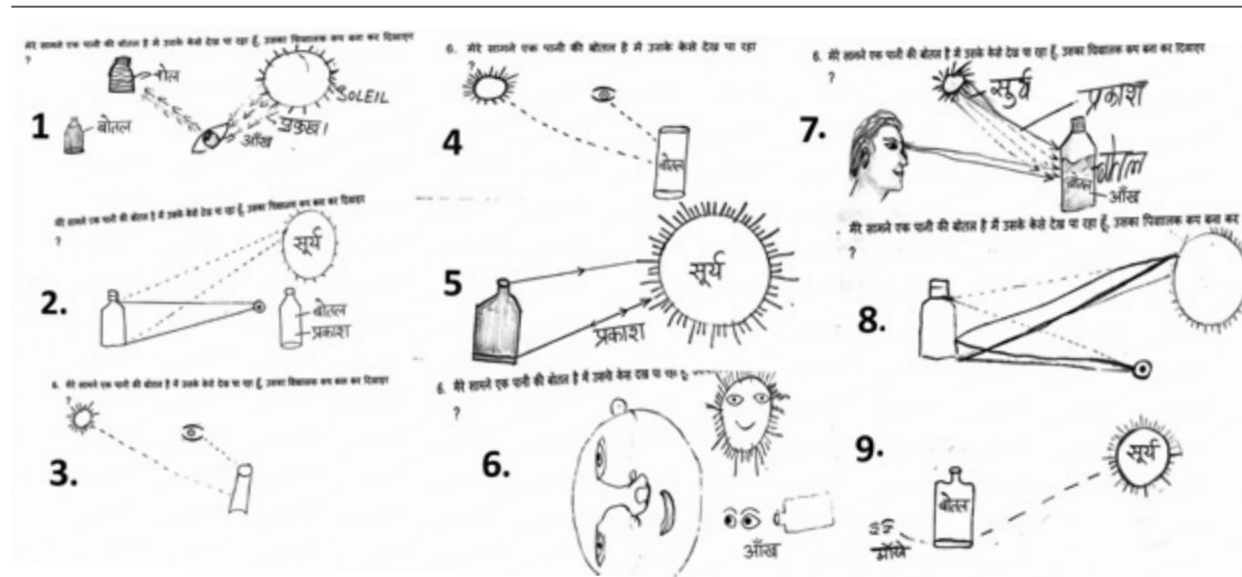


Fig. 3. Some samples of students' representations of how we see an object.

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the bottle. This suggests an intuitive, but scientifically incorrect, belief that our eyes actively project something to 'look' at an object.

- Direct path from the eyes: Some students drew a single continuous line travelling from the Sun directly into the eyes, and then continuing from the eyes toward the bottle.
- Hybrid models: Some combined both ideas, drawing two independent lines—one from the Sun to the eye, and a separate one from the eye to the bottle.

(g) How do plane mirrors alter the path of light?

This question presents students with a diagram of four different arrangements of mirrors within a hollow pipe wrapped around three sides of a solid wall. They are asked to predict which mirror arrangement would allow a person on the left side to see a cat on the right side.

In Chapter 11 of the Grade VII science textbook, students read how: *"...a shiny surface or a mirror changes the direction of light that falls upon it. This change in direction of light by a mirror is called the reflection of light."*¹ They are also encouraged to use plane mirrors to construct a periscope: *"...by placing two plane mirrors in a Z-shaped box... Reflection from two mirrors enables us to see objects that are not visible directly. Periscopes are used in submarines, tanks, or by soldiers to see outside their bunkers. You may use it to look ahead when standing behind taller friends."*¹ The purpose of the question is to explore whether students can use this understanding to reason about the path of light and predict how it is reflected by plane mirrors at each turn of the pipe. A scientifically accurate response would be to choose the third arrangement. This arrangement has a mirror at a 45° angle at every corner. When a straight beam of light hits each mirror, it makes a 90° turn. Because all four corners use these angled mirrors, the light zigzags smoothly around the wall, creating an uninterrupted path from the person's eye to the cat.

At first, almost none of the students could map the path of light correctly. They drew lines that followed the bends of the pipe. This suggests that

they were focusing on the shape of the pipe, while overlooking the role of the mirrors placed at its bends. Once their attention was drawn to the mirrors, some students were able to arrive at the correct response.

(h) How do lenses alter the path of light?

This question asks students to use a drawing to explain how sunlight can be used to burn a piece of paper.

As students move from Grade VII to Grade VIII, the curriculum shifts to ideas related to lenses. Therefore, I included a question that allows students to explore these, more complex, ideas in an everyday context. It builds on the personal observation that many students at this grade level have used magnifying lenses before. This question requires them to think of the interaction between sunlight, lenses, and paper rather than see them as isolated objects. It also challenges them to create a drawing to represent a process rather than simply label a diagram given to them.

A scientifically accurate response would show sunlight being focused by a convex lens onto a small region of the paper. This would suggest that students understand that focusing light energy onto a small region increases its temperature and may eventually cause the paper to burn. Student responses were of two kinds:

- Identifying optical devices: Some students drew a glass bottle with straight sides, while others drew plane mirrors. Neither would focus sunlight in the way a convex lens does. One student represented the paper itself as a mirror. Interestingly, another student included a note stating that: *"We cannot burn a paper using a mirror as a mirror does not have that power."* This is partly correct. Plane mirrors, which are the only mirrors students have been introduced to in the Grade VII science textbook, cannot be used to focus light.¹ But concave mirrors can. Students learn this in Grade VIII. In fact, Activity 10.7 in Chapter 10 ('Light: Mirrors and Lenses') of the Grade VIII science textbook (NCERT, 2026–

27) encourages students to try burning a thin piece of paper with a concave mirror.⁶

- Representing the process: Among students who recognised that lenses could burn paper, some simply drew a lens and paper. Many others captured the accurate sequence—showing the path of the light going from the Sun to the lens and being focused by the lens onto the paper. Interestingly, one student drew how two lenses could be used together to focus the light onto paper. They may have intuitively reasoned that if one lens can concentrate light, adding a second lens would make the focusing effect stronger.

(i) Students' reflections on the assessment:

The final question asks students what they think about the assessment. They are invited to share difficulties, suggestions, and reflections. I included this question because an assessment need not be used only to gather information from students. It can offer students the opportunity to comment on classroom practices rather than simply participate in them. It can also offer teachers the opportunity to learn from students about the assessment process itself.

Several students reported that they were not accustomed to questions that required them to draw their ideas. Others said that some questions were difficult because they had never been asked to think about these situations before. Here are some other things I learnt from students' responses to this question:

- While assessments can be designed to support inquiry, they cannot replace classroom investigation—observation, experimentation, and hands-on activities remain essential parts of science learning.
- In several questions, students appeared to be working with assumptions that were not explicitly stated. Future versions of this tool and similar assessments could include opportunities for students to describe the assumptions they are making before drawing their responses.
- A drawing does not always reveal exactly what a student is thinking. Different students may

produce similar drawings for different reasons. Some students may understand a concept, but struggle to represent it. Others may produce a scientifically accurate diagram without fully understanding the underlying ideas. For this reason, drawings are most useful when accompanied by opportunities for students to explain their thinking.

Parting reflections

This exercise highlights the role that prior assumptions play in science learning. Students rarely approach a problem with an empty mind. They enter classrooms with ideas developed through personal observation and experience that strongly influence how they interpret diagrams, understand explanations, and respond to questions.

How do we draw these ideas out? Assessments such as this one offer one possibility. For example, students frequently brought their everyday experiences into their responses to this assessment, drawing upon observations from their homes, surroundings, and objects encountered in daily life. Interestingly, when the question 'Can light move through a small opening?' was discussed with 13 teachers (three of whom had used this assessment tool in their classrooms), many produced responses similar to those of the students. This became an important moment of reflection, revealing the prior assumptions that adults also bring to the classroom.

In discussing the role assessments could play in drawing out prior ideas, some teachers expressed the concern that designing such tools on the theme of light would require specialised laboratory equipment or lasers. Yet many of the questions in my assessment tool drew upon simple everyday situations involving familiar materials. Students' responses suggest that such situations already offer rich opportunities for scientific thinking. The challenge is often not the lack of resources, but the kinds of questions that we ask.

When students are asked only to reproduce definitions, teachers may never discover how they

Box 1. Curricular connections:

Students' responses to this assessment tool and class discussions around it can help teachers' meet the following:

A) Curricular goals for middle-stage science:

- CG-2: [The student] explores the physical world in scientific and mathematical terms. Specifically, it can help students develop the competency (C-2.4) to: *"Demonstrate rectilinear propagation of light from different sources (natural, artificial, reflecting surfaces), verify the laws of reflection through manipulation of light sources and objects and the use of apparatus and artefacts (such as plane and curved mirrors, pinhole camera, kaleidoscope, periscope)."*
- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can help students develop the competency to:
 - (C-7.1): *"Use scientific vocabulary to communicate science accurately in oral*

and written form, and through visual representation."

- (C-7.3): *"Represent real world events and relationships through diagrams and simple mathematical representations."*²

B) Learning outcomes (LO) for middle-stage science:

- [The student] explains processes and phenomenon, e.g., the formation of shadows [and] reflection of light from [a] plane mirror.
- [The student] constructs models using materials from surroundings and explains their working, e.g., pinhole camera, periscope, electric torch, etc.
- [The student] identifies materials... such as...mirrors and lenses on the basis of observable features, i.e., appearance, texture, functions, etc.
- [The student] differentiates materials... such as, images formed by mirrors and lenses, etc., on the basis of their properties, structure and function.³

are actually thinking. But questions that require prediction, representation, interpretation, and explanation can help bring these assumptions to light. For example, when the question 'What happens when torchlight hits a wall?' was discussed with teachers, many explained that the wall would be illuminated because it was opaque and would not allow light to pass through. But when asked to draw what the illuminated region would look like, they admitted that they had not previously paid attention to these details. The discussion became an opportunity for teachers to reflect on how often assessments move directly to testing whether students can explain, without first spending time asking what they have observed.

Similarly, while discussing responses to the question 'Where will a shadow not be formed?', one teacher commented that students might be struggling because such mirror-alignment or path-prediction activities were not explicitly part of the curriculum. This observation led to an interesting conversation about curricular goals and learning outcomes (see Box 1). One of the

learning outcomes expected for middle-grade science students is to construct models such as pinhole cameras and periscopes and explain how they work. If students are expected to understand such models, then they must also reason about the paths followed by light. The question therefore seemed closely connected to the broader goals of the curriculum even though it did not appear directly in the textbook. The responses also highlighted an important distinction between reproducing a model and understanding its functioning. Students often construct models by following instructions. However, understanding why a model works requires prediction, inference, and explanation. This question, therefore, provided insights into whether students could move beyond recalling information to applying their understanding.

In many classrooms, science learning is assessed through students' ability to write definitions or explain concepts in complete sentences. But while working with students across Grades VI–VIII, I have observed that students often know more

than what they are able to express in writing. Since this assessment tool did not rely on writing skills alone, many students engaged with it more confidently. Drawing a diagram is often treated as an exercise in copying a textbook image from memory. But when students are asked to create their own representations, teachers gain rare access to how they visualise scientific processes and relationships. While these representations were not always scientifically accurate, they often revealed observations, assumptions, and attempts at explanation that might otherwise have remained hidden in a written assessment. In this way, drawings provided richer opportunities to understand how students, especially those who struggled with writing, were making sense of the world around them.

Perhaps the most important insight I gained from this exercise is that an assessment can itself become a form of inquiry. While analysing student responses, I began to see representations less as illustrations that accompany explanations and more as active tools for thinking and learning. Students were not merely drawing answers; they were actively constructing explanations. The process of moving between observation, drawing, discussion, and explanation allowed students to refine their thinking, test ideas, and draw upon their experiences to make sense of scientific phenomena. This served as a powerful reminder that the task of teaching is not simply to replace students' ideas with correct answers, but to create opportunities for students to examine, refine, and extend their own thinking.

Key takeaways

- Students enter science classrooms with prior observations and experiences. Assessment tasks that invite prediction, representation, interpretation, and explanation can reveal these otherwise hidden assumptions.
- Everyday phenomena involving familiar materials provide rich opportunities for assessing students' understanding. The key lies in the kinds of questions we ask about them—whether they focus solely on recall or also encourage scientific thinking.
- Students often know more than they can express in writing. Drawing-based assessment tools provide them with another way to communicate scientific ideas.
- Assessments that allow students to construct their own explanations can themselves become a form of inquiry. They can create opportunities for students to examine, refine, and extend their thinking.



Notes:

- Credits for the image (Observing Torchlight Hitting a Wall in a Darkened Classroom) used in the background of the article title: Created for i wonder... using ChatGPT, under prompting by Chitra Ravi (Jun 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- This article includes one classroom resource: **Concept Builder: Think About Light Through Drawing**.

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Deepa is a Block Coordinator with Azim Premji Foundation in Magarlod Block, Dhamtari, Chhattisgarh. She previously worked at Ericsson in signal processing and networking. She holds a BTech in Electronics and Communication Engineering from Indira Gandhi Delhi Technical University for Women (IGDTUW), New Delhi, and an MA in Education from Azim Premji University, Bengaluru. Deepa enjoys working with teachers and students in mathematics, science, and environmental studies. Her interests include inquiry-based learning, curriculum design, and inclusive education. She can be contacted at: deepa.singh@azimpremjifoundation.org.

Perspectives

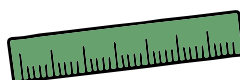
CONCEPT BUILDER: THINK ABOUT LIGHT THROUGH DRAWING

Aim: To use drawings to show how you think light behaves in everyday situations.

You will need:



Pencil



Ruler



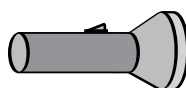
Eraser

What to do:

- This sheet has 9 questions.
- Questions 1 to 8 show pictures from everyday life. Look carefully at each picture and think about what is happening.
- Predict how light moves and behaves in each situation.
- Where asked, draw the path of light using arrows to show its direction. Use a pencil so you can easily erase and correct your drawing if you change your mind.
- Use the lines below each question to explain your answer. Do not worry about using difficult scientific terms—just use your own words.

Think about:

Q1. A torch is pointed toward a screen.
Draw what you expect to see on the screen when the torch is switched on.
Draw the path the light will follow from the torch to the screen.

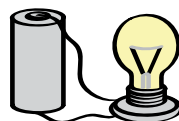


Torch



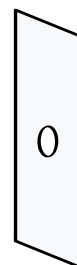
Screen

Q2. A cardboard sheet with a small hole is placed between a bulb and a screen.
The bulb is switched on. Draw what you think will appear on the screen.
Draw the path the light will follow from the bulb to the screen.

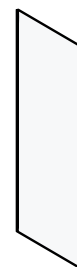


Battery

Bulb



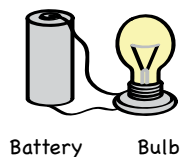
Screen with hole
in the centre



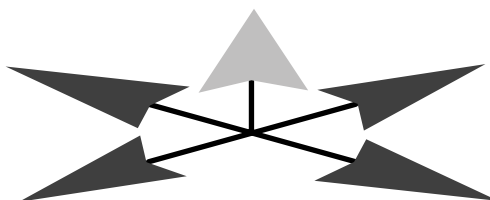
Screen



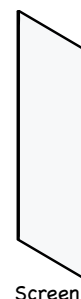
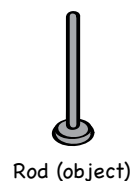
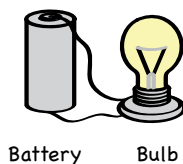
- Q3.** Two identical balls (A and B) are placed between a bulb and a screen. Four points are marked on the screen. At which of these points will **no** shadow be formed? Show your reasoning by drawing the paths of the light rays.



- Q4.** Look closely at the picture. Label the light source, object, and every shadow you see in the picture. Draw the path light takes from the light source to show which shadow (or shadows) will actually form.

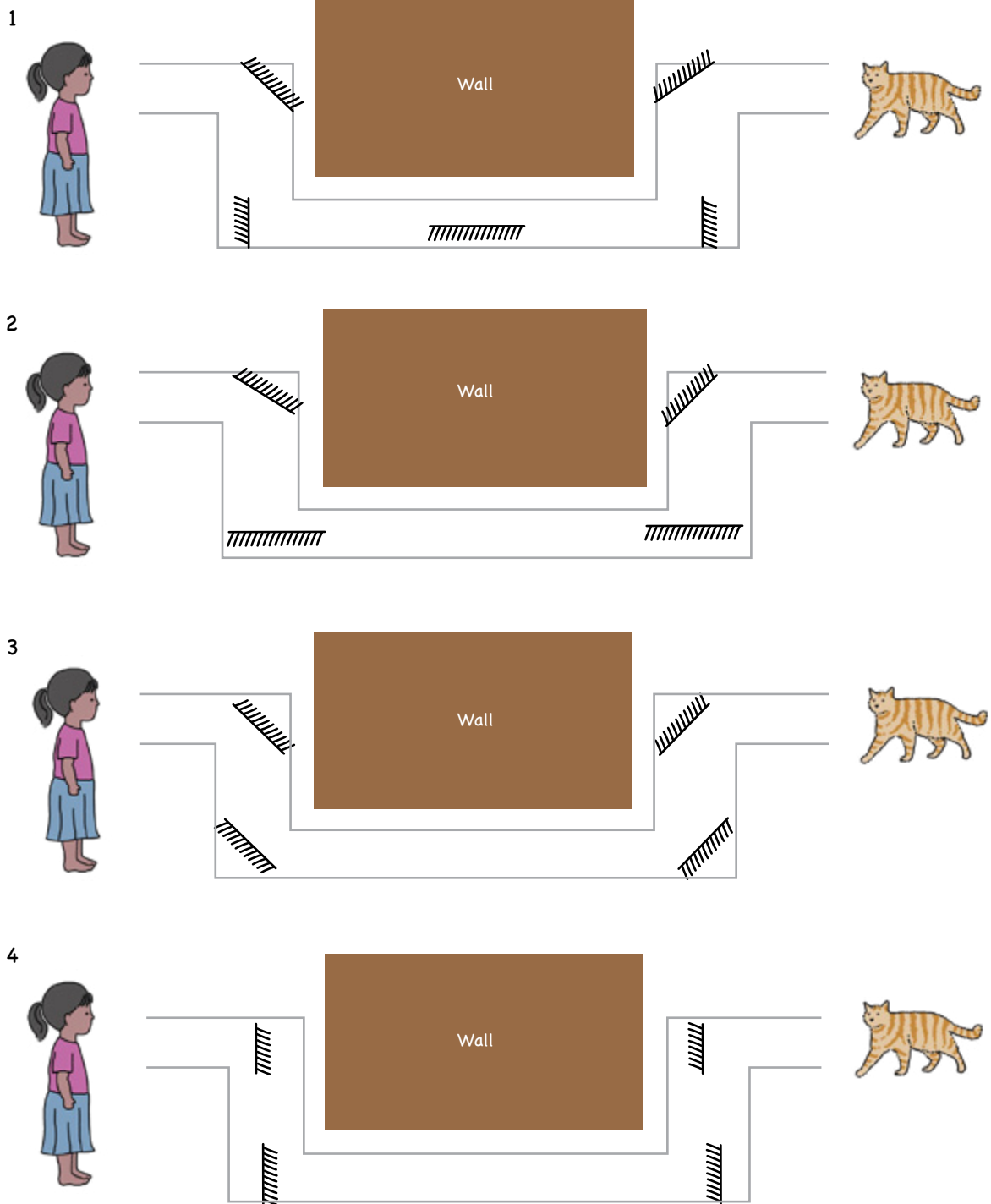


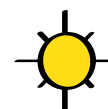
- Q5.** A solid iron rod is placed between a bulb and a screen. The bulb is switched on. Draw what you expect to see on the screen. Draw the path the light will follow from the bulb.



- Q6.** A bottle is placed in sunlight. Use the blank space to the right to draw a picture showing the Sun, the bottle, and an eye looking at the bottle. Draw arrows to show the path light travels so that the person can see the bottle.

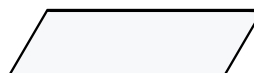
Q7. A girl and a cat are standing on opposite sides of a wall. A hollow tube goes around the wall. Look carefully at the four options shown below. Mirrors have been placed inside the tube in different ways. The smooth side of the mirror reflects light, and the bristly side does not. Which of these options will allow the girl to see the cat? Show your answer by drawing the path of light through each tube.





Sun

- Q8.** Can you use sunlight to burn a piece of paper? Name the tool you would choose for this task. Draw the path of light to show how you would use the tool to burn the paper.



Paper

- Q9.** What did you think about this drawing-based exercise? Did you find any of the questions or drawing tasks difficult? If yes, which ones? Did any question make you think about light in a new way? How could we make this exercise better?

Discuss:

Pair up with a classmate and exchange your answer sheets.

- Compare: Look at your classmate's drawings for Questions 1 to 8. Pay attention to how they drew the path of light in each question.
- Discuss: Pick one question where your drawings are different and ask your classmate: "Why did you draw it that way?"
- Reflect: Listen to their explanation. Did seeing their drawing change your mind about any of your answers?
- Write: On the lines below, briefly note what you discussed and what you learned from your classmate.



THINKING ABOUT LIGHT: USING A SEQUENCE OF CONNECTED INVESTIGATIONS

NIRMAL KUMAR NEOLIYA

Grade VII science students are usually introduced to light through individual textbook activities. How would their understanding change if these activities were organised into a sequence of connected investigations that students helped design?

Light is an important theme in the middle-stage science curriculum. Students are formally introduced to it in Chapter 11 ('Light: Shadows and Reflections') of the Grade VII science textbook (NCERT, Reprint 2026–2027) through a series of activities.¹ This series is designed to help children understand light as a physical phenomenon that can be observed, investigated, and explained scientifically.

In many classrooms, only part of this series is carried out. Even when all the activities are conducted, they are frequently treated as isolated classroom experiences. Children may not receive support in recognising how the ideas developed in one activity help explain another. As a result, children may learn about different aspects of light without recognising how they are connected. What would students learn about this theme if they participated in designing a sequence of connected investigations?

Building a sequence of investigations

Over three years, we explored this question through activity-based workshops on light that were deliberately designed to help students

develop these conceptual connections. Around 50 students from the upper primary and secondary stages participated in these workshops.

Instead of starting with activities, each workshop began with a discussion on where we see light in everyday life. This brought up many questions—some from the students' prior observations and others from the discussion itself. Rather than answering them, we divided the students into small groups and asked them to choose a topic to investigate. The students discussed what they already knew about the topic, what they wanted to find out, and how they might investigate those questions. During this stage, our role as teachers was mainly to listen to children's ideas, ask questions, and help them refine their plans where necessary.

Over the next three weeks, each group worked on its activity. Students began by listing the materials they needed. Most were low-cost, local items—such as PVC pipes, cardboard, plastic bottles, candles, torches, clay, and scrap paper—which the students brought from home or the school store. Any extra items were bought by sharing the cost.

The groups tested their setups over two or three trials, modified them as needed, and presented their work to the school. During these sessions, the students answered questions, discussed alternative explanations, and reflected on their learning. Here are some examples of their investigations:

(a) What factors are necessary for us to see an object? Some students said that we need eyes to see. Others suggested that seeing depends mainly on the presence of light. A few asserted that if an object is present, it can always be seen. Rather than sharing the correct answer, we encouraged children to test these ideas through simple observations. The students recorded whether they could see an object (like the markings on a pencil) when it was kept inside an empty shoebox in a darkened room with:

- A bulb that was not switched on;

- The bulb switched on;
- The bulb switched on, but their view of the pencil blocked by a screen;
- The bulb switched on, but their view of the bulb blocked by a screen.

Though children use light daily, they rarely think about its role in seeing. This investigation helped them recognise that three conditions are needed: a light source must be present, the object must either emit or reflect light, and that light must reach the eye.

(b) What path does light take in travelling from an object to our eyes? Some students were able to recall the textbook fact that light travels in straight lines. Rather than confirming this, we asked the students to test this through a series of activities, each of which addressed a slightly different question:

- How does moving holes out of line affect our view of a candle flame? The students arranged three cardboard sheets with small holes at their centres so that they could look through them towards a luminous object (like a glowing candle). When all the holes were exactly aligned, the candle flame was clearly visible. Even a slight displacement of the middle sheet made the flame disappear from view. As soon as the holes were brought back into one straight line, the flame became visible again. When asked why, some students initially suggested that the eye could not "adjust" when the cardboard moved. After repeating the investigation several times, they suggested that when the holes were misaligned, light from the candle could not reach the eye.
- How does changing the position of the hole change the position of the light spot? Children made a small hole in a cardboard sheet and placed it between a light source (such as a torch or a bulb) and a coloured paper screen. They observed that light formed a single, hole-shaped spot on the screen, and as the position of the hole changed, so did the position of the light spot.

- How does bending a pipe change our view of a candle flame? Children compared their observations of a candle flame viewed through two PVC pipes—one straight and the other bent. They found that the flame was not visible through the bent pipe.
- What path does the laser beam follow? Finally, children observed a laser beam passing through a container of slightly milky water. The tiny particles of milk suspended in the water made the beam visible, allowing the students to actually observe, for the first time, the path taken by light.

The first three activities gave the students indirect evidence that light travels in straight lines. The last activity allowed them to see this path directly. Comparing all four observations helped students realise that light always behaves this way.

(c) What are the different ways in which light can interact with objects? We started by asking students to compare some of the many objects they encounter every day such as glass windows, wooden doors, plastic bottles, steel utensils, leaves, cloth, water, and paper. The students described the differences between these objects in terms of their colour, shape, or everyday use. We then invited them to compare the same objects in a different way—by observing how they interact with light.

This investigation began with a simple task. Working in pairs, one student shone a torch on a variety of everyday objects, while another carefully observed and recorded what happened. The objects included glass, butter paper, cardboard, aluminium foil, plastic sheets, cloth, leaves, coloured bottles, and other everyday items available in the classroom. The students

noticed that the surfaces of these objects behaved differently when light fell on them. They grouped the objects into three categories: shiny, dull, and non-shiny.

The students were then asked to focus on how much light passed through the objects. As they repeated the activity with this question in mind, they quickly noticed that the objects behaved in three different ways. Some materials, like glass, allowed almost all the light to pass through. Some, like butter paper, allowed only some of the light to pass through. Others, like cardboard, blocked light almost entirely. At this point, we introduced the terms 'transparent', 'translucent', and 'opaque' to describe these different properties.

Once the groups had organised their observations in a table (similar to **Table I**), we asked them to justify their classifications. As each group explained why an object belonged to a particular category, other groups sometimes disagreed with them. These disagreements became opportunities for further observation and discussion. For example, several students initially used words such as 'shiny' and 'transparent' as though they meant the same thing. Some of their peers pointed out that a sheet of aluminium foil is shiny, but it did not allow much light to pass through. This discussion helped the students recognise that transparency describes how much light passes through a material, whereas shine describes how much light bounces off its surface. It also helped them appreciate that the same object can be classified in more than one way depending on the property being investigated.

This investigation encouraged the students to see classification not simply as an exercise in

Objects	Shiny	Non-shiny	Transparent	Opaque	Translucent	Reasons

Table I: Classification framework used by students to record how materials interact with light.

sorting objects into groups, but also as a way of identifying patterns. These patterns would later help explain other phenomena related to light. But we deliberately avoided presenting these links immediately. Instead, we encouraged the students to retain their observations and refer back to them when they encountered new situations involving light. This allowed them to discover the connections for themselves.

(d) How are shadows formed? We asked the students to use what they had learned about materials to explore a new question: how might the way an object interacts with light affect its shadow?

The students began by recalling situations in which they had seen shadows being formed. We followed this with questions such as: *Can a shadow be formed without a source of light? Do all objects form shadows? How do changes in the positions of the light source, object, and screen affect the shadow?*

After recording their initial ideas, the students placed transparent, translucent, and opaque objects of different shapes between a bulb and a screen. They compared the shadows that were formed and recorded their observations. They were surprised to find that transparent and translucent objects also cast shadows, although these were not as dark as those formed by opaque objects. They also noticed that the shape and orientation of an object affected the outline of its shadow.

The investigation was then extended by changing one factor at a time. The students changed the distance between the light source and the object, the distance between the object and the screen, and the angle at which light fell on the object. With each change, they observed how the shadow changed. They saw that a shadow's size and clarity depend on the distances between the light source, object, and screen. Some groups also tried using two different coloured torches (like red and green) and found that different parts of the screen received light from different sources.

Blocking the light from one source with an opaque object did not prevent light from another source from reaching the same region of the screen. This demonstrated that each light source can form its own shadow. As a result, a region blocked from one coloured light source could still be illuminated by another, producing a coloured shadow rather than a dark one.

As before, students checked their initial ideas against what they observed. Building on the idea that light travels in straight lines, they realised that a shadow forms whenever an object blocks the path of light to a screen. When another source was present, its light could still reach the same region of the screen, producing a different pattern of illumination. Many revised their initial ideas—such as believing that only opaque objects make shadows or that a shadow's size never changes. Instead of relying on guesswork, they were now using evidence from their own investigation to explain shadows.

Parting reflections

The activities described in this article might be familiar to many teachers because they are included in the textbook.¹ These activities often succeed in engaging children, but engagement alone does not always lead to deeper understanding (see **Box 1**).^{2,3} That is why we started by having students ask questions about light in their daily lives and design their own investigations. As the students worked in groups, we encouraged them to make observations, raise further questions, and discuss whether the evidence supported their initial ideas. This approach appeared to help the students relate to textbook ideas with greater confidence.

This approach also allowed us to see more clearly how children engaged with the process of investigation. For example, we noticed that children generally had little difficulty making observations. They could describe whether light passed through a material or whether an object reflected light strongly. In fact, many of the questions that guided later investigations

did not come from the textbook; they arose from the students' own observations. However, children struggled to explain the reasons for these observations. This suggests that careful observation alone does not automatically lead to conceptual understanding. This became even more noticeable as the number of investigations increased. Their tentative explanations suggested that they were treating each activity as an isolated task rather than relating it to other investigations.

Based on this observation, we began asking them a different kind of question: *How is this investigation connected with the ones we have already completed?* Instead of moving directly to the next activity, each group was asked to identify the important concepts that had emerged from its investigation and discuss them with other groups.

Looking back, we realised that these discussions were just as important as the activities themselves. By comparing investigations, the students spotted key connections. For example, understanding how we see helped explain how light travels, which in turn explained how shadows form. This allowed them to revisit earlier investigations and explanations. The class discussions also began to change. The students, now, increasingly referred

to one another's investigations. Instead of saying, *"This is our activity,"* they started saying things such as: *"This is similar to what the other group found"*, *"We also needed that idea in our investigation"*, *"The explanation seems to be the same"*. This growing awareness influenced the way subsequent investigations were planned and discussed. Familiar ideas acquired new meaning as children encountered and applied them in new contexts. In this way, the sequence of investigations itself became an important resource for learning.

To further support this process, one group was given the responsibility of bringing together ideas from different investigations in worksheets with blank spaces for showing the connections between them (see the **Worksheet**). This group discussed: (a) which concepts were more general and which depended upon earlier ideas, and (b) which investigations helped explain later ones. After comparing the concept maps prepared by the different groups, the synthesis group gradually developed a common map for the entire theme (see **Fig. 1**).

When the common map was presented to the class, it led to a lively discussion. The other children sometimes disagreed about where a concept was placed or how two ideas were connected.

Box 1. Curricular connections:

This pedagogical approach can help meet the following:

A) Curricular goals for middle-stage science:

- CG-2: [The student] explores the physical world in scientific and mathematical terms. Specifically, it can help students develop the competency (C-2.4) to: *"Demonstrate rectilinear propagation of light from different sources (natural, artificial, reflecting surfaces), verify the laws of reflection through manipulation of light sources and objects and the use of apparatus and artefacts (such as plane and curved mirrors, pinhole camera, kaleidoscope, periscope)."*
- CG-6: [The student] explores the nature and processes of science through engaging with the

evolution of scientific knowledge and conducting scientific inquiry. Specifically, it can help students develop the competency (C-6.2) to: *"Formulate questions using scientific terminology (to identify possible causes for an event, patterns, or behaviour of objects) and collect data as evidence (through observation of the natural environment, design of simple experiments, or use of simple scientific instruments)."*²

B) Learning outcomes (LO) for middle-stage science:

- [The student] explains processes and phenomena, e.g., the formation of shadows [and] reflection of light from [a] plane mirror.³

The class revisited earlier activities, referred to observations they had recorded, and justified their decisions before making changes. The concept map was therefore not a final summary prepared by the teacher; it became a way for the children to investigate their own understanding. It also revealed how children were beginning to organise

the entire theme into a coherent conceptual framework of how light behaves in different situations.

This experience suggests that the educational value of activities on a single theme increases considerably when they are treated as connected

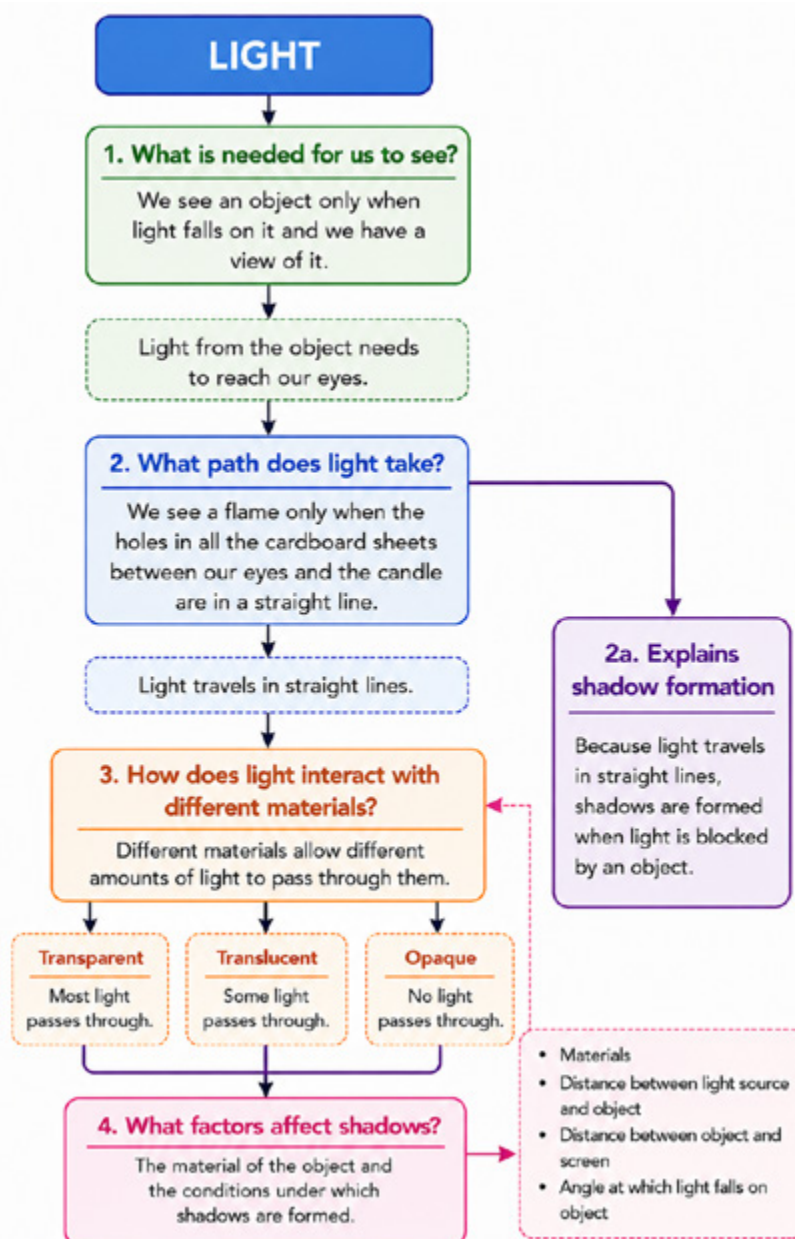


Fig. 1. An example of a concept map showing how children's understanding of light can gradually develop across a sequence of connected investigations.

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investigations that build upon one another rather than as isolated activities or demonstrations. When children have opportunities to revisit, extend,

and connect ideas across investigations, they can begin to organise their understanding in ways that individual activities alone may not achieve.

Key takeaways

- Hands-on textbook activities on light spark student interest, but engagement alone does not guarantee conceptual understanding. Beginning with a discussion about everyday observations of light can encourage students to approach activities as ways of investigating their own questions.
- Working in small groups helps children make careful observations, but they may still struggle with explaining the reason behind what they observe. Guided discussion with peers and teachers can help them develop and compare possible explanations, challenge initial misconceptions, and refine their scientific thinking.
- Children often view hands-on activities as isolated classroom events unless explicitly helped to see links between them. Prompting them to connect ideas from different investigations can help students develop a coherent conceptual framework of how light behaves in different situations.



Notes:

- a) Credits for the image (Observing a Candle Flame through a Straight PVC Pipe) used in the background of the article title: Created for i wonder... using ChatGPT, under prompting by Chitra Ravi (Jul 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- b) This article includes one classroom resource: **Worksheet: Connect Your Observations About Light**.

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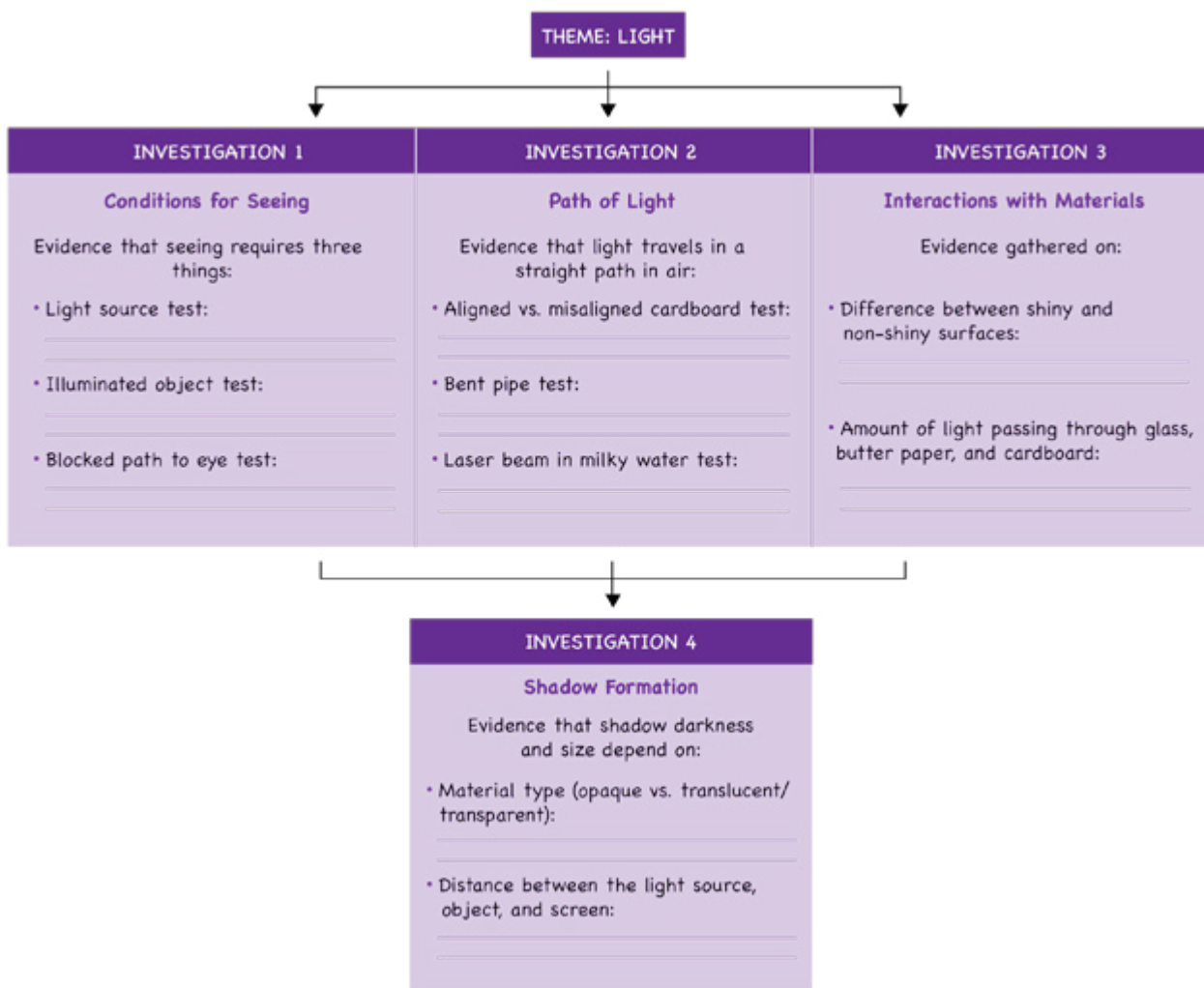


Nirmal Kumar Neoliya is a biology teacher at Rajiv Gandhi Navodaya Vidyalaya, Khatima, Udham Singh Nagar, Uttarakhand, a co-educational residential senior secondary school run by the state government and recognised by CBSE. His work includes children's science education, experiential learning, and the popularisation of science through workshops and mentoring. He also promotes scientific activities at the school and community level and contributes to science and technology forums. His interests include connecting classroom science with scientific inquiry and real-life community challenges. He can be contacted at: nirmalneoliya@gmail.com.

WORKSHEET: CONNECT YOUR OBSERVATIONS ABOUT LIGHT

Aim: To examine the evidence gathered across different investigations and explore how different properties of light are connected.

What to do: Check your notebook for records from each investigation. Use these to complete each section of the concept map below.



Think about:

Use evidence from one investigation to help explain what you observed in another.

- In Investigation 1 (Conditions for Seeing), you learned that seeing an object requires light to travel from the object to your eyes. How does Investigation 2 (Path of Light) explain why you cannot see an illuminated object when a cardboard screen is placed directly between the object and your eye?

- In Investigation 3 (Interaction of Light with Materials), you observed how light interacts with clear glass compared to thick cardboard. Imagine the same toy is placed in two identical boxes—one made of clear glass and the other of thick cardboard.
 - If you shine a torch on both, which toy will you be able to see? Which box will cast the darker shadow?
 - Use your findings on how light passes through materials (Investigation 3) to explain why your predictions make sense for both seeing the toy (Investigation 1) and the darkness of the shadow (Investigation 4).
- In Investigation 2 (Path of Light), what happened to your view of the candle flame when the hole in the middle cardboard sheet was moved slightly out of line?
 - How does light's property of moving in straight lines explain why opaque objects create well-defined shadows in Investigation 4 (Shadow Formation)?
 - Now imagine if light could easily bend or curve around solid objects like water flowing around a rock. Can you predict what effect this would have on shadows?

Discuss:

In each question below, you will see two different explanations for the same observation. Read both carefully and ask yourself: Do your observations support or contradict either explanation? Notice any gaps in your evidence and think about how you could fill them. For some questions, you will also need to imagine new situations—use what you have observed to reason through your answers.

Q1. Group A says: *"If you stay in a pitch-black room for 20 minutes, your eyes adapt so you can eventually see the furniture."*

Group B says: *"No matter how long you wait, if there is absolutely no light in the room, you will never see the furniture."*

 Question: Can you see an object in total darkness? Use evidence from the shoebox activity to explain why. Now **try this**: Enter a dark room and wait until you can just make out the outline of some furniture. How could you test whether the room is completely dark or if small amounts of light are still entering? *Hint: Check for small gaps where outside light might leak in, or look closely at the object to see if a light source is illuminating it.* What does this tell us about Group A's explanation?

Q2. Group A says: *"The Moon is a non-glowing object. We can see it at night even though the Sun is not visible. So we do not need light to see non-glowing objects."*

Group B says: *"We can only see a non-glowing object, like a wooden desk, because light from a source (like a torch or the Sun) scatters off its surface and reaches our eyes."*

 Question: Is light needed to see a non-glowing object? Explain using your observations from the shoebox activity. Now **think about this**: To see a wooden desk in a dark room, which path must light take: (a) Your Eyes → Desk, or (b) Torch → Desk → Your Eyes? Can you use the path of light to explain how we can see the Moon at night when the Sun is not visible in our sky?

Q3. Group A says: *"In the activity with three cardboard sheets in Investigation 2, when the hole in the middle sheet is moved to one side, we cannot see the candle flame because our eyes failed to focus or align properly."*

Group B says: *"We cannot see the flame because light travelling from it is physically blocked by the solid parts of the cardboard sheet."*

 Question: What difference did you observe when you looked at a candle flame through a straight pipe compared to a bent pipe? Now **try this**: Move your eye closer to or farther from a bent pipe, or look through it from different angles. Does the flame ever become visible? Which group's explanation do your observations support?



Q4. Group A says: "A polished metal tray and a clean glass sheet are the same because both bounce light off when you shine a torch on them."

Group B says: "They interact with light differently: the metal tray reflects light off its surface, while the glass sheet lets light pass through."

? Question: Shine a torch on a polished metal tray and a clean glass sheet. Do both objects bounce light off their surfaces? Now, look at the wall behind each object. Are the two shadows equally dark? The first test gave you one piece of evidence, and the second test gave you another. Did both tests support the same claim? What does this tell you about why scientists might use more than one observation when investigating a question? Now **think about this**: Imagine standing outside a bus on a sunny day. You can see your reflection on the glass surface, but you can also clearly see passengers sitting inside. Based on this observation, how would you classify the bus window: shiny (like Group A claims), transparent (like Group B claims), or both? What does this tell us about classifying materials into strict categories?

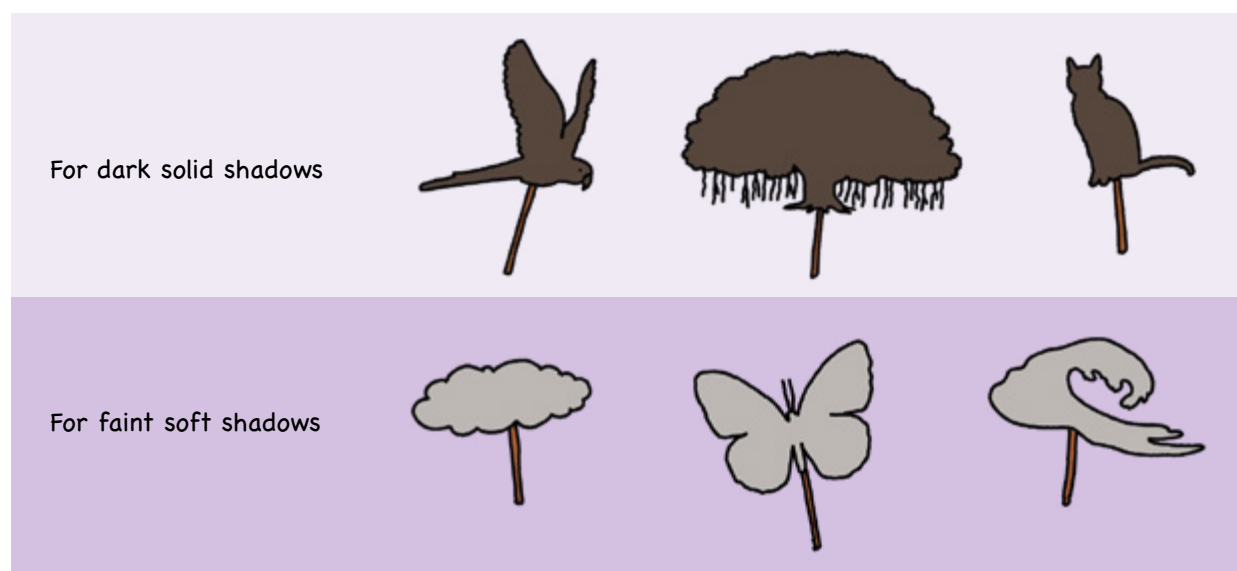
Q5. Group A says: "A chair's shadow is a physical part of the chair that stretches out onto the floor."

Group B says: "A shadow is not part of the chair at all. It is simply an area on the floor where light from a source, like a bulb, is blocked by the chair."

? Question: **Try this**: Place a chair in front of a light source, such as a bulb or torch, so that the chair casts a shadow on the floor. Turn off the light source. What happens to the shadow? Turn the light back on and change its position. How does the chair's shadow change? If the shadow were a physical part of the chair, like one of its legs, would it disappear when the light is turned off? Which group's description best explains what you observed? Now **think about this**: Sundials are some of the earliest clocks people used to tell the time. A simple sundial has a stick fixed upright on a flat surface marked with hours. In sunlight, the shadow of the stick moves across the marked surface like the hand of a clock. How would you use your observations to explain how a sundial can be used to tell the time?

Q6. Group A says: "If you see any mark or even a faint outline of an object on a screen when light falls on it, the object must be opaque."

Group B says: "Transparent and translucent materials like clear plastic or tracing paper can also cast faint marks because they do not allow all light to pass through."



✂ Imagine designing puppets for a shadow play. For objects like birds or trees, you need dark, solid shadows. For objects like floating clouds or ocean waves, you need faint, soft shadows. Which materials—thick cardboard, clear plastic, or tracing paper—would you choose for each effect?



? Question: What differences did you notice in the shadows cast by clear plastic, tracing paper, and cardboard when you shone a torch on them? This is one piece of evidence. Now look through the three materials one by one. Based on how clearly you can see objects through them, which material is transparent, which is translucent, and which is opaque? This is a second piece of evidence. Compare both pieces of evidence. Can you always decide whether a material is transparent, translucent, or opaque just by looking at its shadow? Explain your answer. **Think about this:** Imagine you are designing puppets for a shadow play. For objects like birds or trees, you need dark, solid shadows. For objects like floating clouds or ocean waves, you need faint, soft shadows. Which material—cardboard, clear plastic, or tracing paper—would you choose for each of these puppet categories? Explain your choices based on how each material interacts with light. Now **try this:** Imagine shining a torch through five sheets of clear plastic stacked together. Would the shadow of the stack be lighter or darker than that of a single sheet? First predict and then test. What does this tell you about transparency—is it a fixed property or can it change depending on the thickness of a material?

Q7. Group A says: "A small eraser can only make a small shadow because a shadow's size is always the same as the object's size."

Group B says: "An eraser can cast a shadow that is bigger than it depending on how close it is to the torch and how far it is from the screen."

? Question: You may have noticed that your shadow on a wall can look much larger than you when you stand close to a streetlight. Why does this happen? Now **try this:** Hold up a finger so that it casts a well-defined shadow on a wall or screen. Can you make the shadow about twice the size of your finger? What did you change to make this happen? Now move your finger towards the screen. What happens to the size of the shadow when your finger touches the screen? Which group's claim do your observations support? Explain. Now **think about this:** During a total solar eclipse, the Moon appears to completely block the Sun from our view in some places on Earth. How can the much smaller Moon block the much larger Sun? *Hint: Think about how close the Moon is to Earth compared to how far away the Sun is.*

Acknowledgements: The author thanks Anish Mokashi for his support in making the wording of Questions 2 and 7 more pedagogically unambiguous for Grade VII students.



INVESTIGATING PUDDLES: SHIFTING STUDENTS' IDEAS ABOUT MICROORGANISMS



MEENA KHARATMAL

The Grade VIII science textbook encourages students to observe microorganisms in water and soil samples from their surroundings. How can teachers use such observations to help students examine and refine their ideas about microbes?

Students are formally introduced to microorganisms in Chapter 2 ('The Invisible Living World: Beyond Our Naked Eye') of the Grade VIII science textbook (NCERT, Reprint 2026–2027): *"Some living organisms are made up of just one or very few cells. They are so small that they cannot be seen with the naked eye. These are called microorganisms."*¹ They also learn that *"...microorganisms can be found everywhere, be it in water, soil, air, or even in some food items."*¹ Students are asked: *"Have you ever wondered what you might see if the invisible world around you became visible? How do you think your observation of this hidden world might change the way you think about size, complexity, or even what counts as 'living'?"*¹ They are then encouraged to use a microscope to observe microbes in water and soil samples from their immediate environment.¹

Observation is an important part of scientific inquiry. Yet simply engaging students in observing microbes does not reveal how they make sense of what they see. Before introducing formal explanations, it is useful to understand their prior ideas about microbes. Research suggests that while

students cannot see microorganisms with the naked eye, they often draw on their knowledge of the macroscopic world to construct their own ideas about them. These existing ideas can strongly shape how learners interpret new observations. How can we draw on textbook activities to design classroom experiences that uncover students' prior ideas and help them examine and refine these ideas through observation?

Turning observation into inquiry

I explored this question by designing a project-based learning unit. This unit was introduced to teachers from several schools through a workshop, after which they implemented it in their classes. Here, I describe the classroom experiences of one teacher who tried it with 20 Grade VIII students.

A) Drawing out students' prior ideas:

Students were asked to observe puddles, water-logged drain covers, and other temporary collections of rainwater that appear on school grounds and near their homes. The teacher then facilitated a discussion around four questions designed to reveal students' existing ideas about microorganisms, their habitats, and their survival.

a) Do you think there is life in those puddles? All the students believed that there was life in puddles and water-logged drain covers. This suggests that they recognised that life is not always visible to the naked eye. One student reasoned that *"millions of microorganisms could exist even in a puddle only 10 cm in diameter."* Another explained that puddles *"can provide all necessary living elements to the microorganisms."* These responses indicate an understanding that even small, temporary habitats can support microscopic life.

b) Are there any life forms in dry soil? If yes, where do they come from—soil, water, or air?

Many students believed that dry soil could contain microorganisms. One student reasoned that microorganisms can survive *"in any type of climatic conditions, from marshy lands to dry deserts."* Many students identified air as the primary source of these organisms, with one student reasoning

that *"if soil is dry there will be no water in it, only air can be there."* While some students thought soil was the source of these microbes, others suggested that they came from water. This suggests a belief either that 'dry'-looking soil retains invisible traces of moisture, or that microbes in dry soil originated in water and persisted after it evaporated.

c) When the puddle or a wet soil sample dries up, what do you think happens to the life forms living in it? Most students believed that water was essential for survival and that its absence would lead to death, as reflected in responses such as: *"If there is no water then the microorganisms will die,"* and *"When the soil sample dries the microorganisms will die."*

However, some students considered the possibility that microbial responses to drying might vary. One student wrote: *"When the wet soil sample dries up... some microorganisms will [be] left over as we know that microorganisms can live in every climate."* Another explained: *"When the wet soil sample dries the organisms that require water may die, but other organisms may live in it."* A third student wrote: *"When the soil sample dries... the number of microorganisms will decrease..."*

Interestingly, one student wrote, *"When the wet soil sample dries, life forms such as bacteria can exist there. But some microorganisms cannot resist the temperature."* Although the prompt focused on drying, this student introduced the idea of temperature. It is likely that they were conflating water loss with heat exposure, possibly from seeing puddles dry up on hot days. The student also appeared to believe that bacteria can withstand both dryness and heat, whereas other microbes might survive desiccation, but not increases in temperature.

Taken together, these responses suggest that while many students regarded water as the primary requirement for microbial life, some were beginning to recognise that different microorganisms respond differently to environmental stress. It is important to

note that these discussions took place before students were formally introduced to the idea of bacterial dormancy, where metabolic activity is suspended until environmental conditions become favourable again.

d) Are there life forms in a drop of clear water?

Why do you think so? Many students believed that clear water could host microorganisms. One explained that clear water “provides all the necessary elements of the microorganisms.” Many asserted that microbes multiply rapidly in water

and would be present in large numbers, with some adding that these organisms could be beneficial. These students seemed to assume the invisible ubiquity of microbes—that they exist wherever water is present, even if it appears clean to the naked eye.

Some students were less certain. One wrote, “I don’t think so because if the water is clarified... microorganisms are also removed, but some microorganisms may be living in that drop of water because we cannot see them.” Another

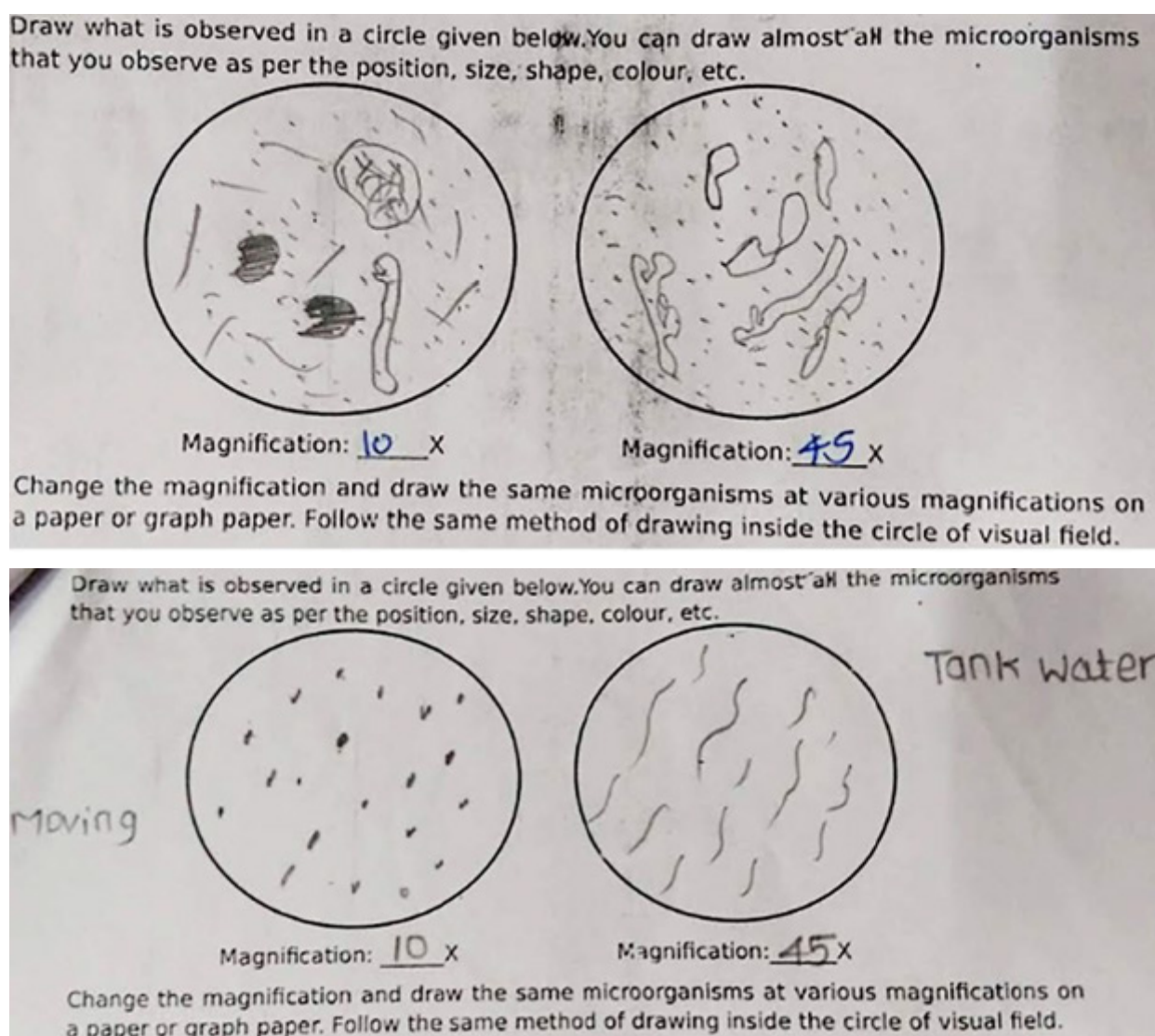


Fig. 1. Examples of students’ drawings of microorganisms observed under low and high magnifications. These were of a sample that the teacher collected.

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asked, *"Microorganisms cannot be seen with naked eye. Then how we can see that there are life forms in a drop of water or not?"* These responses highlight how students grappled with two conflicting ideas: microbes are too small to see with the naked eye and filtering water removes living beings. Rather than accepting either blindly, they articulated the need to look for evidence.

B) Testing students' ideas:

Following these discussions, students were invited to use a microscope to test their ideas through direct observation of water and soil samples. The first sample was collected by the teacher from a puddle on the school grounds. Students learnt how to prepare a slide, observe it under low magnification, scan different parts of the slide, and switch to higher magnification for detailed study. Rather than being told what to expect, students were encouraged to record what they actually observed (see Fig. 1). The teacher supported them in this process by sharing a series of guiding questions:

a) What do you observe under the microscope? Describe what you see in terms of the number of organisms, their size, shape, colour, location, movement, and any other features you notice. Students' records showed a remarkable diversity of details. Colors were described as *"violet, blue, yellow, and white,"* while shapes were categorised as *"thread-like," "elliptical," "circular,"* and *"irregular."* Some students also specified spatial distribution—noting whether organisms were concentrated at the center of the visual field, located along its edges, or scattered throughout. Movement attracted particular attention. One student wrote: *"we saw some... organisms in that slide... they were still in that place at the centre. But when we saw them at 45X... they were moving."* Another observed that *"some of them were randomly moving also."*

b) Do you think the objects you observed are living or non-living? Why do you think so?

One student wrote, *"Some microorganisms were moving and some were not. This shows us there*

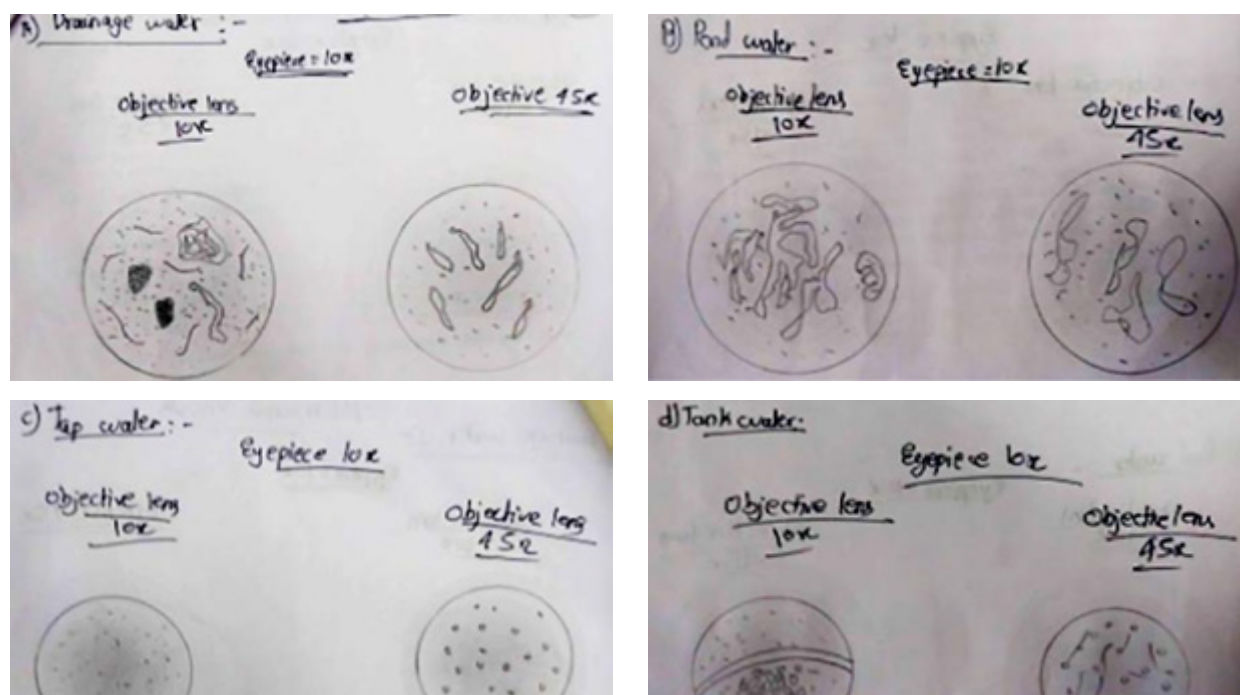


Fig. 2. Examples of students' drawings of microorganisms observed in samples they collected from different sources. These included samples of (a) drainage water, (b) pond water, (c) tap water, and (d) tank water.

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were some living organisms and some non-living organisms." Another shared, "The objects are non-living forms. Because they are not showing any movement." These responses indicate that students strongly associated life with motility.

c) Draw what you observed. Students used drawings to document variations in size, shape, position, and visual features under different magnifications, with some students attempting to depict movement through dynamic lines and arrows.

Building on Activities 2.4 and 2.5 in the Grade VIII science textbook, students then collected their own samples from puddles and drainage ditches near their homes or school.¹ As with the sample collected by their teacher, students mounted each sample, compared low- and high-power views under the microscope, and recorded their findings in detailed drawings (see **Fig. 2**).

Finally, students compared their sketches with textbook illustrations and a simple identification key provided by the teacher. Paramecia were the easiest to identify because their distinctive

shape closely matched the textbook drawing, but the key enabled students to name other common microscopic organisms including rotifers, nematodes, and Spirogyra (see **Fig. 3**).

Parting reflections

This learning unit illustrates a pedagogical approach that can help students build a strong scientific understanding of microorganisms (see **Box 1**).

Rather than starting from textbook explanations, students were invited to articulate prior beliefs about microbes and their underlying reasoning. This exercise revealed rich insights into how children think of the conditions necessary for microbial life and the habitats that support them. Two factors may have influenced these responses:

- **Scale:** School textbooks often highlight large ecosystems like ponds, lakes, and gardens. Consequently, students may have struggled to predict whether microhabitats (such as puddles or drainage ditches) could also support (microbial) life.

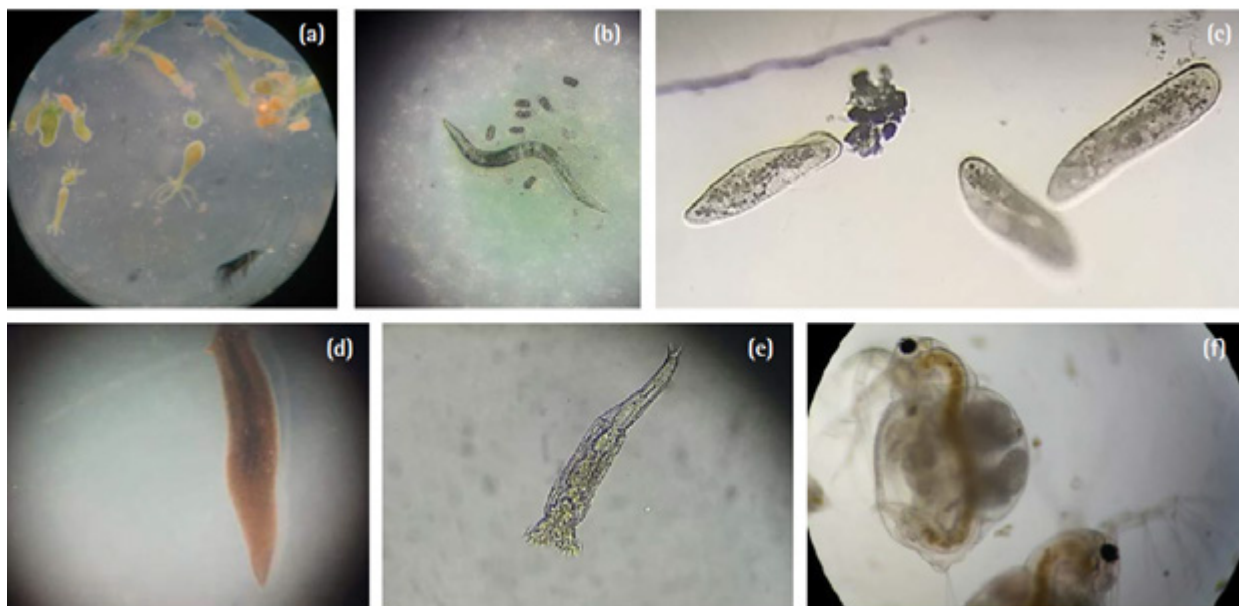


Fig. 3. Examples of microscopic organisms that students identified using the textbook and an identification key. These include: (a) hydra, (b) nematodes, (c) paramecia, (d) planaria, (e) rotifers, and (f) water fleas.

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Box 1. Curricular connections:

The approach in this learning unit can help teachers meet and assess the following:

A) Curricular goals for middle-stage science:

- CG-3: [The student] explores the living world in scientific terms. Specifically, it can help students develop the competency (C-3.1) to: *"Describe the diversity of living things observed in the natural surroundings... including at a smaller scale (microscopic organisms)."*
- CG-6: [The student] explores the nature and processes of science through engaging with the evolution of scientific knowledge and conducting scientific inquiry. Specifically, it can help students develop the competency (C-6.2) to: *"Formulate questions using scientific terminology (to identify*

possible causes for an event, patterns, or behaviour of objects) and collect data as evidence (through observation of the natural environment, design of simple experiments, or use of simple scientific instruments)."

- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can help students develop the competency (C-7.1) to: *"Use scientific vocabulary to communicate science accurately in oral and written form, and through visual representation."*²

B) Learning outcomes (LO) for middle-stage science:

- [The student] prepares slides of microorganisms and describes their microscopic features.³

- **Stability:** The short-lived nature of puddles may have led students to question whether (microbial) life requires constant moisture or whether these organisms can survive major changes in their environment, such as the drying of their habitat.

This initial exercise allowed students to see direct observation as a way of examining their prior ideas. Rather than observing prepared slides, they learned to collect local samples, prepare slides, and conduct microscopic investigations (see the **Activity Sheet**). Comparing samples across different microhabitats allowed the class to appreciate the rich biodiversity present in their immediate surroundings. This approach can easily be extended into a multi-week project that tracks how microbial communities shift across seasons and locations.

Asking students to record their observations as drawings gave a clear view of what they

were actually noticing and thinking. Even when students used similar words in their written notes, their drawings differed noticeably. These differences revealed both the diversity of samples collected and the specific microscopic details each student focused on. Drawing also flipped the role of the textbook: rather than seeing it as a way of learning how microbes looked, students used it as a tool for interpreting their observations.

In this learning sequence, observation is not used merely to confirm textbook ideas about microorganisms. It provides hands-on evidence that helps teachers and students examine initial ideas about microbes. Teachers can then use this evidence to build scientific explanations, helping students see science as a way of making sense of what they observe, rather than facts to be memorised.

Key takeaways



- Students are formally introduced to microorganisms in Grade VIII through a series of observation tasks. Inviting students to articulate their prior ideas and reasoning before starting these tasks can help teachers see how students make sense of later observations.
- Puddles, water-logged drain covers, and other temporary collections of rainwater can serve as a rich context for investigation. Their temporary nature can prompt students to think about what conditions sustain microbial life and what happens when those conditions change.
- Instead of giving students prepared slides, asking them to collect, prepare, and observe their own samples helps them learn important scientific skills. It can also reinforce that microorganisms are a natural part of their immediate environment and helps them appreciate local diversity.
- Asking students to record their observations as drawings strengthens their ability to notice microscopic details. It can also help them see the textbook as a resource for identifying what they observe, rather than one that tells them what to expect.

Acknowledgements: The author acknowledges the support of the Department of Atomic Energy, Government of India, under Project Identification No. RTI4001. The author also thanks Nagarjuna G, MC Arunan, and Ankush Gupta for their contributions to the development of the learning unit; Mayuri Tawade and Sushma Rawool for conducting classroom observations; and the teachers and students of Atomic Energy Central School, Mumbai, for using the unit and sharing their classroom experiences.

Notes:

- Credits for the image (Collecting Samples from Puddles) used in the background of the article title: Created for i wonder... using ChatGPT, under prompting by Chitra Ravi (Jul 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- This article includes one classroom resource: **Activity Sheet: Observe Microbes from Your Surroundings**.
- This article was first published in i wonder..., June 2021, pp. 25–31. The original version is available at: <https://publications.azimpremjiuniversity.edu.in/2846/>. The version published in this issue has been revised by Chitra Ravi. It includes direct connections to the NCF-SE (2023) and the Grade VIII science curriculum, and highlights the pedagogical relevance of this experience for other middle-stage science teachers.
- For more details on Meena Kharatmal's approach to teaching about microorganisms, see: Azim Premji University (2024). i wonder... Webinar: Observing the Microbial World. YouTube. URL: <https://www.youtube.com/watch?v=SRB4p8SLV00>. Accessed on July 10, 2026.
- The learning unit described in this article is available at: <https://vigyanpratibha.in/index.php/microorganisms-at-our-doorstep/>. It was developed as part of the Vigyan Pratibha project, which aims to build scientific skills through curriculum-aligned learning units. These units are implemented by teachers in Kendriya Vidyalayas, Jawahar Navodaya Vidyalayas, and Atomic Energy Central Schools. Additional units for Grades VIII and IX are available at: <https://vigyanpratibha.in/>.
- An extension of this learning unit, developed by the author to help students estimate the size of microorganisms using simple methods, is available at: <https://teacherplus.org/2020/classroom-update/getting-down-to-the-micron/>.

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Meena Kharatmal is Scientific Officer–E at the Homi Bhabha Centre for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR), Mumbai. She holds a PhD in Science Education (2024) from TIFR and was a Postdoctoral Scholar at Texas State University, USA (2024–2025). Meena's research focuses on students' understanding of experimentation and experimental design, discipline-based biology education research, and the use of AI tools in biology teaching and learning. More details about her work can be found here: <https://www.hbcse.tifr.res.in/people/scientific/meena-kharatmal>. She can be contacted at: meena@hbcse.tifr.res.in.

Experiences

ACTIVITY SHEET: OBSERVE MICROBES FROM YOUR SURROUNDINGS

Aim: To test your ideas about microbes by observing water and soil samples from your surroundings.

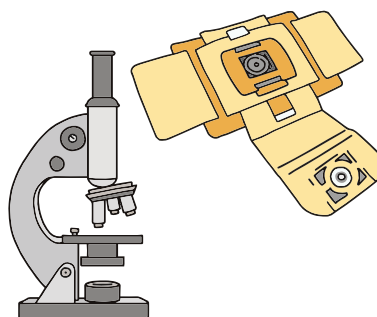
You will need:



Small containers for collecting samples (such as clean plastic bottle caps, empty medicine cups, or small washed jars) and foil to cover them



Samples of water (standing or tap) and soil (moist or dry)



A compound microscope or Foldscope



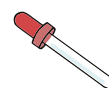
Glass slides (or clear plastic strips cut from flat sections of transparent plastic bottles)



Coverslips (or small 1.5 cm squares of clear plastic)



Pencil and notebook



A dropper

Step 1: Collect your sample



Gather one or more samples from areas around your school or home.

- **For wet habitats:** Collect a small amount of water from a puddle, pond, drainage ditch, or any standing water source. Try to scoop up some sediment or organic material from the bottom.
- **For dry habitats:** If no standing water is available, scrape a small sample of dry surface soil into a clean container. Mix it with a small amount of clean (boiled and cooled) water. Let the mixture stand for a few minutes so the soil settles.
- **Label your samples:** On each container, clearly write the location, date, and time of sample collection. Also mention whether the habitat was wet or dry.

Step 2: Predict



Before observing your samples under the microscope, discuss the following questions with your classmates and write your own responses.

- 1) Why do you think microbes might be present in the places you chose? What conditions make a place a suitable habitat for microbes? Do microbes need the same things that other living beings need to survive? Or do they need different things? Explain your answer.
- 2) If microbes live in different places, would you expect them to differ from one another? For example, would you expect to find different kinds or numbers of microbes in different habitats? Explain your reasoning.

- 3) What do you think happens to microbes when their surroundings change? For example, if a puddle dries up, will all the microbes die, or could some survive? Explain your answer.
- 4) Based on your discussion, where do you think microbes might be present? You may choose none, one, or more than one option: (a) Standing water (from ponds or drainage ditches), (b) Tap water, (c) Wet mud/soil, (d) Dry soil or sand, (e) Air.

Step 3: Observe and record



Prepare a slide following your teacher's instructions. Place the slide under a compound microscope and start by observing your sample under low power. This will give you a wide view. Once you find an interesting object, switch to high power and observe it again. This will give you a close-up view.

Copy the table below in your notebook. Record your observations at both powers:

What do you notice?	Low power (10X)	High power (40X)
How many objects do you see? Many, few, or none?		
What shapes do the objects have? Round, rod-shaped, thread-like, irregular, or other?		
Are there any objects moving? Fast or slow? Swimming, crawling, tumbling, or drifting?		
How large do the objects appear? Tiny, small, medium, large, or a mix of sizes?		
What colours do the objects appear to be? Colourless, green, brown, or other colours?		
What other details do you notice? Soil particles, air bubbles, or other features?		

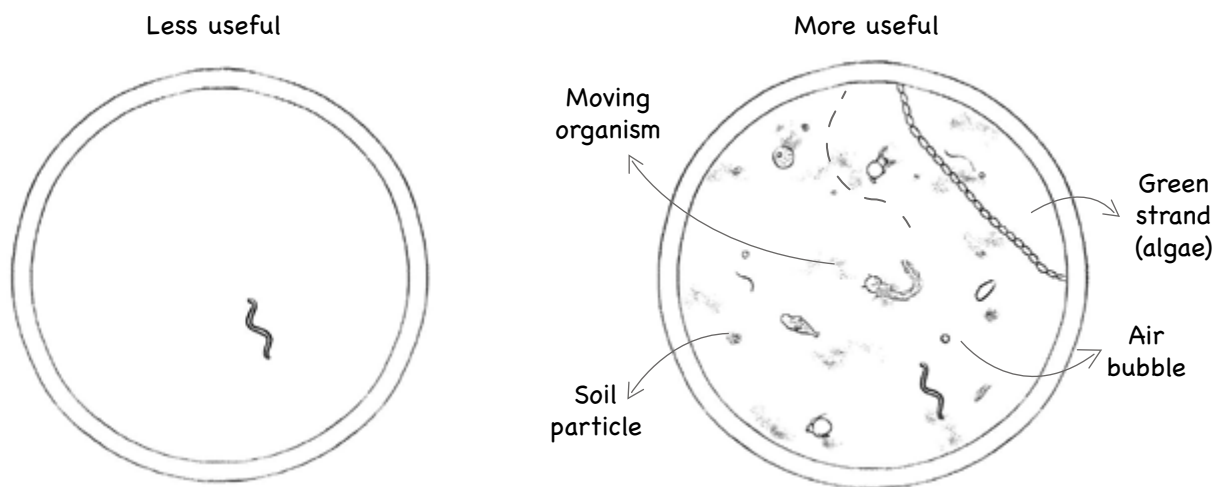
Draw **two large circles** in your notebook. Think of these as the areas you can see under the microscope (one for low power, one for high power). Within these, draw all that you can see. Here are some things to keep in mind:

- **Show the whole view:** Do not just draw one large organism in the middle. Try to map out the entire circular area, showing the position of each organism or particle. **Tip:** Imagine a clock face to help place objects correctly.
- **Show relative size:** Draw objects in proportion to one another. For example, try to show the difference in size between a tiny microbe and a noticeably larger soil particle near it.
- **Be honest with colours:** Most live microbes are completely clear or transparent—draw these using simple outlines. Only use colour if you actually see it through the lens (for example, use green only if you see a green strand of algae). **Tip:** Transparent microbes often disappear in bright glare. Dim the light slightly to see their outlines clearly.
- **Show movement:** If you see an organism moving, you can use small dash marks or path arrows to show the direction in which it is travelling. **Tip:** Gently turn the fine focus knob back and



forth to spot organisms floating at different depths.

- **Label your drawing:** Use arrows to point to and label anything you recognise or want to describe (for example: “green strand”, “swimming fast”, or “clump of soil”).



Make two drawings—one for low power (10x) and one for high power (40x). In each drawing, record everything you see in the field of view. Show where things are, how large they are compared with one another, and any movement or colours you notice.

For example, the two circles above show two different ways of recording a low-power view. The drawing on the left shows only a single organism, whereas the one on the right records the full range of organisms and soil particles visible. The second drawing is, therefore, a much more useful scientific record. Remember: Your view depends on your sample—you might see many organisms or just a few. Record whatever you actually see as accurately as possible.

Think about

- Compare your observations under low power and high power. What details became clearer to see when you switched to high power? Was there anything you missed under low power?
- If you saw something moving, what evidence helped you decide whether it was a living organism or a piece of soil drifting in the water?
- Look back at your predictions from Step 2. Which ideas were supported by what you saw under the microscope, and which have changed? For example: Did you find microbes where you expected? Did anything surprise you?

Discuss

- Q1. Compare your drawings with those of your classmates. Do you see differences in the types and numbers of microbes in samples taken from:
- (a) different types of habitats, such as pond water versus wet soil?
 - (b) the same type of habitat, such as water from two different puddles?
 - (c) the same habitat, like the same puddle or patch of soil?
- Q2. What environmental factors might explain differences in the numbers and kinds of microbes found in different kinds of samples? Discuss possible explanations.
- Q3. Work with your classmates to create a single display featuring every unique microbe observed across all class samples. Compare your drawings with the microbe illustrations in Chapter 2 ('The Invisible Living World: Beyond Our Naked Eye') of your Grade VIII science textbook (NCERT). Can you identify any of the microbes you saw? Label your drawings with their scientific names where

possible. How do the textbook drawings differ from your ones? Which of these drawings looks closer to what you saw under the microscope and why?

- Q4. A water or soil sample may look as if it contains nothing living when seen with the naked eye. Based on what you learnt during this activity, can you predict whether a sample contains microbes before looking at it under a microscope? What would be the most likely types or numbers of microbes in the sample? What visible clues or habitat conditions would help you make these predictions? Explain your reasoning.
- Q5. As a class, what new investigation could you carry out to learn more about microbes in your surroundings?





STUDENT-LED INQUIRY: WHAT FOOD CAN TEACH US ABOUT OUR WORLD

EXPERIENCES

MRIDALI PANDEY

Grade VI students are formally introduced to the connections between food, health, and nutrition through textbook facts. How can their everyday food experiences become a starting point for student-led inquiry into local crops, packaged foods, and community knowledge?

Chapter 1 ('The Wonderful World of Science') of the Grade VI science textbook (NCERT, Reprint 2026–2027) introduces students to science as *"a way of thinking, observing and doing things to understand the world we live in and to uncover the secrets of the universe. Think of it as a big adventure—we ask questions, explore the world and try to understand how things work."*¹ Yet, in schools, science education is often perceived as the transmission of facts, concepts, and theories. Opportunities for students to investigate questions through first-hand experiences remain limited to special projects, exhibitions, or competitions.

My experience of working with Grade VI–VIII students at Government Girls Inter College, Gairsain, Chamoli, has shown me that investigation need not be an additional activity; it can emerge naturally from everyday science teaching. In Uttarakhand, this process of student-led inquiry is commonly known as *Baal Shodh*. I decided to experiment with this approach through Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, Reprint 2026–2027), which formally introduces students to the connection between health and food.² I wanted

to explore how I could use the chapter to help students connect textbook concepts with their local context through opportunities for inquiry and interdisciplinary learning (see Box 1).

Inquiry into mindful eating in everyday contexts

(a) Beginning with familiar food practices: I started the class by asking what students had eaten for breakfast that morning. One student said: *"I had roti and vegetables."* Another added, *"I had tea and biscuits."* A third said, *"We made mandua roti at home today."* Mandua is finger millet, commonly known as ragi. Other students joined in, sharing what they had eaten. The responses were immediate and familiar—*roti, sabzi, chai*, biscuits, rice, and leftovers from the previous night.

Pointing out the variety of breakfasts in our own classroom, I asked, *"Do we all eat the same kind of food every day?"* The students quickly said no. One student said: *"We make different kinds of food during festivals."* Another student said: *"We have different kinds of food at weddings too."* A third student said: *"In winter, we mostly make bhatt dal or mandua roti at home."* Bhatt is a local variety of black soybean. These observations led other students to start comparing the foods prepared in their homes during different seasons, festivals, and special occasions.

I helped the students consolidate what they had noticed—we do not eat the same food every day,

and different people eat different kinds of food. Drawing their attention to Table 3.2 in their textbook, I pointed out that food choices vary across regions.² I then asked the students what might explain this diversity. We discussed the role of factors such as climate, soil, local crops, and cultural traditions. This discussion raised two related questions for us:

- How are the food habits of a place connected to what is grown locally? To explore this question through foods familiar to them, I asked the students to bring small samples of the pulses and grains they regularly eat at home. I also encouraged them to find out the local names, where they were grown, their nutritional benefits, and the dishes made from them.
- How do food practices develop and change over time? To investigate this question, I encouraged the students to ask older family members about changes in food and cooking practices over their lifetimes. I pointed out that they could use the questions in Activity 3.3 of their textbook to guide these conversations.²

(b) Exploring local food knowledge: The next day, students returned with stories about foods traditionally eaten in their homes. They spoke about staples such as *mandua* roti, *jhangora* (barnyard millet), *gahat* dal (horse gram), *bhatt* (black soybean), and different kinds of *saag* (leafy greens), as well as regional specialties such as *Kandali* (stinging nettle), *linguda* (fiddlehead fern), and *chandra* (Himalayan peony).

Box 1. Curricular connections:

The pedagogical approach in this article can support teachers in meeting and assessing the following curricular goals for middle-stage science:

- CG-4: [The student] understands the components of health, hygiene, and wellbeing. Specifically, it can help students develop the competency to:
 - (C-4.1) "Undertake a nutrition-based analysis of food components with special reference to Indian culinary practices and modern

understanding of nutrition, and explain the effect of nutrition on health."

- (C-4.2) "Examine different dimensions of diversity of food—sources, nutrients, climatic conditions, diets."
- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can help students develop the competency (C-7.1) to: "Use scientific vocabulary to communicate science accurately in oral and written form, and through visual representation."³



Fig. 1. Bringing local crops into the classroom. The display combines samples of pulses and grains brought from students' homes with information they gathered through conversations with elders.

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We then used the samples brought by students to create a simple chart titled 'Pulses and Grains of Uttarakhand'. I drew different jars on the chart and asked students to sort their samples. One sample of

each type of pulse or grain was pasted inside a jar, with its name written below and an information bubble beside it. Each bubble included details such as the sowing season, season of availability, health

benefits, water requirements, climate suitability, and any special uses (see Fig. 1).

Bringing together samples and information from various homes allowed students to compare the foods represented in their community and learn from one another's knowledge. For example, one student pointed towards a sample and said: *"Ma'am, we eat bhatt at home, but I did not know that it contains so much protein."* Another student shared what her grandmother had told her: *"My grandmother says that this is eaten more during winter because it keeps the body warm."* This led to a discussion on how Uttarakhand's cold climate, hilly terrain, and water availability influence which crops can be grown, and why crops such as *mandua* and *gahat* are well suited to these conditions.

We also looked at how these food practices had changed over time. Students noted that while *mandua* and *kandali ki sabzi* were still part of their diets, *jhangora ka chaval* (barnyard millet rice) was eaten less frequently than before. They had also learnt that many foods used to be prepared at home using locally available ingredients. One student mentioned: *"Ma'am, my grandmother said that earlier people did not buy so many things from the market. They ate whatever was grown at home."* We discussed how this was different from food practices today, when packaged foods are more commonly used, and machines have made some aspects of food preparation faster and less labour-intensive. This discussion highlighted the contrast between an earlier reliance on locally grown foods and the many foods that are now bought from shops.

(c) Investigating food labels: When I asked students what foods they regularly bought from shops, they enthusiastically listed chips, biscuits, chocolates, juices, and instant noodles. The textbook mentions that *"packaged food items must have information about the nutrients on their cover. The information should list the amount of each nutrient."*² But when asked, no

one could tell me the nutritional content of the packaged goods they regularly ate. So, I asked them to bring empty packets of their favourite snack items to the next class.

The next day, students brought a wide variety of wrappers they had collected. I divided them into groups and asked each to examine a few packets closely: *"What can we find out about a food item's nutritional value from the information on its packet?"* Very soon, students started noticing details they had previously overlooked. One exclaimed: *"Ma'am, there is so much written on the back!"* Another pointed to the nutrition table and asked, *"Ma'am, what is this energy value?"* I explained that it indicates the amount of energy provided by the food, expressed in kilocalories (kcal). A third student excitedly pointed to the FSSAI logo. I reminded them that FSSAI stands for the Food Safety and Standards Authority of India, which the textbook introduces as *"a government agency that regulates food quality in India."*² We then discussed why packaged foods must meet safety and quality standards set by this organisation and provide transparent information to help consumers understand what they are buying.

Students in each group then worked together to organise their findings. Looking closely at the nutrition tables, they recorded the energy values, nutrient amounts, and details such as manufacturing and expiry dates. Some groups pasted parts of the wrappers onto chart paper, drawing arrows to connect the labels with specific nutrients (see Fig. 2).

I reminded students that the textbook describes junk foods as *"unhealthy as they contain high levels of sugar and fats but little protein, minerals, vitamins, and dietary fibres."*² I then asked the groups to use the packet information to classify their items as healthy or junk. As students shared reasons for their classifications, we discussed what label data reveals about our diet. I also used this opportunity to suggest healthier alternatives, such as roasted chana instead of chips and lemon water instead of cold drinks.

Char Chare		
Energy	554.0 kcal	5.54%
Protein	6.5g	-
Carbohydrate	55.5g	-
Total fat	34.0g	10.14%

Date of Manufacture	13/01/26
MRP (incl. of all taxes)	5.00

Fig. 2. Reading packaged food labels. This chart is an example of how students organised information about nutrients, energy value, and other details from the cover of a snack they regularly ate.

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I then asked, *"If this information is useful for all of us, how can we help others learn about it too?"* Students worked together to create a food-label awareness chart, drawing on the observations and questions that had emerged during their examination of the packets. The completed chart was displayed in the school, where it became a resource not only for the students who had created it, but also for the wider school community.

(d) Investigating the components of food: Our discussions on traditional and evolving food practices led to another question: what do the foods we eat contain, and how can we find out? We first reviewed the key components of food—carbohydrates, fats, proteins, vitamins, and minerals—and their roles in maintaining health. I then asked how we could test for these components in familiar foods, taking up the items suggested in activities 3.5–3.7 (such as potato, cucumber, boiled rice, boiled gram, peanuts, bread or *chapati*, butter, and coconut)² After students predicted which nutrients each food contained, we planned how to test these predictions using simple procedures: the iodine test for starch, the translucent patch test for fats, and the protein test.

We began with the fat test, which required only paper and food samples, before moving to the starch test, which required test tubes and iodine solution. The school had a laboratory, but it had not been actively used for a long time. Rather than seeing this as a barrier, I encouraged students to consider how we might adapt everyday items for our investigation. I showed them a cleaned perfume bottle and an empty Strepsils blister pack. Puzzled, one student asked, *"Ma'am, are we really going to do an activity with these?"* When I asked what we needed for our test samples, another replied, *"We need small compartments to keep different samples separate."* Holding up the blister pack, I asked, *"Could this work?"* The students looked closely and smiled. *"Yes, Ma'am! It has separate sections."*

The students placed different food samples into the sections of the blister pack, and I demonstrated how the perfume bottle could be used to add drops of iodine solution to the samples. As the students repeated the steps and watched several samples turn blue-black, their surprise turned to excitement (see Fig. 3). I encouraged them to record their observations in the same table as their predictions, making it easy to compare the two and discuss our results.



Fig. 3. Testing the presence of nutrients. The students used empty Strepsils blister packs and an empty perfume bottle to test their predictions about the presence of starch in everyday food items.

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them, *"To find answers, we need to gather the courage to ask questions."*

When the students approached the vendor, one of them introduced the group and explained their purpose: *"Namaste, Uncle. We are studying food and nutrition for Baal Shodh. Can we ask you a few questions?"* The vendor smiled and invited them closer. The students asked about seasonal vegetables, storage methods, local produce, and how customers choose vegetables. One student also asked, *"Uncle, how can we tell if a vegetable is fresh?"* The vendor explained, *"You can look at the vegetable's colour, its leaves, and texture. Fresh vegetables are usually firm and crisp, while older vegetables may begin to appear wilted."* Another student asked, *"Is there a difference between local vegetables and vegetables that come from outside?"* Here, *"vegetables that come from outside"* referred to those brought to the local market from elsewhere. This question opened up a real-world connection to the concept of food miles, which the textbook introduces as: *"The entire distance travelled by a... food item, from the producer to the consumer."*² The textbook also emphasises the importance of reducing food miles, *"because it helps to cut down the cost and pollution during its transport; it helps support*

*local farmers; and it also keeps our food fresh and healthy."*² The vendor replied, *"Local vegetables may be fresher when they have been harvested nearby and brought to the market quickly. People here still like many local vegetables."* We later discussed that the freshness of vegetables might be affected by many other factors, including how they are handled and stored after harvesting.

Another group spoke with a medical shop owner about the role of medicines and nutritional supplements in maintaining health. One student asked, *"Uncle, are all vitamins the same?"* Using the example of fat-soluble and water-soluble vitamins, the owner clarified that vitamins are of different kinds. Touching upon the different ways in which the body uses and stores them, he concluded, *"That is why we need each vitamin for a different function."* As the conversation continued, the owner made a statement that caught the children's attention: *"We should not make the intestines do the work of the teeth."* The children looked surprised. One student asked, *"Uncle, what does that mean?"* The shop owner explained, *"Every organ has its own function. When we chew food properly instead of swallowing it quickly, we help break the food into smaller pieces and make it easier for the*



Fig. 5. Interviews with members of the broader community. Students discussed (a) seasonal and local produce with a local vegetable seller, and (b) medicines nutritional supplements with a local medical shop owner.

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digestive system to process." Another student asked, "Uncle, when medicines are available, why do doctors put so much emphasis on eating fruits and vegetables?" The medical shop owner replied, "Medicines can help when we are ill, but they cannot take the place of good food. If our food is not right, even medicines can provide only limited help. Our body gets its everyday energy and nourishment from a balanced and nutritious diet."

The interviews showed students that knowledge relevant to a science investigation is not located only in textbooks or classrooms; it can also come from people's everyday experiences. When the children approached community members with genuine curiosity, listened carefully, recorded their responses, and showed interest in what they knew, many responded with patience, enthusiasm, and pride (see Fig. 5). For the vegetable vendor, discussing seasonal and local produce was part of everyday work; for the medical shop owner, talking about medicines and vitamins was routine. Yet their response to the interviews showed an awareness that they were doing more than

answering questions—they were contributing to what and how the children learned.

When we returned to school, I noticed that many students' records of the interviews consisted mostly of keywords and fragmented notes. We discussed how documentation involves more than recording answers—it also requires organising information, making sense of what was learnt, and communicating it clearly. Students then used their notes from the interviews to write structured reports (see Fig. 6). This allowed them to look back at their conversations with community members and make sense of the information they had collected.

Parting reflections

Looking back at this *Baal Shodh* journey, one thing that stands out for me is how the investigation grew from things that were already familiar to the children. It began with a simple question about what they had eaten for breakfast and led to further questions about how food practices change, what packaged foods contain, how

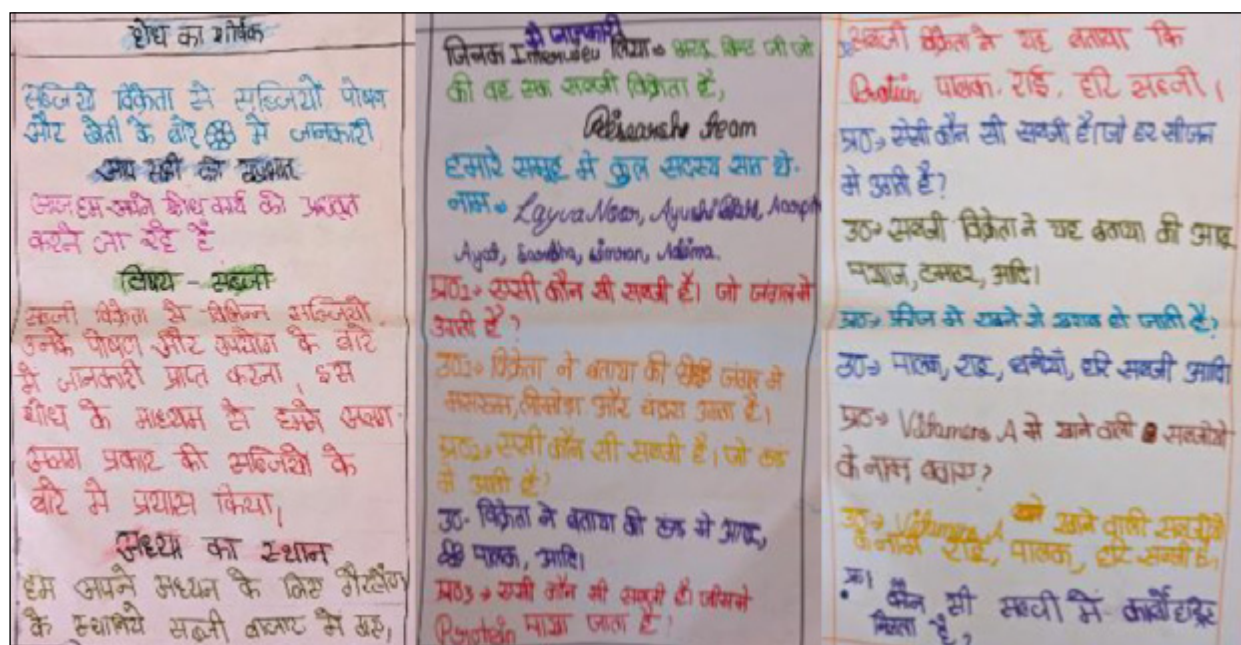


Fig. 6. Documenting interview responses. An example of how one group organised their learning from keywords and fragmented notes recorded during interviews with members of the broader community.

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nutrients can be tested, and what we can learn from people in our families and communities.

I noticed that when learning was connected to their own lives and the local context, students were more willing to ask questions and explore ideas further. For example, one of the homework exercises I gave students was: *"You are stuck on a snowy mountain for 10 days. What food will you choose to carry with you in a survival kit and why?"* When we discussed the exercise in class, the students were initially quiet. I then asked students to consider what they themselves eat in winter, what their grandmothers prepare when someone is ill, and what foods are available in the mountains. As the exercise became connected to experiences and knowledge familiar to them, students began to respond more readily and explore ideas about what food they would choose and why.

This experience helped change the way students approached knowledge. When investigating the components of food, students made predictions, tested familiar foods, observed the results, and compared them with their predictions. When they discovered that an empty Strepsils blister pack and a used perfume bottle could be adapted for the activity, they saw that scientific investigations do not always require specialised equipment. At the same time, they learnt that knowledge is not located only in textbooks or classrooms; they could find it in food labels, in their own experiences, and in conversations with family and community members.

It also reinforced for me that giving students ownership of an inquiry does not mean that they do not need help in developing the skills required for it. For example, in planning the interviews with the broader community, students initially

framed questions that could be answered by a simple yes or no. I used role-play and discussion to help them recognise the value of open-ended questions and prepare for their conversations with community members. During the interviews, there were instances when some students were unsure how to keep a conversation going. We returned to these in class, discussed possible follow-up questions, and thought about what they might do differently next time. Students needed support after the interviews as well. For example, while many students had captured only keywords and fragments of their conversations, discussing what they found interesting or surprising in their interviews helped them recall details and organise their thinking before writing their reports.

The experience created opportunities for learning across subjects. Science helped students understand food and nutrition; mathematics supported the organisation and comparison of information; language was used to frame questions, record conversations, and communicate findings; and social science helped students think about food practices in relation to culture, geography, agriculture, and livelihoods. These connections emerged naturally as students pursued their investigation.

This journey ended with students presenting their findings to the school community through charts, models, displays, and oral presentations. They spoke with confidence about the people they had interviewed, what they had observed, and what they had learnt. For me, one of the most valuable aspects of these presentations was seeing how students had moved from receiving answers to actively seeking them in the world around them. Perhaps this is where authentic learning begins.

Key takeaways



- Science teaching offers many opportunities for student-led investigation to emerge naturally from everyday classroom instruction, rather than as an additional activity.
- Encouraging children to observe variations in what their classmates eat every day and across seasons makes the concept of food diversity immediately relevant.
- Inviting students to bring food samples and stories from home allows them to connect local food practices with the crops, climate, and geography of their region.
- Learning to examine information on food labels helps children bridge textbook concepts about nutrition with the food choices they encounter in everyday life.
- Repurposing inexpensive everyday objects can give children accessible ways to test predictions and gain firsthand experience with scientific investigation.
- Encouraging students to interview broader community members brings experiential, real-world knowledge into classroom learning.
- Even when students take ownership of an inquiry, they may need structured teacher support to build the necessary research and communication skills for it.

Notes:

- a) Credits for the image (Testing food components with repurposed everyday materials) used in the background of the article title: Created from a template shared by Mridali Pandey for i wonder... using ChatGPT, under prompting by Chitra Ravi (Sep 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- b) This article includes one classroom resource: **Activity Sheet: Food Claims—What Makes You Say That?**

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Mridali Pandey has been with Azim Premji Foundation since the 2025–26 academic year as an Associate Resource Person. She is currently working as a science Resource Person in Chamoli, Uttarakhand. She holds a master's degree in Industrial Biotechnology from the Central University of Lucknow. Outside work, she enjoys trekking and exploring new places. She can be contacted at: mridali.pandey@azimpremjifoundation.org.

Experiences

ACTIVITY SHEET: FOOD CLAIMS—WHAT MAKES YOU SAY THAT?

Aim:

We hear many claims about food from family, friends, shopkeepers, television, and textbooks. A claim is a statement that someone presents as a fact, but which may or may not be true. In this activity, you will become a science detective! Your task is not to guess if a claim is true or false, but to ask: *What evidence supports this statement?*

What to do:

A) **What kind of claim is it?** The table below has some examples of claims. Read each one and decide which category it fits:

- **An observation:** Something you have directly seen, heard, smelt, tasted, touched, or otherwise noticed using your senses.
- **A traditional belief or idea:** A practice, explanation, or idea that has been passed down through families or communities and is based on people's experiences or traditions.
- **A testable scientific claim:** A statement that can be checked by direct observation, measurement, comparison, or a simple test.



Remember:

Some claims may fit more than one category. For example, a traditional belief or idea may also be a testable claim if we can investigate it by gathering evidence. Think carefully about why you place each claim in a particular category.

Claim	Category	Reason
"This food is healthy."		
"This packet contains a lot of protein."		
"This vegetable is fresh."		

Claim	Category	Reason
"Local food is better."		
"These traditional grains are good to eat in winter."		
"People in our area eat this food because of the climate."		
"People used to eat more locally grown food."		

Tip: As you read each claim, ask yourself: What do terms like "healthy" or "fresh" actually mean? What does "a lot of protein" mean? What would make one food "better" than another?

B) What questions do we ask? Work in groups. Choose one claim from the list above. Think about these questions:

- What do we already know?
- What are we assuming (guessing without evidence)?
- What do we need to find out?

Here is a worked example:



Write down your ideas	
Our claim:	"This spinach is fresh."
What do we already know?	• The spinach was bought at the local market this morning. • It looks bright green, feels firm, and has crisp leaves. • The vendor said it was harvested nearby.
What we are assuming?	• "Bright colour" means it was picked recently. • "Fresh" means it was harvested within the last 24 hours. • The spinach has not been made to look fresh by spraying it with water or storing it in a refrigerator.
What do we need to find out?	• When was this spinach harvested? • How long did the spinach take to reach the market? • What physical changes can we observe as spinach loses freshness? For example, would it show wilting, loss of moisture, or changes in colour?

C) What source of evidence could help? Different questions need different kinds of evidence. Think about what kind of evidence would help you answer your questions and where you could find it. Here are some examples:



Source of evidence	How we will find out	What we will record
A food packet/ wrapper	Read the ingredients list, nutrition table, and other product details.	Nutrient amounts (like sugar and protein) in grams, ingredient lists, manufacturing dates, and expiry/ best-before dates.
A simple activity	Perform simple tests using everyday items (like empty medicine blister packs, paper, droppers, etc.).	Colour changes in the iodine test for starch or oily patches on paper in the fat test.
Community interviews	Ask open-ended questions to elders in the family, local vegetable sellers, farmers, health workers, or other people with relevant experience.	Details about harvest dates, storage methods, transport distance, and traditional food practices.
Classroom observations	Compare food samples kept in the classroom by observing them over 3–5 days.	Rates of wilting, moisture loss, and changes in color or texture over time.

D) Plan your investigation: Now, think like a scientist! Plan how your group will gather evidence:

- Our claim:
- What question do we need to answer?
- Which source of evidence will we use?
- How will we gather evidence?

Here are some examples of an investigation:

Claim	Classification	How could we gather evidence?
" <i>Bhatt dal (black soybean) keeps the body warm in winter.</i> "	Traditional belief / Testable scientific claim	Check the nutritional profile: Find out whether <i>Bhatt dal</i> contains high amounts of protein or fat. Protein and fat require more energy to digest than carbohydrates, and digestion produces some heat in the body. Discuss whether this information provides enough evidence for the claim that <i>Bhatt dal</i> keeps the body warm in winter.
" <i>Local vegetables are always fresher than ones brought from outside.</i> "	Testable scientific claim	Measure travel time: Find out (by asking the vendor, for example) when local and outside vegetables of the same kind were harvested and where they came from. Calculate the time between harvesting and reaching the market. Compare the two values.
		Classroom observation: Leave samples of local and outside vegetables at room temperature for

Claim	Classification	How could we gather evidence?
		2–3 days. Compare changes in their appearance and texture. Observe how quickly they wilt, lose moisture, or rot over the next few days.
<i>"We should not make the intestines do the work of the teeth—chew your food properly!"</i>	Observation / Testable scientific claim	Physical surface area test: Take two identical pieces of boiled potato. Leave one whole and break the other into small pieces. Place both in separate cups of warm water and stir them gently. Observe which one breaks apart faster. Discuss how chewing breaks food into smaller pieces and increases the surface area on which digestive juices can act.
		Chemical iodine test: Place a whole potato piece and a mashed potato piece into separate cups of warm water mixed with a crushed digestive enzyme tablet (available at any medical shop). After 10 minutes, test the liquid in both cups with iodine solution. Which sample shows less blue-black colour? Discuss how chewing well allows more of the starch in a sample to be broken down by digestive enzymes in the intestine.
<i>"Medicines can help when ill, but they cannot replace a balanced diet."</i>	Testable scientific claim	Information gathering: Interview a health worker and use the science textbook to find out what medicines are used for and what nutrients from food do in the body. Compare the information from these sources.

E) Investigate and record: Carry out your investigation and record your results in a table like the one below. Make sure to separate exact observations or statements from what you interpret from them. The table has some examples.

What we did	What we observed, measured, or were told	What this shows
Interviewed the local vegetable seller.	He said that local spinach reaches the market within 2 hours of harvesting, while outside spinach takes 2 days.	The local spinach may be fresher because it was harvested more recently.
Tracked wilting of both samples over 3 days.	Outside spinach leaves turned yellow and limp by Day 2. Local spinach stayed green until Day 3.	The local spinach may be fresher because its leaves stayed green and firm for longer at room temperature.

F) Return to the claim: Look at all your findings from section E. What do they tell you about the original claim?

- ☐ The evidence supports the claim.
- ☐ The evidence does not support the claim.
- ☐ We need more evidence before we can decide.
- ☐ The claim needs to be more specific.

Our conclusion: _____

The key evidence that helped us decide: _____

G) Improve the claim: A scientific claim should be clear and specific. Here is an example:

- Original claim: "Local food is better."
- Improved claim: "Local spinach is fresher than spinach brought from outside because it reaches the market sooner after harvesting."

Can you use your evidence to rewrite the claim you investigated so that it is clearer?

Your original claim: _____

Your improved claim: _____

Think about:

Work with your partner to think about your investigation before sharing with the class.

- **Checking your evidence:** What was the strongest piece of evidence your pair collected? Was there any information you collected that was not useful?
- **Missing information:** What is one question about your claim that your investigation could not answer? What more would you need to find out?
- **Surprises:** Did any result or answer surprise you? What made it unexpected?

Discuss with your class:

- What makes evidence useful?** A claim does not become true just because someone says it loudly, an older person tells us, or we have heard it many times. Looking at all the class investigations, what made some evidence more useful than other evidence? How can we tell the difference between someone's opinion and testable evidence?
- Respecting traditional knowledge:** Many traditional practices (like eating specific grains in winter) come from experience gained over many generations. Did any of the traditional claims investigated by your class have a scientific explanation? What can we learn from traditional knowledge while also using science to investigate these practices?
- It is okay to change your mind:** We may change our ideas when we get new evidence. This is an important part of doing science. Why is it important to examine all available evidence before deciding what to believe? Looking back at the claims your class explored (like checking food packets or asking vendors about harvest dates), what is one practical advantage of checking the evidence over sticking to your first idea?



FOLLOWING THE PHASES OF THE MOON

AMOL ANANDRAO KATE

Students may have noticed that the Moon does not look the same every day. What can they discover by regularly observing the Moon's appearance and location in the sky over a month?

Students are formally introduced to the phases of the Moon in Chapter 11 ('Keeping Time with the Skies') of the Grade VIII science textbook (NCERT, Reprint 2026–2027).¹ Meera, a fictional character, notices the Moon in the daytime sky on Makar Sankranti: *"She remembered learning that the Moon is spherical and shines by reflecting sunlight. Then why isn't the whole Moon visible every night? For a moment, she wondered if it was due to a lunar eclipse. But eclipses are rare and brief. So, what causes the Moon's changing shape?"*¹ These are questions that many children have.

One way to help them answer such questions is to give them opportunities to observe the phenomenon for themselves. A single observation only reveals what the Moon looks like at a particular moment. What can students learn by tracking the Moon's appearance and position in the sky over time?

Following the Moon

Rather than starting with a formal textbook explanation, I planned a series of observations that would allow students to observe the Moon over time and notice patterns in its appearance and position in the sky. We could then return to these observations in the classroom and construct a conceptual explanation together.

Step 1—Eliciting prior ideas: I started by asking students what natural objects they had seen in the sky. They replied, *"Clouds, Sun, stars, and the Moon."*

I asked, *"When do you see the Moon in the sky?"* The students replied, *"At night."* To see if they had assumed that the Moon is strictly a night-time object, I asked, *"Is the Moon always seen only at night?"* They replied, *"No, Sir, sometimes it is also seen during the day."*

I then asked, *"And how does the Moon appear?"* *"Sometimes it looks round, sometimes half a round, and sometimes less than that,"* they replied. To see whether they recognised this change in appearance as something distinctive to the Moon, I asked, *"Does this happen with the Sun too? Is it round at times and only half at others?"* Some students immediately said no, while others paused to think. Rather than elaborating, I suggested that we find out through observation: *"Let us each carefully observe the Moon over the next few weeks."* To guide their observations, I asked the students to record: *"When did you see the Moon? Where was it in the sky? What shape did it appear to have?"*

Step 2—Developing a shared frame of reference:

I led the students outside so that we could make our first observation together. This allowed them to look at the same part of the sky, compare what they saw, and develop a shared way of describing the Moon's position.

The students and I stood in a circle so that everyone had an unobstructed view. When I asked them to locate the Moon, two or three of them

quickly pointed towards a part of the sky and said, *"There! The Moon is there."* I asked, *"Carefully observe it. How would you describe its position in the sky?"* One of the students replied, *"Above my head."* Others agreed.

To help students refine their description, I asked, *"Is it directly above your head?"* A student replied, *"No, Sir. It is a little to one side."* I asked, *"What do you mean by 'one side'? Which side?"* Seeing the child hesitate, I introduced directions as a way of describing positions in the sky. *"In which direction does the Sun rise?"* *"In the east,"* said the children. *"Can you point in the direction where the Sun rises?"* Some of the children pointed east. I reminded the students that once we know one direction, we can identify the remaining three directions. Then I asked, *"If we take the point directly above our heads as a line dividing the sky into two halves, in which half is the Sun?"* The children replied, *"In the eastern half."* I asked, *"So now tell me, in which half is the Moon?"* Some students responded, *"It is in the western half."* To help make their description a little more precise, I asked, *"Is it all the way towards the west?"* Some replied, *"No, it is somewhere between the point right above our heads and the west."* The students had now moved from *"above my head"* to a more precise description using a common reference point and the cardinal directions.

Step 3—Connecting shape to sunlight: I then turned to the Moon's appearance. *"What is the shape of the Moon today?"* Many students replied, *"It is half a circle today."* I asked, *"Since only half is visible, does this mean only half of the Moon exists?"* One student said, *"No, Sir. The Moon is still round. We can see only this part because of the Sun's light."* I asked, *"Is the Moon round like a flat circle or round like a ball?"* Some said, *"Round like a ball."* I said, *"That is right. The Moon is a sphere."* I then reminded the class that they had seen an Indian Space Research Organisation (ISRO) image of the Moon as a spherical body in Chapter 12 ('Beyond

Earth') of their Grade VI science textbook (NCERT, Reprint 2026–2027).²

I now wanted to see whether the students could use this idea to make sense of what they were observing. I asked, *"Can you tell which side of the Moon appears bright to us?"* When none of them replied, I brought their earlier observation back into the discussion: *"You said that the Moon is somewhere between the point right above our heads and the west. Where is the Sun now?"*

The students looked towards the Sun and replied, *"It is in the east."* I then asked, *"Look carefully at the Moon. Which side appears bright?"* The children observed the Moon and replied, *"The side facing east."* I returned to the idea one of the children had mentioned earlier: *"Remember, the Moon does not produce its own light; it reflects sunlight. The side of the Moon facing the Sun is lit up. So, the bright side of the Moon can help us work out where the Sun is."*

I then extended this idea: *"As you observe the Moon on different days, look carefully at which part appears bright and where the Moon is in the sky. This can help you think about how the Moon is illuminated by the Sun, even when the Sun is not visible in the sky."*

Step 4—Tracking daily shifts: When we met again two days later (Day 3), the students shared their notebook entries. While their records were not identical—some had even made multiple entries in a single day—together they provided useful observations to compare.

As I reviewed their notes, I asked, *"Does the distance between the Moon and the Sun in the sky look different than it did two days ago?"* *"The Moon looks closer to the Sun,"* several students noted. *"Keep watching,"* I encouraged. *"You will notice that its position relative to the Sun changes every day."*

I then asked, *"Will we be able to see the Moon on the new moon day?"* When some students said

no, I asked why. There was silence as they thought it over. *"On a new moon day,"* I explained, *"the Moon is in roughly the same direction as the Sun. The side facing us receives no direct sunlight, and the Sun's glare makes it even harder to spot."*

After a pause, I continued, *"But this upcoming new moon day is special because of a solar eclipse. Does anyone know why a solar eclipse occurs?"* *"The Moon comes directly between the Sun and the Earth,"* one student offered. *"So it blocks our view of the Sun,"* added another.

"Right. But does this happen every new moon day?" I asked. Silence again. I repeated the question. *"No,"* a student replied. *"The Moon's orbit is tilted, so the Sun, Moon, and Earth are not in a straight line every month."* (I later learned this student had read about eclipses in a library book.)

I confirmed that the explanation was accurate and then elaborated: *"On every new moon, the Moon is positioned between the Earth and the Sun. But the plane of the Moon's path around the Earth is slightly tilted (by about 5°) compared to the plane of the Earth's path around the Sun. Because of this tilt, the Moon usually passes just above or below the Sun in our sky. So its shadow misses the Earth. A solar eclipse occurs only at those rare times when the Sun, Moon, and Earth line up. This is when the Moon's shadow falls on the Earth and partly or completely blocks our view of the Sun."*

Step 5—Observing the Moon in the evening:

On Day 16 of our observations, I organised an evening session to observe the night sky through a telescope. When the students gathered for the session, the Sun had just set, but the sky was still bright. I began by reviewing the horizon—the line where the Earth appears to meet the sky. Asking the students to recall what they learned in our previous session, I invited them to identify the cardinal directions again. Using the setting Sun to locate the west, the students quickly pointed out the east, north, and south.

Once the sky was dark enough to see the stars clearly, I pointed out the Moon high in the southern sky. I then asked the students to draw an imaginary line from us towards where the Sun had set, and another line from us to the Moon's position in the sky. I pointed out that the angle between these two lines was slightly over 90° . At this position, just over half of the Moon's visible disk was illuminated.

Then I focused the telescope on the Moon and invited the students to look through it. Along the boundary between the bright and dark parts (called the terminator line), they could see surface details not visible to the naked eye. I explained that the Moon has craters and mountain ranges that cast shadows across its surface. Seeing the Moon through a telescope gave the students a concrete experience of it as a solid, three-dimensional sphere rather than a flat, two-dimensional circle. The look of wonder on their faces showed how deeply they enjoyed the experience.

Step 6—Connecting observations with explanations: Our next classroom discussion took place on Day 26. By this time, the students had together prepared a record showing how the Moon's appearance and position had changed over several days. I reminded them that the numbers we had used—Day 1, Day 8, Day 16, and so on—were the days on which we made our observations. Astronomers, however, describe the Moon's changing appearance in terms of its phases (such as new moon, first quarter, and full moon) or by how many days have passed since a new moon.

To help them make sense of these observations, I brought together two ideas we had already discussed:

1. **The Moon is a spherical body illuminated by sunlight:** At any given time, only the half of the Moon facing the Sun is illuminated.
2. **The Moon orbits the Earth:** As it does so, the angle between the Sun, Earth, and Moon

changes continuously. Because of this changing geometry, we see different portions of the Moon's illuminated half.

We then mapped the Moon's changing appearance onto its orbit around the Earth, treating the orbit as a 360° path:

- **Day 1 to Day 8 (from waning crescent to new moon):** The children had observed the Moon in the morning sky becoming progressively closer to the Sun. I emphasised that during this period, the illuminated portion of the Moon visible from the Earth gradually shrank. On Day 8 (Oct 25, 2022), the children had observed a partial solar eclipse. I had deliberately planned the teaching of this chapter around this event because the solar eclipse gave the students visual evidence that the Moon is present in the sky on a new moon day, even though it is not normally visible at that time.
- **Day 8 to Day 16 (from new moon to first quarter):** Whenever the children observed the Moon after Day 8, it appeared to the east of the Sun and could be seen in the western sky after sunset. I pointed out that as the angular distance between the Sun and the Moon increased, an increasing portion of the Moon's illuminated side became visible to us each evening.
- **Day 16 to Day 22 (from first quarter to full moon):** We first looked back at our evening observation session on Day 16. The students' records for this day showed the Moon high in the sky after sunset. At this point, a little more than half of the Moon's illuminated disk had been visible to us. I reminded them that the angular distance between the Sun and the Moon that day had been a little over 90° . From Day 16 to Day 22, their observations showed that more of the Moon's illuminated side became visible until the Moon was full on Day 22. I explained that this was because the angular distance between the Sun and the Moon increased progressively, reaching about 180° on Day 22, when the Moon was opposite the Sun in the sky.

- **Day 22 to Day 26 (from the full moon to the next new moon):** The students observed that, after the full moon, the portion of the Moon's illuminated side visible from the Earth progressively shrank. By Day 26, their records showed a clear reduction in the illuminated portion, and the Moon had become a waning gibbous.

Parting reflections

To understand the phases of the Moon, students need to connect what they observe in the sky with the changing positions of the Sun, Earth, and Moon in three-dimensional space (see **Box 1**). This concept is often taught solely through textbook diagrams and models. In contrast, the approach I used allowed children to gather their own observations and use these to identify patterns and build explanations (see the **Worksheet**). Through this extended project, they saw for themselves that the phases are not physical changes in the Moon's shape, but result from seeing different portions of its illuminated half as it completes its 29.5-day cycle (see **Fig. 1**). The students who regularly observed the sky participated more actively in class discussions, drawing on direct experience to make sense of textbook concepts.

Looking back at this experience, I found that a few simple pedagogical moves helped children move from their initial ideas about the Moon to

a more accurate explanation of what they were observing:

- **Encourage observation of more than one feature:** Recording only the Moon's shape tells us what it looks like at a particular time, but not how its appearance changes in relation to its position in our sky. By tracking additional variables—such as the time of observation, the Moon's position relative to the Sun, and daily changes in the size of its illuminated portion—children can connect shape with spatial movement. This helps them identify patterns in their observations over time. Since my students were observing the sky in this way for the first time, I encouraged them to begin by keeping a simple and more open-ended record (see the **Activity Sheet**). As children become more familiar with observing the sky, they can move to more structured recording formats, such as the table provided in Activity 11.1 in the textbook.¹
- **Build a shared frame of reference through guided questioning:** Children need a common language to describe and compare their observations. Starting with a group observation allowed me to help them develop this frame. For example, when some students described the Moon's position as being “*above their heads*,” I did not immediately provide a more precise answer. Instead, I asked follow-up questions

Box 1. Curricular connections:

The pedagogical approach in this article and associated resources can help teachers meet and assess the following **curricular goals for middle-stage science**:

- **CG-2:** [The student] explores the physical world in scientific and mathematical terms. Specifically, it can help students develop the competency (C-2.5) to: “*Observe and identify celestial objects... in the night sky using a simple telescope and images/ photographs, and explain their role in navigation, calendars, and other phenomena (phases of the moon, eclipse, life on earth).*”

- **CG-6:** [The student] explores the nature and processes of science through engaging with the evolution of scientific knowledge and conducting scientific inquiry. Specifically, it can help students develop the competency (C-6.2) to: “*Formulate questions using scientific terminology (to identify possible causes for an event, patterns, or behaviour of objects) and collect data as evidence (through observation of the natural environment, design of simple experiments, or use of simple scientific instruments).*”³



Fig. 1. When can students observe different phases of the Moon? This chart can help teachers plan observations by connecting each phase with the time of day when it is visible in the sky.

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such as “Can you describe the position of the Moon in relation to where you see the Sun rising?” or “Which side appears bright?” Such questions guided the students to use their knowledge of cardinal directions to look more carefully and record more precise descriptions.

- Examine prior ideas through observation:**
 Before offering formal explanations, I invited children to share their existing ideas about the Moon and test them against their own records. For example, when some children asserted that the Moon is visible only at night, I asked whether their observations supported this idea. Remembering the times they had seen the Moon

during the day helped students see why making observations more carefully and regularly was important for examining their ideas.

Many teachers may not have regular opportunities to observe the sky themselves, making such outdoor activities feel daunting to organise. However, with deliberate planning, many upper primary astronomy concepts can easily be connected to simple student observations. Giving children sufficient time and structured tools to record and compare data can help them identify patterns in celestial phenomena and use them as evidence to construct scientific explanations.

Key takeaways



- Many students notice that the Moon does not look the same every day. Inviting them to share their ideas about these changes can provide a starting point for investigating the phenomenon more systematically.
- Asking children to make regular observations of the Moon over a month is not enough. It is important to guide them on what to observe (such as its appearance, location in the sky, and time of observation) and how to record these observations (for example, by using cardinal directions to describe the Moon's position) so that their findings can be compared and discussed effectively.
- Making regular observations over several days and comparing them with their peers' findings allows students to identify relationships that help explain the changing appearance of the Moon. These observations can then serve as evidence for a scientific explanation of the phenomenon.



Notes:

- a) Credits for the image (Mapping the position of the Moon in the daytime sky) used in the background of the article title: Created for i wonder... using ChatGPT, under prompting by Chitra Ravi (Aug 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- b) This article includes two classroom resources: **Worksheet: Moon Case Files: Can You Solve Them?** and **Activity Sheet: Moon Observation Log**.

References:

1. National Council of Educational Research and Training (Reprint 2026-27). 'Chapter 11: Keeping Time with the Skies' Curiosity—Textbook of Science for Grade VIII: 170-189. URL: <https://ncert.nic.in/textbook.php?hecu1=11-13>.
2. National Council of Educational Research and Training (Reprint 2026-27). 'Chapter 12: Beyond Earth' Curiosity—Textbook of Science for Grade VI: 231-252. URL: <https://ncert.nic.in/textbook.php?fecu1=12-12>.
3. National Council of Educational Research and Training (2023). 'National Curriculum Framework for School Education (NCF-SE)'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.



Amol Anandrao Kate has been working with Azim Premji Foundation since 2011. He began at the District Institute in Sirohi, Rajasthan, as a teacher educator working with science teachers. From 2019 to 2024, Amol led the Foundation's work in Rajasthan's Sirohi District. Now based in Jaipur, he coordinates the Foundation's capacity development and material development work. Earlier, he gained experience in science communication at the Vikram A. Sarabhai Community Science Centre, Ahmedabad. He can be contacted at: amol.kate@azimpremjifoundation.org.

Experiences

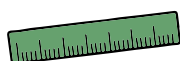
WORKSHEET: MOON CASE FILES: CAN YOU SOLVE THEM?

Aim: To use observations and evidence to develop explanations about the Moon.

You will need:



Pencil



Ruler



Eraser



Grade VIII science textbook
(NCERT, Reprint 2026-2027)



Your Moon
observation log

What to do:

Work through each case on your own first. For some cases, you may need to refer to your Moon observation log or textbook. For others, you may find it helpful to build a model.

- **Look for evidence that can help you solve each case.** Do not rely only on what you remember from the textbook.
- **Write down the evidence that supports your explanation.** You do not need to use scientific words. Explain your thinking in your own words.
- **Compare your explanation with those of a classmate or small group.** If you disagree, discuss the evidence that supports each explanation.
- **Be ready to change your explanation** if you find that the evidence points to a different answer.

Challenge I: The Case of the Daytime Moon

Many people assume the Moon appears only at night. Look at this moonrise and moonset schedule for a 30-day cycle:

Date	Phase	Moonrise time	Moonset time
Day 1	Full moon	6.10 pm	6.05 am
Day 8	Waning half moon (third quarter)	12.05 am	12.15 pm
Day 15	New moon	6.00 am	6.15 pm
Day 22	Waxing half moon (first quarter)	12.10 pm	12.05 am

Think about:

- Daytime school hours are usually between 8:00 am and 4:00 pm. Look at the table: on which of these days is the Moon above the horizon during school hours? Cross-check this with your observation log. Did you actually spot the Moon on all of those days? Why is the new moon (Day 15) invisible in the daytime sky even when it is above the horizon? Based on the days when you could spot it, is it true that the Moon can only be seen at night?
- A student claims: "I saw a thin waxing crescent Moon in the sky at midnight." Look at the table for the new moon and first quarter moon. Between what times would a waxing crescent be

above the horizon? Is it possible to see this phase at midnight? Use evidence from the table to explain your answer. *Hint: A waxing crescent occurs between the new moon and the first quarter moon. During this time, the Moon rises after sunrise and sets before midnight.*

- Why can we never see a full moon in the sky at 12:00 pm? Look at your table and observation log. When does the full moon rise and set? What does this tell you about where the full moon is at 12:00 pm from our position on Earth? Now draw a simple overhead diagram showing the positions of the Sun, Earth, and Moon on a full moon day. On your Earth circle, draw a stick figure standing on the side facing the Sun (where it is 12:00 pm). Imagine this figure is a person looking up at the daytime sky. Can you predict what they will see there? Draw a line from them into space showing which of the two—the Sun or the Moon—will lie within their line of sight. Use your diagram to explain why this person cannot see a full moon at 12:00 pm.

Challenge II: The Case of the Moon's Changing Shape

Student A claims: *"The Moon changes shape because the Sun actually lights up different portions of the Moon's surface from day to day."*

Student B claims: *"Half of the Moon is always illuminated by the Sun. As the Moon orbits the Earth, we see different fractions of its lit half in our sky."*

Think about:

- Put a ball on a table and shine a torch on it from one side. How much of the ball is lit by the torch? If you move around the table, does the lit half of the ball change, or does your view of the lit half change? Look at your observation log: when you see a crescent Moon, which direction does its bright, curved edge point relative to the Sun?
- If half of the Moon is always lit by the Sun, what phase would an observer on Earth see when the Moon is roughly in line with the Sun (new moon)? What phase would we see when the Earth is between the Sun and the Moon (full moon)?
- Based on your findings from the torch activity and your observation log, which student's claim best explains why the Moon seems to change shape as it moves around the Earth?
- Look at Figure 11.5 in Chapter 11 ('Keeping Time with the Skies') of your Grade VIII science textbook. Part (a) shows the Moon at different positions in its orbit around the Earth. Part (b) shows the corresponding phases of the Moon as seen from the Earth. How does part (a) help explain part (b)?

Challenge III: The Case of the Eclipse Myth

Three students are debating what causes the Moon's shape to change each night:

- Rohan: *"The Moon's phase changes because the Earth gets between the Sun and the Moon, casting a shadow on it."*
- Priya: *"Earth's shadow always points away from the Sun. When we see a crescent Moon near the Sun, Earth's shadow is pointing in the opposite direction, so it cannot be what causes the Moon to appear crescent-shaped."*
- Amal: *"A lunar eclipse happens only when the Sun, Earth, and Moon are nearly in a straight line. The Moon's orbit around the Earth is tilted by about 5° compared to Earth's orbit around the Sun. Most months, the Moon passes slightly above or below Earth's shadow."*

Think about:

(A) Test these claims with observations: Look at your observation log for a crescent Moon.



- Where is the Sun relative to the crescent Moon in the sky?
 - Since Earth's shadow extends away from the Sun, could it fall on a crescent Moon that appears close to the Sun in the sky? How does this observation go against Rohan's claim and support Priya's claim?
- (B)** Test the claims with a model: Set up the model from Activity 11.2 (Fig. 11.4) in Chapter 11 of your Grade VIII science textbook. Use a light source to represent the Sun, a small ball to represent the Moon, and your head to represent the Earth.
- Move the ball around your head, holding it slightly higher or lower than the level of your eyes so that it stays out of your head's shadow. As you turn, can you still see different lit shapes, such as crescents and half-moons?
 - Now, bring the ball directly into the shadow cast by your head on the opposite side from the light source. What happens to the ball when it enters your head's shadow? How is this position different from its regular orbit?
 - Draw a simple side-view diagram showing the Sun, Earth, and the Moon's tilted orbital plane. Use your diagram to explain why a lunar eclipse does not happen at every full Moon.

Challenge IV: The Case of the Drifting Calendar

Different natural cycles can be used to make calendars:

- Lunar calendar: A full cycle of Moon phases takes about 29.5 days. A year of 12 lunar months therefore has about 354 days. In a purely lunar calendar, like the Islamic calendar, no adjustments are made to keep the year aligned with the solar year.
- Solar calendar: A solar year takes about 365 days (nearly 365.25 days). An extra day is added every four years as a leap day to keep a purely solar calendar, like the Gregorian calendar we use every day, aligned with Earth's orbit around the Sun.
- Luni-solar calendar: Months follow the Moon's phases, but an extra month is added from time to time to keep the calendar aligned with the solar seasons. In many traditional Indian calendars, this is done by adding an Adhika Masa approximately every 2–3 years.

Think about:

- Why might a lunar calendar be useful for everyday life? How does watching the Moon's changing shape help someone tell roughly how much of a month has passed, even without a written calendar?
- Imagine a festival is celebrated according to a purely lunar calendar. By about how many days earlier would this festival occur each solar year? Summer and winter are about 180 days (half a year) apart. About how many years would it take for this festival to shift from around mid-winter to around mid-summer? *Hint: Divide 180 by the yearly difference between the lunar and solar years.*
- A farmer traditionally plants seeds in Month 1 of her calendar, believing that Month 1 will always mark the end of winter. If her village follows a purely lunar calendar, what problem might she face 8–9 years later, when Month 1 arrives nearly three months earlier in the seasonal cycle? How might the weather and soil conditions affect her crops?
- Compare a solar calendar and a luni-solar calendar. What are the advantages and limitations of each for an agricultural community? Explain your answer using what you have learnt about the two calendars.

Discuss:

Q1. Imagine it is new moon day. Two people are looking at the sky at the exact same time. One

of them is a person standing on Earth. The other is an astronaut standing on the Moon, looking towards the Earth.

- (a) The person on Earth cannot normally see the Moon because the part of the Moon facing the Earth is not illuminated by direct sunlight. But what would the Earth look like in the astronaut's sky? What fraction of it would be lit up: all, half, or none?
- (b) Draw a simple diagram showing the positions of the Sun, Moon, and Earth. Use stick figures to show the person on Earth and the astronaut on the Moon. Use your diagram to explain your answer to part (a).

Q2. Priya says: "Starting from a full moon night, I looked out of my bedroom window every night at 8:00 pm. For the first few days, the Moon's shape barely seemed to change. But by the end of the week, I could not find the Moon at 8:00 pm at all!"

- (a) Look at the moonrise and moonset table. By approximately how many hours does the moonrise time shift over a 7-day period? Use this time shift to explain why the Moon was no longer above the horizon at 8:00 pm by the end of Priya's week of observation.
- (b) How should Priya change when, where, and how she makes her observations if she wants to observe and record a complete 29.5-day cycle of Moon phases? What should she record each time she observes the Moon?

Q3. Suppose the Moon took 365 days instead of 29.5 days to complete one full cycle of phases.

- (a) Would we still see all the same shapes (crescents, half-moons, full moons)? Explain why or why not.
- (b) What would happen to the number of days between one full moon and the next?

Q4. Some cartoons show stars shining inside the dark part of a crescent moon.

- (a) Why is this picture scientifically impossible? *Hint: What are you actually looking at when you see the dark area of a crescent moon?*
- (b) Imagine a star in the sky appears right next to a crescent moon. What would happen to our view of the star as the Moon passes in front of it?

Reflect:

- Which case or question required the most mental effort? What visual model or idea helped you solve it?
- Write down one new question about the Moon that you could answer yourself over the next month just by looking at the sky—without using a book or the internet.

Safety note: Never look directly at the Sun—either with the naked eye or through optical devices such as binoculars or telescopes—when observing objects near the Sun or during daytime observations. Direct viewing of the Sun can cause serious and permanent eye damage.

Acknowledgments: The author thanks Anish Mokashi for his feedback on making this resource more pedagogically unambiguous for Grade VII students.



Experiences

ACTIVITY SHEET: MOON OBSERVATION LOG

Aim: To observe and record the changing shape and position of the Moon over a month.

You will need:



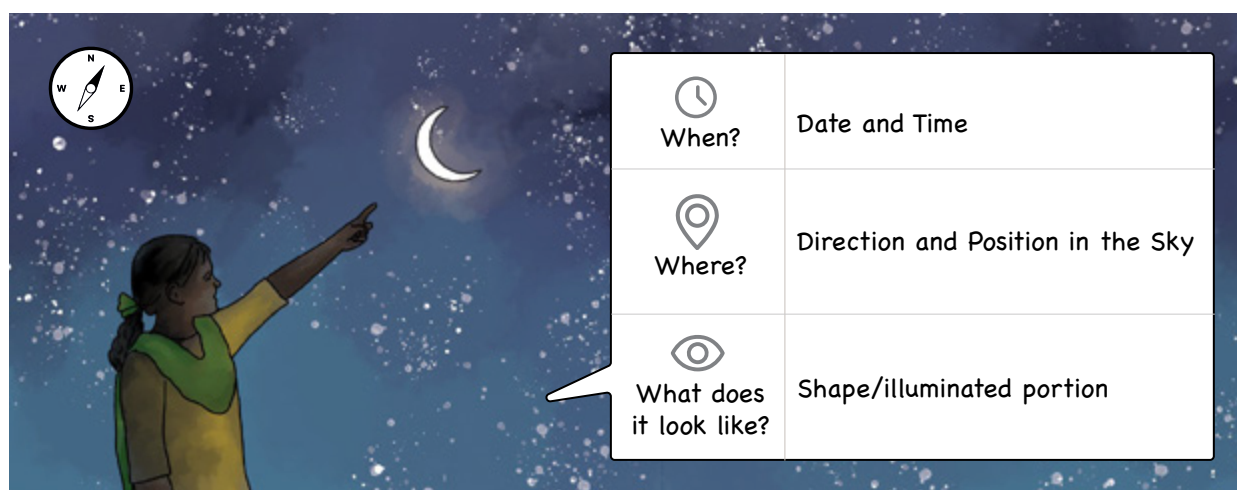
A notebook



Pencil and eraser

Observe and record:

Use the table below to record your observations whenever you see the Moon. You can make more than one observation each day:



 When?	Date and Time
 Where?	Direction and Position in the Sky
 What does it look like?	Shape/illuminated portion

S. No.	Date & Time	Moon Drawing/Shape	Remarks

Tip: Begin your observations during the waxing phase (shortly after a new moon). Try observing for a full month to record a complete lunar cycle.

(a) When to look:

- The Moon is not always visible at the same time every day—it rises about 50 minutes later each day!

- During the first half of the cycle (waxing phases), look in the afternoon and evening.
- During the second half of the cycle (waning phases), look in the late night or early morning.

(b) How to record:

- Date and time: Note the observation number, date, and exact time of day (e.g., Day 1, Oct 12, 6:30 pm).
- Moon Drawing / Shape: Draw a circle to outline the Moon. Inside the circle, shade the dark part so that the unshaded portion shows the illuminated shape you see in the sky.
- Remarks: In this column, include the following details:
 - Position and direction: Note the Moon's direction (e.g., south or west) in relation to the direction of the rising or setting Sun, and its height in the sky relative to the horizon or nearby landmarks (e.g., just above the treeline or rooftops or high in the sky).
 - Surrounding sky: Note any bright stars or planets nearby, their position relative to the Moon, and their colour. (This can help track the Moon's changing position across the sky.)
 - Weather conditions: Note if the sky is clear, partly cloudy, or fully cloudy.

Think about and discuss:

- Q1. Does the Moon's shape change suddenly or gradually from day to day?
- Q2. Did you notice the Moon in the sky during daytime or early afternoon hours? Did its illuminated side face toward or away from the Sun?
- Q3. Can you predict what the Moon will look like three days from now based on the pattern in your table?



WHEN SCIENTIFIC OBSERVATION TRANSFORMS “BUGS” INTO LIVING ORGANISMS

SEBASTIÁN ALBERTO CHIAPELLA

The Grade VI science curriculum invites children to explore the rich diversity of life around them. What might they learn when their fear or rejection of spiders, ants, cockroaches and other small arthropods becomes a starting point for scientific inquiry?

Chapter 1 ('The Wonderful World of Science') of the Grade 6 science textbook (NCERT, Reprint 2026–2027) reminds children that: “As human beings, we have always been curious about our surroundings. We start exploring our surroundings and asking questions right from our childhood...” Science is introduced as “a way of thinking, observing and doing things to understand the world we live in and to uncover the secrets of the universe. Think of it as a big adventure—we ask questions, explore the world and try to understand how things work. Whether it is studying tiny grains of sand or massive mountains, a leaf of grass or a vast forest, there is always something new and exciting to discover.” Children are then invited to recognise their everyday surroundings as the starting point of this inquiry: “There is an amazing variety of life on Earth—plants and animals that have managed to survive and thrive in different regions on this planet. You might have seen a seed grow into a plant, a caterpillar transform

into a beautiful butterfly, and many more such observations.”

But what happens when we encounter organisms in our immediate surroundings that we do not particularly want to look at? Everyday examples from children's surroundings include spiders, cockroaches, or other small animals that are quickly labelled as “bugs.” I have often seen children instinctively react to these organisms with fear or the assumption that they should be eliminated. What might children discover when the organisms they instinctively reject become the subjects of a scientific inquiry?

An inquiry into neighbourhood bugs

This question was at the heart of a natural sciences workshop I conducted with approximately thirty sixth-grade students, aged 11 to 12, at Colegio Schöenthal in Argentina.

a) The fear that comes before understanding:

The work began a few days before the workshop session, when I introduced the purpose of the workshop and talked with the students about the organisms they would be studying. Before we began, I asked a simple question: “*What do you do when you find a bug in your home?*” The question was deliberate. I was not looking for a “correct” answer; I wanted to make visible what students thought before they began observing. Several students answered immediately, “*We kill it.*” When I asked why, they all agreed on the reasons: it scared them, and they thought it might bite or sting them. This response was not necessarily about cruelty; rather, it reflected how these organisms were often perceived as unpleasant or potentially dangerous. I then asked, “*But do you really know them? Do you know how they live, what they eat, what characteristics they have, or whether all of them pose the same kind of risk?*” The silence that followed my question was the beginning of a different way of looking at the natural world.

Here, I was not suggesting that children's fear was simply caused by a lack of knowledge—emotional responses to animals have many possible causes.²

The purpose was also not to teach children to like arthropods. What I wanted to do was open up a pedagogical possibility: what if something that normally triggered an immediate reaction could instead become the subject of observation? If an animal that provokes rejection can first be observed, compared, identified, and understood, perhaps that experience can also help us reflect on what happens when we judge something—or someone—we do not yet know.

b) The challenge of searching without harming:

I proposed a challenge: over the following days, they would need to look for small arthropods in their homes, gardens, or nearby green spaces, and later bring them to school, always taking care not to harm them. I then taught the students how to capture these animals without hurting them, how to prepare containers with ventilation and substrate to transport them, and how to handle them with care. This collection had both a scientific and a pedagogical purpose. Students would have the opportunity to observe the living organisms they had encountered in their own surroundings. Such direct experiences with nature are also known to foster positive attitudes toward biodiversity conservation.³

Some students admitted they did not feel brave enough to touch these animals. There was no need to push them. I established a condition that I considered essential: no student would be forced to touch an animal that caused fear or discomfort. Instead, students could participate by observing, asking questions, using a small brush to gently move the substrate, or helping classmates. What mattered was that everyone was part of the experience. Physical contact was not a requirement for taking part in the scientific activity. This decision was important because I did not want the workshop to become a test of bravery. I wanted the focus to remain on scientific observation and understanding.

c) When rejection gave place to curiosity: On the day of the workshop, the lab filled with excitement; each student arrived carefully holding



Fig. 1. Direct observation of living organisms can transform initial fear and hesitation into active scientific curiosity. Students used magnifying glasses to examine live arthropods moving in a terrarium.

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the small container in which they had transported the creatures they had found. This included ants, spiders, centipedes, millipedes, woodlice, earwigs, cockroaches, some flies, and other small arthropods. Already, there was a change. Some students no longer looked at these animals with fear; now they wanted to find out what they were.

We gathered all the organisms in a large terrarium prepared for group observation (see Fig. 1). During this first stage, I did not ask the students to touch them; the instruction was simply to look. To facilitate observation without harming or unnecessarily handling the organisms, students used small brushes and magnifying glasses to gently move the soil in the terrarium and make the animals easier to see. That first shift—from “there is a bug” to “there is an organism we can observe”—was significant. I did not give the class a list of questions to answer; instead, questions emerged naturally from the students' observations of the living organisms moving in front of them: “Why does this one have antennae?”, “Why does

that one have eight legs?”, and “Are they all the same?” Without even realising it, the students had stopped asking themselves whether these creatures should be killed. Now they wanted to understand them, and that, precisely, was the workshop's first objective.

d) When the bug started to have a name:

Rather than answer their first set of questions immediately, I invited students to observe previously prepared and identified specimens in entomological specimen boxes (see Fig. 2). While these are sometimes used as a substitute for observing living organisms, I introduced them here to expand the possibilities for comparison and encourage students to make more careful, systematic observations.

The comparisons came up spontaneously: the students counted legs, looked for antennae, told insects apart from arachnids, noticed the differences between a spider and a scorpion, compared a pill bug with other crustaceans, and



Fig. 2. Systematic comparison of structural features can provide concrete evidence for biological classification. Students examined anatomical details across preserved specimen boxes to distinguish insects from arachnids.

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discovered that organisms which looked very similar could actually belong to different groups. Every new specimen sparked new questions, and every answer led to a new observation. Biology stopped being a list of concepts and became a living experience. They were not observing simply because I asked them to; they were observing because they wanted to discover more.⁴

This exercise became the basis of classification—a process that is formally introduced to children in Chapter 2 ('Diversity in the Living World') of the Grade VI science textbook (NCERT, Reprint 2026–2027). The chapter explains that *"grouping of animals is important for understanding their diversity."* Students are first asked to group animals based on how they move—whether

they fly, run, crawl, walk, hop, or jump—and the body parts they use for movement, such as wings, legs, and fins. The chapter then points out that animals can also be classified based on differences in shape, size, structure, and colour.⁵ In the workshop, we worked together to make introductory distinctions among insects, arachnids, myriapods, and crustaceans based on the visible characteristics of their body organisation. For example, we identified three pairs of legs in insects, and four pairs in arachnids.

This process helped transform general impressions into more precise observations. What just minutes earlier had simply been a *"bug"* now began to take its place within a biological group, with

characteristics that students could use to describe, compare, and classify it. An important idea also emerged: a superficial glance may not be enough to identify what we are observing. We need to look attentively at specific characteristics and use what we observe to explain why an organism belongs to one group rather than another.

e) What the microscope revealed: The next step was to bring the group back together around a microscope. One by one, we placed the arthropods the students had brought in under the lens. Legs, eyes, antennae, and mouthparts appeared in a level of detail that sparked enormous enthusiasm.

The microscope was not simply used to *"make things look bigger"*; it made anatomical structures visible that might otherwise have gone unnoticed. For example, we could now observe structures such as chelicerae, which are involved in feeding in some arachnids. More importantly, this exercise gave the students' questions a concrete basis. For example, when students asked about the role of antennae, we went back to observing those of different insects under the microscope. The discussion on their sensory function in detecting environmental stimuli was built around these observations. In this way, scientific explanation was not presented as information separate from the experience. It emerged directly from what the students were looking at and from the questions they were asking.

Questions about whether any of the animals could hurt them provided another powerful opportunity to deepen their understanding of science. Rather than simply answering "yes" or "no," we looked more closely at the mouthparts of different organisms. In this way, a question initially driven by fear—*"Can it hurt me?"*—was transformed into a scientific question about anatomy, feeding, diversity, and classification. This comparison helped students understand that commonly found household arthropods do not all share the same characteristics or pose the same potential risks to people. Merely finding an arthropod in the home does not automatically mean there is a danger of

harm. That was when they began to question some of the ideas and fears they had arrived with. What had been a source of fear for years was starting to become a source of admiration.⁶

f) Arthropods and people: The questions kept coming, one after another. *Where do they live? Why do some come out at night? Why do they hide when we shine a light on them?* Every answer opened a new conversation, and every conversation reinforced an idea that kept growing throughout the whole activity: that understanding is worth more than reacting out of fear.

At that point, I deliberately introduced a reflection with them that shifted their perspective once again. I asked students to think about an everyday situation: we often assume that certain animals are *"invading"* our space. But the reality is more complex: in many cases, we build our cities, our houses, and our gardens within environments that have long supported other forms of life. Other organisms use these spaces in ways different from our own and are adapting to environments that we too have a role in changing. Understanding that also means learning to respect them.⁷ Chapter 10 ('Living Creatures: Exploring Their Characteristics') of the Grade VI science textbook (NCERT, Reprint 2026-2027) also reminds students that plants and animals are part of the living world and that by *"nurturing and preserving their homes, we contribute to this flourishing living world."*⁸

The activity ended the same way it had begun, with respect. All the arthropods were carefully returned to a terrarium prepared with plants and material suitable to maintain them, where they remained under our care. After observing them, studying them, and getting to know them, the act of releasing them to that space became a gesture that came naturally to the students. If organisms are collected from the school grounds, students can also be encouraged to carefully release them back where they were found, where appropriate. This reflects an essential principle of studying living organisms: recognising that we are working with living organisms, not simply laboratory objects.

Parting reflections

Perhaps one of the most interesting possibilities of teaching the natural sciences through encounters with living organisms is that it does not appear only as a set of concepts that students are expected to learn. Students can experience science as a way of looking: stopping, carefully observing, asking questions, identifying differences, understanding functions, and reconsidering what we think we already know (see **Box 1**). In this sense, my pedagogical decisions were not designed to produce a particular emotional response towards arthropods, but to create the conditions for students to observe and construct knowledge from what was in front of them. For example:

- While I had planned the overall sequence to progress from general observation towards detailed microscopic examination, I did not plan every question or conversation. This allowed students' curiosity to shape many of the explanations that developed.
- I chose not to force any student to touch organisms. Participation in the scientific process does not depend on physical manipulation. Careful observation, comparison, asking questions, identifying differences, and explaining what we see are all valid ways of participating in scientific inquiry.
- My role was to listen to what the students were observing and what caught their attention. When a question provided an opportunity to deepen understanding—such as comparing an ant and a spider, or addressing a fear of being

stung—I used it as an entry point to introduce classification or examine feeding structures.

What changed during the workshop? At the beginning, students saw some animals simply as “bugs” that provoked fear or rejection. After learning about them by observing, comparing, and classifying them, students could see those same organisms differently. Scientific knowledge had not turned every student into someone who wanted to touch arthropods, nor was that the goal. Rather, direct observation offered an alternative to an immediate reaction of fear or rejection.

This shift was not the same for everyone, nor did it happen in the same way. One student, who had shown particularly strong discomfort towards arthropods from the beginning, was not forced to approach or touch the organisms. Yet, when an ant accidentally escaped from the aquarium, she voluntarily extended her hand and let it walk across her palm, laughingly exclaiming that it tickled. This had not been planned as an exposure activity, nor had I expected it to happen. This spontaneous moment showed that a student who initially rejected physical contact could choose to approach an organism after spending time observing it. Later, some students commented that certain arthropods no longer frightened them as much. I remember comments such as, “*I did not really know them before,*” or “*I used to see them from a distance and had prejudices about them.*” Although not a formal assessment or a measurement of changes in attitude, these

Box 1. Curricular connections:

The pedagogical approach in this article can support teachers in meeting and assessing the following **curricular goals for middle-stage science**:

- CG-3: [The student] Explores the living world in scientific terms. Specifically, it can help students develop the competency (C-3.1) to: “*Describe the diversity of living things observed in the natural surroundings (insects, earthworms, snails, birds, mammals, reptiles, spiders, diverse plants, and fungi), including at a smaller scale (microscopic organisms).*”
- CG-6: [The student] Explores the nature and processes of science through engaging with the evolution of scientific knowledge and conducting scientific inquiry. Specifically, it can help students develop the competency (C-6.2) to: “*Formulate questions using scientific terminology (to identify possible causes for an event, patterns, or behaviour of objects) and collect data as evidence (through observation of the natural environment, design of simple experiments, or use of simple scientific instruments).*”⁹

comments suggest that this experience changed the way some students looked at these animals.

Before wrapping up the workshop, we returned to the question that had started everything. I explained to them that the real goal had never been simply to learn about arthropods; what mattered was understanding that before passing judgment on any living creature, we first need to get to know it. I then introduced a broader reflection: could something similar happen in our relationships with other people? Can we think about how much of our judgment is built on what we actually know, and how much on our own ideas or fears? The comparison was intentional. One student responded, *"It is true, teacher. Sometimes I do not know a friend, and I judge them beforehand. If I talk to them for a little while, maybe I will have the chance to get to know them first."* This reflection on people

followed the scientific process; it did not replace it. First, the students observed organisms, formulated questions, identified differences, and learned biological characteristics. Only after they had begun reconsidering their initial ideas did we use that experience as a starting point for reflecting on prejudice. I would not claim that a pedagogical experience of this kind can demonstrate that knowledge eliminates fear or automatically produces empathy. Such a conclusion would be too broad. While knowing may not be enough to eliminate all our prejudices, it can be a first step towards questioning them.¹⁰

The students went back to their classrooms with new knowledge of the natural sciences, but also with a lesson that reached far beyond the lab. Their day began with observing small arthropods and ended with reflecting on how knowledge can become a path towards respect for different forms of life.

Key takeaways

- Asking students how they respond to familiar organisms before beginning an activity can reveal their initial assumptions. Teachers can then use these responses as a starting point for inquiry, rather than treating fear or rejection as a barrier to learning.
- Scientific inquiry does not require students to handle the organisms they study. Allowing students to participate through observation, comparison, and questioning enables those who feel discomfort to engage fully without being forced into physical contact.
- When students' questions are used to guide them back to observing specific structures in increasing detail, textbook concepts of biological classification can be connected directly to visible evidence. Body regions, mouthparts, and leg counts become concrete features to examine rather than abstract definitions to memorise.
- Giving students time to move from an immediate reaction to careful observation creates opportunities to reconsider their initial assumptions. This shift can also provide a starting point for broader discussions about how we form judgements about living organisms—and people—before getting to know them.



Notes:

- a) Credits for the image (Observing and collecting arthropods in the local surroundings) used in the background of the article title: Created for i wonder... using ChatGPT, under prompting by Chitra Ravi (Sep 2026). License: [CC BY-NC-ND 4.0 International Deed](#).
- b) This article includes one classroom resource: **Activity Sheet: Get to Know Some Neighbourhood "Bugs"**.
- c) While a terrarium, entomological specimen boxes, and a microscope enriched this workshop, they are not essential to its core learning goals. Transparent ventilated jars or containers, small brushes, hand magnifiers or simple magnifying glasses, and basic materials for careful observation are enough to begin. What matters most is not the equipment, but the sequence of work.
- d) An earlier account of this workshop was published here: <https://elreporterosf.com/knowning-leads-to-respect-when-science-transforms-fear-into-curiosity/>. The version published in i wonder... develops this account further to focus on connections to the Grade VI science curriculum, the role of scientific observation and classification in learning, and the pedagogical insights the experience offers teachers.

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Sebastian Alberto Chiapella is an Argentinian teacher of Biology, Physics, and Chemistry and a graduate of the Instituto Superior del Profesorado "Joaquín V. González" (Buenos Aires, Argentina). With 27 years of teaching experience, he has worked with students at all levels, including adult learners. He specialises in laboratory work, where he designs experiments with his students to test scientific hypotheses, always seeking a connection to real-world issues grounded in respect for both nature and the individual. He currently teaches at Schönthal School, La Candelaria School, and Cárdenas School. He has also worked as a student tutor and as head of the biology department at one of the institutions where he teaches. He can be contacted at: sebchiapella@gmail.com.

Experiences

ACTIVITY SHEET: GET TO KNOW SOME NEIGHBOURHOOD “BUGS”

Aim: To carefully observe small “bugs” from your surroundings, record their visible features, compare them with one another, and use evidence from your observations to classify them into groups.

You do not need to catch or bring a “bug” to the classroom to study it. Many can be observed where they live—in gardens, around plants, under stones or leaves, on walls, or in other places around your school or home.

The aim is not simply to find out what an organism is called. It is to learn how careful observation can help you describe, compare, and classify living organisms.

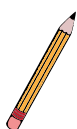
You will need:



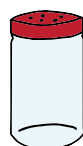
A hand magnifier
or simple
magnifying glass



A small
notebook
or
observation
sheet



A pencil



A transparent ventilated jar or
plastic container (with small air
holes in the lid) to use only if
an organism needs to be moved
briefly for closer observation



A small soft brush for
gently guiding a bug
into a jar or moving
soil or leaves around it
without touching it



Observe without harming:

Remember: A “bug” is a living organism, not a laboratory object.

- Whenever possible, observe the organism where you find it.
- Do not disturb its shelter, web, or habitat unnecessarily.



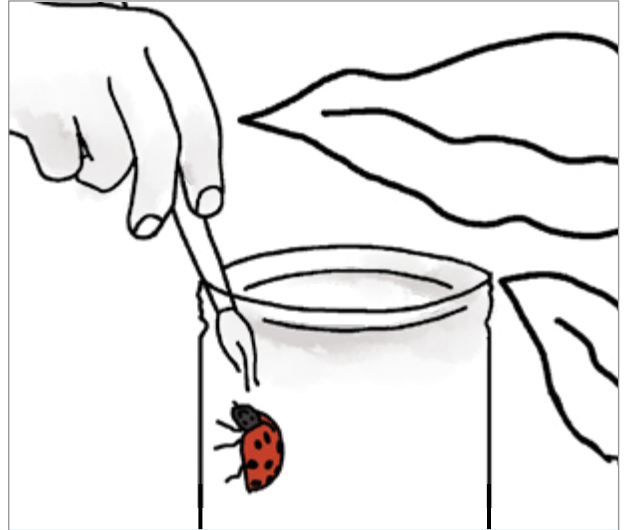
Look closely. Do not disturb its home.



Let the bug climb onto the soft brush.



Use a clean jar with holes in its lid.



Use the brush to guide the bug into the jar.



Keep the jar safe and in the shade.



Observe the bug gently without disturbing it.



Release the bug as soon as you can.



Return the bug to where you found it.



- Do not pick up an organism just to observe it more closely.
- Do not touch an organism that makes you uncomfortable. You can participate fully by observing, taking notes, or drawing.
- If an organism needs to be moved briefly, use your soft brush to gently guide it into a ventilated jar. Keep the jar in the shade and return the organism to where you found it as soon as you have finished observing it.
- Do not deliberately hurt, trap, crush, or kill an organism for this activity.



Observe and record:



A) Where you find it: Work in pairs. Find a “bug” that you can observe safely without disturbing it. Before trying to identify it, spend some time simply watching. You do not need to notice or record every detail below. Look for the details you can see, and record what you observe.

Detail	Example
Where was it?	On a brick wall, in the sun, under a damp fallen leaf, crawling on loose soil, hidden in tree bark, on a plant stem, or near a water puddle?
What was around it?	Dry soil, rotting wood, green leaves, small pebbles, shade, direct sunlight, or rubbish/leaf litter?
Was it alone or were there other organisms nearby?	Alone, moving with others of its kind, or near other small organisms?
What was it doing when you first saw it?	Sitting still, running across a surface, carrying a small object, crawling slowly, or moving into a darker place?



B) What does it look like: First, observe the organism carefully with your naked eyes. Then, use a hand magnifier if this helps you see details more clearly. You will not be able to see every detail, and that is okay. Look for the features you can see clearly and record what you observe. Do not fill in a feature simply because you expect it to be there. If you cannot see something clearly, write “could not see” rather than guessing. Here are some features to look at:

Feature	What to look for and record
Size	How long or wide is it? Compare it to an everyday object (e.g., as tiny as a rice grain, the size of a coin, or as long as your thumbnail).
Body shape	What shape best describes its body from above and from the side? (e.g., flat like a pancake, round like a seed, long like a stick, or teardrop-shaped?)
Colour and patterns	What colours do you see? Are there stripes, spots, patches, or a metallic shine? Is the underside a different colour than the top?
Number of legs	Look closely and count the legs you can see. How many are there (0, 6, 8, 10, or more than 10)?



Feature	What to look for and record
Arrangement of legs	Where do the legs 'sprout' from? Are they all attached to the middle part of the body, or do they spread along the whole length of the body in pairs?
Mouthparts	Look closely near the head. Can you see tiny pincers/jaws moving, a long needle-like straw, or small feelers near the mouth?
Antennae	Does it have feelers on its head? How many can you see (0, 2, or 4)? Are they long and thin like threads, short and stubby, or feathery like tiny leaves?
Eyes	Can you spot its eyes? Are they two large dark domes, tiny shiny dots, or are they too small to see at all?
Wings	Can you see wings? How many (0, 2, or 4)? Are they thin and clear like glass, or protected under a pair of hard outer shells? Are they visible when the organism is at rest?
Body regions	How many main sections does its body appear to have? Does it look like one continuous body, two connected parts, or three parts?
Body covering	What does its outer covering look and feel like? Is it hard and glossy, dull and bumpy, covered in tiny hairs, or divided into armour-like rings?
Others	What else catches your eye? How does it react if a shadow falls over it? What does it do (e.g. does it curl into a ball, become still, or move away)?



- C) Make a detailed drawing:** Now that you have watched the organism closely, draw what you observed. Use your magnifying glass to inspect tiny details before you draw. First, look at the organism as a whole. Notice the shape of its body and how its main parts are arranged. Then draw the body and add the parts you can see clearly, such as its legs, antennae, eyes, wings, and body sections. As you draw, keep looking at the organism and check your drawing against what you can actually see. It is okay if you cannot see every detail.



Draw accurately: Draw the shape as it actually appears, rather than what you think a "bug" looks like.



Include key parts: Make sure to draw the number of legs, antennae, eyes, and body sections you observed.



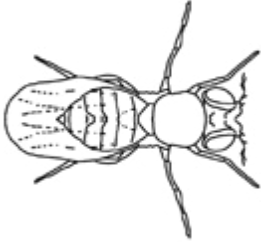
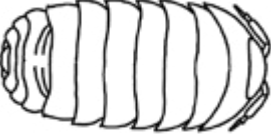
Label your diagram: Draw arrows pointing to specific features and write a short label or note next to each arrow (e.g., "6 legs attached to middle section", "long thin feelers", "hard shiny shell").

- D) How does it move?** Spend at least a few minutes watching the organism move. You may not notice all of the details below, and that is okay. Look for the things you can see clearly and record what you observe. Do not touch, prod, blow on, shine a light on, or otherwise disturb the organism to make it move. Watch what it does naturally. Here are some details you could look for:

Detail	Example
Where does it move?	Across flat ground, up a vertical wall, under loose soil, along a plant stem?
How does it move?	Does it walk, crawl, scurry, jump, wiggle, or fly?
How fast does it move?	Does it move rapidly in bursts, move slowly and steadily, or stop often?
How does it react to its surroundings?	What does it do if a shadow falls near it or something comes close? Does it freeze, hide, change direction, or move faster?
Can you trace its path?	In your notebook, sketch a simple line or map using arrows to show the path it took while you watched it.



E) Classify into groups: Scientists classify living organisms by grouping those that share important features. Use the observations you recorded to work out which group your “bug” belongs to.

	Legs	Antennae	Body
Insects (e.g., ants, flies, and beetles).	6	2	3 main body parts 
Arachnids (e.g., spiders and scorpions)	8	0	2 main body sections 
Crustaceans (e.g., pill “bugs”, land crabs)	Usually 10+	2 pairs	Hard outer covering 



	Legs	Antennae	Body
Myriapods (e.g., centipedes, millipedes)	Many	1 pair	Long segmented body 

F) Classify within a group: Now that you have placed your organism into a main group (Insects, Arachnids, Crustaceans, or Myriapods), compare it with another organism from the same group. Even organisms that look similar at first can show important differences when you look at them more closely. The questions below give some examples of what you could compare.

Group	Questions
Insects	- Do they all have the same body shape? - Do they all have wings, or are some wingless? - If they have wings, are they visible when the insect is at rest? - Do their antennae look the same, or are they different in shape?
Arachnids	- Do they all have the same features? - If you observed more than one kind, what features are different?



What features could you use to divide your main group into smaller groups? Record your idea: *We could divide our group into two smaller groups based on whether they have _____ or _____.*

Think about:



- You could not see the antennae of your organism clearly. What should you record? Why is it important to record "could not see" rather than guess?
- You find two "bugs" living under the same rock. Does living in the same place mean they belong to the same group? What physical features could you compare to find out?
- You count 6 legs on your "bug". Is this one feature enough to classify it as an insect? What other features could you check to support your classification?
- Your organism stays completely still or rolls into a ball while you watch. How could you classify it if you cannot use its movement as a clue? What other features could you look at?
- When you look through a magnifying lens, what feature do you notice that you could not see with your bare eyes? What does this feature tell you about your organism?

Discuss:



- Q1.** Did another pair observe the same kind of “bug” as you did, like a different ant, or another “bug” from the same group, like a different insect? After hearing what they observed, is there anything you would add, change, or correct in your first drawing or description? Would it make you change your original classification? Why?
- Q2.** Think of the “bug” you observed today. Did looking closely through your magnifying lens reveal any physical features or behaviours that you missed at first glance? What did you notice only after watching it for a longer time? Now imagine two “bugs” that look almost identical from a distance. Based on what you observed today, which features would you compare to find out whether they belong to the same group? Why?
- Q3.** Imagine that three students sorted the exact same collection of “bugs” in different ways:
- Student A grouped them by how fast they move.
 - Student B grouped them by the number of legs they counted.
 - Student C grouped them by body size.
- Which of these features would you find most reliable for classification, and why?
- Q4.** Imagine that one “bug” has visible wings and another does not. Does this difference alone mean that they belong to different groups? Why or why not? (*Hint: Think about worker ants and winged ants, or beetles with wings covered by hard wing covers.*)
- Q5.** Suppose you find a “bug” with only 5 visible legs or 1 visible antenna. You think it is an insect. Are there any observations from today that would support this classification?
- Q6.** How might any of the physical features you looked at today—such as long antennae, a hard outer covering, or specialised legs—be connected to the behaviour you observed? What might this tell you about how the organism finds food, shelter, or safety?
- Q7.** You spent time observing an organism that is often called a “bug” or “pest” and seen as something to avoid or get rid of. Now that you know more about it, how do you feel about this view? Has looking closely at it changed how you see it? If a friend were frightened of it, what could you show or tell them to help them become curious instead?
- Q8.** We followed the “*Observe without harming*” rule today. Why is it important not to disturb an organism or the place where we find it? What might happen if we did?



WHAT'S INSIDE?

Every issue has content to support your professional journey as an EVS or science schoolteacher. The content in this issue has been reorganized into new sections. Each section focuses on the rigour and reasoning behind a different aspect of your teaching practice.

Articles (Support for Professional Learning from Practice):

- **Experiences (Textbook Ideas in Real Classrooms):** What do you do when students finish an activity, but remain unsure what it means? How do you respond when their explanations differ from the textbook? Here are stories that stay close to how teaching choices unfolded in class and made students' ideas visible. Read how teachers paused, asked questions, looked closely at how students responded, and redesigned instruction. See how students' understanding shifted when asked to predict outcomes, check claims, compare results, and explain their reasoning. Also, do share experiences from your own classroom—the 'messiness' of learning matters more than the 'perfection' of your results.
- **Perspectives (Realities Shaping Learning Spaces):** How do curricular policies and assessment designs shape science learning in the classroom? How do community beliefs or school realities influence science teaching? Here are articles that focus on the broader principles that shape classroom instruction and what students learn to value in science. Read how teachers interpret curriculum in practice, design assessments that build scientific skills, and promote inquiry with simple materials. See how science classrooms engage with social realities such as health, nutrition, and community dialogue. Also, do share how policy or community realities shape your practice—thoughtful reflection matters more than definitive solutions.
- **Explorations (Retracing Ideas in the Classroom):** How did scientists arrive at the textbook ideas students are asked to accept? What do students learn when they test a claim rather than simply read about it? Here, the evidence and reasoning behind textbook ideas are examined and opened to exploration through real-world questions. Read pieces on how scientific understanding evolved and how it can be investigated in classrooms today. See how the process of science connects what scientists do with how students can learn to think like scientists. Also, do share your explorations of ideas from the EVS and science curriculum—the tentativeness of your approach is more important than the completeness of your conclusions.
- **Extensions (Learning Materials Beyond the Textbook):** How does a teaching-learning material (TLM) extend a curricular idea beyond the textbook? How might you adapt it for diverse learners and contexts? Here are introductions to materials that make textbook knowledge more tangible and reshape it to reflect students' experiences and social realities.

Read how they connect science to students' worlds and widen who feels represented within it. See how their diverse formats support learners with varied language backgrounds and attention spans. Also, do share material you have worked with (whether a children's story, YouTube video, low-cost science kit, podcast, community science project, or online app)—the emphasis is on reflection, not promotion.

- **Readers' Voices (Refining and reshaping i wonder... in diverse contexts):** What understanding of textbook concepts emerged from using an i wonder... piece? We examine how teachers carry these ideas into classrooms and workshops, adapting them to match their time constraints, language requirements, accessibility to materials, and institutional routines. Also, do add your voice by sharing how you used an i wonder... piece with students or teachers—the emphasis is on conceptual insights, shifts in interactions, and contextual realities; not on endorsements or formal research.

Resources (Support for Practical, Inexpensive Classroom Inquiry):

- **Classroom (For Students to Observe, Question, and Explain):** How can our everyday surroundings become sites for scientific investigation? What do students understand differently when they test, measure, or build themselves? Here are student-facing resources for direct use in EVS and science classrooms. See how simple and inexpensive materials are used to explore familiar contexts—the natural world or built structures. Read how students are invited to observe, question and document patterns, gather and compare evidence, or explain their reasoning. Also, do share an activity sheet, field guide, or poster that helped your students investigate everyday phenomena—conceptual clarity and thoughtful design matter more than specialised equipment.
- **Staffroom (For Teachers to Plan, Reflect, and Refine):** What pedagogical decisions can help ensure that an activity builds students' conceptual understanding? How do we approach socially-contested scientific questions in the classroom

with care and rigour? Here are teacher-facing resources for planning and reflection across EVS and science themes. See how they model careful questioning, unpack key concepts, anticipate common misconceptions, and suggest ways to structure inquiry. Read how they support thoughtful teaching in everyday contexts with limited resources and diverse learners. Also, do share a resource to help other teachers strengthen conceptual clarity or navigate sensitive classroom dialogue—pedagogical reasoning and classroom insight matter more than formal research.

Join the conversation!

Share your questions with authors in our free, live, online discussions. Could not make it to the live session? Catch up here:

- How do children know the Earth is not flat? Exploring mental models and evidence with Anand Narayanan and Amol Anandrao Kate. Watch here: <https://www.youtube.com/watch?v=gMKyAZuu4tY>.
- Why Science Matters: A deep dive into the purpose of science education with Anil Kumar Challa, Reeteka Sud, and Vinay Suram. Watch here: <https://www.youtube.com/watch?v=KeJlBY1lqpM>.
- Plants and Pollinators: Let's Explore! Investigating local ecology with Meenakshi and Radha Gopalan. Watch here: <https://www.youtube.com/watch?v=cqYu1zwmLX0&t=9s>.
- Exploring Motion through a Balloon's Flight: Simple physics in action with Anish Mokashi and Vinay Suram. Watch here: <https://www.youtube.com/watch?v=NgIRXGDpnfw>.

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WRITE FOR US

[i wonder...](#) is an Azim Premji University publication for preparatory-stage (Grades III–V) Environmental Studies (EVS) and middle-stage (Grades VI–VIII) science teachers. Our aim is to share articles and resources that support classroom instruction, specifically within the context of government schools.

What we look for: We welcome contributions from practicing teachers, teacher educators, and researchers that emerge from classroom practice and offer students direct experiences in observing, reasoning with evidence, and testing textbook claims.

We publish work that:

- 1) Is guided by grade-appropriate textbooks: Focuses on themes, topics, or questions in the latest NCERT EVS and science textbooks (freely available at: <https://ncert.nic.in/textbook.php>), reflecting their specific scope, complexity, and level of abstraction.
- 2) Aligns with the national curriculum: Supports teachers in meeting the curricular goals and competencies defined in the NCF-SE 2023 (freely available at: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf).
- 3) Is rooted in practice: Has been tried, reflected on, or refined through actual classroom or workshop experience.
- 4) Is adaptable: Shows how ideas can be contextualised in different classroom conditions, time constraints, and learning levels.
- 5) Prioritizes accessibility: Uses materials that are inexpensive and locally available, ensuring that activities and approaches are inclusive and easy to implement in all classroom settings.
- 6) Respects teacher agency: Invites teachers to think, decide, and respond to students rather than follow fixed steps mechanically.

What is not a good fit? To ensure your submission meets our needs, please avoid:

- 1) Abstract discussion: General opinions or policy commentary without grounding in classroom practice.
- 2) Rote learning: A focus on memorizing facts and definitions rather than conceptual understanding.
- 3) Prescriptive manuals: Step-by-step instructions that leave no room for teacher or student inquiry.
- 4) Expensive requirements: Experiments that depend on formal laboratory spaces or costly instruments.

How to submit: You may submit a brief pitch (approx. 200 words) or a complete draft (800–1500 words). Your submission should have:

- Simple language: Use clear, non-academic prose. Tell us why these ideas matter to you.
- Links to the textbook and curriculum: Explicitly state how your work supports NCERT content and aligns with NCF-SE 2023 goals.
- A brief bio: A short paragraph (< 50 words) about your background in science education and your areas of interest.
- Images: Of a resolution (> 300 dpi) with captions and credits. Note: Please avoid front-facing images of children where possible. Written permission from guardians is required to publish images of students.

Publication terms:

- Originality: We have zero tolerance for plagiarism. Submissions must be your original work. If previously published, include a permission letter from the original publisher.
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Submit your pitches and drafts to: iwonder@apu.edu.in We welcome submissions in English, Hindi, or Kannada throughout the year.

If you have a purpose, we have the programme.



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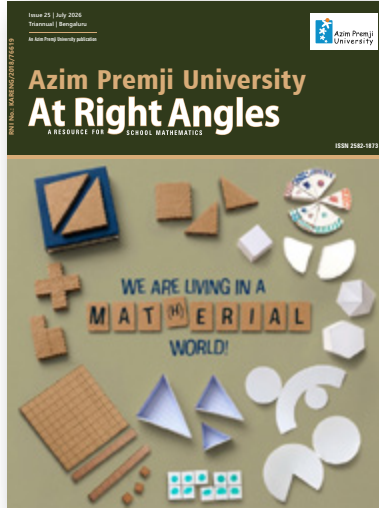
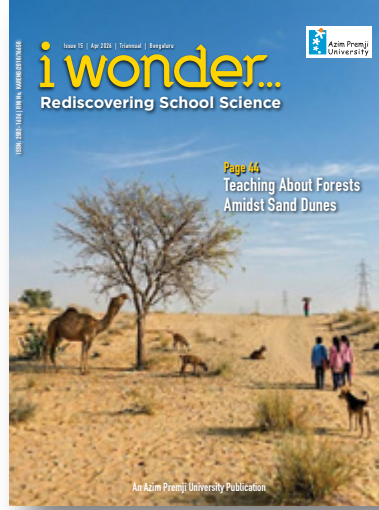
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better than you found it.
If you seek mentors who inspire,
not just instruct.
If you're restless for opportunities
that match your ambition.
If you're driven by a higher purpose,
then this is your next step.
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