ISSN: 2582-1636 | RNI No. KARENG/2018/76650

Issue 12 | Apr 2025 | Triannual | Bengaluru

i wonder...

Rediscovering School Science

Azim Premji University

Page 4

Why Add Eggs to Midday Meals?

An Azim Premji University Publication

Publications Office: Azim Premji University, Survey No. 66, Burugunte Village, Bikkanahalli Main Road, Sarjapura, Bengaluru 562125.
Email: publications@apu.edu.in | Website: www.azimpremjiuniversity.edu.in

---

About Us: i wonder... is an Azim Premji University publication. Our main aim is to publish articles and resources (like activity sheets, teacher's guides, posters, and booklets) that support the classroom instruction of preparatory-stage (Grades III-V) Environmental Studies (EVS) and middle-stage (Grades VI-VIII) science teachers. We present critical perspectives and pedagogical approaches that are aligned with the broader curricular goals and competencies that the National Curriculum Framework for School Education (NCF-SE) 2023 recommends for children at these stages of schooling. Our target readership is of teachers from government schools and teacher educators from Azim Premji Foundation.

i wonder...
REDISCOVERING SCHOOL SCIENCE

About this issue:

Welcome to our Apr 2025 issue. The theme section of this issue is 'Science in Action'. If any of the articles and detachable classroom resources featured in this issue support your classroom practice, tell us how. Experiences that can be of help to other teachers will be featured in our next issue.

To:

- Download a soft copy of this issue, visit: https://azimpremjiuniversity.edu.in/iwonder.
- Share your feedback on this issue, visit: https://forms.gle/GmPtRA1eFD7fDm8ZA.
- See details on our submission guidelines, turn to the **Write for Us** section on page 82 of this issue.
- Share your questions or suggestions, write to us at: iwonder@apu.edu.in.

Image credits:

Front cover: A scene from a midday meal with eggs. Credits: Anil Kumar Jangir, Azim Premji School, Sirohi, Rajasthan. License: Published here with permission from the right owner and the parents of the children featured in the photo. Available only for restricted use, with permission, and only in relation to this issue of i wonder...
Back cover: Indian Long-billed Vulture in Flight, Desert National Park, Jaisalmer, Rajasthan. Credits: Chinmayisk, Wikimedia Commons. URL: https://commons.wikimedia.org/wiki/File:Indian_long_billed_vulture_bottom_view_in_flight.jpeg. License: CC BY-SA 3.0 Unported Deed.

Please note:

- All views and opinions expressed in this issue are that of the authors. Azim Premji University or Azim Premji Foundation bear no responsibility for the same.
- To cite our articles, please use the following format: Author name (Year of publication). Name of article. i wonder... (Issue number): Page numbers. ISSN 2582-1636. URL: Link from the university repository (http://publications.azimpremjifoundation.org/view/divisions/fiel18=2E1/).
-

Editorial

We make many decisions in our everyday life about the food we eat, our health, and how we use water and materials. These decisions are informed by what we have read, heard, and experienced, as well as our beliefs and feelings. These also shape how we relate to our immediate surroundings, each other, and other living beings. Children in the preparatory- and middle- stages (~6-14 years) read about many concepts related to these everyday experiences and relationships (food, health, disease, water, caring for all living beings) in their Environmental Studies (EVS) and science textbooks (NCERT, 2024-2025). However, without opportunities to connect what they learn in class to their everyday life, they may not see the relevance of this learning in their real worlds. Science may remain a subject they learn in school, distant and disconnected from their realities.

According to the National Curriculum Framework for School Education (NCF-SE) 2023, school science: *"should enable students to use available scientific evidence to make decisions and choices of their everyday lives, such as decisions to vaccinate oneself, make healthier eating choices, examine media claims critically, or contribute to an inclusive society by critically examining one's beliefs..."* This shapes one of the NCF-SE's aims for school science education, which is to build scientific temper in students: *"by developing the capacities for critical and evidence-based thinking and freedom from fear and prejudice."* It recognises this as being *"central to the learning of Science"* and in helping students *"imbibe scientific values and dispositions such as honesty, integrity, scepticism, objectivity, tenacity, perseverance, collaboration and cooperation, concern for life, and preservation of the environment."*

How do we teach science in a way that will help our students think clearly and critically so they can separate belief from fact? How do we equip them with the knowledge and skills to make informed choices about their health and well-being? Amol Kate and Rakesh Tewary share how a fact-based discussion on common beliefs around eggs can help students and their parents think more critically about the nutritional quality of their diets and connect textbook concepts with the health-related decisions they make. Aditya Prakash shares how offering students' hands-on science learning experiences to understand concepts, build scientific skills, and connect both to applications in everyday life can help students see the relevance of science in their real worlds. Satyajit Rath's article on what we know about the recent Guillain-Barre Syndrome (GBS) outbreaks offers teachers a real-world example they can use to help students see the relevance of what they learn about infectious diseases, sanitation, and access to clean drinking water. It can also be used to involve them in taking precautionary action.

What real-world experiences can help students appreciate that science is also about patience, perseverance, and caring deeply about the natural world? Lavanya Karthik's introduction to the childhood experiences of the Indian botanist Janaki Ammal can inspire students to deepen their relationship with the natural world. It can also show them the curiosity and courage they may need to let this relationship shape their life.

How have you helped your students see the relevance of science in their lives? How has it shaped the way they think about issues that affect their real world? How has it shaped your teaching practice? Share your ideas and experiences with us.

Radha Gopalan
Consulting Editor

CONTENTS

RESOURCE REVIEW

THE SCIENCE EDUCATOR AT WORK

WHY ADD EGGS TO MIDDAY MEALS?

AMOL ANANDRAO KATE & RAKESH TEWARY

We offered our students the option to add an egg to their midday meal. What are the benefits of this addition? What are some of the most common beliefs that parents and children may associate with eggs? Can we use the science of nutrition as a tool to analyze the validity of these beliefs?

In 2017, we offered each Grade I-VIII student in Azim Premji School (APS), Sirohi, Rajasthan, the option to include an egg in their midday meal. Most students in our school came from neighbouring villages. For some of them, the midday meal provided in school was the only nutritious meal they received in a day (see **Box 1**). The height and weight of many of our students (measured regularly as part of our health monitoring programme), particularly the girls, did not meet age-appropriate standards. They also showed other signs of undernutrition (like difficulty in focusing, fatigue, and frequent illness).

Are common beliefs about eggs scientifically valid?

Parents of 35-40% of the children in our school were concerned about eggs being served in their midday meals. Some of these concerns were based on the following beliefs:

A) Belief: Daily consumption of eggs is not required if children get sufficient food.

Facts: The belief that eating sufficient food (enough calories) ensures good nutrition is quite common. However, for a meal to be balanced, the nutritional quality of the food sources that provide these calories is more important than the number of calories. For this reason, the recommendation is that each midday meal provide 450 calories and 12 g of the daily protein requirement of Grade I-V students and 700 calories and 20 g of the protein requirement of Grade VI-VIII students (see **Box 2**).[12] Midday meals that are cereal- or millet-based, even when fortified, may meet these caloric requirements without satisfying the recommended protein requirements.[7] In contrast, including protein-rich food in these meals can help meet both requirements.

Box 1. The role of midday meals in school education:

Till the age of 14, children undergo rapid changes in the development of their bodies, organs, bones, brain, and cognitive processes.[1] Good nutrition is essential in supporting these changes. But the National Family Health Survey (NFHS)-5 in 2019-2021 found that 35.5% of children under five are stunted (shorter than the height appropriate for their age), 32.1% are underweight (lower than the weight appropriate for their age), and 19.3% are wasted (lower than the weight appropriate for their height).[2, 3] This suggests that many children are undernourished before they join school. The Comprehensive National Nutrition Survey (CNNS) in 2016-2018 found that 22% of 38,355 school-age (5–9-year-old) children were stunted, 35% were underweight, 21.5% had vitamin A deficiency, and 18.2% had vitamin D deficiency.[4, 5] A Food and Agriculture Organization (FAO) report on food security and nutrition in Asia and the Pacific suggests that 70.5% of Indians were unable to afford a healthy diet in 2020.[5, 6] The prevalence of undernutrition and its effects is higher in children from rural areas, poor families, and marginalized communities. These may have worsened due to the pandemic and lockdowns.[7]

The role of nutrition in education is reflected in the National Educational Policy (NEP) 2020: "*Children are unable to learn optimally when they are undernourished or unwell. Hence, the nutrition and health (including mental health) of children will be addressed through healthy meals*".[8] The midday meal scheme (MDMS), now called the Pradhan Mantri Poshan Shakti Nirman Scheme (PM-POSHAN scheme), aims to supplement the diets of children from Grades I-VIII in government-run and government-aided schools of our country with one hot balanced meal a day.[9] As described in Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025): *"This scheme has played a role in improving the health and nutrition of millions of children nationwide"*.[10] It has also played an important role in boosting enrollment, retention, and attendance of children in these schools.[11]

In Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025), students learn that we can get proteins (body-building nutrients) from both plants and animals (see **Fig. 1**). Plant-based foods rich in proteins include pulses, peas, beans, soya, and nuts. Animal-based foods rich in proteins include milk, paneer, eggs, meat, and fish.[10]

The midday meals in Rajasthan include pulses and milk to meet the recommended protein requirements. We chose to also offer eggs as an option because they are nutrient-dense sources of proteins with high biological value. Eating just one average-sized egg (44-56 g) per day can provide a child with 6-7 g of protein that: (a) Can be readily digested by the child's body, (b) Releases each of the nine essential amino acids (these amino acids cannot be produced by humans, but are necessary for us) when digested, and (c) Allows a child's body to readily absorb and use these amino acids. This is not all. Each egg has almost all vitamins (except vitamin C) and many important minerals (like calcium, zinc, selenium, iron, iodine, and phosphorous). It also contains antioxidants (like lutein and zeaxanthin that support eye health) and is one of the richest sources of choline (essential in supporting cognitive functions). Like its proteins, many of the other nutrients in an egg are present in highly bioavailable forms. This means that they can be readily absorbed by a child's body.[14, 15] Also, eggs are tasty, widely available, relatively affordable, and have a longer shelf life than milk and bananas. They are easy to prepare (can be served boiled), and may be less prone to adulteration (like watering down) than pulses and milk (see **Teacher's Guide I**).

Box 2. A balanced diet for children:

A balanced diet is crucial to support the growth, development, and overall health of children. It plays a vital role in supporting their immune system and preventing health issues later in life. Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025) defines a balanced diet as one that has: "*...all essential nutrients, roughage, and water in the right amount for proper growth and development of the body*".[10] Indian Council of Medical Research-National Institute of Nutrition (ICMR-NIN) highlights the need to plan a child's diet to ensure that:

- The amounts of nutrients, roughage, and water match nutritional requirements specific to the child's age, gender, physiological status, and physical activity.
- The nutrients and roughage come from diverse food sources that are locally available and accessible.
- It also provides children with the antioxidants necessary for good health.[13]

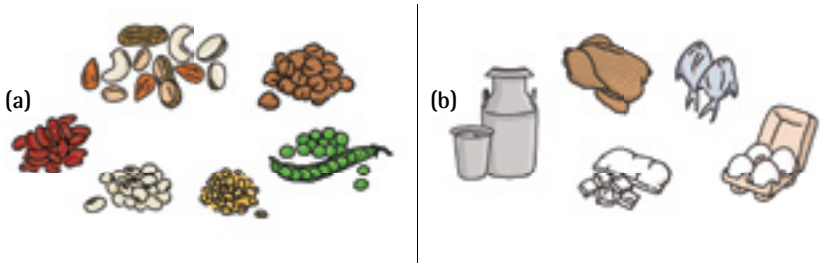


Fig. 1. Adapted from an illustration from Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025). This illustration shows some common sources of protein. **(a)** Plant-based sources include nuts, chickpeas, green peas, moong dal, soya, and kidney beans. **(b)** Animal-based sources include meat, fish, eggs, paneer, and milk.

B) Belief: A single egg is enough to meet the daily protein requirements of a child.

Facts: Proteins are vital in the physical and mental development of growing children. ICMR-NIN recommends a daily allowance of 23 g of protein for a 7–9-year-old child and 33 g of protein for a 10–12-year-old.[13] While eggs are an excellent source of protein, one boiled egg is not sufficient to meet a child's daily protein allowance. In contrast, a diet that includes eggs and other sources of protein (like dairy, legumes, or soya chunks) is more likely to help a child get their daily allowance of protein, while also providing other essential nutrients.

C) Belief: Since eggs can hatch into chicks, they are non-vegetarian.

Facts: Vegetarian diets are of different kinds. They may exclude all animal products (vegan). Or they may include milk and milk products (lacto-vegetarian), eggs (ovo-vegetarian), or fish (pescatarians). A common belief is that eggs are non-vegetarian food because they can hatch into chicks. This is not accurate. Most eggs that are sold commercially for our consumption are unfertilized (see **Teacher's Guide II**).

D) Belief: Eating eggs can cause stomach pain due to digestive issues like bloating or build-up of gas.

Facts: Eggs are considered a good source of digestible protein.[1, 16] But some children (about 2%), especially under the age of five, may be allergic to egg proteins, while some other children may be intolerant to them. It is important that parents of children experiencing any adverse effects after consuming a meal with eggs consult with a medical doctor to confirm the cause.[17, 18]

For children who are allergic or intolerant to egg proteins, alternative sources of dietary protein recommended in the PM-POSHAN scheme include milk, groundnut-jaggery (*chikki*), and bananas. For children who do not have such allergies or food intolerances, eggs are an affordable and accessible source of essential nutrients that may not always be found in other alternatives (see **Table I**).

E) Belief: Boiled eggs are unhealthy because they increase blood cholesterol levels. This could lead to heart disease or other health issues later in life.

Facts: Eggs are naturally high in cholesterol (all in their yolks). But research shows that they do not raise blood cholesterol levels as much as food items that are rich in saturated and trans fats (such as palm oil, *vanaspati*, butter, ice cream, fried food, cakes, and pastries) do.[19-21]

Some studies suggest that the more eggs you eat per week, the higher your risk of cardiovascular disease. But this could be related to how eggs are cooked (for example, fried in saturated fats such as butter or oil) and what they are eaten with (for example, parathas cooked in oil or bread and butter).[21] Eggs in midday meals are boiled and not accompanied by foods rich in saturated fats.

Health experts suggest reducing dietary cholesterol levels to 300 mg per day. If the rest of a child's diet is not rich in cholesterol, they can eat an egg (a 50 g egg has 186 mg of cholesterol) a day.[21] At APS Sirohi, each child receives one egg a day, six days a week. In many states, each child receives 2-3 eggs per week under the PM-POSHAN scheme.[12]

F) Belief: Eating eggs during the hot summer months can cause discomfort, dehydration, or other heat-related issues.

Facts: Studies suggest that eggs can be consumed in moderation year-round by children. They may also provide the nutrients needed to maintain energy levels during hot weather.

Many studies suggest that the risk of food-borne illnesses can increase during hot months. So extra care may need to be taken to ensure that eggs are stored, handled, and cooked hygienically enough to avoid causing such illnesses.

It may also help to ensure that children have access to enough clean drinking water and that their meals include more locally available water-rich vegetables (like cucumber, bottle gourd, ash gourd, and ridge gourd). These steps can

Nutrients	(a) Boiled Egg	(b) Banana	(c) Milk	(d) Peanuts
	per 100 g			
Carbohydrate (g)	1.12	**22.8**	4.63	21.3
Protein (g)	12.6	1.09	3.27	**24.4**
Fat (g)				
Saturated fat	3.27	0.112	1.86	**7.72**
Cholesterol	**0.372**	0	0.012	0
Trans fat	0	0	**0.112**	0.027
Omega-3s	**0.043**	0.027	0.008	0.026
Vitamins other than B (mcg)				
A	**149**	3	32	0
D	**2.2**	0	0.96	0
E	1030	100	50	**4930**
K	0.3	0.5	**5.1**	0
C	0	**8700**	0	0
Vitamin B (mg)				
B1	0.066	0.031	0.056	**0.152**
B2	**0.513**	0.073	0.138	0.197
B3	0.064	0.665	0.105	**14.4**
B6	0.121	0.367	0.061	**0.466**
B9	0.044	0.02	0	**0.097**
B12	**0.0011**	0	0.00054	0
Minerals (mg)				
Calcium	50	5	**123**	58
Iron	1.19	0.26	0	**1.58**
Potassium	126	358	150	**634**
Choline	**294**	9.8	17.8	64.6
Zinc	1.05	0.15	0.42	**2.77**
Phosphorous	172	22	101	**363**
Phytochemicals (mg)				
Beta-carotene	0.011	**0.026**	0.007	0
Lutein + Zeaxanthin	**0.353**	0.022	0.006	0
Calories (kcal)	155	89	60	**587**

Table 1. Comparison of the nutritional value of 100 g of boiled eggs, bananas, milk, and peanuts. Milk and eggs contain all nine essential amino acids, bananas contain seven, and peanuts contain eight.

Credits: The information in this table is compiled from the following data sources: (a) US Department of Agriculture (2019). FoodData Central. Eggs, whole, cooked, hard-boiled. URL: https://fdc.nal.usda.gov/food-details/173424/nutrients. (b) US Department of Agriculture (2019). FoodData Central. Bananas Raw. URL: https://fdc.nal.usda.gov/food-details/173944/nutrients. (c) US Department of Agriculture (2019). FoodData Central. Whole milk, 3.25% fat with added vitamin D. URL: https://fdc.nal.usda.gov/food-details/746782/nutrients. (d) US Department of Agriculture (2019). FoodData Central. Peanuts, dry roasted without salt URL: https://fdc.nal.usda.gov/food-details/173806/nutrients.

help children stay hydrated during hot summers and cope with some of the negative effects of heat stress.

G) Belief: Eating eggs may alter the onset of puberty.

Facts: We found no evidence to support this belief. There is evidence that a balanced diet is necessary at all stages of a child's growth. But, as emphasized in Chapter 7 ('Reaching the Age of Adolescence') of the Grade VIII science textbook (NCERT, 2024-2025), it is particularly important in supporting the growth spurt that adolescents experience during puberty and the menstrual cycle.[22] Eggs are considered protective foods because they protect against deficiencies and support overall health. Including them in the diet of adolescents, especially girls, can help meet part of the daily allowance of protein, iron, and vitamin D that they need for healthy growth and bone development during puberty (see **Teacher's Guide III**). [23]

Parting thoughts

Decisions related to the food choices of Grade I-VIII children are made mostly by their parents. Many beliefs that children and parents, especially in rural areas, hold towards food may be influenced by the larger community they are part of. Based on our experience of including eggs in the midday meals of our students, open and continuing discussions with children and parents can play an important role in addressing food-related beliefs. We used such discussions to: (a) Draw out and record concerns that parents and children had about eggs, and (b) Communicate scientifically valid facts on eggs and their effects on human health.

Box 3. Curricular connections:

Students are introduced to the midday meal scheme in Chapter 20 ('Eating Together') of the Grade IV Environmental Studies (EVS) textbook (NCERT, 2024-2025).[24] They learn more about it in Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025).[10] Both chapters encourage children to think more critically about the nutritional quality of the food they eat. Preparatory-stage EVS and middle-stage science teachers can use these chapters to involve students in discussions around the inclusion of eggs in midday meals.

These discussions can help students develop what Article 51A (h) of the Constitution of India lists as the fundamental duty of every citizen: *"...to develop the scientific temper, humanism, and the spirit of inquiry and reform"*.[25] This duty shapes an aim of school science, as outlined in the National Curriculum Framework for School Education (NCF-SE) 2023: *"...to build scientific temper by developing the capacities for critical and evidence-based thinking and freedom from fear and prejudice"*. The NCF-SE 2023 recognises this aim as being: *"...central to the learning of Science"*.[26]

These discussions can also help meet the following:

- Curricular goal (CG-4) for middle-stage science: [The student] understands the components of health, hygiene, and well-being. Specifically, it can help students develop the competency to: (a) C-4.1: "*Undertake a nutrition-based analysis of food components with special reference to Indian culinary practices and a modern understanding of nutrition, and explain the effect of nutrition on health*", (b) C-4.2: *"Examine different dimensions of the diversity of food—sources, nutrients, climatic conditions, and diets"*, and (c) C-4.3: "*Describe biological changes (growth, hormonal) during adolescence, and measures to ensure overall well-being*".[26]
- Learning outcomes for: (a) Grade VI science: Students apply their learning of scientific concepts to: *"...select food items for a balanced diet"* and (b) Grade VIII science: Students apply their learning of scientific concepts to: *"...challenge myths and taboos regarding adolescence"*.[27]

This process has helped our students connect concepts on nutrition from their science textbooks with food-related decisions they make in school (like the options they choose for their midday meals) and outside it (see **Box 3**). It has helped improve their nutrition and foster a more open-minded approach toward dietary diversity in our school.

Eggs are offered as an option in the midday meals of students in all nine Azim Premji Schools (APS) in the country (in Karnataka, Chhattisgarh, Rajasthan, and Uttarakhand). Some of the beliefs parents of our students in APS Sirohi had about eggs may be common to parents of children from these and other schools. We have shared our experience in the hope that it will help teachers and parents from across the country use the science of nutrition to make healthier food choices for children.

Key takeaways

- Children in the age range of 6-14 years show rapid growth and changes in the development of their bones, brain, and cognitive processes. A balanced diet is crucial to support these changes.
- Eggs are nutrient-dense sources of protein, present in a form that can be readily digested and absorbed by a child's body. They are also widely available, relatively affordable, and easy to prepare.
- Offering Grade I-VIII students the option to include an egg in their midday meals can help support their nutrition and growth in important ways. But in some geographical and cultural contexts, this addition can challenge parental beliefs and community norms about food.
- Facilitating fact-based discussions on common beliefs around eggs can help parents make more informed decisions about the inclusion of eggs in their children's meals.
- Involving students in fact-based discussions on common beliefs around eggs can help them think more critically about the nutritional quality of the food they consume. It can also help them appreciate the real-world relevance of what they learn about health, nutrition, and development from the middle-stage science curriculum.

Notes:

(a) Credits for the image (Boiled Eggs) used in the background of the article title: Ritesh Man Tamrakar. URL: https://www.flickr.com/photos/_rmt_/4062190929. License: CC BY 2.0 Generic Deed.

(b) Where relevant, information shared with parents has been updated in this article with additional details from more recent studies of the effect of egg consumption on children's health.

(c) As shared in the article, some children may suffer from an allergy or intolerance to egg proteins. Symptoms of an egg allergy tend to appear within a few minutes of eating an egg. A mild reaction may cause abdominal pain, diarrhea, nausea, vomiting, rashes, itching, or swelling of the lips, tongue, or throat. A severe reaction may cause anaphylaxis, dizziness, difficulty in breathing and/or swallowing, tightness in the chest and/or throat, confusion, or shortness of breath. Without immediate medical treatment, an anaphylactic reaction can be fatal. On the other hand, symptoms of an egg intolerance develop over 48 hours and can include stomach pain, cramps, diarrhea, nausea, or vomiting. If you plan to add eggs to the midday meals at your school, it may be useful to ask parents if their children have shown symptoms of an allergy or intolerance in the past. If any of the children in your school are eating eggs for the first time, it may be necessary to be prepared for this possibility. It may also be useful to keep in mind that about 50% of children with egg allergies are likely to develop a tolerance for egg proteins by the age of five and up to 70% of them are likely to outgrow this reaction by the age of 16.

(d) This article includes three detachable classroom resources: **Teacher's Guide I: What Do We Do With Eggshells?, Teacher's Guide II: Can all Chicken Eggs Hatch into Chicks?,** and **Teacher's Guide III: Can Eating Eggs Alter the Onset of Puberty?**

References:

1. Saavedra JM & Prentice AM (2023). 'Nutrition in school-age children: a rationale for revisiting priorities'. Nutrition Reviews, 81(7): 823-843. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC10251301/.
2. Vaishnav, Anurag & Ram, Anya Bharat (2020). 'Vital Stats: National Family Health Survey 5'. PRS Legislative Research. URL: https://prsindia.org/files/policy/policy_vital_state/NFHS-5_VitalStats.pdf.
3. Ministry of Women and Child Development (2023). 'Steady improvement in indicators for malnutrition'. Press Information Bureau (PIB). URL: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1988614.
4. Ministry of Health and Family Welfare (MoHFW), Government of India, UNICEF and Population Council (2019). 'Comprehensive National Nutrition Survey (CNNS) National Report'. National Health Mission. URL: https://nhm.gov.in/WriteReadData/l892s/1405796031571201348.pdf.
5. Raman, Shreya (2024). 'Parents & Students Want Eggs In Schools, But As Influence Of Right-Wing Politics Grows, Child Nutrition Suffers'. Article 14. URL: https://article-14.com/post/parents-students-want-eggs-in-schools-but-as-influence-of-right-wing-politics-grows-child-nutrition-suffers-65d560048fc80. Accessed on Jan 27, 2025.

6. FAO, UNICEF, WFP and WHO (2023). 'Asia and the Pacific—Regional Overview of Food Security and Nutrition 2022'. Urban food security and nutrition. URL: https://doi.org/10.4060/cc3990en.
7. Paikra, Gangaram et. al., Right to Food Campaign (2021). 'Egg in mid-day meals-Resistance is against child rights'. Countercurrents.org. URL: https://countercurrents.org/2021/12/egg-in-mid-day-meals-resistance-is-against-child-rights/. Accessed on Jan 27, 2025.
8. Ministry of Human Resource and Development, Government of India (2020). 'National Education Policy 2020'. Ministry of Education. URL: https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf .
9. Pradhan Mantri Poshan Shakti Nirman. Ministry of Education, Government of India. 'Frequently Asked Questions on Mid Day Meal Scheme. Jharkhand State Food Commission'. URL: https://jharkhandsfc.in/docs/faq/faq_mdm.pdf.
10. National Council of Educational Research and Training (2024). 'Chapter 3: Mindful Eating: A Path to a Healthy Body'. Science Textbook for Grade VI: 35-59. URL: https://ncert.nic.in/textbook.php?fecu1=3-12.
11. Child Rights and You (CRY), India (2024). 'Importance of Mid-Day Meal Schemes in Schools in India'. URL: https://www.cry.org/blog/importance-of-mid-day-meal-schemes-in-schools-in-india/. Accessed on Jan 27, 2025.
12. Sanjay (2023). '14 states provide eggs as part of mid-day meal scheme: Education ministry'. News Careers 360. URL: https://news.careers360.com/pm-poshan-scheme-mid-day-meal-egg-nutrition-budget-allocation. Accessed on Jan 27, 2025.
13. Indian Council for Medical Research—National Institute of Nutrition (2024). 'Dietary Guidelines for Indians'. Pg. 57-59. URL: https://www.nin.res.in/dietaryguidelines/pdfjs/locale/DGI07052024P.pdf. Accessed on December 10, 2024.
14. CARE Medical Team (2024). 'How Much Protein in an Egg?' CARE Hospitals Blog. URL: https://www.carehospitals.com/blog-detail/protein-in-egg/. Accessed on Jan 27, 2025.
15. Réhault-Godbert S, Guyot N, & Nys Y (2019). 'The Golden Egg: Nutritional Value, Bioactivities, and Emerging Benefits for Human Health'. Nutrients 11(3): 684. doi: 10.3390/nu11030684. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC6470839/.
16. Calvez J, Azzout-Marniche D, & Tomé D (2024). 'Protein quality, nutrition, and health'. Front Nutr. 11: 1406618. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC11165183/#sec1. Accessed on December 14, 2024.
17. Cleveland Clinic (2023). 'Egg Allergy'. Cleveland Clinic Health Library. URL: https://my.clevelandclinic.org/health/diseases/25086-egg-allergy. Accessed on Jan 27, 2025.
18. American College of Allergy, Asthma & Immunology. 'Egg'. URL: https://acaai.org/allergies/allergic-conditions/food/egg/. Accessed on Jan 10, 2025.
19. Harvard T. H. Chan School of Public Health (2020). 'Eggs. The Nutrition Source'. URL: https://nutritionsource.hsph.harvard.edu/food-features/eggs/. Accessed on Jan 10, 2025.
20. US Department of Agriculture (2019). 'Eggs, whole, cooked, hard-boiled'. FoodData Central. URL: https://fdc.nal.usda.gov/food-details/173424/nutrients. Accessed on Jan 10, 2025.
21. Lopez-Jiminez, F (2024). 'Eggs: Are they good or bad for my cholesterol?' Mayo Clinic. URL: https://www.mayoclinic.org/diseases-conditions/high-blood-cholesterol/expert-answers/cholesterol/faq-20058468. Accessed on Jan 27, 2025.
22. National Council of Educational Research and Training (2023-2024). 'Chapter 7: Reaching the Age of Adolescence'. Science Textbook for Grade VIII: 79-92. URL: https://ncert.nic.in/textbook.php?hesc1=7-13.
23. National Institute of Nutrition (2011). 'Dietary Guidelines for Indians—A Manual'. Pg. 47–48. URL: https://www.nin.res.in/downloads/DietaryGuidelinesforNINwebsite.pdf. Accessed on Jan 10, 2025.
24. National Council of Educational Research and Training (2023-2024). 'Chapter 20: Eating Together'. EVS Textbook for Grade IV: 166-173. URL: https://ncert.nic.in/textbook.php?deap1=20-27.
25. Government of India. 'The Constitution 42nd (Amendment) Act, 1976. Part IV A. Fundamental Duties, 51A (h)'. india.gov.in. URL: https://www.india.gov.in/my-government/constitution-india/amendments/constitution-india-forty-second-amendment-act-1976
26. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
27. National Council of Educational Research and Training (2017). 'Learning Outcomes at the Elementary Stage'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/publication/otherpublications/tilops101.pdf.

Amol Anandrao Kate works with Azim Premji Foundation as a teacher educator and science resource person at Sirohi, Rajasthan. He can be contacted at: amol.kate@azimpremjifoundation.org.

Rakesh Tewary has been with Azim Premji Foundation since May 2009. As a science resource person, he brings grassroots experience, including hands-on work with government school science teachers. Currently, he leads the Foundation's efforts in education, health, and livelihoods in Jharkhand. He can be reached at: rakesh.tewary@azimpremjifoundation.org.

TEACHER'S GUIDE I: WHAT DO WE DO WITH EGG SHELLS?

In the article 'Why add eggs to midday meals?', Amol Anandrao Kate and Rakesh Tewary tell us that every Grade I-VIII student in Azim Premji School (APS), Sirohi, Rajasthan, is offered the choice to have: *"...one egg a day, six days a week. In many states, each child receives 2-3 eggs per week under the PM-POSHAN scheme"*. This would leave these schools with a lot of egg shells to manage! What do we do with them?

(A) Preparatory-stage EVS: Chapter 12 ('Taking Charge of Waste') of the Grade III environmental studies (EVS) textbook (NCERT, 2024-2025) introduces children to recycling as one way to manage food waste including egg shells: *"Materials such as dried leaves or branches, fruit peels, vegetable waste, or egg shells.....rot easily and mix with the soil.....[they] can be added to soil where it gets converted into compost food for plants and for tiny animals that live in the soil"*.[1]

Invite your students to find out what is done with the egg shells in school, at home, and in their community.

- In school: Divide the students into two groups. One group can find out how many eggs are served per day in the midday meal. Ask them to use this number to calculate the number of egg shells that will need to be managed every week. The other group could talk to the person/people who prepare the midday meal to find out what happens to the egg shells: How are they collected, stored (for example, are they stored in a separate bin?), and disposed? Bring the two groups together to observe how egg shells are stored in school. If possible, also see where they are disposed. Encourage students to record their observations and questions.
- At home and in the wider community: Invite your students to talk to family members, friends, and neighbours who eat eggs to find out what they do with the egg shells. Do any of them compost kitchen and farm waste? Do any of them add egg shells to the compost? What do they do with this compost? Where it is possible, encourage them to observe the compost pit and note down what they see. For example, what is the colour of the compost? What does it smell like? Are egg shells thrown in whole or crushed? Can they spot any insects or worms?

Discuss students' observations and questions from this exercise in class. Ask if they observed any differences in how egg shells are managed in school, at their homes, and in their community. Can they think of reasons for these differences? Invite them to think about the possible impacts of throwing egg shells as waste versus composting them. Share that when egg shells are disposed as waste, they accumulate in landfills taking a long time to breakdown. This can encourage pathogen growth, release foul odours, attract rodents, and contaminate soil and water.[2, 3] Egg shells can be composted with vegetable waste or mixed with manure and applied to soil as fertiliser for vegetables, crops, and other garden plants.[4, 5] You could also use this opportunity to think about and discuss some actions you could take together to manage egg shells

in school. Students could also create a poster on the benefits of composting egg shells and share it in school and their neighbourhood to create awareness.

(B) Middle-stage science: Chapter 12 ('Forests: Our Lifeline') of the Grade VII science textbook (NCERT, 2024-2025) introduces students to concepts around composting, decomposers, and humus formation through an activity: *"Activity 12.3: Dig a small pit. Put vegetable waste and leaves in it. Cover them with soil. Add some water. After three days, remove the upper layer of the soil. Does the pit feel warm inside?"*.[6] In Chapter 1 ('Crop Production and Management') in the Grade VIII science textbook (NCERT, 2024-2025), students read that: *"Manure is an organic substance obtained from the decomposition of plant or animal wastes.* ***Farmers dump plant and animal waste in pits at open places and allow it to decompose.*** *The decomposition is caused by some microorganisms. The decomposed matter is used as organic manure"*.[7]

- Invite your students to predict what could happen to egg shells when (i) left untreated and (ii) added to a compost pit. Encourage them to design an activity to verify their predictions. Write it down on the board.
- Through discussion, help them set up the activity. For example, you could divide students into 3 groups. Invite each group to set up a pit. Pit 1 could have only whole egg shells. Pit 2 could have whole eggs shells, vegetable waste, and dried leaves. Pit 3 could have crushed egg shells, vegetable waste, and dried leaves. The vegetable waste can come from the school kitchen. Cover all three pits with soil and sprinkle water.
- Ask students to remove the upper layer of soil after a week and observe the compost. Encourage them to record their observations (for example, soil colour, texture and appearance, smell, egg shells' appearance, and any living creatures). Let them repeat this once a week for three months. Interested students could do this for 12 months. Encourage them to also note down any change in temperature of the pits. Ask them to think about why and how to do this? To help students record their observations systematically, teachers could use the format of Table 2 in the activity sheet: 'Looking for Humus-II' in the article titled 'Getting to the Soul of Soil'.[8]
- Discuss their observations. For example, did they observe any differences in the egg shells in the three pits? How did it compare with their predictions? Did they observe any difference in temperatures between the three pits? Can they think of plausible explanations for their observations?

Why do egg shells take so long to break down when left untreated? One reason is the shells' chemical composition. Almost 95% of the shell is made of **calcium carbonate**.[5] Grade VIII student read about the function of this hard layer in hens' eggs in Chapter 6 ('Reproduction in Animals') of their science textbook (NCERT, 2024-2025): *"Soon after fertilisation, the zygote divides repeatedly and travels down the oviduct. As it travels down, many protective layers are formed around it.* ***The***

hard shell that you see in a hen's egg is one such protective layer. *After the hard shell is formed around the developing embryo, the hen finally lays the egg".*[9] Studies by agricultural scientists and experiences of gardeners tell us that egg shells in various forms (crushed, composted) can be a good source of calcium and other minerals (such as magnesium, potassium, and phosphorus) for plants.[5, 10] In Chapter 1 ('Nutrition in Plants') of the Grade VII science textbook (NCERT, 2024-2025), students are introduced to the role of fertilisers in plant nutrition: *"Have you seen farmers spreading manure or fertilisers in the fields, or gardeners using them in lawns or in pots? Do you know why this is done? You learnt that plants absorb* ***minerals and nutrients*** *from the soil. So their amounts in the soil keep on declining. Fertilisers and manures contain nutrients such as nitrogen, potassium, phosphorous, etc. These nutrients need to be added from time to time to enrich the soil".*[11] In Chapter 4: 'Acids Bases and Salts' of the Grade VII science textbook (NCERT, 2024-2025), students read that: *"Excessive use of chemical fertilisers makes the soil acidic. Plants do not grow well when the soil is either too acidic or too basic. When the soil is too acidic, it is treated with* ***bases like quick lime (calcium oxide) or slaked lime (calcium hydroxide)****. If the soil is basic, organic matter (compost) is added to it. Organic matter releases acids which neutralises the basic nature of the soil".*[12]

- Encourage students to talk to their parents (if they are farmers or have a kitchen garden) or to other farmers they know to find out how they enrich their soils. They could ask questions like: *Are their soils acidic or basic and how do they know this? Do they test their soil before deciding what nutrients need to be added? Do they add calcium? Have they used egg shells for their crops? If so, in what form and why? What has been their experience?* Students could also read the labels on fertiliser packets to see if some of them contain calcium. Encourage students to record this information in their notebooks.
- Discuss the information that students have collected. Ask questions to help them connect it with what they learn about acids and bases. For example, you could invite students to use a natural acid-base indicator to compare the acidity or alkalinity of soil samples with that of compost with egg shells. This exercise could help students identify acidic soils and appreciate the difference that the addition of compost with egg shells could make to them. Also, invite them to share ideas on ways to recycle egg shells as fertiliser.

Curricular connections:

The activities and discussions presented in this guide align with following recommendations of the National Curriculum Framework (NCF-SE) 2023 in its 'Approach to Learning about and Caring for the Environment': *"Students should be encouraged to engage with the content at an intellectual level through active participation in the classroom (e.g., asking questions, engaging in debates) and also at an experiential level by undertaking hands-on community projects (e.g.,* ***participating in environmentally sustainable activities at school, composting, minimising waste and maximising recycling****/ upcycling, raising a small plot or bed of medicinal plants... **community service in and around the school locality**)".*[13]

They can also help teachers meet the following grade-specific learning outcomes:

(a) Grade IV: "[The learner] *suggests ways for hygiene,* ***reduce, reuse, recycle*** *and takes care of different living beings (plants, animals, ...), resources (food, water and public property)".*

(b) Grade V: "[The learner] *suggests ways for hygiene, health,* ***managing waste****... protecting/saving resources (land... etc.)".*

(c) Grade VII: "[The learner] *applies learning of scientific concepts in day-to-day life, e.g., dealing with acidity; testing and treating soil..."*

(d) Grade VII: "[The learner] *makes efforts to protect environment, e.g., following good practices for sanitation at public places; minimising generation of pollutants…."*

(e) Grade VIII: "[The learner] *applies learning of scientific concepts in day-to-day life, e.g., …* ***segregating biodegradable and non-biodegradable wastes; increasing crop production***".[14]

References:

1. National Council of Educational Research and Training (2024). 'Chapter 12: Taking Charge of Waste'. Environmental Studies (EVS) Textbook for Grade III: 149-162. URL: https://ncert.nic.in/textbook.php?ceev1=12-12.
2. Mignardi, S, et. al. (2020). 'Valorization of Eggshell Biowaste for Sustainable Environmental Remediation'. Scientific Reports, 10: 2436. URL: https://doi.org/10.1038/s41598-020-59324-5.
3. Waheed, Marium et. al. (2020). 'Channelling eggshell waste to valuable and utilizable products: A comprehensive review'. Trends in Food Science & Technology, Volume 106: 78-90. URL: https://www.sciencedirect.com/science/article/abs/pii/S0924224420306324.
4. Enroth C (2018). 'Using Eggshells in the Garden and Compost'. College of Agricultural, Consumer and Environmental Sciences. University of Illinois Urbana-Champaign. URL: https://extension.illinois.edu/blogs/good-growing/2018-03-28-using-eggshells-garden-and-compost.
5. Sulegaon, R (2025). 'Eggshells as fertiliser in horticultural practices'. International Journal of Horticulture and Food Science. URL: https://www.hortijournal.com/archives/2025.v7.i3.A.277.
6. National Council of Educational Research and Training (2024). 'Chapter 12: Forests: Our Lifeline'. Science Textbook for Grade VII: 142-155. URL: https://ncert.nic.in/textbook.php?gesc1=12-13.
7. National Council of Educational Research and Training (2024). 'Chapter 1: Crop Production and Management'. Science textbook for Grade VIII: 138-149. URL: https://ncert.nic.in/textbook.php?hesc1=1-16.
8. Gopalan, Radha (2018). 'Getting to the soul of soil'. i wonder.... pp. 58-62. ISSN 2582-1636. URL: https://publications.azimpremjiuniversity.edu.in/2830/.
9. National Council of Educational Research and Training (2024). 'Chapter 6: 'Reproduction in Animals'. Science textbook for Grade VIII: 66-78. URL: https://ncert.nic.in/textbook.php?hesc1=6-13.
10. Fisher S (2024). 'Egg shell fertiliser for Plants'. BBC Gardeners' World Magazine. URL: https://www.gardenersworld.com/how-to/grow-plants/egg-shell-fertiliser-for-plants/.
11. National Council of Educational Research and Training (2024). 'Chapter 1: Nutrition in Plants'. Science Textbook for Grade VII: 1-10. URL: https://ncert.nic.in/textbook.php?gesc1=1-13.
12. National Council of Educational Research and Training (2024). 'Chapter 4: Acids, Bases, and Salts'. Science Textbook for Grade VII: 38-46. URL: https://ncert.nic.in/textbook.php?gesc1=4-13.
13. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
14. National Council of Educational Research and Training (2017). 'Learning Outcomes at the Elementary Stage'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/publication/otherpublications/tilops101.pdf.

i wonder...
Rediscovering school science

Contributed by:

Radha M, who works as a science resource person at Azim Premji Foundation, Bengaluru. She collaborates with government school teachers to enhance their conceptual understanding and refine their pedagogical practices. Her work focuses on supporting seamless and effective classroom practices towards contributing to meaningful educational experiences for students.

Radha Gopalan, who works at Azim Premji University, Bengaluru. She is also a member of the Kudali Intergenerational Learning Centre, Telangana.

TEACHER'S GUIDE II: CAN ALL CHICKEN EGGS HATCH INTO CHICKS?

Parents of some students may hold the belief that all hen's eggs are non-vegetarian food because they have the potential to hatch into chicks. The fact is that most eggs sold for our consumption (by grocery stores and poultry farms) are unfertilised. Even when uneaten, they do not have the potential to hatch into chicks.[1]

Rather than 'tell' students this, teachers can use this question to invite students to connect related concepts from the preparatory-stage Environmental Studies (EVS) and middle-stage science curricula with what they observe in their everyday worlds. Such an exercise can also help students develop the skill to examine common beliefs more critically.

Opportunities for the classroom:

How do we get eggs? In Chapter 8 ('Food we Eat') of the Grade III EVS textbook (NCERT, 2024-2025) students read that: *"Some people also eat things that are taken from animals, such as milk, curd, ghee, cheese, paneer, honey, eggs, and meat".*[2] Similarly, in Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025), students learn that: *"Animal sources of protein are milk, paneer, egg, fish, and meat".*[3] Teachers can use these textbook connections to ask students how we get these different kinds of food from animals. Invite students to share observations from their real worlds. Use this discussion to highlight the fact that eggs, like milk, are derived from animals. But, unlike meat and fish, not all food derived from animals comes from killing them.

Why do hens lay eggs? Chapter 2 ('Ear to Ear') of the Grade IV EVS textbook (NCERT, 2024-2025) invites students to observe which animals in their neighbourhood lay eggs and which ones give birth to young ones.[4] Chapter 16 ('A Busy Month') of the Grade IV EVS textbook (NCERT, 2024-2025) introduces students to the fact that birds lay eggs that hatch into young birds (see **Fig. 1**).[5] Activity 6.2 in Chapter 6 ('Reproduction in Animals') of the Grade VIII science textbook (NCERT, 2024-2025) encourages students to: *"...observe eggs of the following organisms—frog, lizard, butterfly or moth, hen and crow or any other bird. Were you able to observe eggs of all of them? Make drawings of the eggs that you have observed".*[6] Teachers can encourage students to try this activity out. Invite them to share their observations and drawings in class. You can then ask questions like: *Do the hens in your neighbourhood lay eggs at specific times or throughout the year? How many eggs do they lay at one time? Do they build nests for their eggs? Do all the eggs hatch into chicken? How long does it take for chicken to hatch from the eggs? How big are the chicks compared to the eggs they hatch from? What happens to the eggs after chicks have hatched from them? Are the shells empty or do they have something in them?* Once students have shared their first responses to these questions, invite them to explore these questions by observing hens in their neighbourhood more closely. Discuss the observations they bring to class. These observations can help lay the foundation for students to understand animal reproduction at later stages.

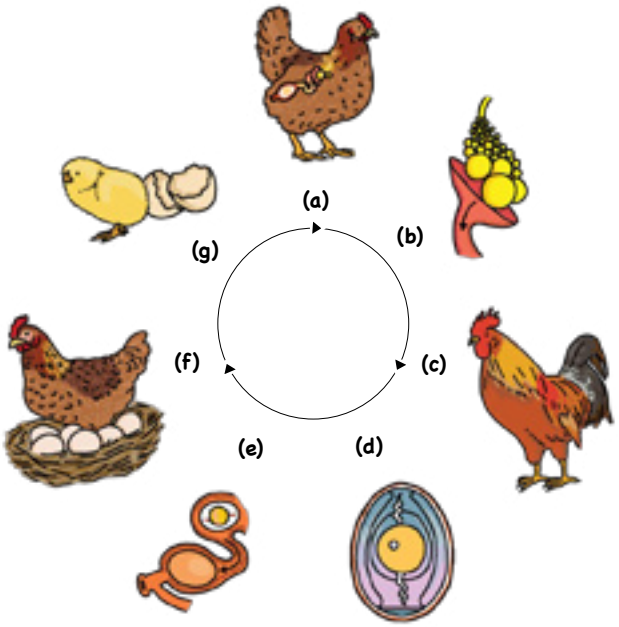


Fig. 1. The lifecycle of a hen. (a) Hens start producing egg cells when they are 4-6 months old. **(b)** Mature egg cells are released into the oviduct. **(c)** If the hen mates with a rooster, sperm from the rooster can fuse with the egg cell soon after it enters the oviduct. **(d)** The egg (fertilised or unfertilised) travels down the oviduct to the uterus. During this process, different layers (like egg white, shell membranes, shell, and pigments) are added to it. **(e)** The egg (fertilised or unfertilised) is released and the process starts again. **(f)** The embryo in a fertilised egg needs sufficient warmth to develop into a chick. A hen provides this warmth by sitting on her eggs. **(g)** Fertilised eggs can hatch into chicks.

How are eggs formed? In Chapter 6 ('Reproduction in Animals') of the Grade VIII science textbook (NCERT, 2024-2025), students learn that hens (like other birds) reproduce sexually (see **Fig. 1**). In the same chapter, students learn that: *"Fertilisation which takes place inside the female body is called internal fertilisation. Internal fertilisation occurs in many animals including humans, cows, dogs, and hens".*[6] Teachers can explain that this means that the sperm from a rooster and the egg cell (a small cell on the surface of the yolk) from a hen fuse within the body of the hen to form a zygote. Students are likely to wonder how the zygote develops into a chick. The same chapter explains this process: *"Soon after fertilisation, the zygote divides repeatedly and travels down the oviduct. As it travels down, many protective layers are formed around it. The hard shell that you see in a hen's egg is one such protective layer. After the hard shell is formed around the developing embryo, the hen finally lays the egg. The embryo takes about 3 weeks to develop into a chick. You must have seen the hen sitting on the eggs to provide sufficient warmth. Did you know that development of the chick takes place inside the egg shell during this period? After the chick is completely developed it bursts open the egg shell."*[6] To allow students to see these different layers of shell, membranes, albumen, and yolk, teachers can demonstrate a simple egg dissection in class. You can read how here: https://curiodyssey.org/learn-explore/science-experiments-for-kids/how-to-do-an-egg-dissection/. Use the questions in this activity to invite students to think about the role each layer in the egg plays in the development of the embryo. Highlight the fact that once an egg is laid, it remains 'viable' for about two weeks. During this period, the embryo can only develop if it is incubated naturally (by the hen sitting on it) or artificially at a temperature of 37-38°C.[1] If students show interest, you can ask them: *Why do you think fertilised eggs need to be incubated?*

Are the eggs served in midday meals fertilised? Teachers could start by reminding students that for an egg to be fertilised, the hen and rooster need to mate. Point out that eggs for midday meals come from grocery stores or poultry farms, where hens bred for their eggs (called layer chicken) are kept separate from roosters. Introduce the fact that hens (wild and domesticated) can lay unfertilised eggs. An unfertilised egg has all the layers that a fertilised egg has. But since it has no zygote, it cannot hatch into a chick even when incubated.[1] Draw their attention to the following activity for 'Extended Learning' suggested in Chapter 6 ('Reproduction in Animals') of the Grade VIII science textbook (NCERT, 2024-2025): *"Visit a poultry farm. Talk to the manager of the farm and try to find out the answers to the following. (a) What are layers and broilers in a poultry farm? (b) Do*

hens lay unfertilised eggs? (c) How can you obtain fertilised and unfertilised eggs? (d) Are the eggs that we get in the stores fertilised or unfertilised? (e) Can you consume fertilised eggs? (f) Is there any difference in the nutritional value of fertilised and unfertilised eggs?".[6] Teachers can plan this visit or encourage students to try this out for themselves. If you like to keep your students thinking about what they have learnt in class for some time after it has ended, you can close this discussion by asking students: *Why do hens lay unfertilised eggs? What do you think happens to unfertilised eggs in the wild?*

Curricular connections:

Activities and discussions around this question can help meet the following curricular goals listed in the National Curriculum Framework for School Education (NCF-SE) 2023 for:

(A) The preparatory stage:

- CG-4: [The student] develops sensitivity towards the social and natural environment. Specifically, it can help students develop the competency (C-4.1) to: *"Observe and describe diversity among plants, birds, and other animals in their immediate environment (shape, sounds, food habits, growth, habitat)".*
- CG-6: [The student] uses data and information from various sources to investigate questions related to their immediate environment. Specifically, it can help students develop the competency (C-6.1) to: *"Perform simple inquiry related to specific questions independently or in groups".*

(B) The middle stage:

- 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 (...birds, mammals...), including at a smaller scale...".*
- 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...)".*[7]

References:

1. Lesley, Chris (2024). 'How DO Chicken Eggs Get Fertilized?' Almanac. URL: https://www.almanac.com/fertilized-chicken-eggs-facts-and-myths. Accessed on December 10, 2024.
2. National Council of Educational Research and Training (2024). 'Chapter 8: Food we Eat'. EVS Textbook for Grade III: 100-108. URL: https://ncert.nic.in/textbook.php?ceev1=8-12.
3. National Council of Educational Research and Training (2024). 'Chapter 3: Mindful Eating: A Path to a Healthy Body'. Science Textbook for Grade VI: 35-59. URL: https://ncert.nic.in/textbook.php?fecu1=3-12.
4. National Council of Educational Research and Training (2024). 'Chapter 2: Ear to Ear'. EVS Textbook for Grade IV: 11-20. URL: https://ncert.nic.in/textbook.php?deap1=2-27.
5. National Council of Educational Research and Training (2024). 'Chapter 16: A Busy Month'. EVS Textbook for Grade IV: 127-136. URL: https://ncert.nic.in/textbook.php?deap1=16-27.
6. National Council of Educational Research and Training (2024). 'Chapter 6: Reproduction in Animals'. Science Textbook for Grade VIII: 66-78. URL: https://ncert.nic.in/textbook.php?hesc1=6-13.
7. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

i wonder...
Rediscovering school science

Contributed by:
Chitra Ravi, who works at Azim Premji University, Bengaluru.

TEACHER'S GUIDE III: CAN EATING EGGS ALTER THE ONSET OF PUBERTY?

Parents of some preadolescent and adolescent students may hold the belief that including eggs in midday meals may alter the onset of their child's puberty. Teachers can use this question to invite Grade VIII students to connect what they learn about nutrition in the Grade VI science curriculum and puberty in the Grade VIII science curriculum. Discussions around this theme can also help students think more critically about the food choices they make and how diet can affect their development. It may be important to keep in mind that students at this age are often self-conscious and uncomfortable about physical changes in their appearance. For this reason, this exercise will be most effective if handled with sensitivity and respect for each student in class.

Opportunities for the classroom:

Chapter 7 ('Reaching the Age of Adolescence') of the Grade VIII science textbook (NCERT, 2024-2025) introduces students to puberty in this way: *"Growth begins from the day one is born. But upon crossing the age of 10 or 11, there is a sudden spurt in growth which becomes noticeable. The changes taking place in the body are part of growing up. They indicate that you are no longer a child but are on the way to becoming an adult... The period of life, when the body undergoes changes, leading to reproductive maturity, is called adolescence... The human body undergoes several changes during adolescence. These changes mark the onset of puberty. The most important change which marks puberty is that boys and girls become capable of reproduction. Puberty ends when an adolescent reaches reproductive maturity".*[1] This chapter also tells students that: *"Adolescence begins around the age of 11 and lasts up to 18 or 19 years of age... In girls, adolescence may begin a year or two earlier than in boys. Also, the period of adolescence varies from person to person".*[1] Teachers can expand on this theme and share that a variety of factors can affect the age of onset of puberty. These include our genetics, ethnicity, general health, socio-economic status, and even the chemicals we are exposed to in our environment.[2]

Highlight the importance of a healthy diet in supporting our nutritional needs during this period of change. Activity 7.4 of Chapter 7 in the Grade VIII science textbook invites students to: *"Make a group with your friends. Write down the items of food in your breakfast, lunch, and dinner you had on the previous day. Identify the items responsible for proper growth. Also identify the junk food that you consumed the previous day".*[1] Encourage students to try this activity out. Discuss any observations or reflections that they feel comfortable sharing in class. Highlight the fact that many scientific studies have shown that poor diets can alter the onset of puberty in one of two ways:

- Some diets can increase the risk of early onset or precocious puberty. Early onset puberty is when signs of puberty appear in girls before the age of eight (rather than between 8-13 years of age) and boys before the age of nine (rather than between 9-14 years of age).[3] Share that this effect has been seen in children

who consume diets rich in fat, sugar, animal proteins, and processed food.[4, 5] Draw students' attention to this line in the textbook: *"Chips and packed or tinned snacks, though very tasty should never replace regular meals as they do not have adequate nutritional value"*.[1] You could also invite them to reread Chapter 3 ('From Tasting to Digesting') of the Grade V Environmental Studies (EVS) textbook (NCERT, 2024-2025). This chapter draws students' attention to Kailash who: *"...does not like to eat homecooked food like dal-rice, vegetables, and roti. The only things he finds tasty are chips, burger, pizzas, and soft drinks from the market"*.[6] Because of these food habits, Kailash: *"...looks older than his age. His body is fat and flabby. He has pain in his legs. He is not very active"*.[6] Invite students to discuss what kinds of diets allow us to consume necessary quantities of fats, carbohydrates, and proteins. You can then share that early onset puberty has also been seen in children whose diets are contaminated with endocrine-disrupting chemicals like Bisphenol A (BPA).[4, 5] Point out that BPA is present in the plastic used in food containers, pesticides, fuels, and other industrial chemicals. Invite students to think of some possible ways in which this chemical can make its way into the food we consume. You can then draw their attention to the effect this chemical has on endocrine glands. Chapter 7 of the Grade VIII textbook tells students that: *"The changes which occur at adolescence are controlled by hormones. Hormones are chemical substances. These are secretions from endocrine glands or the endocrine system. The male hormone or testosterone begins to be released by the testes at the onset of puberty. This causes changes in boys about which you have just learnt, for example, the growth of facial hair. Once puberty is reached in girls, ovaries begin to produce the female hormone or estrogen which makes the breasts develop. Milk secreting glands or mammary glands develop inside the breasts. The production of these hormones is under the control of another hormone secreted from an endocrine gland called pituitary gland"*.[1] Invite students to think of how BPA can cause early-onset puberty: *We know that testosterone and estrogen are released at the onset of puberty. Can you guess or predict what effect BPA is likely to have on the glands producing these hormones? How would you support your prediction? Imagine you are a scientist. Can you think of a way to test your prediction?* You can share newspaper articles that show that paediatricians and gynaecologists from across India are reporting a rise in precocious puberty. But it is important to highlight the fact that the exact numbers of children showing it and the factors responsible for it are not known yet.[7]

- Some diets can delay the onset of puberty. Delayed onset of puberty is when a girl shows no breast development by age 13 and a boy shows no testicular enlargement by age 14.[8] Share that undernutrition (seen as children being underweight and/or showing stunting) and frequent illness in children, especially during critical stages of development, can disrupt their hormonal balance.[9, 10] This can delay the onset of puberty. Here, again, you can ask students: *Can you predict what effect undernutrition has on endocrine glands? How would you support your prediction?* Share with your students that there is evidence that undernutrition can play an important role in the delayed onset of puberty in Indian girls, especially those from rural (and marginalized) communities.[9, 10] Ask students: *Can you think of some reasons why girls from rural areas may not be getting enough or good quality food? Have you seen girls getting less or different food from the boys in their family?* Encourage students to support their responses with observations from their immediate environment. Highlight that midday meals can reduce the risk of delayed onset of puberty by supporting the nutrition of children and adolescents. You could ask students: *Do you get enough food in your midday meals? Do you think these meals are balanced? What would you add to these meals to make them more nutritious?*

Can including eggs in midday meals increase the risk of early-onset puberty? We could not find any study that links egg consumption with early-onset puberty in India. Can including eggs in midday meals reduce the risk of delayed onset of puberty? Rather than answer this question, ask your students why Chapter 7 of the Grade VIII science textbook lists eggs as an example of nutritious

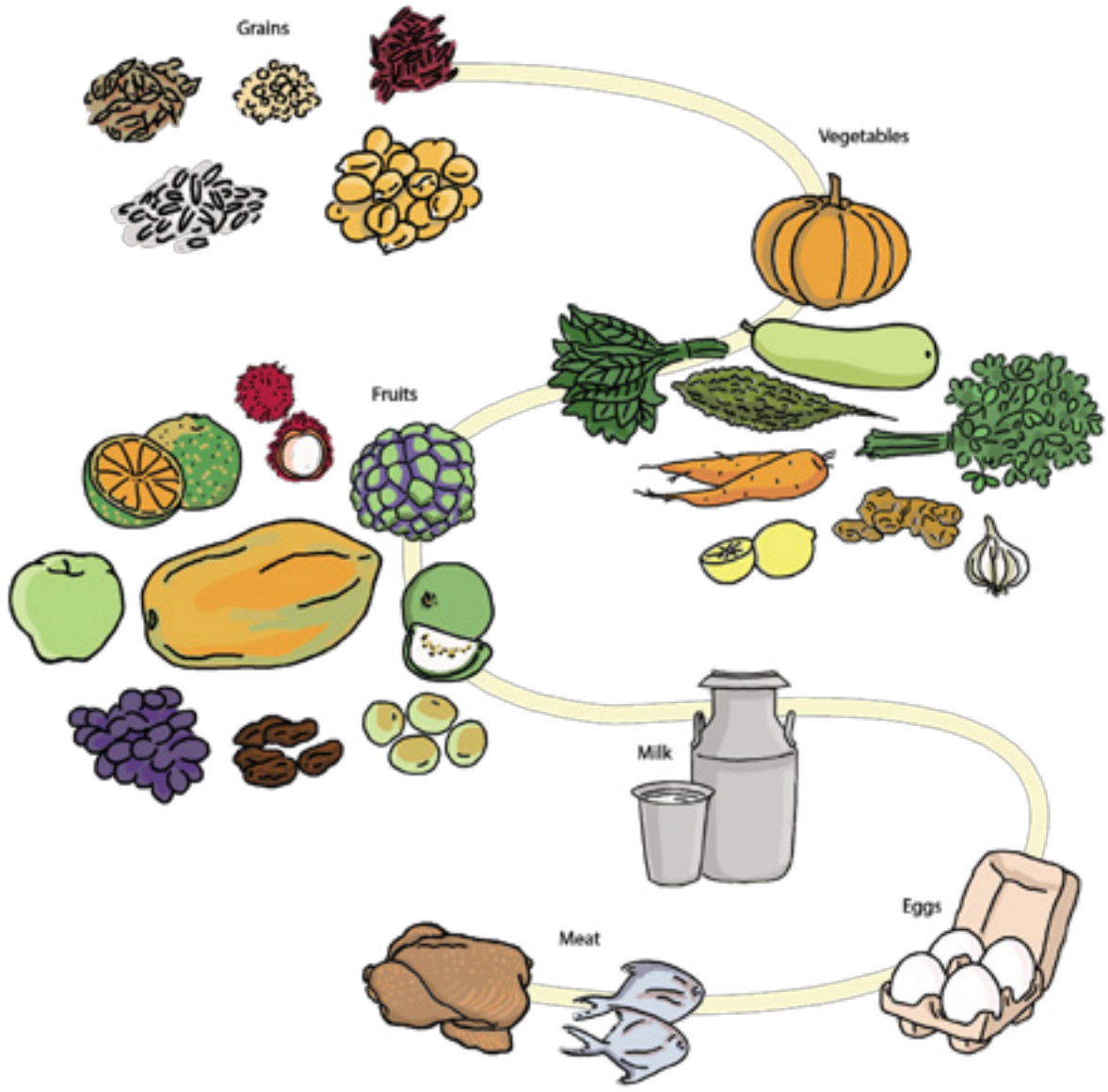


Fig. 1. Examples of foods that support the nutritional needs of adolescents. These are listed (on page 87) in Chapter 7 ('Reaching the Age of Adolescence') of the Grade VIII science textbook (NCERT, 2024-2025).
Credits: i wonder... Apr 2025 issue. License: CC BY-NC.

food for adolescents (see **Fig. 1**). Encourage students to respond to this question by connecting it to what they have learnt about the different components of a nutritious and balanced diet in Chapter 3 ('Mindful Eating: A Path to a Healthy Body') of the Grade VI science textbook (NCERT, 2024-2025).[11]

You could end this discussion by drawing your students' attention to Activity 7.5 in Chapter 7 of the Grade VIII science textbook (NCERT, 2024-2025). This activity invites students to: *"Prepare charts or posters and paste them in the class so that you are aware of the diet for adolescents. You may use your creative ideas and present it like an advertisement"*.[1] Encourage students to work in groups and display their charts and posters in class.

Curricular connections:

Activities and discussions around this question can help meet the following curricular goals listed in the National Curriculum Framework for School Education (NCF-SE) 2023 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: (a) 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"*; (b) C-4.2: *"Examine different dimensions of diversity of food—sources, nutrients, climatic conditions, diets"*; and (c) C-4.3: *"Describe biological changes (growth, hormonal) during adolescence and measures to ensure overall well-being"*.
- 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"*.[12]

References:

1. National Council of Educational Research and Training (2024). 'Chapter 7: Reaching the Age of Adolescence'. Science Textbook for Grade VIII: 79-92. URL: https://ncert.nic.in/textbook.php?hesc1=7-13.
2. Mancini, Alessandra, Magnotto, John C., & Abreu, Ana Paula (2022). 'Genetics of Pubertal Timing'. Best Practice & Research Clinical Endocrinology & Metabolism, Vol. 36: Issue 1. https://doi.org/10.1016/j.beem.2022.101618. URL: https://www.sciencedirect.com/science/article/pii/S1521690X22000057.
3. Mayo Clinic Staff (2023). 'Precocious puberty'. Mayo Clinic. URL: https://www.mayoclinic.org/diseases-conditions/precocious-puberty/symptoms-causes/syc-20351811. Accessed on Jan 27, 2025.
4. Kim, Toni (2023). 'Top 5 Foods that Cause Early Puberty'. Life Pediatric Endocrinology. URL: https://lifeendo.com/blog/top-5-foods-that-cause-early-puberty. Accessed on Jan 27, 2025.
5. Renown Health (2018). 'Early Onset of Puberty in Girls on the Rise'. URL: https://www.renown.org/blog/early-onset-of-puberty-in-girls-on-the-rise. Accessed on Jan 10, 2025.
6. National Council of Educational Research and Training (2024). 'Chapter 3: From Tasting to Digesting'. EVS Textbook for Grade V: 22-34. URL: https://ncert.nic.in/textbook.php?eeap1=3-22.
7. Datta, Sumi Sukanya (2024). 'Rate of early puberty rising in India? ICMR plans nationwide project to find answers'. The Print. URL: https://theprint.in/health/rate-of-early-puberty-rising-in-india-icmr-plans-nationwide-project-to-find-answers/2011194/. Accessed on Jan 27, 2025.
8. The Johns Hopkins University (2025). 'Delayed Puberty'. John Hopkins Medicine. URL: https://www.hopkinsmedicine.org/health/conditions-and-diseases/delayed-puberty.
9. Soliman, Ashraf, De Sanctis, Vincenzo, & Elalaily, Rania (2014). 'Nutrition and Pubertal Development'. Indian Journal of Endocrinology and Metabolism 18 (Suppl 1): S39-S47. URL: https://journals.lww.com/indjem/fulltext/2014/18001/nutrition_and_pubertal_development.6.aspx
10. D., Ramamani, Rajendiran, Ramyaa, & Kannan, Iyanar (2020). 'Nutritional status and age of menarche in adolescent girls in urban and rural area schools'. International Journal of Contemporary Pediatrics, 7 (2), 355–358. https://doi.org/10.18203/2349-3291.ijcp20200108. URL: https://www.ijpediatrics.com/index.php/ijcp/article/view/3004.
11. National Council of Educational Research and Training (2024). 'Chapter 3: Mindful Eating: A Path to a Healthy Body'. Science Textbook for Grade VI: 35-59. URL: https://ncert.nic.in/textbook.php?fecu1=3-12.
12. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

Contributed by:
Chitra Ravi, who works at Azim Premji University, Bengaluru.

UNDERSTANDING GBS OUTBREAKS

SATYAJIT RATH

Since January 2025, Pune has reported a spike in cases of Guillain-Barré Syndrome, a rare disorder that can cause paralysis. This has been linked to contaminated water sources. What precautions can we take? Can this example help students see the real-world relevance of textbook concepts on infectious diseases, water hygiene, wastewater treatment, and antibodies?

We have all been reading or hearing media reports of apparently large numbers of cases of a serious illness called Guillain-Barré Syndrome (GBS) in Pune over January-March 2025. (see **Box 1**). Since dozens of these cases began to be reported from nearabout one part of the city within a few days to weeks, researchers began to think of it as an 'outbreak' (see **Box 2**).

GBS is a serious illness. To date more than 200 people are reported to have become affected during this period, a number that is usually reported over an entire year. A few, perhaps a couple of handfuls, have died. The reliability of these numbers is subject to the reliability of our public health information systems. But it is clear that there have been many cases of a serious illness. So it makes sense for us to think about the disease (see **Teacher's Guide I**).

What is GBS?

The symptoms and signs of GBS are primarily those resulting from damage and loss of normal function in the peripheral nerves (see **Fig. 1**). These are nerves outside the brain and spinal cord. All nerves, broadly, help us feel sensations and let us move muscles. So damage to and loss of function of nerves would mean loss of the ability to move muscles (or paralysis), loss of normal sensations, and feelings of odd 'unreal' sensations such as pain and tingling numbness (or feelings of 'pins and needles') instead. For example, people commonly start

Box 1. What does 'Guillain-Barre syndrome' actually mean?

The formal name of this disease is not terribly informative. It just uses the surnames of two French physicians who described it over a hundred years ago. Even the word 'syndrome' is simply an acknowledgement of a difficulty. We recognise patterns of illnesses first as combinations of particular 'symptoms' (what the ill person feels as unusual and uncomfortable) and 'signs' (what other people, such as physicians, see in the ill person or the 'patient'). If some particular characteristic combination of symptoms and signs turns up again and again among ill people, it is a pattern of illness, a 'syndrome'. The idea is useful, because it allows physicians to plan focused supportive efforts to reduce these particular symptoms and signs. But the trouble is that this remains just a description of the illness. It does not say anything about what may have caused it.

Box 2. When do we think of a disease as an 'outbreak'?

An outbreak of any disease is a way to think about a number of cases of that disease occurring very close to each other 'in space and time'. This means that there may be many cases of the disease reported in, for example, the same neighbourhood during just a few weeks. Clearly, for us to notice such a clustering of GBS cases, cases in the area before the 'outbreak' began must not have been as frequent. One reservation about this is: How sure are we that there were much fewer cases earlier? We can be sure only if our public health system of reporting and recording all diseases is robust and working well. All of us can think about how likely this is.

reporting feeling as though they are wearing thick socks or gloves and having difficulties in walking or picking up teacups.

Since GBS involves nerve damage ('neuropathy'), usually in the peripheral nerves, it is a 'peripheral neuropathy'. But peripheral neuropathies are not unique to GBS. GBS is identified separately from other such neuropathies by three related findings. Firstly, it appears in most affected people a few days to weeks after they have recovered from an acute respiratory or gut infection. Secondly, affected people do not have symptoms (such as, say, fever) that might indicate another infection. This makes it unlikely that the neuropathy is the result of an ongoing microbial infection. Thirdly, the protein content of the cerebrospinal fluid (the fluid surrounding the brain and spinal cord) of affected people changes. This despite the fact that the symptoms and signs of this disease do not seem to involve the brain and spinal cord much. All of this appears, and indeed is, quite tentative. It provides no inkling of what may actually be causing GBS.

What do we know of the cause/s of GBS?

GBS appears to be 'post-infectious'. This means that it is identified as occurring in people soon after they have had and recovered from an infection. These are mostly gut infections with, for example, the bacterium *Campylobacter jejuni* (*C. jejuni*), which seems to be involved in about a third of GBS cases, and Hepatitis E virus. Or respiratory infections, such as with *Mycoplasma pneumoniae*. GBS has also been associated with infections caused by Zika virus and Cytomegalovirus. There are also claims that GBS can sometimes occur after vaccination. But, such cases have only been reliably reported as very rare events that happen after receiving some recent highly effective adenovirus-based vaccines against COVID-19.

But while GBS is a rare consequence, infections (especially gut and respiratory infections) are quite common. All of us get them quite often. This means that there are some cases of GBS in all communities at all times. In fact, it is not easy to find any differences between the people who do get affected by GBS and those who do not. Everyone seems to be at some low level of GBS risk. If there is an outbreak of an infection, GBS numbers may also go up. So if there

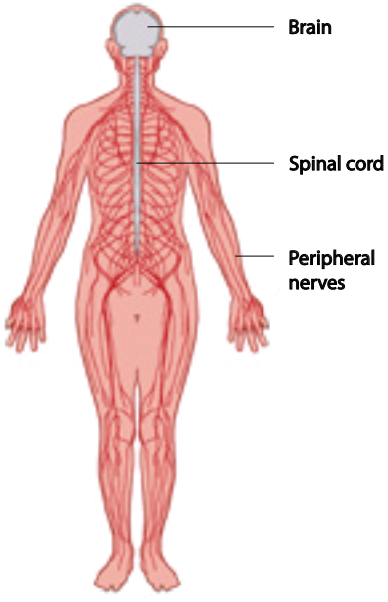


Fig. 1. Peripheral nerves. These are nerves outside the brain and spinal cord.

is an outbreak of GBS cases, the most obvious explanation to look for is an outbreak of infection. This could be an outbreak of a respiratory infection, like COVID-19, or a gut infection associated with, say, a contaminated water supply (see **Teacher's Guide II**).

But it is not as if everyone who has had a respiratory or gut infection will get GBS. Estimates are that only about one in a few thousand people recovering from infection are affected with GBS. So, the really puzzling question is: What happens differently in the rare GBS-affected people to cause this neuropathy after infection? While we do not yet understand this very well, it seems to be an 'autoimmune' disorder. What does this mean? Usually, the immune mechanisms in the body recognise potentially dangerous 'targets' coming into the body, such as microbes, and make responses that help get rid of them. These immune mechanisms do not usually recognise components of the body itself as targets. If they did, such 'auto'-immune mechanisms would try to get rid of parts of the body itself. This is clearly a recipe for some trouble and, perhaps, even serious disease. But, sometimes, some such autoimmune responses do come up. If they escape the regulatory mechanisms that can keep them in check, such responses can cause illness. In more than half of all people affected with GBS, there is evidence that such autoimmune mechanisms are activated. These mechanisms identify some parts of the peripheral nerves as targets. Immune activity against these nerves leads to nerve damage and the symptoms and signs of GBS.

All of this tentative understanding is limited by uncertainties. There are people, huge numbers of them, who get microbial infections and do not develop GBS. There are also people who get GBS without any history of microbial infections. Did they simply forget that they had a recent infection? Or was the infection in them so mild that they did not notice it? Or can GBS occur without prior infections? We do not know yet.

If this sort of autoimmunity is the way that GBS can be caused, what is its connection with respiratory or gut infections? The link seems to be a situation of mimicry. When we have a microbial infection, such as with the gut infecting bacterium *C. jejuni*, immune mechanisms against targets in *C. jejuni* are activated. These help get rid of the infection. But, in some rare situations, for reasons we still do not understand, these microbial targets look like nerve 'auto'-targets to the immune mechanisms. So, for example, some people make antibodies against *C. jejuni* that also recognise nerve components. We do not know how this difference arises. Also, GBS does not commonly occur in the same person again and again. So it is not clear if and how they made mimicking autoimmune responses just that one time.

There are puzzles here too. This mimicking autoimmune response would be quite strong during the infection that causes it. How does the nerve damage not start during infection? Why do these symptoms occur a few days to weeks 'after' symptoms of infection have subsided? We do not know yet.

This, as far as we understand it, seems to be how GBS comes about.

How is GBS treated?

Since we do not understand the cause very well, treatment of GBS is mostly limited to treating symptoms and signs. If the affected person cannot move their muscles and feel sensations in certain parts of their body, they will be bedridden and will need proper intensive and skilled nursing care. In about one in four or five cases, people will begin to have difficulty in breathing because their breathing muscles cannot move. At this point, ventilator support in intensive care units in hospitals will be needed. Even so, people in such dire situations can and do die. As many as one in twenty affected people die. Recovery is usually complete in seven out of ten people. But this can take many months. In others, some muscle weakness can remain for much longer.

In addition to the much-needed invalid care, ill people are commonly treated with immunoglobulin from the blood of a healthy person (a donor). Immunoglobulin is a pool of **all** the antibodies that the body of the healthy person is making (see **Box 3)**. Antibodies are proteins that the immune system makes

Box 3. What are antibodies?

Chapter 2 ('Microorganisms: Friend and Foe') of the Grade VIII science textbook (NCERT, 2024-2025) offers this introduction: *"When a disease-carrying microbe enters our body, the body produces antibodies to fight the invader. The body also remembers how to fight the microbe if it enters again. If dead or weakened microbes are introduced into a healthy body, the body fights and kills the invading bacteria by producing suitable antibodies. The antibodies remain in the body and we are protected."*[1]

Box 4. Curricular connections:

Activities and discussions around this theme can help meet the following curricular goals outlined in the National Curriculum Framework for School Education (NCF-SE) 2023 for:

(A) Middle-stage science:

- CG-3: [The student] explores the living world in scientific terms. Specifically, it can support students in developing the following competency: C-3.1: *"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)".*[2]
- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can support students in developing the following competency: C-7.1: *"Use scientific vocabulary to communicate science accurately in oral and written form, and through visual representation".*[2]
- CG-9: [The student] develops awareness of the most current discoveries, ideas, and frontiers in all areas of scientific knowledge in order to appreciate that science is ever evolving and that there are still many unanswered questions. Specifically, it can support students in developing the following competency: C-9.1: *"State concepts that represent the most current understanding of the matter being studied—ranging from mere familiarity to conceptual understanding of the matter as appropriate to the developmental stage of the students".*[2]

(B) Preparatory-stage Environmental Studies (EVS):

- CG-2: [The student] understands the interdependence in their environment through observation and experiences, developing the basis for appreciation of the idea of *'Vasudhaiva Kutumbakam'*. Specifically, it can support students in developing the following competency: C-2.1: *"Identify natural and human-made systems that support their lives (water supply, water cycle, river flow systems, seasons, life cycle of plants and animals, food, household items, transport, communication, electricity in the home)".*[2]
- CG-3: [The student] explains how to ensure the safety of self and others in different (normal as well as emergency) situations. Specifically, it can support students in developing the following competency: C-3.1: *"Describe the basic safety needs and protection (health and hygiene, food, water, shelter, precautions, awareness of emergency situations, abuse, and unsafe situations) of humans, birds, and animals".*[2]

Discussions around this theme can also help meet the following learning objectives for Grade VIII science:

- Define pathogens to list the class of harmful microorganisms.
- List examples of diseases in humans, plants, and animals caused by microorganisms in order to explain the harmful effects of microorganisms.[3]

against specific targets that activate it. So the antibodies in pooled immunoglobulin could be against any of the microbes, vaccines, etc., that the donor may have encountered. This brings up the next GBS puzzle: How does this treatment help relieve the illness of autoimmune nerve damage? There are any number of speculations, but the reality is that we do not know. It does seem to work, though not completely nor reliably. And it is relatively cheap, unlike the more targeted therapies (such as those that remove nerve-specific antibodies) being investigated.

Parting thoughts

GBS as an illness by and large goes away on its own in a few weeks, provided we keep the affected people alive and functioning till then. This is the next part of the GBS puzzle that we do not quite understand yet. If an immune response against certain microbes also happens to affect human nerve components and causes illness, how does it stop? This disease-causing immune response is initially triggered by microbes. So it is possible that it simply runs down and disappears when the microbe is no longer present.

All in all, there is a lot we do not know about GBS (see **Box 4**). We do, however, know that it can result from gut infections. Therefore, being careful about hygiene in the food and water we eat and drink is a commonsense precaution to take.

Key takeaways

- A rise in GBS cases is being reported from Pune, Maharashtra, since early January 2025. This rare autoimmune disorder occurs in people soon after they have had and recovered from a respiratory or gut infection. Its symptoms and signs are mainly those resulting from damage and loss of normal function of the peripheral nerves.
- Since GBS is in the news and is a matter of strong public concern, it can be used as an example of science in action. Students can be invited to use newspaper clippings (including ones in local languages) to investigate what is known about its causes, symptoms, diagnosis, treatment, and preventive measures.
- Since this spike in GBS cases is linked to contaminated water, it can be used as a real-world example of the relevance of what students learn in the EVS and science curricula about access to clean drinking water. Students can be invited to find out where the water in their school and homes comes from as well as how it is stored and treated to reduce the risk of disease.

Acknowledgments: The editors thank Hridaykant Dewan for his help in inviting Satyajit Rath to write this article for i wonder...

Notes:

(a) Credits for the image (Child Drinking Water) used in the background of the article title: Anil Gulati, India Water Portal. URL: https://www.flickr.com/photos/indiawaterportal/4483915884. License: CC BY-NC-SA 2.0 Generic Deed.

(b) This article includes two detachable classroom resources: **Teacher's Guide I: GBS as a Theme for Student Investigation** and **Teacher's Guide II: GBS and Contaminated Water**.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 2: Microorganisms: Friend and Foe'. Science Textbook for Grade VIII: 17-31. URL: https://ncert.nic.in/textbook.php?hesc1=2-13.
2. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
3. Central Board of Secondary Education (2020). 'Teachers' Resource for Achieving Learning Outcomes, Classes 1 to 10'. URL: https://cbseacademic.nic.in/web_material/Manuals/TeachersResource_LODoc.pdf.

Satyajit Rath is Professor Emeritus at the Indian Institute of Science Education and Research (IISER) Pune, Maharashtra. He was formerly a scientist at the National Institute of Immunology (NII), New Delhi.

TEACHER'S GUIDE I: GBS AS A THEME FOR STUDENT INVESTIGATION

In the article 'Understanding GBS Outbreaks', the scientist Satyajit Rath shares what we know about the causes, signs and symptoms, diagnosis, treatment, and prevention of GBS. Students may have seen or heard of this 'outbreak' on television, in newspapers, or through conversations between adults. This theme can be used in the middle-stage classroom as a real-world example of the nature and process of science.

Textbook connections:

Chapter 1 ('The Wonderful World of Science') of the Grade VI science textbook (NCERT, 2024-2025) introduces students to science as a: *"...giant and unending jigsaw puzzle. Every new discovery we make adds another piece to that puzzle. And you know the best thing about this puzzle? There is no limit to what we can discover, since every new piece of knowledge leads to more questions and more things to find out".*[1] Later in the chapter, students learn that: "*Science is not just about memorising facts and figures or doing experiments. It is about following a step-by-step process that helps us find answers to our questions".*[1]

Classroom exercise:

- Invite your students to see if they can put together the pieces of the GBS puzzle. Start by sharing news about the outbreak. Ask them to think about and list any questions about the disease that come to their mind. Write their questions on one side of the board.
- Use Rath's article to share questions that scientists ask in thinking of GBS. Write these questions down on the other side of the board.
- Invite students to identify similarities and differences between their questions and the ones scientists ask. What can they learn from this exercise about how scientists think and the scientific process?
- Invite students to group their questions to help them understand different aspects of the disease. For example, they could group their questions under causes, signs and symptoms, diagnosis, treatment, and prevention. Share details from Rath's article about each of these aspects in grade- and level-appropriate ways.
- Divide the students into 5 groups. Assign one aspect of the disease to each group

(for example, causes to Group 1, signs and symptoms to Group 2, and so on). Give each group time to discuss the aspect they have been assigned and make a note of what they have learnt about it. Also, ask them to make note of any new questions that come to their mind during the discussion.

- Discuss what each group learnt about GBS. Help them put all the pieces together on the board. They could do this in words or through a diagram. Ask if any of the questions about GBS they listed at the beginning of class or that came up during group discussion are unanswered. Use Rath's article to identify questions from this list that scientists do not have answers to yet.
- Invite students to share and discuss what they have learnt about the nature of science from this exercise. Highlight how every new piece of information scientists discover can lead to more questions.

Curricular connections:

This exercise and discussions around it can help meet the following curricular goals listed in the National Curriculum Framework for School Education (NCF-SE) 2023 for middle-stage science:

- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can help students develop the following competency: C-7.1: *"Use scientific vocabulary to communicate science accurately in oral and written form, and through visual representation."*
- CG-9: [The student] develops awareness of the most current discoveries, ideas, and frontiers in all areas of scientific knowledge in order to appreciate that science is ever evolving and that there are still many unanswered questions.[2]

References:

1. National Council of Educational Research and Training (2024). 'Chapter 1: The Wonderful World of Science'. Science Textbook for Grade VI: 1-8. URL: https://ncert.nic.in/textbook.php?fecu1=1-12.
2. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

Contributed by:

Radha Gopalan, who works at Azim Premji University, Bengaluru. She is also a member of the Kudali Intergenerational Learning Centre, Telangana.

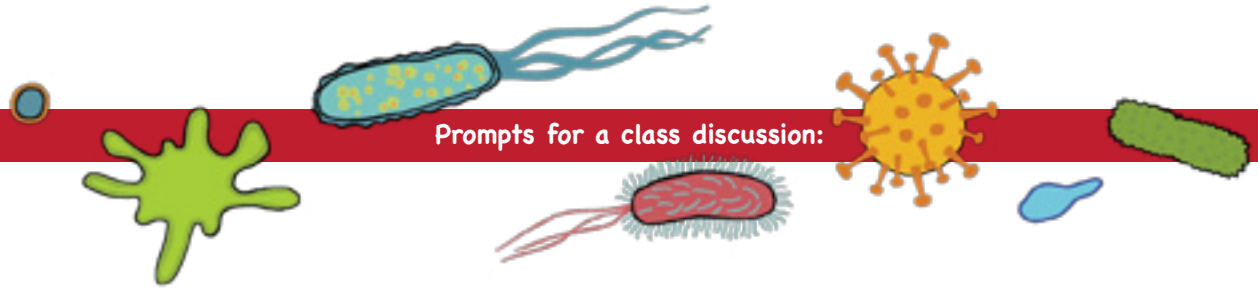
TEACHER'S GUIDE II: GBS & CONTAMINATED WATER

In the article 'Understanding GBS Outbreaks', the scientist Satyajit Rath tells us how an outbreak of GBS could be connected to a contaminated water supply. Contamination of natural sources of water and access to clean water are important themes that run through the preparatory-stage Environmental Studies (EVS) and middle-stage science curricula. Students at both these stages are encouraged to think about where they get water from and whether the water in their homes and school is fit for drinking. Teachers could use GBS to have grade-appropriate discussions on the relevance of these concepts in the real world.

Textbook connections:

- Chapter 18 ('Too Much Water, Too Little Water') of the Grade IV EVS textbook (NCERT, 2024-25) introduces students to differences in access to clean drinking water: *"Deepak had gone with his mother to Raziya Madam's house. His mother worked there... Raziya called out, "Pushpa, it says in the newspaper that the gutter water has got mixed with the water in the drinking water pipes, in this area. It says that many people are sick with diarrhoea and vomiting because of this. Why don't you throw away the water that was filled yesterday? Put some fresh water to boil, for drinking. Also take home some boiled water for your family" Deepak was happy to hear this. He thought, "At least today I will not have to stand in a queue for hours to get water for our house. It is a real holiday for me!""*.[1]
- Chapter 13 ('A River's Tale') of the Grade IV EVS textbook (NCERT, 2024-2025) lists some of the ways in which human activities can dirty sources of drinking water (like rivers, lakes, and ponds): "*... as the river flowed through or near many villages, towns and cities the water changed. The people used the river water for many different things such as washing clothes, bathing animals and cleaning utensils. Many of these activities made the water dirty. The water in the river kept changing as it flowed through various places. Water in ponds and lakes can also become dirty due to similar reasons.*" Later in the chapter, students learn that: "*...it is important that we clean water before drinking it. One of the best ways to do this is to boil the water*".[2]
- In Chapter 13 ('Wastewater Story') of the Grade VII science textbook (NCERT, 2024-2025) students learn that: "*Clean water is a basic need of human being... It has been reported that more than one billion people have no access to safe drinking water... Poor sanitation and contaminated drinking water is the cause of a large number of diseases... Groundwater is a source of water for wells, tubewells, springs and many rivers. Thus, it becomes the most common route for water borne diseases. They include cholera, typhoid, polio, meningitis, hepatitis, and dysentery*".[3]
- In Chapter 2 ('Microorganisms: Friend and Foe') of the Grade VIII science textbook (NCERT, 2024-2025), children learn that: *"Pathogens enter our body through the air we breathe, the water we drink, or the food we eat. They can also get transmitted by direct contact with an infected person or carried by an animal. Microbial diseases that can spread from an infected person to a healthy*

person through air, water, food, or physical contact are called communicable diseases".[4]



Prompts for a class discussion:

1. **Local sources of water:** Invite students to list major sources of water in their locality. Work with them to classify these into surface water and ground water sources.

2. **Causes of water contamination:** Ask students if it would be safe to drink water directly from any of the local sources they have listed. Can they think of some ways in which these water sources get contaminated or unfit for drinking? Encourage students to share observations from their everyday lives that support their responses. For example, have they seen how humans and animals use these water sources? Is there a landfill nearby that can contaminate land and water? Have they read (in newspapers), heard about (on radio or television or through conversations between friends, family members, or teachers), or seen sewage from homes mixing with clean water? Is there a factory or mill nearby that dumps harmful material in water bodies?

3. **Sources of drinking water at school and home:** Ask students if they use the same water for washing and drinking. Where does the drinking water in school and in their homes come from? Do they get water from wells or taps in their homes? Do they get it from water tankers? Or do they fetch water from a pond, river, or a community well? What challenges do they, their families, and people from their neighbourhood face in getting drinking water?

4. **Quality of drinking water:** Are there ways to tell if the drinking water in school and their homes is contaminated? Do they know some ways to test this? If possible, you could arrange for them to visit and talk to local government officials (like the Panchayat President or Sarpanch) to find out more about how, when, and how often water is tested in their locality. You could also show them the **Jal Jeevan Mission** website (see **Fig. 1**). They could use this government website to view and download test reports for some of the water sources in their locality. One of these tests is for the presence of bacteria. Highlight these 'bacteriological' test results and discuss what this tells them about the water quality from these sources.

5. **Connection with disease:** With this context, introduce the fact that reports from Pune suggest that the microorganism most likely to be involved in the rise of GBS cases is a bacterium most commonly found in animal (including poultry) faeces.

- Share that the infections that trigger GBS could be caused by eating undercooked meat or dairy products. Invite one group of students to think of how the bacterium makes its way to such food products. You could encourage students to present this in the form of a diagram.

- Share that the infections that trigger GBS could be also be caused by drinking contaminated water. Invite a second group of students to think of how the bacterium makes its way to drinking water sources. Encourage this group to also present this in the form of a diagram.

- Invite both groups to display and explain their diagrams to the rest of the class. Draw their attention to the number of GBS cases being reported from the same geographic area. Ask students to use this fact to discuss which of these two sources of contamination (food or water) seem more likely to be linked to these cases? What kind of evidence would they need to support their response? Discuss the kind of evidence that scientists have used to arrive at the most likely

cause of the outbreak. Ask students to share how similar or different this is from their own approach.

6. **Preventive measures**: Ask students to observe how drinking water is treated and stored in their homes and school. What steps are taken to make it safer to drink? Is it boiled? Is it filtered? Can they think of other simple measures their classmates and other children in school can take to reduce their chances of falling sick from drinking contaminated water?

At the end of this exercise, you could invite students to present what they have learnt in the school assembly. Emphasize the need to focus on simple preventive measures that can help protect us from disease. They could create a poster, song, or skit for the presentation (preferably in the language they use to speak to their classmates and other students outside class hours). Encourage them to use their own words rather than what they hear teachers use or read in their textbooks.

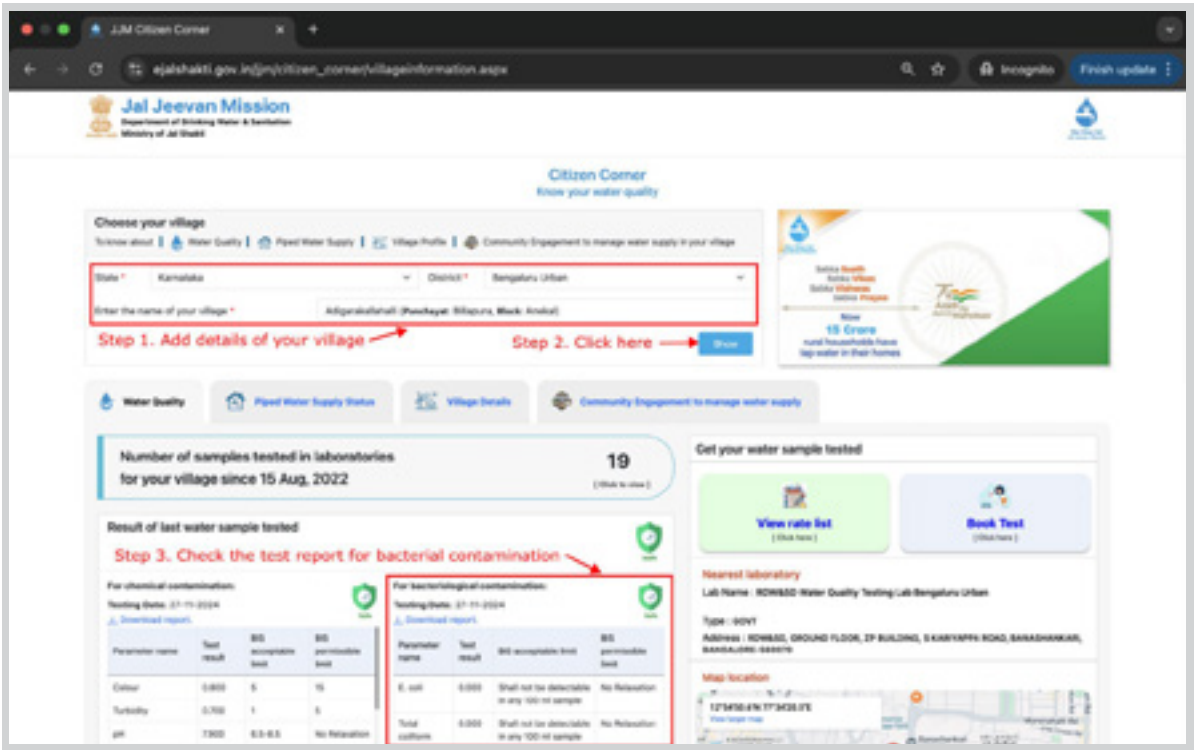


Fig. 1. A screenshot from village-level information on water sources on Jal Jeevan Mission—Citizen Corner. Steps: (1) Fill the spaces given for "State", "District", "Enter the name of your village". (2) Click "Show". (3) Highlight the test results "For bacteriological contamination". URL: https://ejalshakti.gov.in/jjm/citizen_corner/villageinformation.aspx.

Curricular connections:

Discussions around this theme can help meet the following curricular goals listed in National Curriculum Framework for School Education (NCF-SE) 2023 for:

(A) Preparatory-stage EVS:

- CG-1: [The student] explores and engages with the natural and socio-cultural environment in their surroundings. Specifically, it can help them develop the following competency: C-1.1: *"Observe and identify the natural (...natural resources) and social... components in their immediate environment."*
- CG-2: [The student] understands the interdependence in their environment through observation and experiences, developing the basis for appreciation of the idea of '*Vasudhaiva Kutumbakam*'.

Specifically, it can help students develop the following competency: C-2.1: *"Identify natural and human made systems that support their lives (water supply, water cycle, river flow systems… food…)."*

- CG-3: [The student] explains how to ensure the safety of self and others in different (normal as well as emergency) situations. Specifically, it can help students develop the following competencies: (a) C-3.1: *"Describe the basic safety needs and protection (health and hygiene, food, water… precautions, awareness of emergency situations…) of humans, birds, and animals"* and (b) C-3.3: *"Develop simple labels and slogans, and participate in role play on safety and protection in the local environment to be displayed/done in school and locality."*
- CG-4: (The student) develops sensitivity towards social and natural environment. Specifically, it can help students develop the following competencies: (a) C-4.3: *"Describe usage of natural resources in their immediate environment"*, (b) C-4.4: *"Demonstrate how natural resources can be shared, maintained, and conserved"*, and (c) C-4.7: *"Learn about basic social and behavioural norms, values, and dispositions that benefit our social and natural environments and that help our society function smoothly (conserving water… keeping one's environment clean…)."*

(B) Middle-stage science:

- CG-5: [The student] understands the interface of Science, Technology, and Society. Specifically, it can help students develop the following competencies: (a) C-5.1: *"Illustrate how Science and Technology can help to improve the quality of human life (health care…) as well as some of the harmful uses of science in history"*, and (b) C-5.2: *"Share views on news and articles related to the impact that Science/Technology and society have on each other."*
- CG-7: [The student] communicates questions, observations, and conclusions related to science. Specifically, it can help students develop the following competency: C-7.1: *"Use scientific vocabulary to communicate science accurately in oral and written form, and through visual representation."*[5]

Supporting resources:

In discussions around GBS, especially around preventive measures, your students may have many questions about microbes and how they make their way into our body. Two pictorial resources, published in the Oct 2020 issue of i wonder... may be of help:

(a) An 8-page booklet titled 'Common myths about microbes' written by Somdatta Karak.

(b) A poster titled 'The Chain of Infection' written by Vijeta Raghuram.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 18: Too Much Water Too Little Water'. EVS Textbook for Grade IV: 146-157. URL: https://ncert.nic.in/textbook.php?deap1=18-27.
2. National Council of Educational Research and Training (2024). 'Chapter 13: A River's Tale'. EVS Textbook for Grade IV: 106-112. URL: https://ncert.nic.in/textbook.php?deap1=13-27.
3. National Council of Educational Research and Training (2024). 'Chapter 13: Wastewater Story'. Science Textbook for Grade VII: 156-166. URL: https://ncert.nic.in/textbook.php?gesc1=13-13.
4. National Council of Educational Research and Training (2024). 'Chapter 2: Microorganisms: Friend and Foe'. Science Textbook for Grade VIII: 17-31. URL: https://ncert.nic.in/textbook.php?hesc1=2-13.
5. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training.URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

i wonder...
Rediscovering school science

Contributed by:

Chitra Ravi, who works at Azim Premji University, Bengaluru.

Vijeta Raghuram, who is a science communicator with a PhD from the Centre for Cellular and Molecular Biology (CCMB), Hyderabad. She can be contacted at: vijeta.raghuram@apu.edu.in.

CONNECTING
POLICY & PRACTICE IN THE SCIENCE CLASSROOM

PERSPECTIVE

ADITYA PRAKASH

Policies on school science education recommend that teachers offer children hands-on experiences and connect textbook concepts to their real world. What role do these approaches have in middle-stage science classrooms in government schools?

Good science education must help children learn concepts through hands-on experiences and see the relevance of these concepts in their everyday life. Both these aspects are emphasized in the National Curriculum Framework for School Education (NCF-SE) 2023 (see **Box 1**).

The role of 'doing' in science learning is widely recognised. But here are three practical ways in which my colleagues from the science team at Azim Premji Foundation in Damoh, Madhya Pradesh (MP), and I have seen it support more effective classroom practice:

(a) Starting a topic with an activity can engage interest. We have seen this not only with students in a classroom, but also with teachers in a workshop. We start a session, for example, by asking a question that students or teachers can answer only by doing an activity and recording what they observe. This sparks their curiosity and provokes more questions and explorations.

(b) Many of us have memorised illustrations of experiments and activities from our textbook. But it is only when we try doing an activity by ourselves that we begin to question and learn. For example, in a recent workshop, we invited teachers to use a concave mirror to study the reflection of a candle flame. They had seen an illustration of the set-up for this activity in Chapter 11 ('Light') of the

Box 1. School science in policy:

In the section on aims of school science education, the NCF-SE (2023) highlights the need to enable students to: *"..develop an understanding of the natural and physical world through systematic inquiry. Learning science also builds important capacities such as observation, analysis, and inference. This in turn enables the meaningful participation of individuals in society and the world of work with scientific temper, critical and evidence-based thinking, asking relevant questions, analysing practices and norms, and acting for necessary change".*[1] Similarly, speaking of science-related curricular goals and competencies, the NCF-SE (2023) underlines the need for teachers to ensure that: *"... along with conceptual understanding, the capacities of scientific inquiry are developed as age appropriate. These concepts and capacities are chosen both from a disciplinary perspective and in terms of what is useful and necessary in their everyday lives. Students thereby understand the world around them with increasing depth, explore scientific questions at different levels through discussion and experimentation, and learn to communicate this understanding in different ways."*[1]

Both these aspects are particularly important at the middle stage. According to the position paper on teaching science by the National Council of Educational Research and Training's (NCERT) Focus Group (2006), students at this stage: *"... should be engaged in learning principles of science through familiar experiences, working with hands to design simple technological units and modules (like designing and making a working model of a windmill to lift weights) and continuing to learn more on environment and health through activities and surveys. Scientific concepts are to be arrived at mainly from activities and experiments. Science content at this stage is not to be regarded as a diluted version of secondary school science. Group activity, discussions with peers and teachers, surveys, organization of data and their display through exhibitions, etc., in schools and neighbourhood are to be an important component of pedagogy..."*[2]

I think these aims and goals are influenced by both Gandhi Ji's head-heart-hands framework and Bloom's taxonomy's cognitive-affective-psychomotor skills (cognitive skills relate to the head, affective skills to the heart, and psychomotor skills to the hand) framework.[3,4]

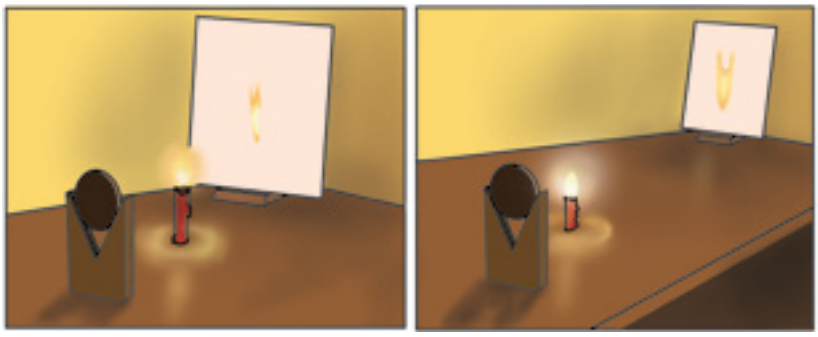


Fig. 1. Adapted from an illustration from Chapter 11 ('Light') of the Grade VII science textbook (NCERT, 2024-2025). This illustration shows the set-up of for an activity to observe the images formed by reflection of light by a concave mirror.

Grade VII science textbook (NCERT, 2024-2025), but had not had the chance to try it by themselves (see **Fig. 1**).[5] It took some trials before they could figure out where the mirror, screen, and object needed to be placed in relation to each other.

(c) The process of doing an activity and sharing observations from it can encourage creativity. Rather than looking for ready-made answers, students and teachers begin to express different ways of thinking and understanding. Discussion around their understanding can help both to develop the ability to reason and a scientific attitude.

'Doing' is particularly important in science teaching and learning in government schools. One example of this can be seen in MP. Due to a shortage of teachers, Grade VI-VIII students are grouped into multigrade classes for every subject, including science. Teachers know which grade-level each student is at, but it is not necessary that a students' understanding of a topic matches their grade-level. To address this, we suggest that teachers begin each topic with an activity. For example, Chapter 4 ('Acids, Bases, and Salts') of the Grade VII science textbook (NCERT, 2024-2025) introduces students to acids and bases.[6] Teachers can begin this chapter by assessing students' ability to identify and group everyday substances as acidic, basic, or neutral. Observing students do this activity can help teachers group them according to their current level of understanding of the topic. Each such group can, therefore, have a mix of students from Grades VI-VIII. The teacher can

now introduce the class as a whole to neutralisation reactions with acid-base combinations. But each group can be assigned an activity with a level of complexity that is appropriate to their current level of understanding.

Another example is related to the pandemic and lockdowns. During this period, students suffered significant learning losses in literacy and numeracy. This had a significant impact on science learning too. Let me give you an example. Chapter 13 ('Light') of the Grade VIII science textbook (NCERT, 2024-2025) introduces children to reflection through activities that require them to measure distances and angles (see **Fig. 2**).[7] Children are expected to learn to measure length and distances in Grade II-IV mathematics. They are introduced to angles in Grade V mathematics. But Grade VII science teachers found that to introduce concepts around reflection, they had to first teach children how to measure angles. Similarly, many children were able to do an activity, but literacy losses meant that they were unable to record their observations or communicate their understanding verbally or in writing. Despite these challenges, science learning did not stop. Government school teachers worked with groups of 8-10 children in *mohalla* classes in the villages. Here too, an activity-based approach was useful. For example, Chapter 7 ('Experiments with Water') of the Grade V Environmental Studies (EVS) textbook (NCERT, 2024-2025) invites children to group different household objects based on their tendency to sink or float in water.[8] Teachers extended this understanding by asking students to compare what would happen to lemon and eggs dropped in plain water versus water with some salt added to it. We designed activity sheets that allowed students to record their observations by checking boxes with a tick or cross. This allowed them to express what they had observed despite their reading and writing losses. Teachers then discussed the explanations for these observations. Even after schools reopened, literacy and numeracy losses continued to affect science learning. For example, Chapter 10 ('Electric Current and its Effects') of the Grade VII science textbook (NCERT, 2024-2025) invites students to set up an electrical circuit (see **Fig. 3**).[9] When this was demonstrated through an activity, students were able to accurately set up their own working circuits. But they were unable to communicate their understanding in grade-appropriate terms in more formal assessments. To address this, we designed activity sheets that helped teachers assess their students' conceptual understanding of topics from the middle-stage science curriculum (like solubility, acids and bases, and physical

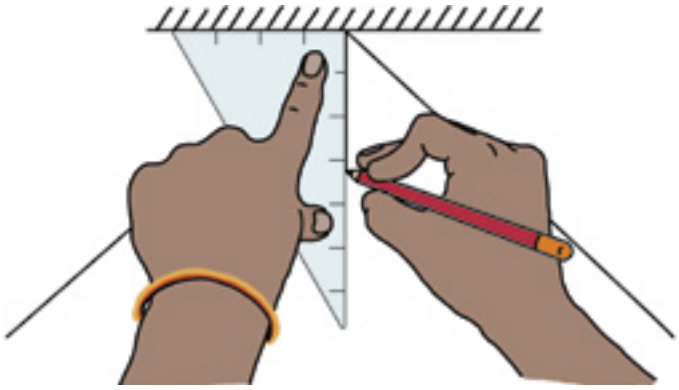


Fig. 2. Adapted from an illustration from Chapter 13 ('Light') of the Grade VIII science textbook (NCERT, 2024-2025). This illustration shows students how to measure the angle of incidence and reflection.

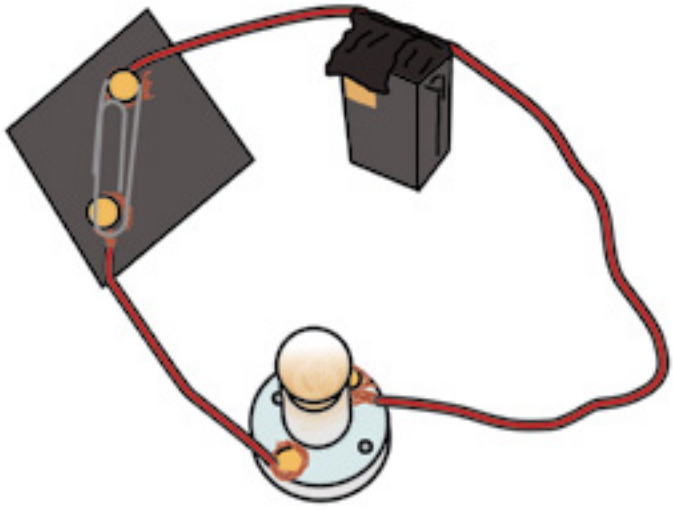


Fig. 3. Adapted from an illustration from Chapter 10 ('Electric Current and its Effects') of the Grade VII science textbook (NCERT, 2024-2025). This illustration shows students how to set up an electrical circuit.

and chemical changes), while also building their Foundational Literacy and Numeracy (FLN) skills.

It is also important that children see science not just as a subject, but as a way to understand the world around us. Many of the children we work with drop out from school after Grade VIII, IX, or X. If we teach science in a way that can help build and develop their skills to pursue a vocation and earn a livelihood, then science becomes relevant even for children who are not able to pursue higher education. It also gives them a sense of identity and dignity in society. Gandhi Ji highlights this in his ideas on education: *"Literacy in itself is no education. I would therefore begin the child's education by teaching them a useful handicraft and enabling them to produce from the moment they begin their training... I hold that the highest development of the mind and the soul is possible under such a system of education. Only, every handicraft has to be taught not merely mechanically as is done today, but scientifically, i.e., the child should know* ***the why and the wherefore of every process.***"[10] For example, Chapter 11 ('Chemical Effects of Electric Current') of the Grade VIII science textbook (NCERT, 2024-2025) introduces students to one application of the chemical effects of electric currents: *"Electroplating is a very useful process. It is widely used in industry for coating metal objects with a thin layer of a different metal. The layer of metal deposited has some desired property, which the metal of the object lacks.*"[11] It shares many real-world applications of this process (see **Fig. 4**). Students learn that tin and zinc are used to electroplate iron. We started a discussion on why iron containers needed this coating. Since students had observed rusting in their everyday world, they were able to appreciate the role tin plays in protecting iron vessels against rusting by sealing it off from the atmosphere. Then we drew their attention to the age-old handicraft of *kalai*. In this process, tin is used to coat the surface of copper and brass vessels. Many students had seen this process in their everyday world and were able to connect it with what they were learning about electroplating in the textbook. They were now able to appreciate how tin could protect these metals against oxidation. This kind of science learning has relevance for them.

Fig. 4. Adapted from an illustration from Chapter 11 ('Chemical Effects of Electric Current') of the Grade VIII science textbook (NCERT, 2024-2025). This illustration shows some common uses of electroplating.

Credits: i wonder... Apr 2025 issue. License: CC BY-NC.

Fig. 5. A photo from our *'Jadu Nahi, Vigyan Hai'* session.

Credits: Aditya Prakash. License: CC BY-NC-ND.

Using this approach to science teaching can contribute to students feeling more motivated to attend school. It can also help build parents' trust in the teachers and school. Let me provide some context here. Some parents send their children to government schools because they cannot afford to send them to private ones. They may, however, believe that children do not learn anything of value in school. So, whenever there is an opportunity, parents may send their children to work (harvesting crops in the field, helping at a local bakery, or working in a local industry) rather than to school. To change this, building a relationship of trust between parents and the teacher is important. How do we do this? In a parent-teacher meeting about midday meals, we invited children to share what they had learnt about food and nutrition in school. The children were able to share some simple facts that had relevance for the discussion. For example, some of them explained why nuts are a good source of nutrition (especially proteins) and energy (calories). But they were also aware that their families and school may not be able to afford a regular supply of many kinds of nuts. So they suggested including peanuts in midday meals, explaining to their parents why this could be a good nutritional alternative to more expensive nuts (like almonds). Parents expressed appreciation that their children were learning things at school that were of practical importance. Organising fairs or *melas* with the help of the Gram Sabha is another way of creating awareness about what children learn in school. For example, our *'Jadu Nahi, Vigyan Hai'* programme aimed to create awareness about science and how children can use it to separate myths from facts in their real world (see **Fig. 5**). Such instances can help change common perceptions about education in government schools. It may even motivate parents to send their children to school rather than engage them in work outside school. We see how this has created small shifts in our Damoh block.

Key takeaways

- Many policies on science education recommend that teachers allow students to 'learn by doing' and connect the textbook with students' real world.
- Learning science concepts by doing an activity can help engage student interest, encourage them to question and learn from their observations and experience, and strengthen their reasoning skills.
- In multigrade classrooms, starting class with an activity can help teachers assess and group students based on their current level of understanding. Teachers can then plan activities for each group at a level of complexity that is best suited to help them learn more advanced concepts.
- With students who struggle with foundational literacy and numeracy skills, hands-on learning experiences in science allow teachers to demonstrate concepts, assess learning, and build scientific skills in more inclusive and less challenging ways.
- For science to become a way that students understand the world, it needs to help them separate myth from fact, be better informed about issues that affect their health and well-being, pursue a vocation, or earn a livelihood. Making such connections can help students see the relevance of science in their real world and its role in developing a sense of identity and dignity in society.
- Parent-teacher meetings and science *melas* can give students the opportunity to demonstrate their skills and the relevance of what they learn in science classes to their parents. This can help build parents' trust in teachers and ensure their support in sending children to school.

Acknowledgments: The editors thank Aditya Prakash for agreeing to our request for an interview and for sharing these reflections from his practice.

Notes:

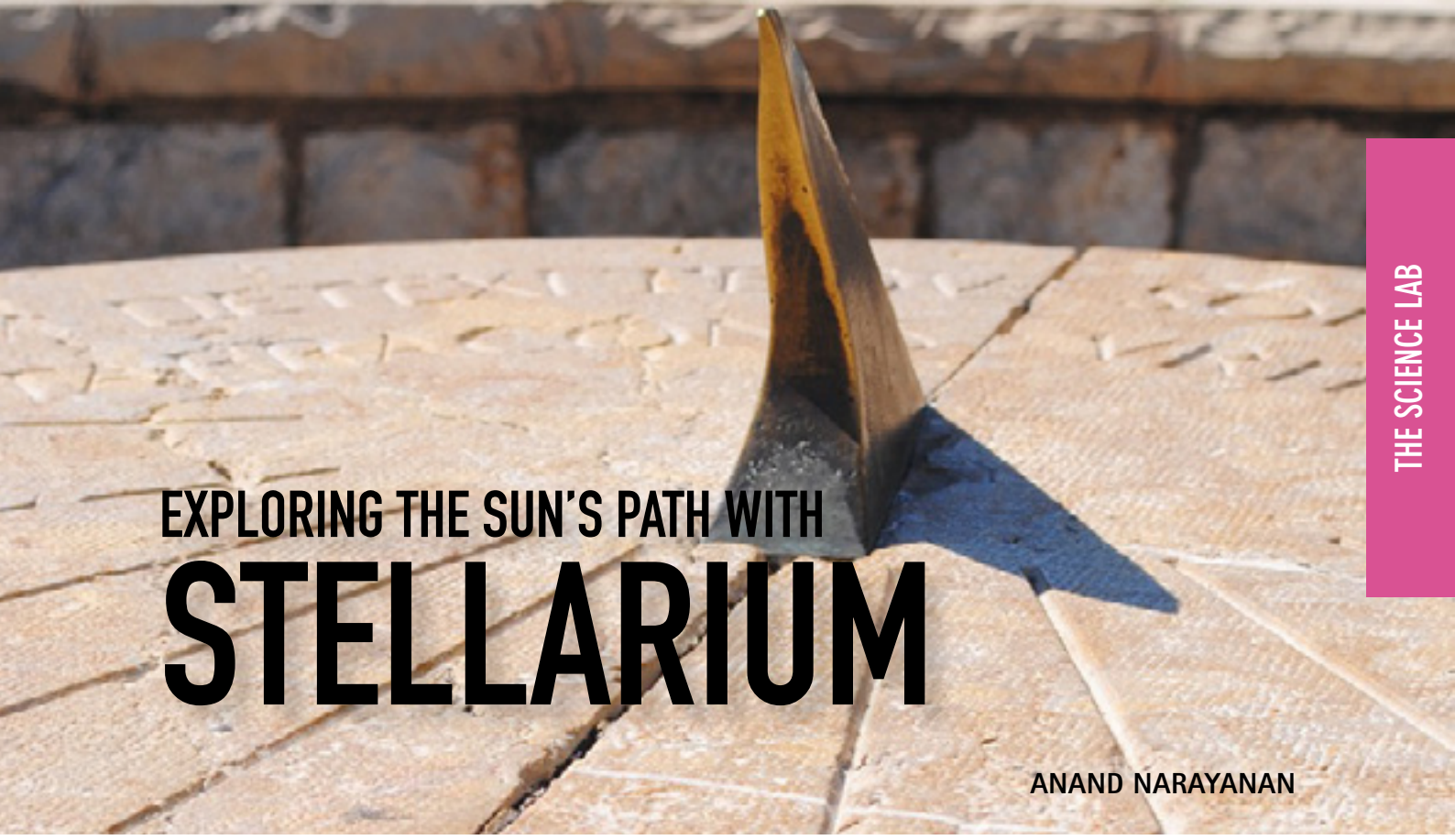
(a) Credits for the image (A Science Experiment) used in the background of the article title: GPE/Deepa Srikantaiah (Flickr.com). URL: https://www.flickr.com/photos/gpforeducation/8644430776. License: CC BY-NC-ND 2.0 Generic Deed.

(b) This article is based on an interview with Aditya Prakash. The questions for the interview were put together by Vijeta Raghuram, Radha Gopalan, and Chitra Ravi. The interview was conducted by Vijeta Raghuram and Radha Gopalan. It was transcribed by Vijeta Raghuram using DESCRIPT. The transcript was cleaned up and translated from Hindi into English by Rajesh Utsahi. The English transcript was reviewed and cleaned up by Radha Gopalan. The excerpts presented in this piece were selected, edited, and structured by Chitra Ravi.

References:

1. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
2. National Council of Educational Research and Training (2006). 'Position Paper National Focus Group on Teaching of Science'. URL: https://ncert.nic.in/pdf/focus-group/science.pdf.
3. Tandon, Shruti (2019). 'Gandhi's Educational Thoughts'. URL: https://www.mkgandhi.org/articles/Gandhis-educational-thoughts.php. Accessed on February 7, 2025.
4. Clark, Donald R. (1999). 'Bloom's Taxonomy of Learning Domains'. URL: http://www.nwlink.com/~donclark/hrd/bloom.html.
5. National Council of Educational Research and Training (2024). 'Chapter 11: Light'. Science Textbook for Grade VII: 123-141. URL: https://ncert.nic.in/textbook.php?gesc1=11-13.
6. National Council of Educational Research and Training (2024). 'Chapter 4: Acids, Bases, and Salts'. Science Textbook for Grade VII: 38-46. URL: https://ncert.nic.in/textbook.php?gesc1=4-13.
7. National Council of Educational Research and Training (2024). 'Chapter 13: Light'. Science Textbook for Grade VIII: 165-180. URL: https://ncert.nic.in/textbook.php?hesc1=13-13.
8. National Council of Educational Research and Training (2024). 'Chapter 7: Experiments with Water'. EVS Textbook for Grade V: 60-66. URL: https://ncert.nic.in/textbook.php?eeap1=7-22.
9. National Council of Educational Research and Training (2024). 'Chapter 10: Electric Current and its Effects'. Science Textbook for Grade VII: 109-122. URL: https://ncert.nic.in/textbook.php?gesc1=10-13.
10. Gandhi, M. K (1969). 'The Selected Works of Mahatma Gandhi, Vol. 5: The Voice of Truth'. Navijan Publishing House. URL: https://www.mkgandhi.org/ebks/the-voice-of-truth.pdf.
11. National Council of Educational Research and Training (2024). 'Chapter 11: Chemical Effects of Electric Current'. Science Textbook for Grade VIII: 138-149. URL: https://ncert.nic.in/textbook.php?hesc1=11-13.

Aditya Prakash works with Azim Premji Foundation as a teacher educator and science resource person at Damoh, MP. He joined the Foundation as an associate member at Khargone, MP, in July 2018. Aditya has been working on supporting FLN skills, focusing on middle-stage science, for the past seven years. He completed an integrated graduation (B.Sc.-B.Ed.) and post-graduation from Hari Singh Gour Central University, Sagar, MP. He can be reached at: aditya.prakash@azimpremjifoundation.org.



EXPLORING THE SUN'S PATH WITH STELLARIUM

ANAND NARAYANAN

Does the Sun always rise due East? Does the length of day change with our latitude? Why is the length of our day-night cycle 24 hours? How do we use Stellarium, a free virtual planetarium software, to help students visualise the movement of the Sun and other stars across our sky?

Systematic observations of patterns in the apparent motion of heavenly bodies across our sky have played an important role in shaping our concept of time, our sense of direction, and how we navigate the globe. The preparatory-stage Environmental Studies (EVS) and middle-stage science curricula encourage students to observe some of these patterns themselves (see **Teacher's Guide I**). But making these observations in the real world can be a slow (taking as long as a year) and imprecise process. Observations from one location may not capture differences caused due to the Earth's tilt and rotation. Also, making such observations may not be practical in all contexts.

For these reasons, virtual planetarium software can be good substitutes to real-world observations. Chapter 12 of the Grade VI science textbook (NCERT, 2024-2025) suggests that: *"To find out when and in which portion of the sky a star or a constellation will be visible from your location, you may take the help of sky mapping apps that can be downloaded on a mobile phone or other online resources. Sky Map is a very handy app for identification of stars, constellations, and planets from mobile phones. Stellarium is another such app. The computer version of Stellarium is free for download and has many features".*[1] This is one application of Stellarium (see **Box 1**). Teachers can also use this interactive and visually engaging educational tool in the classroom to help students investigate many patterns in the sky (see **Teacher's Guide II**). I share some examples.

Rising and setting positions of the Sun

Students learn that, when seen from any location on Earth, the Sun appears to rise in the east and set in the west. For example, Chapter 10 ('Walls Tell Stories') of the Grade V EVS textbook (NCERT,

Box 1. About Stellarium:
Stellarium can be downloaded for free from www.stellarium.org. Students can use this software in the classroom to see the position of celestial objects (including deep-sky objects like galaxies and star clusters) on any date and at any time. They can zoom into or out of an object, change their location of observation to any place on the Earth, move forward or back in time, see the sky without the Earth's atmosphere, and switch on or off a feature that provides labels and boundaries for constellations. These features are easy to locate on the software and are also outlined in the user's guide that comes along with it.

2024-2025) asks students: *"Where is east-west? At the place where you are, where does the Sun rise? Where does it set? Where you are standing, find out what all is there to your east? What all is there to your west? Also, find out what places are there to your north and south?"*.[2] But does the Sun always rise exactly due East? Does it always set exactly due West? Do the rising and setting positions of the Sun remain the same throughout the year? Would we see any difference in these positions if we were to view them from a different latitude? Invite students to investigate these questions using Stellarium (see **Activity Sheet I**).

By the end of this activity, students will observe that the position of the rising Sun, for example, drifts in the following cyclical manner:

- March 21 (± 1 day): The Sun rises exactly due East.
- From March 22-June 20: The rising Sun drifts towards the north of East.
- June 21 (± 1 day): The rising Sun reaches maximum north of East.
- From June 21-September 21: The rising Sun starts drifting towards the South.
- September 22 (± 1 day): Again, the Sun rises exactly due East.
- From September 23-December 21: The rising Sun continues to drift towards south of East.
- December 22 (± 1 day): The rising Sun reaches its maximum south of East.
- From December 23-March 20: The rising Sun starts drifting towards the North.

Discussion around these observations can highlight the following:

(a) On most days of the year, the Sun rises somewhere along the eastern horizon and sets somewhere in the west. Neither does it always rise due East nor does it always set due West.

(b) The Sun rises due East and sets due West only twice a year. These two days can be introduced as the 'Vernal Equinox' or *'Vasantha Sampath'* (March 21 ± 1 day) and 'Autumnal Equinox' or *'Sharat Sampath'* (September 22 ± 1 day). 'Equinox' loosely translates into 'equal day and night'.

(c) The centuries-old calendar system in India divides the year into two halves. The six-month period between December and June, when the rising (and setting) position of the Sun moves from the south to the north, is called *'Uttarayana'* (*'uttara'*: north and '*ayana*': journey) or its 'northward' journey. The other six-month period, between June and December, when the rising (and setting) position of the Sun drifts from the north to the south, is called *'Dakshinayana'* or its 'southward' journey.

These questions can be shared with students for further exploration:

(a) How would this pattern change if observed from a location at a different latitude? Students can investigate this by using the 'Location Window' on Stellarium to view the position of sunrises and sunsets from 1-2 other locations (chosen from both the Northern and Southern Hemispheres) of their choice. This can be used to highlight the fact that the shift in the Sun's rising and setting points over a year is the same in both the Northern and Southern Hemispheres.

(b) Do stars other than the Sun also appear to rise from the east and set in the west? Students can observe the apparent movement (fast-forwarded in time) of stars (other than the Sun) in the sky by increasing the time speed from the bottom control panel. Discussions around their observations from this exercise can be used to highlight that all stars (like the Sun) appear to rise in the east and set in the west because the Earth's spin is oriented from west to east on its axis (see **Fig. 1**). This means that if the Earth were to be viewed from above the North Pole, it would show counterclockwise rotation (also called prograde rotation).

Length of day and night

Students learn that the rising and setting times of the Sun determine the duration of day and night at any location and at any time of the year. For example, Chapter 9 ('Motion and Time') of

the Grade VII science textbook (NCERT, 2024-2025) tells students that: *"Our ancestors noticed that many events in nature repeat themselves after definite intervals of time. For example, they found that the Sun rises every day in the morning. The time between one sunrise and the next was called a day... A year was fixed as the time taken by the Earth to complete one revolution of the Sun".*[3] But is the length of day equal to that of night at any time of the year? Does the duration of day (or night) at their location remain the same throughout the year? Does it change at different latitudes? Invite students to investigate these questions using Stellarium (see **Activity Sheet II**).

By the end of this activity, students will observe that:

- For locations along the equator, the duration of day and night is roughly equal and does not vary much over the course of a year.
- For locations away from the Equator, day and night are of near equal duration on two days of the year: On March 21 ± 1 day (or Vernal Equinox in the Northern Hemisphere and Autumnal Equinox in the Southern Hemisphere) and on September 22 ± 1 day (or Autumnal Equinox in the Northern Hemisphere and Vernal Equinox in the Southern Hemisphere).
- For locations in the Northern Hemisphere, the duration of day increases from December-June (the *Uttarayana* phase) and decreases from June-December (the *Dakshinayana* phase). The longest day of the year in this hemisphere typically occurs on June 21 ± 1 a day (called 'Summer Solstice'). The duration of night proportionately decreases from December-June and increases from June-December. The longest night of the year in this hemisphere typically occurs on December 22 ± 1 day (called 'Winter Solstice').
- For locations in the Southern Hemisphere, the duration of day decreases from December-June and increases from June-December. The longest day of the year in this hemisphere typically occurs on December 22 ± 1 day (or Summer Solstice). The duration of night proportionately increases from December-June and decreases from June-December. The longest night of the year in this hemisphere typically occurs on June 21 ± 1 day (or Winter Solstice).
- The seasons are opposite in the two hemispheres. For example, in December, when the Sun completes its Dakshinayana journey, it is winter in the Northern Hemisphere, but summer in the Southern Hemisphere. In June, when Uttarayana is about to end, it is summer in the Northern Hemisphere and winter in the Southern Hemisphere.
- At both geographic poles, a day (called 'Polar Day') lasts for six months (of continuous sunlight) and is followed by a night (called 'Polar Night') that lasts for six months (of continuous darkness). When it is day in the North Pole, it is night in the South Pole, and vice versa.

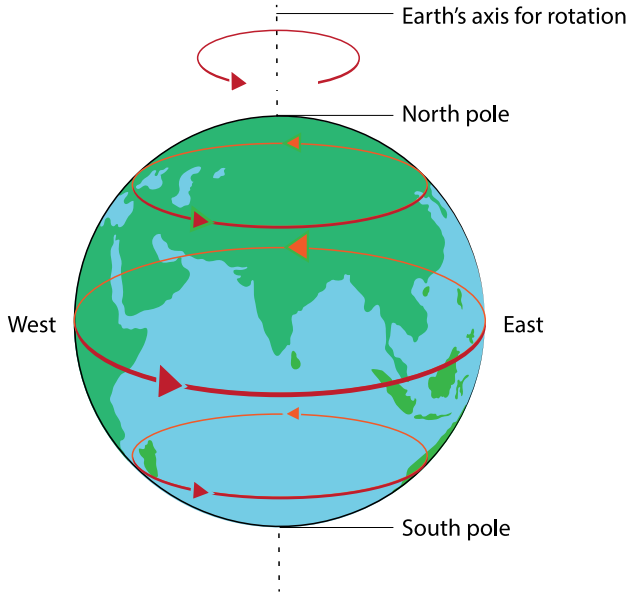


Fig. 1. The orientation of the Earth's spin on its own axis is from the west to east. This is why the stars (including the Sun) we see from the Earth seem to move from the east to the west.

Credits: Adapted from an image from Earth & Space Science—Big Kid Science. URL: https://grade8science.com/1-3-1-how-is-earth-moving-in-our-solar-system/.

The daily period of the Earth

The length of the Earth's daily day-night cycle is the time it takes to complete one 360° rotation about its own axis. How do we know when this occurs? By observing the Earth's spin relative to another celestial object. This object could be the Sun or any other star. The period of the Earth can be calculated by measuring how long it takes for it to return to its original position in relation to this reference point. Chapter 12 ('Beyond Earth') of the Grade VI science textbook (NCERT, 2024-2025) tells students that: *"While revolving around the Sun, the Earth is also rotating about its own axis. For one full rotation, the Earth takes about 24 hours,*

Box 2. Calculating altitude on Stellarium:

Altitude is a measure of how high or how low an object is with reference to our horizon. A star that is just rising from the eastern horizon has an altitude of 0°. A star that is just setting in the western horizon also has an altitude of 0°. A star that is directly above our head (called the 'Zenith Point') is at an altitude of 90°. A star that has crossed the zenith has an altitude less than 90°. (see **Fig. 2**).

Just as an hour is divided into sixty minutes and a minute is divided into sixty seconds, angles that span less than a degree are divided into minutes and seconds. 1 minute is 1/60th of a degree and one second is 1/60th of a minute. Instead of writing angles in decimal notation, it is common to express them in minutes and seconds. Thus, 45.5° is also written as 45 degrees 30 minutes (or 45°30'). Similarly, 60.73° is also written as 60 degrees 43 minutes 48 seconds (or 60°43'48").

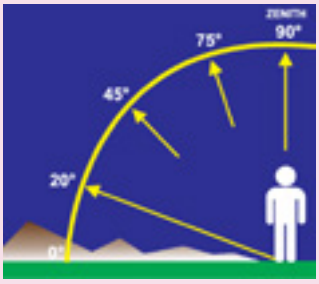


Fig. 2. Measuring the altitude of a celestial object in our sky.

Credits: Anand Narayanan. License: CC BY-NC.

Box 3. Curricular connections:

These activities and discussions can help meet the following curricular goals outlined in the National Curriculum Framework for School Education (NCF-SE) 2023 for:

(A) Preparatory-stage EVS:

- CG-1: [The student] explores and engages with the natural and socio-cultural environment in their surroundings. Specifically, it can support students in developing the following competencies: (a) C-1.1: *"Observe and identify the natural (... sun and moon, stars, planets...) and social components in their immediate environment"*, and (b) C-1.3: *"Ask questions and make predictions about simple patterns (season change...phases of the moon, movement of stars and planets...) observed in the immediate environment"*.[4]

(B) Middle-stage science:

- CG-2: [The student] explores the physical world in scientific and mathematical terms. Specifically, it can support students in developing the following competency: C-2.5: *"Observe and identify celestial objects (stars...)... using a simple telescope and images/ photographs, and explain their role in navigation, calendars, and other phenomena (...life on the Earth)"*.[4]
- 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 support students in developing the following competency: C-6.2: *"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...)"*.[4]

which is called a day".[1] This value is based on the apparent daily motion of the Sun in the sky. Viewed from the Earth, the Sun appears to take 24 hours to complete a full circle around it. But is this period exactly or approximately 24 hours? Would it be the same if we chose a different star as our reference? Invite your students to explore these questions using Stellarium (see **Activity Sheet III**). For this exercise, students will need to measure how long it takes for the Sun to reappear at the same altitude in the sky (see **Box 2**).

By the end of this activity, students will observe that:

- It takes 24 hours for our point of observation on the Earth to return to the same position in relation to the Sun. This duration is called a 'Solar Day'. Since our everyday activities are tightly linked to the rising and setting of the Sun, all the clocks we use are based on solar time.
- It takes 23 hours and 56 minutes for our point of observation on the Earth to return to the same position in relation to any star other than the Sun. This duration of time is called a 'Sidereal Day' ('Sidereal' is derived from a term in Latin that means 'in relation to stars'). Because of their interest in objects beyond the Sun that become visible during the night, astronomers often use sidereal time.

Discussions around this difference can be explained by sharing the following: The Earth takes 365 days to complete 360° around the Sun. This means that the Earth moves a little less than a degree in the time it takes to complete a rotation around its own axis. To return to its exact position in relation to the Sun, it needs to rotate by an additional amount, equal to 1/365 of a full turn. The Earth takes four minutes to cover this distance. This is why a solar day is longer than a sidereal day.

Parting thoughts

Stellarium allows students to simulate real-world observations of the movement of the Earth in relation to the Sun over a year from different latitudes, while sitting in their classroom. It can also help students appreciate the role these observations have played in shaping our concepts of time and direction (see **Box 3**).

The activities shared in this article are only a small handful of the exercises that can be simulated on Stellarium. As your students and you become more familiar with the interactive features that this software offers, you will be able to write your own exercises to explore other patterns and movements in our changing sky.

Key takeaways

- Tracking the apparent movement of the Sun and other stars across our sky can help students appreciate their role in shaping our concept of time and direction.
- Student explorations of the patterns that shape these concepts through real-world observations can be slow, limited, and imprecise.
- Using free virtual planetarium software, like Stellarium, as a teaching tool in the classroom allows students to inquire into and observe how these patterns change during a year and across different latitudes.

Notes:

(a) Credits for the image (Sundial) used in the background of the article title: CarolinaP (pixabay.com). URL: https://www.needpix.com/photo/558618/sun-dial-tarragona-tourist-traditional-solar-ancient-watch-clock-day. License: Public Domain.

(b) This article was first published in i wonder..., November 2015, pp. 105-109. The original draft can be found here: https://publications.azimpremjiuniversity.edu.in/1246/. The version included in this issue has been reviewed and modified in structure and wording to align with our readership of middle-stage science and preparatory-stage EVS teachers. It includes new material.

(c) This article includes five detachable classroom resources: **Teacher's Guide I: Tracking the Sun**, **Teacher's Guide II: Using Stellarium on a Computer**, **Activity Sheet I: Track the Sun's Rising & Setting Positions**, **Activity Sheet II: Track the Length of Day**, and **Activity Sheet III: Find the Length of the Day-Night Cycle**.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 12: Beyond Earth'. Science Textbook for Grade VI: 231-252. URL: https://ncert.nic.in/textbook.php?fecu1=12-12.
2. National Council of Educational Research and Training (2024). 'Chapter 10: Walls Tell Stories'. EVS Textbook for Grade V: 87-98. URL: https://ncert.nic.in/textbook.php?eeap1=10-22.
3. National Council of Educational Research and Training (2024). 'Chapter 9: Motion and Time'. Science Textbook for Grade VII: 92-108. URL: https://ncert.nic.in/textbook.php?gesc1=9-13.
4. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

Anand Narayanan teaches astrophysics at the Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram, Kerala. His research is on understanding how baryonic matter is distributed outside of galaxies at large scales. He regularly contributes to astronomy-related educational and public outreach activities. Every so often he likes to travel, exploring the cultural history of South India.

The Science Lab

TEACHER'S GUIDE I: TRACKING THE SUN

Chapter 12 ('Beyond Earth') of the Grade VI science textbook (NCERT, 2024-2025) introduces students to concepts of stars, planets, satellites, and constellations.[1] While many students may enjoy watching the sky, these textbook concepts can seem abstract, distant, and irrelevant to their everyday experience. That the objects they can see in the sky with their eyes seem nothing like the 3-D images they see in their textbooks can increase this disconnection. How do we address this? One approach may be to offer students the opportunity to make observations of celestial objects that have relevance in their real-world.

What can our students observe that have relevance in their world?

To observe details of many celestial objects, students and teachers may require expensive equipment. But many patterns of the movement of these objects across our sky are visible to the naked eye. In a section titled 'Stars and Constellations', Chapter 12 of the Grade VI science textbook shares that: *"Some groups of stars appear to form patterns which are like shapes of familiar things. Long ago, when watching stars in the night sky was a favourite pastime of our ancestors, they identified these star patterns with animals, things, or characters in stories. Many cultures had names for patterns based on their own stories. These imaginary shapes helped them in recognising stars in the sky".*[1] One of the activities suggested by the 'Learning Further' section at the end of this chapter is: *"Try to find out the names of planets in your local language. Also, find out the stories associated with stars and constellations in your region. Present these stories in a pictorial form".*[1] Encourage your students to share what they learn from this exercise in class. This chapter also offers a response to the question that many students may hold: *"Do we find patterns among the stars just for fun or is there some use of these patterns?... Recognising stars and their patterns was a useful skill for navigation in the olden times. Before the arrival of modern technology or even before the invention of the magnetic compass, it helped people, particularly sailors and travellers, in finding directions at sea or on land. It is still used in emergencies as a backup method".*[1]

(A) Observing the night sky: In the same textbook chapter, the section titled 'Night Sky Watching' shares ideas for two activities (Activity 12.2 and 12.3) that students can use to observe some such patterns themselves. Since both activities can only be done outside regular school hours, students may need to do it on their own. This may pose the following challenges:

- Finding a good location: As Chapter 12 of the Grade VI textbook shares: *"If you stay in a big city, you may find that the sky is rarely clear and only a few stars are seen in the night sky. This is due to light pollution, smoke, and dust... In villages or areas where there is less light pollution, a larger number of stars can be seen. Also, your house may be surrounded by tall buildings and trees, which may block your view...".*[1]
- Identifying what they are observing: *"Not all stars and constellations are visible from all places on Earth and on all nights in a year... To identify a star or a*

constellation, you need to know what a particular constellation looks like and where to look for it in the night sky... To find out when and in which portion of the sky a star or a constellation will be visible from your location, you may take the help of sky mapping apps that can be downloaded on a mobile phone, or other online resources".[1] Not all students have access to online resources or mobile phones that can support such apps. Even students who have access to these resources may need some support from an adult till they become confident about using them on their own.

(B) Observing the daytime sky: Is there a star that is visible in the day and that our students can identify without needing aid from parents or teachers? Yes, the Sun. This is also what the astronomer Prajval Shastri points out in her article titled 'Daytime Astronomy with Self-constructed Equipment'.[2] Yet, most of what our students learn about the Sun is as facts from their textbooks. One reason for this could be that viewing the Sun directly can permanently damage the retina of our eyes. It is important for students to learn how to protect their eyes against the risk of such damage.[3] Prajval's article shares step-by-step guides that students can use to construct simple equipment (like a magic mirror and mounted solar ball projector) to safely track the Sun. Unlike the expensive instruments that students may need to inquire into other stars, the equipment in Prajval's article can be made from inexpensive and easily available material.

What can students learn from tracking the apparent motion of the Sun?

In his article titled 'Exploring the Sun's path using Stellarium', the astrophysicist Anand Narayanan highlights the fact that our concepts of time and direction have been shaped by observations of the Sun's predictable path.[4] Teachers can draw attention to the historical role this path has played in determining how we navigate the globe and design the time-keeping devices and calendars we use to structure our lives. In the same article, Anand shares three questions about the Sun's path that students learn as facts. He also shows how students can use Stellarium, a free virtual planetarium software, to explore these questions over long periods and across different latitudes.[4] But which aspects of these questions can students explore through real-world observations?

(A) Does the Sun always rise exactly due East and set exactly due West? Prepare your students for this exploration by introducing them to a compass. Show them how it can be used to determine due East (90 degrees to the right of the north on a compass) and due West (90 degrees to the left of the north on a compass).

Once your students are familiar with these concepts, ask if they can predict how many days in a week the Sun rises due East and sets due West. It can be useful to ask students to share observations or reasoning that support their guesses and open these to class discussion. You could record the guesses that students find most plausible on the board and invite them to share ways of testing them. One approach could be that students record the rising and setting positions of the Sun, relative to due East and due West, on each day of a week. How?

- Keep a compass at eye level.
- Mark the direction of the Sun (looking briefly, and not directly, towards it) the moment it appears above the horizon at sunrise or the moment it disappears below the horizon at sunset.
- Use the compass to estimate the

difference in the angle of sunrise from due East and the angle of sunset from due West.

Once the class agrees on an approach, you could give them a week to make their observations. Ask them to make note of any challenges they face in making precise observations. At the end of the week, invite them to share and discuss their observations in class. It can be helpful at this point to use the board to draw a sketch that shows the Earth revolving around the Sun. **Prompts for discussion:** *If the Earth revolves around the Sun, why does it look like the Sun is moving across our sky? The compass may have helped you get a broad sense of the direction of sunrise and sunset relative to you. But how helpful was it in getting the specific position of sunrise and sunset? Did your estimate of the difference in angle vary by much from one day to the other? Did it change by much over a week? Can you think of some way of making more precise observations of the rising and setting positions of the Sun? Based on what you have seen, do you think the positions of sunrise and sunset show any change in a year? Would you see any difference in these positions if you viewed them from a different latitude?* You could invite students to test their predictions for the last two questions using Stellarium.

(B) Does the length of day and night change over a year? Prepare your students for this exploration by sharing that a day is the duration of time between a sunrise and the sunset that follows it. Similarly, a night is the length of time between a sunset and the sunrise that follows it.

Once your students are familiar with these concepts, ask if they expect to see any differences in the length of day and night over a month. Again, it can be useful to ask students to share observations or reasoning that support their guesses and open these to class discussion. You could record the guesses that students find most plausible on the board and invite them to share ways of testing them. One approach could be that students record sunrise and sunset times at their location for a month. They could also get these details for the past month by looking at sunrise and sunset times in a local newspaper or calendar. Invite students to share and discuss their observations in class. **Prompts for discussion:** *Why do we use sunrise and sunset to define the length of day and night? Does this definition have any (practical) relevance in our real world? What if we decided that the length of day and night everywhere in the world and throughout the year is to be 12 hours each. What would it change about our lives? Did the timings of sunrise and sunset in the newspaper match your own observations? Can you think of some ways of making more precise observations? Do you expect to see any differences in the length of day and night over a year? Do you expect to see any changes in this pattern at other latitudes?* You could invite students to test their predictions for the last two questions using Stellarium.

(C) Is the length of a day-night cycle exactly 24 hours? Prepare your students for this exploration by sharing that the day-night cycle is defined as the duration of time that the Earth takes to make one complete turn around its own axis.

Ask students if they can think of a way:

(a) To measure this period: One approach is to choose an object in space as our reference and measure how long it takes for this object to appear at the same position in the sky. Let us suppose, for example, that the Sun appears to be directly above our heads at noon on a certain day. The day-night cycle would be the shortest amount of time it takes for us to see the Sun return to this position relative to us.

(b) To tell when it is noon at their location: Likely that students may find this question confusing. They may assume that noon is always at 12 PM IST. You could invite them to imagine that they have no clocks or watches. Is there some way they could tell when it is noon? If needed, share that noon is the time of the day when the Sun is at the highest point in the sky. Ask if they have noticed the length of their shadows at noon. If your students show interest in this aspect, invite them to

try the outdoor (Activity 1: Shadow Tracing Over Time) and indoor (Activity 2: Shadow Tracing Indoors) activities that Sanda Roberts shares in her article 'The Science of Sunlight and Shadows'.[5] Both activities can be done with inexpensive and readily available material. If needed, these activities can be made simpler. For example, students may find it easier to use an object rather than a person as a shadow maker. Once students arrive at the fact that noon is when their shadows are shortest, you could invite them to find out when this happens at their location. Discuss their observations in class. You could also share Alok Mandavgane and Varuni P's article 'When is noon?' with them.[6]

Work with students to help them calculate the duration of time it takes for the Sun to return to its highest point in the sky. For this, students may need to find when it is noon on two consecutive school days. If students do not have access to mobile phones that allow the use of apps, encourage them to try the first two methods shared in Alok and Varuni's article and share their findings in class. You could use the 'Zero Shadow Day' (ZSD) app to find the exact timing of noon. **Prompts for discussion:** *Why do we use the Earth's rotation to define the length of our day-night cycle? Does this definition have any (practical) relevance in our real world? Can you think of a simpler and more useful way of defining our day-night cycle? Did the timing of noon that you found by measuring the length of your shadow match the exact timing in the ZSD app? How different was this from your calculation of noon as falling between sunrise and sunset? Can you think of some ways of making more precise observations? When viewed from the Earth, it takes 24 hours for the Sun to appear in the same position in the daytime sky. Do you expect it to take 24 hours for other stars to return to the same positions in the night sky?* You could invite students to test their predictions for the last question using Stellarium.

What can students learn from these exercises?

Doing these exercises in the real world first can help students appreciate the importance and the challenges of making precise observations and measurements in science. They will be able to see for themselves how difficult it is to find differences in the position of sunrise from one day to the next. Or how small the difference in length of day and night over a month can be. For example, the length of day in Bengaluru, Karnataka, on Mar 1, 2025 was 11 hours 53 minutes and 3 seconds. This steadily increased to a length of 12 hours 14 minutes and 31 seconds on Mar 31, 2025.[7] Some of them are likely to share what they did to make their measurements more precise. In this way, students may begin to practice what it means to observe the natural world like a scientist. Likely they will come back to class with more questions than you started this exercise with. They may, for example, want to know how scientists can tell when it is noon with such precision. Discussions around the relevance of how scientists define the day-night cycle, for example, can be connected to the many biological processes (including those related to our own health and well being) that are tightly linked to it in ways that we are just beginning to discover. For example, teachers could ask: Is the concept of day relevant only as a measure of the duration of time we have access to a source of illumination? You

can point out that if this were true, we could extend the length of days by artificial illumination. Invite students to imagine what this would change about their life and the life of other organisms on the Earth. Amol Anandrao Kate's article 'Let there be Night' can be useful in preparing for this discussion.

In addition to helping students appreciate the relevance of textbook concepts in astronomy in their everyday world, these explorations can help meet two curricular goals recommended by the National Curriculum Framework for School Education (NCF-SE) 2023:

- CG-2: [The student] explores the physical world in scientific and mathematical terms.
- CG-6: [The student] explores the nature and processes of Science through engaging with the evolution of scientific knowledge and conducting scientific inquiry.[8]

References:

1. National Council of Educational Research and Training (2024). 'Chapter 12: Beyond Earth'. Science Textbook for Class VI: 231-252. URL: https://ncert.nic.in/textbook.php?fecu1=12-12.
2. Shastri, Prajval (2023). 'Daytime Astronomy with Self-constructed Equipment'. i wonder... (10). pp. 4-16. ISSN 2582-1636. URL: https://publications.azimpremjiuniversity.edu.in/5727/.
3. Vigyan Prasar, Bharat Gyan Vigyan Samiti, and Navnirmiti Learning Foundation (2012). 'Suraj Zameen Par Experiment 13: Safe Viewing'. Beacontelevision, Youtube. URL: https://www.youtube.com/watch?v=-Xdy5TOi2E4.
4. Narayanan, Anand (2025). 'Exploring the Sun's path using Stellarium'. i wonder.... ISSN 2582-1636.
5. Roberts, Sandy (2022). 'The Science Of Sunlight And Shadows'. Science Friday. URL: https://www.sciencefriday.com/educational-resources/sunlight-and-shadows/. Accessed on Apr 2, 2025.
6. Mandavgane, Alok and P, Varuni (2021). 'When is noon?'. i wonder.... pp. 45-46. ISSN 2582-1636. URL: https://publications.azimpremjiuniversity.edu.in/3399/.
7. Time and Date AS (1995-2025). 'Bangalore (South), Karnataka, India — Sunrise, Sunset, and Daylength, March 2025'. URL: https://www.timeanddate.com/sun/@12022490?month=3. Accessed on April 10, 2025.
8. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.

Contributed by:
Chitra Ravi, who works at Azim Premji University, Bengaluru.

The Science Lab

TEACHER'S GUIDE II: USING STELLARIUM ON A COMPUTER

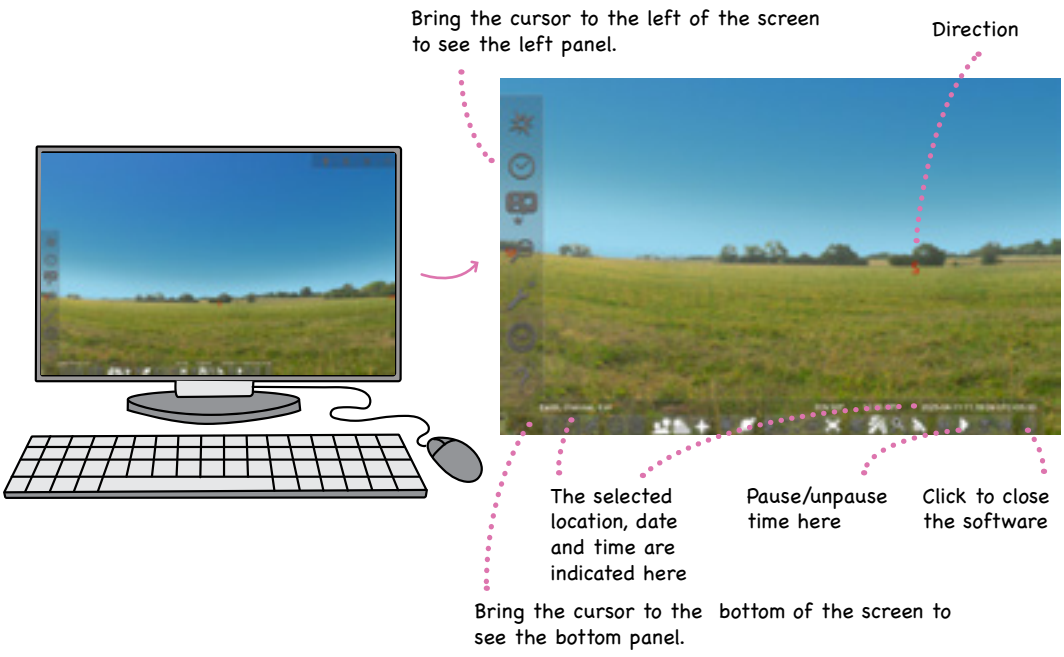
Stellarium can be used free-of-cost after downloading the free software on a computer or a mobile device. It can also be used online, on your web browser. In this Teacher's Guide, you will find a few basic steps to install and demonstrate the software to your students on a computer.

Step 1: Install Stellarium

Visit www.stellarium.org on your web browser. On the top of the page, click on the link that matches the operating system of your computer to start downloading Stellarium. Follow the steps that appear on the screen to install it. Open the software by clicking on its icon.

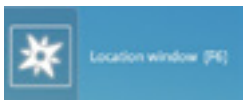
Choose your operating system from here to download and run the application.

Step 2: Familiarize yourself with the icons on the opening screen. Use the cursor to view the icons on the left and bottom panels.



TEACHER'S GUIDE

Step 3: You can set the location using the **'Location window'** on the left panel. Select your location using either Method 1 or Method 2.



Icon on left panel

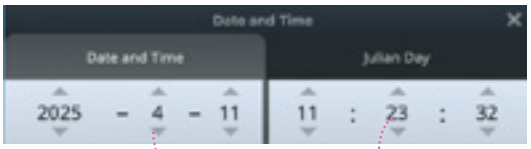
Method 1: Step 1
Type the location of your interest.

Method 1: Step 2
Select the location from the list that appears on the screen.

Method 2:
Select your location by clicking on the map.

Step 4: You can set the date and time using the **'Date/time window'** on the left panel.

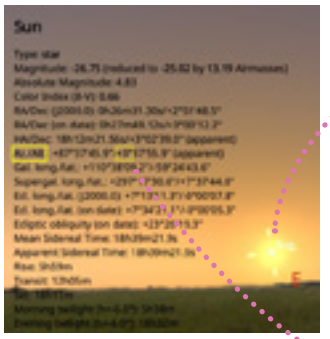
Icon on left panel



Use the arrows or type the number.

Step 5: You can now explore Stellarium to find out more about a celestial object (like its altitude from an observer on Earth)

The Sun as visible on the main screen



Step 1: Click on the object in the sky to get its details.

Step 2: Note down the value of altitude (Alt) in degrees.

Web-version of Stellarium:

This is the **opening screen of the web version** on a computer.

If you are unable to install Stellarium on your computer, but have a good internet connection, then try using Stellarium directly on the website https://stellarium-web.org/. The screen looks slightly different and simpler here:

- The icons to set the location, date and time are clearly visible on the screen and easy to identify.
- The icon to pause time is inside the date and time window.
- Spotting the altitude (Alt) of any celestial object is easier. Click on the object to see the information pop-up on the left side of the screen.

This website can also be viewed on your mobile phone, but the wider screen of a computer provides a better experience.

i wonder...
Rediscovering school science

Contributed by:

Vijeta Raghuram, who is a science communicator with a PhD from the Centre for Cellular and Molecular Biology (CCMB), Hyderabad. She can be contacted at: vijeta.raghuram@apu.edu.in.

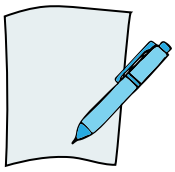
Vidya Kamalesh, who works at Azim Premji Foundation, Bengaluru.

The Science Lab

ACTIVITY SHEET 1: TRACK THE SUN'S RISING & SETTING POSITIONS

You will need:

Stellarium



Paper and pen

What to do:

1. In Stellarium, click on the 'Location Window' on the left panel. Type the location of your town or city next to the search icon and select the correct option. The screen will now show the sky at your location at the current time. Close the location window.
2. Click and drag the screen so that you are facing East (you will see 'E' appear in the centre of the screen).
3. Go back to the left panel and click on the 'Date/time window'. Set the date to March 1 (the year does not matter). Set the time such that the Sun is just above the horizon (just after sunrise). Notice its position. (Has it risen exactly in the East?).
4. Start incrementing the date from March 1 in steps of one day (for example, change the date to March 2, 3, and so on) till you hit March 1 of the following year. Make minor changes to the time after every few dates so that the Sun is roughly just above the horizon. Notice how the direction of sunrise changes over the year.
5. Now click and drag the screen so that you are facing West. (You will see 'W' appear in the centre of the screen).
6. Set the time such that the Sun is just above the horizon (about to set). Notice its position.
7. Start incrementing the date from March 1 in steps of one day (for example, change the date to March 2, 3, and so on) till you hit March 1 of the following year. Make minor changes to the time after every few dates so that the Sun is roughly just above the horizon. Notice how the direction of sunset changes over the year.
8. Use the 'Location Window' to repeat Steps 2–7 at different locations of your choice:

   a) In the Northern Hemisphere

   b) At the Equator

   c) In the Southern Hemisphere

Observe and record:

For each location you try, record your observations in a table like the one on the next page.

Think about and discuss:

Q1. When seen from where you live, how does the position of sunrise change over different months in a year? How would you explain this change?

Q2. When seen from where you live, how does the position of sunset change over different months in a year? How would you explain this change?

Q3. Does the pattern of change in the position of sunrise (or sunset) over a year remain the same when viewed from locations: (a) In the Northern Hemisphere, (b) At the equator, and (c) In the Southern Hemisphere? How would you explain your observation?

Q4. Imagine you could observe the position of sunrise (or sunset) from one of the poles. Would it change over a year? In what way? Can you use Stellarium to test this?

	Your location	Location 2
How many days in a year does the Sun rise due East?		
Which months of the year does the Sun rise due East?		
How many days in a year does the Sun rise North of East?		
Which months of the year does the Sun rise North of East?		
How many days in a year does the Sun rise South of East?		
Which months of the year does the Sun rise South of East?		
How many days in a year does the Sun set due West?		
Which months of the year does the Sun set due West?		
How many days in a year does the Sun set North of West?		
Which months of the year does the Sun set North of West?		
How many days in a year does the Sun set South of West?		
Which months of the year does the Sun set South of West?		

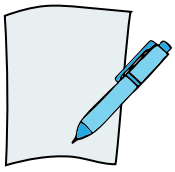
Contributed by:
Anand Narayanan, who teaches astrophysics at the Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram.

The Science Lab

ACTIVITY SHEET II: TRACK THE LENGTH OF DAY

You will need:

Stellarium



Paper and pen

What to do:

1. See **Activity Sheet I** to set observing location, viewing orientation, date and time in Stellarium.
2. For this activity, try choosing an observing location:
   - In the Northern Hemisphere that is close to the equator (like Chennai in India).
   - In the Northern Hemisphere, but farther away from the equator (like Srinagar in India).
   - At the North Pole (latitude 90 degrees north of the equator).
   - In the Southern Hemisphere and close to the equator (like Jakarta in Indonesia).
   - In the Southern Hemisphere, but farther away from the Equator (like Sydney in Australia).
   - At the South Pole (latitude 90 degrees south of the equator).
3. Change your viewing orientation so that you face East. Starting from the month of January, move in increments of a month till December. For example, change the month to February, March, and so on till December. For the same date of each month, note down the time of the day when the Sun rises.
4. Change your orientation towards the West. For January through December, note down the time when the Sun sets.

Observe and record:

Record your observations for each location in the table on the next page.

Discuss:

Q1. How many times in a year is the length of day equal to the length of night?

Q2. How does the length of day (and night) change over a year?

Q3. How do your observations change in the *uttarayana* (December to June) and *dakshinayana* (June to December) halves of a year?

Q4. How do your observations change at different latitudes?

Q5. How is the length of day and night at the poles different from that at other latitudes? Would you want to live at the poles?

i wonder...
Rediscovering school science

Contributed by:

Anand Narayanan, who teaches astrophysics at the Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram.

Date:

Location:

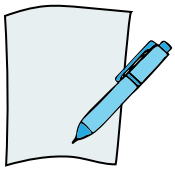
Month	Sunrise time	Sunset time	Length of day	Length of night
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

The Science Lab

ACTIVITY SHEET III: FIND THE LENGTH OF THE DAY-NIGHT CYCLE

You will need:

Stellarium



Paper and pen

What to do:

1. See **Activity Sheet I** to set observing location, viewing orientation, date and time in Stellarium.
2. Select your observing location (the place where you live, a place you may want to visit, or are curious about).
3. Pause time through the controls on the bottom panel. Do not unpause till the end of the activity.
4. To find the daily period of the Sun, pick a time in the day (say 10:00 AM) on any date.
5. Click on the image of the Sun on screen. The altitude of the Sun gets labeled under Az./Alt, where the two numbers are azimuth (this is not of interest to us) and altitude (this is the quantity of interest to us). The altitude is quoted in degrees: arcminutes: arcseconds. Note down only the degree value in the table on the next page.
6. Increase the time in steps of hours. When the altitude comes close to the value recorded in Step 5 (for example, 10 degree lesser), start increasing the time in steps of minutes. Record the time it takes for the Sun to reappear at the same altitude in the sky.
7. To find the daily period of a star other than the Sun, pick a time of your choice in the night (say 10:00 PM).
8. Click on the image of any star visible in the night sky. Again, you will see the altitude of the star displayed for the time you have chosen. Note it down in the table on the next page. Increase the time as you did in Step 6. Record the time it takes for the star to reappear at the same altitude in the sky.
9. Repeat steps 7 and 8 for a third star of your choice.

Discuss:

Q1. In steps 5-6, you recorded how long it takes for the Sun to reappear at the same altitude in the sky. In steps 7-8, you recorded how long it takes for another star to reappear at the same altitude in the sky. Are these two values the same? If not, what do you think causes this difference?

Q2. If we used the Sun as a reference, what would the length of the day-night cycle on Earth be? How different would this be if we used another star as a reference?

Your location:

	Star 1 (The Sun)	Star 2	Star 3
Name of the star			
Date and time at the start			
Altitude of the star (in degrees)			
Date and time when the star reappears at the same altitude in the sky			
Time taken for the star to reappear at the same altitude in the sky (in hours and minutes)			

i wonder...
Rediscovering school science

Contributed by:

Anand Narayanan, who teaches astrophysics at the Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram.

INTRODUCING AN INDIAN SCIENTIST: JANAKI AMMAL

LAVANYA KARTHIK

Can a book that introduces Janaki Ammal as a child with dreams of exploring the world of plants help children identify with her? Can it inspire them to dream of such a life for themselves?

Middle-stage science textbooks (NCERT, 2024-2025) include short introductions to the scientific achievements of many scientists, one of whom is Janaki Ammal. Chapter 2 ('Diversity in the Living World') of the Grade VI science textbook (NCERT, 2024-2025) describes Ammal as an *"Indian botanist dedicated to environmental work and helped to document and preserve India's rich plant biodiversity. She played a key role in the 'Save Silent Valley' movement. As the head of the Botanical Survey of India, she initiated programmes to document the plant diversity of India".*[1] But what was Ammal like as a child? What early experiences shaped her life and work as a scientist?

It is these questions that author and illustrator Lavanya Karthik explores in 'The Girl Who Was a Forest: Janaki Ammal' (see **Fig. 1**). This book introduces young readers to Ammal through her childhood experiences and her dreams of exploring the world of plants. It allows them to see the determination and tenacity with which Ammal followed her passion to overcome societal barriers of gender and caste and pursue a life in science. It also describes the role her father's support and encouragement played in shaping Ammal's life and work. We discuss the book with its author.

Q1. This book is written for 6–9-year-olds. Why this age group? How has this decision shaped the text, language, and design of the book?

Lavanya: It is at this age that children start to read on their own. They become receptive to new ideas and new kinds of stories. They show an increasing understanding of complexity in the interplay of text and illustrations. It is also at this age that their peer groups begin to matter more. When they start to experience feelings of anxiety, loneliness, and failure more keenly.

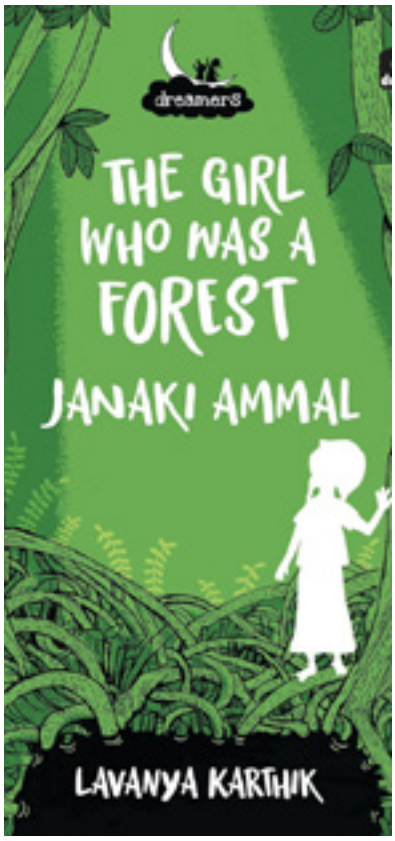


Fig. 1. 'The Girl Who Was a Forest: Janaki Ammal'. Published by Duckbill Books, it is priced at ₹135. You can order a copy on Amazon India (URL: https://www.amazon.in/Girl-Who-Was-Forest-Dreamers/dp/0143451537).

I wanted to write a series of biographies about people who inspired me as a child. Of people who the present generation of children has barely heard of. I also wanted to make the subjects of these books relatable to young readers. Conventional biographies focus on the achievements of grown-ups in various fields. I do not think many kids connect with that. After all, to a child, every adult seems powerful and capable of achieving anything. Children want to read about other children. They want to see themselves in the stories they read. The 'Dreamers' series does just that. Each book in the series focuses on the childhood experiences of its subject, identifying one pivotal experience that shapes the person they go on to be (see **Box 1**). Young readers can see that the feelings they often struggle with also affected the subjects of these books. For example, RK Narayan, the author of 'Malgudi Days' was convinced he would never be a successful writer. JRD Tata, the businessman and philanthropist, was bullied in school for being different from the other kids. PC Sorcar, the magician, folded under pressure just when he needed to prove his skill. In her first race, PT Usha, the athlete, ran against a girl she did not think she could defeat.

I also wanted to explore art in each book. The illustration style of each book relates in some way to the subject of the book. For example, the art in the book on Salim Ali is inspired by Mughal miniatures because he was very fond of them. This art form also holds birds in high regard. The book on Bachendri Pal, the mountaineer, is inspired by *thangka* art from the Himalayan region. And the book on PC Sorcar draws on the Babu Bibi style of *kalighat* painting, commonly used to express social satire. Each book has a limited colour palette. This adds another challenging layer that I enjoyed playing with.

None of the books try to offer a complete picture of their subjects or art forms. They are intended to act as windows that encourage children to learn more about the people and art I have introduced in the book.

Q2. To many 6-9-year-olds, a 'scientist' may be a very abstract term. Why did you choose to write about one?

Lavanya: Not just scientists, most professional roles seem abstract to children of this age. I wrote this book because I wanted to tell Ammal's story. She was one of the earliest women in the world to get a PhD. This was at a time when a minuscule percentage of women finished high school. My book uses the mangrove seed as a powerful metaphor for Ammal's growth in the face of these daunting odds. At a time when women in her community were allowed to be only mothers and wives, she charted a life of independence for herself. She held her own as a woman of colour in a field dominated by white men. She was a feminist, a Gandhian, a scientist—I just had to write about her! Her story is not just about science, it is also about finding your calling. About focusing your life on a passion or interest that shapes your life, becomes your path, and allows you to control your destiny. The book is also the story of her father, whose support was critical in Ammal's success, and whose own lifelong interest in ornithology showed her the possibilities of a life devoted to science.

I was also drawn to a story about the natural environment as I love making botanical illustrations and drawing birds. This story gave me a chance to draw the mangroves, waterways, and birds of the region Ammal grew up in.

Box 1. About the 'Dreamers' series:

This is a set of 12 books for young readers (age six years and above), written and illustrated by Lavanya Karthik. These books are inspired by the real-life stories of people like Satyajit Ray, Teejan Bai, JRD Tata, Janaki Ammal, Mahasweta Devi, Bachendri Pal, Salim Ali, PT Usha, RK Laxman, RK Narayan, PC Sorcar, Nek Chand, and Shakuntala Devi. They draw on the childhood experiences of these people, introducing them to readers as young dreamers—children who not only dreamt of changing the world, but persevered to realise their dreams in their adult lives.

Q3. How important is it for children to know more about 'women' scientists from 'India'?

Lavanya: Very important! Despite all the progress our country has made, we are still not free from the colonial mindset that makes us feel inferior to the West or the patriarchal prejudices that restrict women to limited roles in society. Books are some of the most important windows for children to imagine possible futures they could build for themselves. Reading about Indian women thriving and growing in fields they were traditionally kept from is critical for the growth of both young girls and boys. Science is also about curiosity, method, patience, and observation—qualities that are often devalued in an educational system driven by marks, rote learning, and fear of failure. The impact of social media is a greater pressure, with its focus on instant gratification and peer approval. Stories like Ammal's tell a young reader that it is possible to chart your own path despite the world telling you otherwise. About the quiet joys and triumphs of a life spent observing the mysteries of the natural environment.

Q4. How did you go about researching Ammal's life? What was your experience of doing this?

Lavanya: Despite Ammal's many contributions to botany, so little was known about her when I started writing this book. There were no published biographies. My research was entirely online, based on articles written by two women. Interestingly, both happen to be her descendants. These essays offered great insights into her life. They led me to her childhood in Thalassery, the region's beautiful natural environment, and her

Box 2. Curricular connections:

(A) Middle-stage science: This resource can be used to develop what the National Curriculum Framework for School Education (NCF-SE) 2023 describes as the basis of the curricular goals for middle-stage science: *"... help students engage with the nature and processes of science and **develop scientific values and dispositions** (including **through examining the lives and works of scientists**, and the development of scientific knowledge) that will enable them to take decisions in their daily lives as well as participate in the larger society".*[2] Specifically, it can be used to meet the following curricular goals:

- CG-3: [The student] explores the living world in scientific terms. Specifically, it can be used to inspire students to practice the following competency: C-3.1: *"**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)".*[2]
- 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 be used to build the following competency: C-6.1: *"...identify the scientific values that are inherent and common across the evolution of scientific knowledge (**scientific temper**, science as a collective endeavour, **conserving biodiversity and ecosystems**)".*[2]
- CG-8: [The student] understands and appreciates the contribution of India through history and the present times to the overall field of science, including the disciplines that constitute it. Specifically, it can be used to build the related competency: C-8.1: *"Know and explain the **significant contributions of India** to all matters (concepts, explanations, methods) that are studied within the curriculum in an integrated manner".*[2]
- It is also related to the following learning outcome for Grades VI-VIII science: [The student] "*exhibits values of honesty, objectivity, cooperation, freedom from fear and prejudices.*"[3]

(B) Preparatory-stage Environmental Studies (EVS): This resource can also be used to meet the following curricular goals:

- CG-1: [The student] explores and engages with the natural and socio-cultural environment in their surroundings. Specifically, it can support the development of the following competencies: (a) C-1.1: *"Observe and identify the natural (insects, plants, birds, animals, geographical features, sun and moon, stars, planets, natural resources) and social (houses, relationships) components in their immediate environment"* and (b) C-1.2: *"Describe relationships (including between humans and animals/nature) and traditions (art forms, celebrations, festivals) in the family and community".*[2]
- CG-4: [The student] develops sensitivity towards their social and natural environment. Specifically, it can be used to support the development of the following competencies: (a) C-4.1: *"**Observe and describe diversity among plants, and birds and animals** in their immediate environment (shape, sounds, food habits, growth, habitat)"* and (b) C-4.6: *"Identify the needs of people in different situations—in terms of access to resources, **equal opportunities**, work distribution, and shelter".*[2]

father's own interest in birds. All these threads came together in my story. Serendipitously, a detailed biography of Ammal was published a few months after my book. This book focused on her work as scientist.

Q5. Many of our readers may want to use this book in their science classrooms. Any suggestions on ways in which they can do this?

Lavanya: Several schools across India have introduced the whole 'Dreamers' series to their students. They have held discussions about its themes, and even encouraged their students to work on small projects around them.

The book on Ammal does seem to resonate with young readers, predominantly girls (see **Box 2**). It is less about science itself, and more about Ammal's route to a life of her choosing. But the joy Ammal and her father found in their individual pursuits was in the details—the unique features of plants or birds that they discovered through patient observation. This led Ammal to develop sugarcane species that were significantly sweeter than older varieties. Her father authored two books on the birds of Kerala. I bring up some of these details when I discuss the book in schools. For example, when I tell students that Ammal's research on sugarcane directly contributes to the sweetness of the toffees and chocolates they love, it sparks a lot of interest. Science ceases to be a distant thing happening in labs; it directly touches their lives each time they eat a sweet treat. I have also included a short endnote in the book that lists additional details about Ammal. I hope this will encourage children to read more about her.

My research about Ammal sent me down a rabbit hole, learning about, among other things, mangroves. I think children would enjoy similar activities—finding out more about a plant, bird, or animal species and observing the features that make them unique (see **Activity Sheets I-III** and the **Teacher's Guide**).

In the book, I talk about the idea of a secret garden—an interest that lets you be your authentic self, that you pursue for no other gain than the sheer pleasure it offers. Encouraging children to quietly observe an animal, plant, or natural phenomenon can be a good way to get them thinking about themselves and discovering their own secret gardens!

Key takeaways

- 'The Girl Who Was a Forest: Janaki Ammal' is a biography that introduces the Indian botanist Janaki Ammal to children through the childhood experiences that shaped her life and work.
- Children may struggle to relate to conventional biographies that focus on the achievements of adults and abstract-sounding professions. By focusing on the childhood experiences that shaped Ammal, this book offers children a window to her life that they can more naturally relate to.
- By giving young boys and girls an opportunity to learn about Indian women thriving and growing in fields they were traditionally kept from, this story can inspire children to dream and imagine possible futures they could build for themselves.
- Through Ammal's story, children may learn how science is about curiosity, method, patience, and observation—qualities that are often devalued in an educational system driven by marks, rote learning, and fear of failure.
- Ammal's love for the natural world may inspire children to observe a plant, bird, or other animal species in their neighbourhood to discover features that make them unique.

Notes:

(a) Credits for the image (Black Mangrove) used in the background of the article title: portioid, iNaturalist. URL: https://www.inaturalist.org/photos/27435593. License: CC BY-SA 4.0 International Deed.

(b) Questions for this interview were put together by Vijeta Raghuram, Radha Gopalan, and Chitra Ravi.

(c) To know more about the 'Dreamers' series, please see: https://www.penguin.co.in/book/dreamers-delightfully-illustrated-short-biographies-to-inspire-young-readers-boxset-of-ten-inspirational-indian-men-and-women-who-changed-the-world-perfect-for-7-years/.

(d) This article includes four detachable classroom resources: **Activity Sheet I: Explore Life on a Wall**, **Activity Sheet II: Find Hidden Nature**, **Activity Sheet III: Observe Uses of Human-made structures**, and **Teacher's Guide: Nature-based Outdoor Activities**.

(e) Biographies of scientists can be an effective and engaging way to introduce students to the process of scientific discovery. But what pedagogical approaches can we use to meet this aim? Read how Naresh Kumar Sen, a government school science teacher, explored this question in 'A Project-centred Approach to Biographies of Scientists' from the Dec 2024 issue of i wonder... URL: https://publications.azimpremjiuniversity.edu.in/5902/.

(f) Many Indian women have played important roles in science. Some of their contributions have direct connections to concepts and applications that students learn about in the middle-stage science curriculum. Introduce your students to six such women with the 'Activity Sheet: Who are these Scientists?'. Authored by Vijeta Raghuram, this classroom resource was published in the Dec 2024 issue of i wonder... URL: https://publications.azimpremjiuniversity.edu.in/5896/.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 2: Diversity in the Living World'. Science Textbook for Grade VI: 9-34. URL: https://ncert.nic.in/textbook.php?fecu1=2-12.
2. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
3. National Council of Educational Research and Training (2017). 'Learning Outcomes at the Elementary Stage'. First Edition. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/publication/otherpublications/tilops101.pdf.

Lavanya Karthik is an award-winning author and illustrator of children's books. She started writing and illustrating stories in her school notebooks and returned to this passion after working as a licensed architect. Lavanya has written over thirty children's books, many of which have been translated into over fourteen languages, including Korean and Mandarin.

Dear Readers,

- We have tried our best to ensure that this issue is as accurate as possible. But we also recognise that there may be some errors that we have not managed to catch in our reviews. For example, Madhukara Putty pointed out that the term 'orbitals' had been used in two places in the article 'Why was Pluto a Planet for 76 years?' from our Dec 2024 issue. The accurate term in both instances would be 'orbits'. Have you spotted any such errors in this issue? If yes, please share them with us by writing to: iwonder@apu.edu.in.
- This issue has 19 classroom resources (Teacher's Guides and Activity Sheets). Some of these have been written collaboratively by 2-3 authors. The order in which the author bios appear in these collaboratively written pieces is a reflection of the order in which contributions were made. So the bio of the author who made the first concrete contribution appears first. And the bio of the author who shared their contribution last appears last. Unlike in academic articles, this order is not a reflection of the amount or importance of their relative contributions.
- The strength of each issue lies in the authors who write for us. Many of them share their work, learning, struggles, and experiences in the hope that these will be useful, in some way, to other teachers. If you use an article or resource in your classroom, tell us about it. If you worked with a similar theme, but tried a different pedagogical approach, share it with us. For example, has the school you are part of tried to include eggs in midday meals? Did parents and children express any beliefs other than those Amol and Rakesh have shared in their article? What scientific facts and concepts were you able to bring into action in responding to these beliefs? Aditya tells us how he connected textbook concepts related to electroplating with the age-old handicraft of *kalai* that his students were familiar with in their real world. Have you built such connections between 'modern' science and 'traditional' handicrafts that are specific to the cultural and geographical context in which you work? Ankita shares an example of how her scientific curiosity in natural indicators has shaped her practice as a teacher and teacher educator. Have you had a similar experience teaching this topic or a different one? Did your students find a real-world application for natural indicators that other teachers would love to hear about? If yes, please share these with us by writing to: iwonder@apu.edu.in. You can also share this in the feedback form for this issue. Publishing your classroom experience in our next issue can help continue a wider conversation that the authors in this issue have started. All of us who have been part of the process of putting together this issue look forward to learning from your experience and that of every teacher who contributes to these conversations.

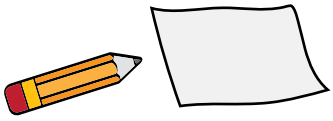
—Chitra Ravi, Editor (Apr 2025).

ACTIVITY SHEET 1: EXPLORE LIFE ON A WALL

Aim:

Lavanya Karthik's book 'The Girl Who Was a Forest' tells us about the joy Janaki Ammal found in observing non-human life forms around her home. Do you see many kinds of plants and animals in your neighbourhood? Where can you find them? Have you seen any of them on the walls of your classroom or house?

You will need:



Paper and pencil

A magnifying lens (optional)

What to do:

You could do this by yourself or with a friend. Choose a patch of the outer wall around your school or home. Take 15 minutes to observe it. Use a plain sheet of paper to record your observations. Note down the time of the day. Try and describe every form of life (and anything they build) that you see on it in as much detail as you can. What does it look like? How big is it? What colours do you see on it? What do you think it is using the wall for?

Record:

Draw a box (like the one on this page) in your notebook. You can make it as long and wide as you want. Use this box to draw the patch of wall that you observed. Is the wall old or new? What colour is it? Is it smooth or rough? What shapes, textures, and patterns do you see? What life forms did you see?

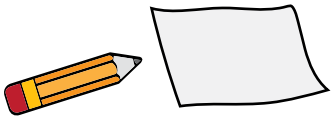
Contributed by:

Nature Classrooms, which develops nature education resources that support the teaching-learning of the preparatory-stage Environmental Studies (EVS) curriculum and conducts capacity-building workshops on nature learning for school teachers and educators.

ACTIVITY SHEET II: FIND HIDDEN NATURE

Aim:
Try to spot plants and animals that you might not have seen before!

You will need:



Paper and pencil

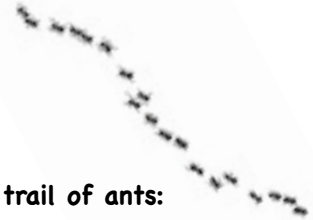
What to do:
Take a walk from your house or school to the nearest market, field, park, or main road. Look for hidden life on walls, pavements, fences, and footpaths.

Observe:
Here are some kinds of hidden life. Which of these did you see on your walk? Tick the circle.

◯ **Insect homes:**
Do you see eggs?

◯ **Mosses and grass:**
Are they wet or dry?

◯ **Spiders and webs:**
Are the webs still being used?

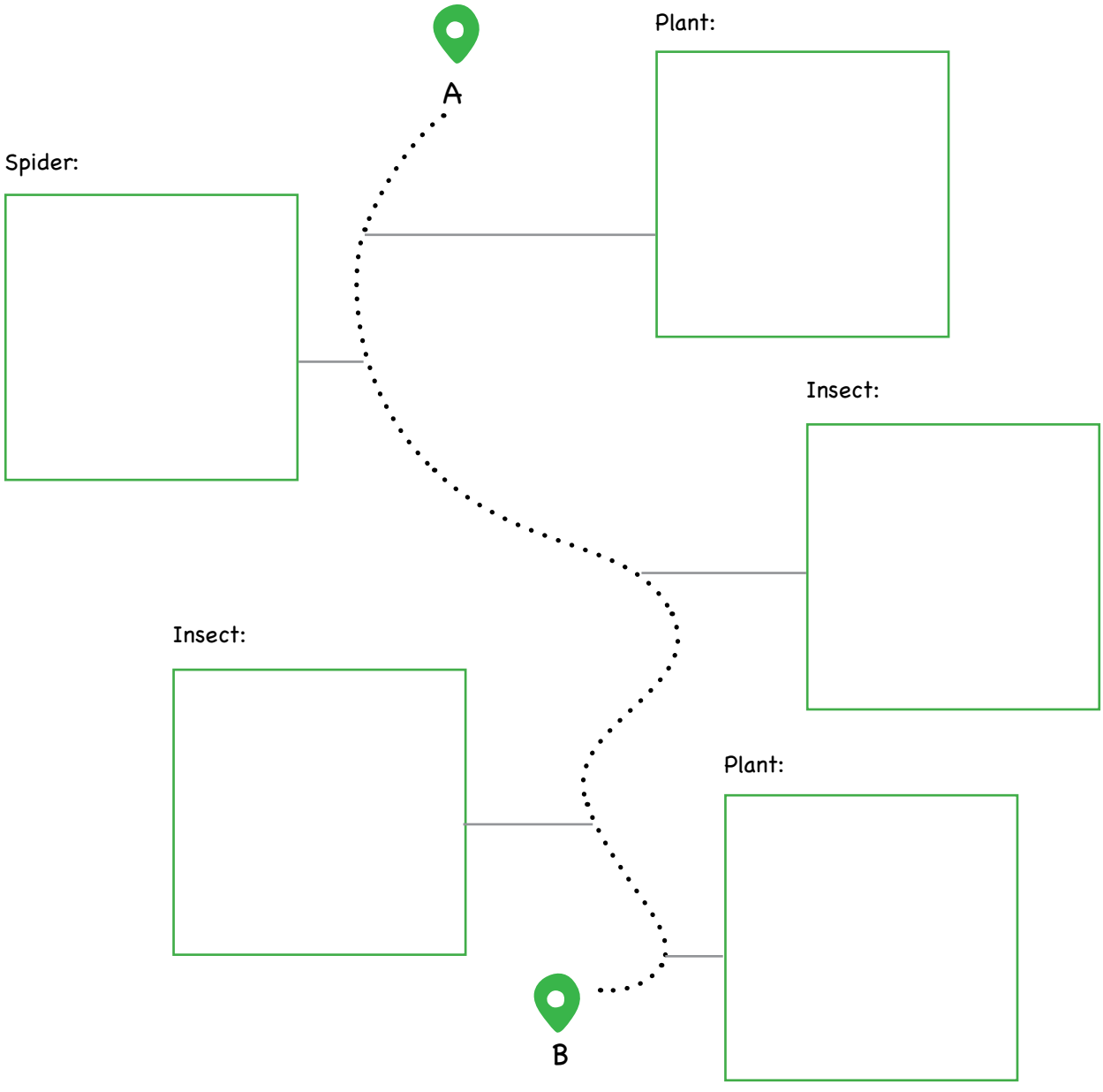


◯ **A trail of ants:**
How do they move?

◯ **Creepers and climbers:**
Are they flowering?

What to do:

Draw a sketch like the one below in your notebook. Doodle your own observations in each box and label it (like Plant, Spider, Insect, etc.). If you see a spider on the pavement, try drawing both the spider and the part of the pavement where you spot it.



Contributed by:

Nature Classrooms, which develops nature education resources that support the teaching-learning of the preparatory-stage Environmental Studies (EVS) curriculum and conducts capacity-building workshops on nature learning for school teachers and educators. Manini Bansal and Nayantara Siruguri offered design inputs for this resource. You can see more of Nature Classrooms' work here.

Nature Classrooms

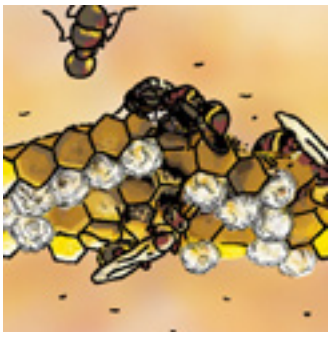
i wonder...
Rediscovering school science

Resource Review

ACTIVITY SHEET III: OBSERVE USES OF HUMAN-MADE STRUCURES

Aim:

You may have seen some non-human life forms on the walls, pavements, fences, and footpaths near your home or school. What do you think they use these structures made of cement, wood, metal, bricks, and stones for? Here are some examples that we have seen:

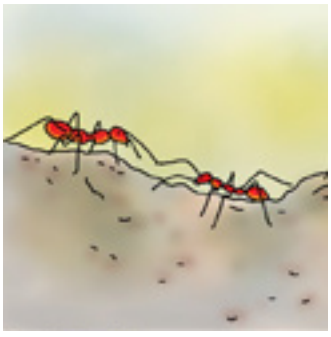


☐

As homes:
Seen the nests of paper wasps on a wall? What do you think the nests are made up of?

☐

To hide or for camouflage:
Seen creatures like spiders, moths, geckos, or assassin bugs camouflage themselves?



☐

To move around:
Seen creatures like ants, caterpillars, or lizards move around? Can you move like them?

☐

For support:
Seen grass, creepers, moss, and even fig saplings grow out of cracks?

How many of these have you seen? Tick the boxes. Have you seen other ways in which non-human life forms use human-made structures? Record these uses by drawing sketches in your notebook.

Contributed by:

Nature Classrooms, which develops nature education resources that support the teaching-learning of the preparatory-stage Environmental Studies (EVS) curriculum and conducts capacity-building workshops on nature learning for school teachers and educators. The photos used for the sketches in this sheet were provided by Samuel John, Vena Kapoor, and Nayantara Siruguri.

Resource Review

TEACHER'S GUIDE: NATURE-BASED OUTDOOR ACTIVITIES

- These three activities are designed to encourage students to explore the many forms of non-human life they can find in their immediate surroundings. Teachers can use them to invite students to observe in more detail the many plants and animals they are most likely to come across in and around their home and school or the nearest market, field, park, and road.
- We have deliberately kept the design of these activities simple. Often, much of what students learn about the natural world is from textbooks and within a classroom. Our aim is to encourage children to slow down, observe the abundance and diversity of life that surrounds them, and help uncover the sense of discovery and wonder that the natural world offers.

Tips to Teachers:

1. Share the theme of each activity with your students a few days before you do it. Encourage students to record any ideas and questions about the theme. A day before the activity, give students the opportunity to share their ideas and questions. Record these on the board and invite discussion around them.
2. On the day of the activity, share the sheet with them. Go through what they need to do in the activity. Emphasize to your students that observing non-human life forms does not mean that they need to identify or name every animal or plant that they come across. Instead, the purpose of each of these activities is to see how well they can describe in their own way what they observe. Encourage them to describe any animal or plant that catches their interest in as much detail as possible.
3. If possible, start each activity together. Say the first life-form your class and you spot on the wall of your classroom or school is an insect, you can ask questions like: *What does the insect look like? How would you describe it to someone who has not seen it? What does the part of the wall or pavement we can see it on look like? What is the insect doing? Do you remember seeing this insect or another insect like it elsewhere? Can you see the insect interacting with any other form of life? What do you find unique or interesting about this insect? Do you know of a name for it in any language?*
4. Allow each student or group to decide the form in which record their observations. They could, for example, record them as descriptions, poems, sketches, or even collages made of pressed plant parts.
5. Invite students to share and discuss their observations with each other at the end of each activity. Encourage them to also record and share any questions they have about each of their observations.
6. If your students show interest in these activities, you could encourage them to keep a nature journal. They can make a journal for themselves by stapling or stitching together a few sheets of one-sided paper. At the end of the term, students can put together a display of some of their most interesting observations for their classmates. They can also invite students from other grades to this display.

TEACHER'S GUIDE

Contributed by:

Nature Conservation Foundation (NCF), which is a non-profit organisation focussing on research and conservation of the natural world. NCF's Education and Public Engagement Programme runs several projects to engage with children and adults in ecological observation. NCF also develops, displays, and distributes nature education material. This guide was first published in the June 2016 issue of i wonder... The revised version presented in this issue is published with permission from the right owners.

EXPLORING ACIDS AND BASES WITH NATURAL INDICATORS

ANKITA CHATURVEDI

Students learn to tell acidic and alkaline substances apart by taste or by the colour change they produce in indicators. The extracts of many colourful plant parts in our surroundings can act as inexpensive and safe-to-handle natural indicators. Can students discover some of these indicators on their own? What can students learn from this exploration?

Chapter 4 ('Acids, Bases, and Salts') of the Grade VII science textbook (NCERT, 2024-2025) introduces students to acids and bases through their sense of taste. It then cautions them against tasting unknown substances and poses the question: *"If we cannot taste every substance, how do we find its nature?"*[1] This is how students are introduced to indicators, which are defined as: *"... special type of substances used to test whether a substance is acidic or basic... indicators change their colour when added to a solution containing an acidic or a basic substance"*.[1]

Some of the most common acid-base indicators used in labs include methyl orange, bromothymol blue, methyl red, bromocresol green, litmus, and universal indicator paper. These may not be available in many schools. When available, they may be too expensive to use for anything other than teacher demonstrations with a limited range of materials. In some cases, teachers with no formal training in science (but teaching it because teachers trained in science are unavailable) may not be confident about handling such chemicals. In such cases, students may only read 'facts' about indicators.

To address such challenges, Chapter 4 of the Grade VII textbook shares examples of two naturally occurring indicators: the powder of Turmeric rhizomes *(haldi)* and the extract of China rose (hibiscus) flowers. It also shares two simple activities (Activities 4.2 and 4.3) that invite

students to prepare and use these indicators to test the acidity or alkalinity of many materials from their everyday world.[1] I share my experience of using these activities to start a wider exploration into other materials from the natural world that can act as acid-base indicators.

Properties of natural indicators

Once students have tried Activities 4.2 and 4.3 from their textbook, teachers can point out that both indicators are extracted from plants. In fact, all natural indicators known to us today come from plants. They can ask students if they have observed any other properties that are common to these indicators. This discussion can lead students to recognise that:

- Contact with an acid or base causes a rapid and sharp change in colour in both indicators. Teachers can share that some indicators show a change in odour. While such 'olfactory' acid-base indicators are formally introduced in Chapter 2 ('Acids, Bases, and Salts') of the Grade X science textbook (2024-2025), you could invite students to try observing how contact with lemon juice and *chuna* water change the odour of onions and cloves.[2]
- For both indicators, the change in colour produced by contact with an acid is different from that produced by contact with a base. Teachers can ask students to predict if this change is reversible and how they would test their response.

Sources of natural indicators

Teachers can ask students if they can think of other plant extracts that can act as natural indicators. Students can be invited to bring at least one potential source (stems, leaves, flowers, fruits, and/or seeds) from their immediate environment to class.

Students will likely bring many different colourful plant parts for this inquiry. Each plant part can be listed on the board. The student who has brought it can be asked to share more details about it, like which plant it comes from (they could share local or common names), where they found this plant, and which part they have chosen to bring to class. They can also be asked why they think the part could be a good acid-base indicator. This question may draw students to share any colour change they may have observed in the plant part in response to a household substance that is acidic or basic. For example, they may have observed how the juice from purple cabbage changes to pink when lemon juice is added to it.

Once the list of potential sources of natural indicators is prepared, students can be introduced to methods of preparing their extracts.

Extracting potential indicators

Natural indicators are prepared by extracting their pigments (like lawsone in *henna* and the anthocyanins in many red-, blue-, and purple-coloured fruits, vegetables, flowers, and leaves). The process of extracting these pigments is similar to making tea. The plant part is 'steeped' in a solvent. The most commonly used solvent is alcohol. But water (cold, warm, or boiling) can be used instead and may be safer for students to handle on their own. The mixture is strained using a tea filter or muslin cloth. The coloured liquid is used as an indicator (see **Fig. 1**).

Chapter 4 of the Grade VII textbook shares one example of this process: *"Collect some China rose (Gudhal) petals and place them in a beaker. Add some warm water. Keep the mixture for some time till the water becomes coloured. Use the coloured water as an indicator".*[1] If students have tried Activity 4.3 in the classroom, they would have prepared this indicator. Teachers

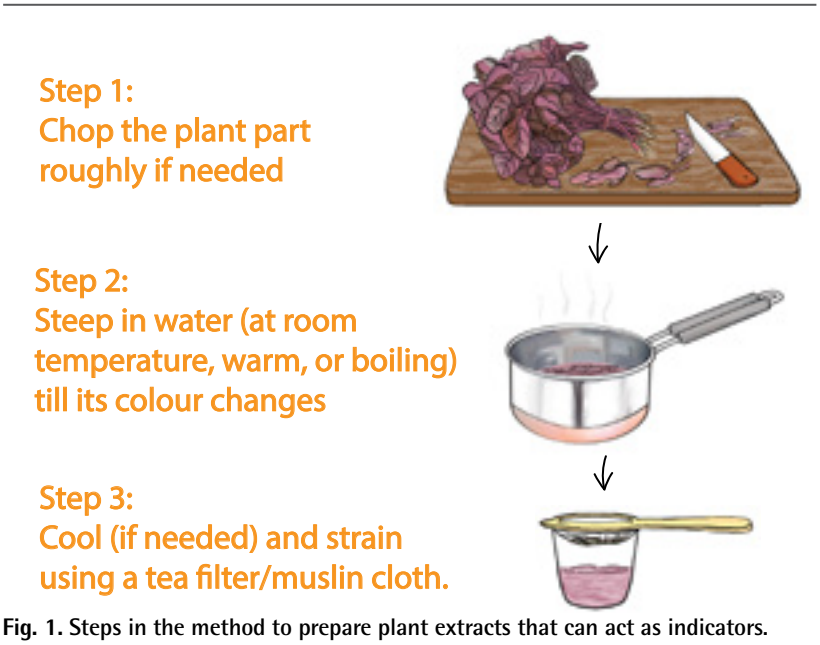


Fig. 1. Steps in the method to prepare plant extracts that can act as indicators.
Credits: i wonder... License: CC BY-NC.

can share that other indicators can be extracted by a similar method. Specify, however, that small variations may be needed for each plant part on their list (see **Teacher's Guide I**). Encourage students to work in groups and extract pigments from at least three different sources on the list.

Identifying potential indicators

In Activities 4.2 and 4.3, students are invited to test turmeric and China rose extracts on 7-8 everyday substances. These include acidic substances like lemon juice and vinegar and basic substances like baking soda solution and lime *(chuna)* water. Students could test the liquids they have extracted from other plant parts in the same way (see **Teacher's Guide II**). Remind students that natural indicators will show the two properties that were common to the turmeric and China rose indicators.

Parting thoughts

According to the National Curriculum Framework for School Education (NCF-SE) 2023: "*...the most important part of learning science is actually 'doing science' through hands-on experiential learning*".[3] This simple hands-on approach to discovering sources of natural indicators from their immediate environment can be very effective in engaging the interest and curiosity of students in middle-stage classrooms. Choosing potential sources of natural indicators can help draw students' attention to the diversity of plant life in and around their home and school. The process of preparing plant extracts and identifying potential indicators using simple everyday materials (like a pan for steeping and a tea filter for straining) can help students develop the ability to be more resourceful. Exploring new materials and methods, discussing their observations, and thinking together can help students build their science skills (see **Teacher's Guide III**). Thus, learning concepts in this hands-on way can not only make science learning fun and colourful, but can also strengthen students' ability to think scientifically (see **Box 1**).

Through this exploration, students will likely identify at least some plants or plant parts in their surroundings that can be used to extract natural indicators. These could include:

- Flowers of plants like rose (*Gulab*), butterfly pea (*Aprajita*), *Acalypha indica* (*Kuppi*) and spiderwort (*Baingani dil*).
- Leaves of plants like pentas, poinsettia, and rangoon creeper.
- Vegetables like red cabbage, purple sweet potatoes, and beetroot.

The ease with which natural indicators can be used to test the acidity and alkalinity of everyday substances can offer teachers many opportunities to connect textbook concepts with the everyday worlds of their students (see **Teacher's Guide IV** and **Activity Sheet**). I have observed that such hands-on experiences can strengthen student-teacher relationships and help create a more harmonious learning environment. Some of the teachers I work with have shared that the confidence they gained in working with natural indicators has encouraged them to design hands-on experiences for other chemistry topics in the middle-stage science curriculum. Similarly, my explorations with this theme have inspired me to design other classroom approaches that use low-cost and everyday materials. I hope that the teachers reading this article will be inspired to try this approach in class and share their experiences so we can learn from each other.

Box 1. Curricular connections:

Activities and discussions around this exploration with natural indicators can help meet the following curricular goals outlined in the NCF-SE (2023) for middle-stage science:

- CG-1: [The student] explores the world of matter and its constituents, properties, and behaviour. Specifically, it can support students in developing the following competency: C-1.1: *"Classify matter based on observable... chemical (pure, impure; **acid, base**; metal, nonmetal; element, compound) characteristics".*
- 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 support students in developing the following competency: C-6.2: *"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]

It can also help meet the following learning outcome for Grade VII science: [The student] conducts simple investigations to seek answers to queries like: Can the extract of coloured flowers be used as acid-base indicators?[4]

Key takeaways

- The middle-stage science curriculum introduces students to two colourful, inexpensive, readily accessible, and safe-to-handle natural acid-base indicators as alternatives to chemical indicators.
- Inviting students to 'discover' other sources of natural indicators from their surroundings can help build many science skills, including the ability to be resourceful, to make observations, and to engage in collaborative investigation.
- Such experiential learning opportunities can help engage student interest, deepen their understanding of textbook concepts on acids and bases, and foster their ability to think like a scientist. They can also strengthen teacher-student relationships, creating a more harmonious learning environment.

Notes:

(a) Credits for the image (Turmeric powder) used in the background of the article title: Formulate Health (Flickr.com). URL: https://www.flickr.com/photos/formulatehealth/50191150578/in/photostream/. License: CC BY 2.0 Generic Deed.

(b) This article includes five detachable classroom resources: **Teacher's Guide I: Extracting Potential Natural Indicators**, **Teacher's Guide II: Colour Change in Natural Indicators**, **Teacher's Guide III: Discovering Other Natural Indicators**, **Teacher's Guide IV: Exploring Uses of Natural Indicators**, and **Activity Sheet: Be an Indicator *Jasoos*!**.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 4: Acids, Bases, and Salts'. Science Textbook for Grade VII: 38-46. URL: https://ncert.nic.in/textbook.php?gesc1=4-13.
2. National Council of Educational Research and Training (2024). 'Chapter 2: Acids, Bases, and Salts'. Science Textbook for Grade X: 17-36. URL: https://ncert.nic.in/textbook.php?jesc1=2-13.
3. National Steering Committee for National Curriculum Frameworks (2023). 'National Curriculum Framework for School Education 2023'. National Council of Educational Research and Training. URL: https://ncert.nic.in/pdf/NCFSE-2023-August_2023.pdf.
4. National Council of Educational Research and Training. 'Learning Outcomes at the Elementary Stage'. First Edition. National Council of Educational Research and Training (2017). URL: https://ncert.nic.in/pdf/publication/otherpublications/tilops101.pdf.

Ankita Chaturvedi works as a science resource person and teacher educator at Azim Premji Foundation, Bhopal, Madhya Pradesh. She has a Masters in Zoology and was part of the fellowship program 'Building Educators for Science, Technology, and Mathematics' (BESTM) from Homi Bhabha Centre for Science Education (HBCSE), Mumbai, Maharashtra. Ankita worked as a science teacher for 13 years before joining the Foundation. For 8 of these years, she worked at Sagar Public School, Bhopal. Ankita enjoys involving teachers and children in hands-on experiences in science. She has been a trainer in teacher training sessions organized by the Central Board of Secondary Education (CBSE) for the last six years. As a teacher, Ankita has guided many students in various national-level science-related competitions, including the Inspire Manak Awards. She also writes poems. Ankita can be contacted at: ankita.chaturvedi@azimpremjifoundation.org.

Azim Premji University

TEACHER'S GUIDE I: EXTRACTING POTENTIAL NATURAL INDICATORS

In the article titled 'Exploring Acids and Bases with Natural Indicators', I invite students and teachers to use colourful plant parts from their immediate environment to extract potential indicators. These indicators are extracted by steeping plant parts in a solvent. The solvent that is most inexpensive and safe to use in the classroom is water. Many teachers I have worked with have extracted indicators from turmeric, China rose, and beetroot. Here are small variations in method that I found by trial and error to work best for extracting indicators from other sources:

Plant Part	Extraction Method
Flowers	Add to boiling water. Continue boiling till the water becomes coloured. Cool.
Vegetables	(a) Red cabbage: Chop and soak in room temperature water for 15-20 minutes or till the water turns a deep purple. (b) Red bell pepper: Chop and add to boiling water. Cook till the water becomes coloured. Cool. (c) Red spinach (Amaranthus): Add leaves and stems to boiling water. Allow the mixture to cook long enough for the leaves to turn green in colour. Cool. (d) Purple yam: Peel and chop into pieces. Add the pieces to boiling water. When they turn soft, mash them with the back of a spoon. Cool.
Fruits and seeds	(a) Crush fruits (like black grapes or strawberries) and seeds (like those of pomegranate) using a ladle or wooden spoon. Add warm water to the mash and stir till you get a jam-like consistency. Cool. (b) Chop pomegranate peel and add to boiling water. Cook till the liquid becomes coloured. Cool.

In each of these cases, you can strain the mixture and use the filtered liquid as an indicator.

i wonder...
Rediscovering school science

Contributed by:
Ankita Chaturvedi who works as a science resource person and teacher educator at Azim Premji Foundation, Bhopal. She can be contacted at: ankita.chaturvedi@azimpremjifoundation.org.

Azim Premji University

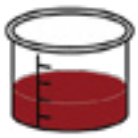
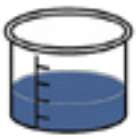
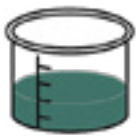
TEACHER'S GUIDE II: COLOUR CHANGE IN NATURAL INDICATORS

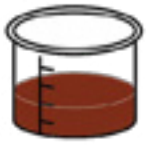
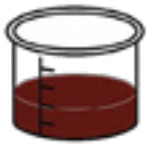
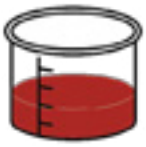
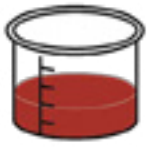
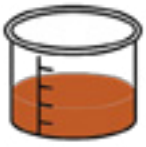
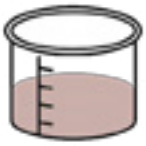
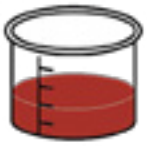
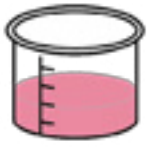
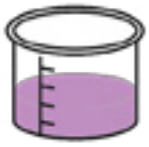
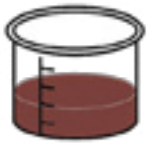
In the article titled 'Exploring Acids and Bases with Natural Indicators', I invite students and teachers to identify which colourful plant parts in their immediate environment can yield natural indicators. How? By adding 2–5 drops of their extract to acidic solutions (like lemon juice and vinegar) and alkaline solutions (like baking soda solution and *chuna* water). Indicators will show:

a) A rapid (and often dramatic) colour change in contact with acidic and alkaline substances.

b) A colour change in contact with an acid that is different from the colour change they show on contact with a base.

Here are the colour changes I observed with the natural indicators that I extracted:

Natural indicator	Initial colour	Colour with acid	Colour with base
Turmeric	 Yellow	 Light Yellow	 Blood Red
Vegetables			
Purple Yam	 Light Mauve	 Light Pink	 Greenish Yellow
Red Cabbage	 Purple	 Dark Pink	 Green
Red Bell Pepper	 Slightly Yellow	 Colourless	 Yellowish Green

Natural indicator	Initial colour	Colour with acid	Colour with base
Red Spinach	 Brown-red	 Rusty-brown	 Yellowish Green
Beetroot	 Deep Red	 Lighter Red	 Yellowish Green
Fruits			
Strawberry	 Red	 Orange	 Yellow
Pomegranate Peels	 Yellow	 Pinkish Grey	 Red
Pomegranate Seeds	 Dark Pink	 Lighter Pink	 Green
Black Grapes	 Pinkish Purple	 Light Pink	 Green
Flowers			
China Rose	 Brownish Red	 Dark Pink	 Green

i wonder...
Rediscovering school science

Contributed by:

Ankita Chaturvedi who works as a science resource person and teacher educator at Azim Premji Foundation, Bhopal. She can be contacted at: ankita.chaturvedi@azimpremjifoundation.org.

TEACHER'S GUIDE III: DISCOVERING OTHER NATURAL INDICATORS

In the article titled 'Exploring Acids and Bases with Natural Indicators', Ankita Chaturvedi shares an inquiry-based approach to engage students in discovering sources of natural indicators from their immediate environment. This approach involves the following group (preferably with 3-4 students per group) activities:

- Activity 4.2 from Chapter 4 of the Grade VII science textbook (NCERT, 2024-2025).
- Activity 4.3 from Chapter 4 of the Grade VII science textbook (NCERT, 2024-2025).
- Preparation of extracts from at least three potential sources.
- Identifying which extracts can act as natural indicators

Here are some pointers to plan these activities:

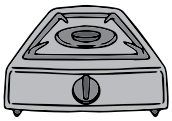
(a) Each of these activities can be done in the classroom and can be designed to fit into a 1-hour session.

(b) Each of these activities will need some of the following:

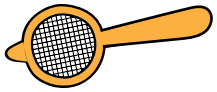
Mortar and pestle for grinding

Knife for peeling and chopping

Water as the solvent for steeping

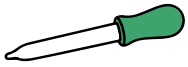


Burner for heating the water



Tea strainer or muslin cloth for filtering out the plant extract

Clear tubes. If you do not have tubes, small and clear plastic/glass cups can be used.



1-2 plastic droppers

Notebook

Pen/pencil

(c) Before starting each activity, share clear instructions about precautions to be taken. Ensure that these are followed during the activity:

- The flowers, leaves, fruit peels, and any other plant material used to prepare indicators should be washed with water to get rid of soil and any other materials.
- None of the plant material should be eaten during this process. Some of them (like

pink oleander) can be poisonous. Students should wash their hands with soap and water before putting their fingers in their mouth.

- If boiling water is needed to prepare a plant extract, clearly specify that you will handle the burner and all the steps of extraction that are done on it. This includes boiling water, adding the plant part to it, mashing the part, and taking the mixture off the burner. Students should not handle the container with boiling water at any point in the activity.
- A separate tube/cup should be used for each acidic and alkaline substance that students use to identify which plant extracts can act as indicators. This is to prevent the acidity or alkalinity of one of these solutions from affecting that of the other. If you do not have enough tubes/cups, each tube/cup should be washed thoroughly with water before it is reused.

(d) Start the exercise to identify which extracts can act as natural indicators with clear instructions, particularly on the sequence of steps:

- Step 1: Label each tube/cup. For example, if you plan to use 5 acidic or alkaline substances, label the test tubes 1, 2, 3, 4, and 5.
- Step 2: In your notebook, write down the name of the substance against each number. For example, if you want to add lemon juice to tube/cup 1, write down: 1 = lemon juice, 2 = soap solution, and so on till all 5 substances are listed. Use at least two acidic and two alkaline substances for this step (ask students why).
- Step 3: Add each acidic or alkaline solution to its corresponding tube/cup. Try and ensure that each cup has the same volume of solution (ask students why solutions are used and why adding the same volume of solution in each cup can be useful).
- Step 4: In your notebook, note down the name of the plant extract from which the indicator has been prepared. Add the indicator to each tube/cup. Start by adding 4-5 drops. You can add more indicator if needed. Ensure that the same amount of indicator is added to each tube/cup (again, ask students why).
- Step 5: Shake each tube/cup well (ask students why).
- Step 6: Make a note of any changes you observe in the mixture. Record changes in colour as accurately as possible. If it helps, you can also use a crayon to capture the exact colour.

(e) Repeat steps 1-6 for each of the indicators that you plan to explore through this activity.

(f) Provide students with a format to systematically record their observations from each activity in this approach. For example, the format on the next page could be used for the activity to identify which plant extracts can act as natural indicators.

Contributed by:

Radha Gopalan, who works at Azim Premji University, Bengaluru. She is also a member of the Kudali Intergenerational Learning Centre, Telangana.

Name of the plant extract (like extract of rose flower, pomegranate peel, etc.):

Colour of the plant extract:

Name of the substance (like lemon juice, soap solution, etc.)	Nature of the substance (acidic or basic)	Colour of substance before adding the plant extract	Colour of the substance after adding the plant extract	Notes (Do you see other changes in the mixture, like cloudiness?)

Is the plant extract an acid-base indicator?

(i) Write down your inference.

(ii) What helped you make this inference?

TEACHER'S GUIDE IV: EXPLORING USES OF NATURAL INDICATORS

Students are introduced to two natural indicators in Chapter 4 ('Acids, Bases, and Salts') of the Grade VII science textbook (NCERT, 2024-2025).[1] The article titled 'Exploring Acids and Bases with Natural Indicators' in this issue of i wonder... shares an inquiry-based approach that students and teachers can use to identify and extract many other natural indicators from plants or plant parts in their surroundings. Because many natural indicators are inexpensive and safe for students to handle on their own, they allow students to learn about acids and bases through their own hands-on experiences rather than through teacher-led demonstrations with synthetic indicators. Here are some other ways in which natural indicators can be used in the middle-grade science classroom:

- In Chapter 6 ('Materials Around Us') of the Grade VI science textbook (2024-2025), students learn to observe and classify everyday objects based on the properties of the materials they are made up of.[2] Students from this grade can be invited to use natural indicators to classify objects based on their acidity and alkalinity. This exercise can often stimulate student curiosity. For example, in one multigrade classroom (with grades VI-VIII), students brought freshly plucked green tamarind for testing. The tamarind was very sour and students wanted to see how this would affect the intensity of colour it produced with the China rose indicator they had prepared. In another class, students brought solutions of many kinds of soaps for comparison. Natural cleansers like *ritha* and *shikakai* can be added to this list. Teachers can share that the pH of healthy skin is slightly acidic. Results from the pH test with a natural indicator can be used to discuss the effect soap's acidity or alkalinity is likely to have on students' hands and skin.
- In Chapter 2 ('Nutrition in Animals'), of the Grade VII science textbook, students learn about the role our teeth play in digestion. They also learn that: "*Normally bacteria are present in our mouth but they are not harmful to us. However, if we do not clean our teeth and mouth after eating, many harmful bacteria also begin to live and grow in it. These bacteria break down the sugars present from the leftover food and release acids... The acids gradually damage the teeth... This is called tooth decay. If it is not treated in time, it causes severe toothache and in extreme cases results in tooth loss. Chocolates, sweets, soft drinks, and other sugar products are the major culprits of tooth decay*".[3] Teachers can invite students to use natural indicators to test and compare the pH of some kinds of soft drinks with some kinds of toothpaste (including *datun*). This exercise allows students to see for themselves that brushing their teeth with toothpaste can help neutralise the acid in their mouth.
- Natural indicators can vary in their sensitivity to changes in pH. The more sensitive the indicator, the more likely that a small change in pH will result in a noticeable change in the indicator's color. Teachers can invite students to test the sensitivity of the different natural indicators they extract. To do this, observe the effect of adding each indicator to a range of everyday substances that have different, but

known, values on a pH scale (see **Fig. 1**). Doing this for 2-3 indicators in one session will allow you to compare their relative sensitivity.

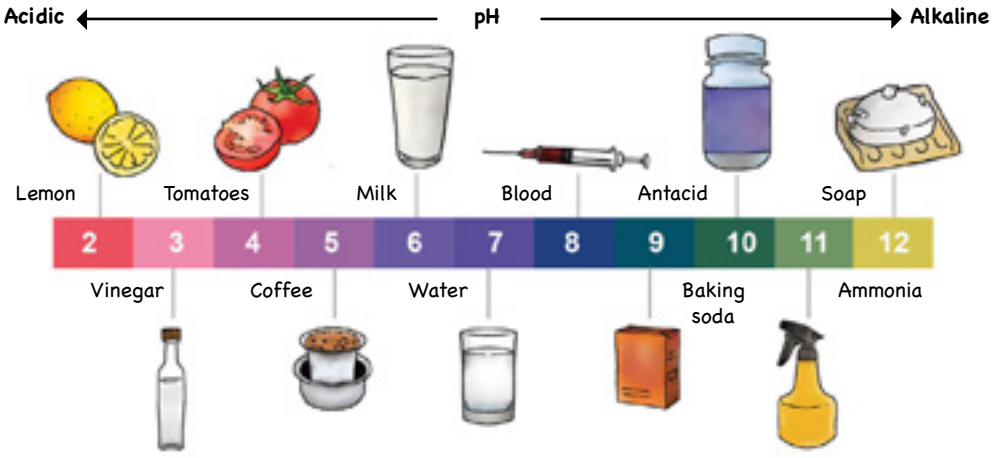


Fig.1. The pH of some everyday substances. Substances with a pH less than 2 and more than 12 have not been included because they are corrosive and can cause serious harm.

With a sensitive indicator, students may be able to develop a pH scale of their own (see **Fig. 2**). Why is this useful? Not only will students be able to use the indicator to tell if a new substance is acidic, basic, or neutral, this exercise will allow students to make a closer estimate of the pH of the substance.

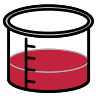
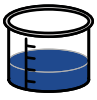
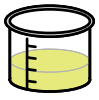
pH	2 - 3	4 - 5	6 - 7	8 - 9	10 - 11	12
Colour						

Fig. 2. Example of a pH scale for red cabbage indicator. Extracts of China rose and beetroot are also known for their sensitivity. What do their pH scales look like?

Are there any other ways in which you have used natural indicators to connect concepts from the middle-grade science curriculum with students' real worlds? Share them with us.

References:

1. National Council of Educational Research and Training (2024). 'Chapter 4: Acids, Bases, and Salts'. Science Textbook for Grade VII: 38-46. URL: https://ncert.nic.in/textbook.php?gesc1=4-13.
2. National Council of Educational Research and Training (2024). 'Chapter 6: Materials Around Us'. Science Textbook for Class VI: 101-121. URL: https://ncert.nic.in/textbook.php?fecu1=6-12.
3. National Council of Educational Research and Training (2024). 'Chapter 2: Nutrition in Animals'. Science Textbook for Grade VII: 11-23. URL: https://ncert.nic.in/textbook.php?gesc1=2-13.

i wonder...
Rediscovering school science

Contributed by:

Radha Gopalan, who works at Azim Premji University, Bengaluru. She is also a member of the Kudali Intergenerational Learning Centre, Telangana.

Ankita Chaturvedi who works as a science resource person and teacher educator at Azim Premji Foundation, Bhopal. She can be contacted at: ankita.chaturvedi@azimpremjifoundation.org.

Chitra Ravi, who works at Azim Premji University, Bengaluru.

The Science Educator at Work

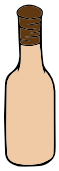
ACTIVITY SHEET: BE AN INDICATOR *JASOOS*!

Aim:

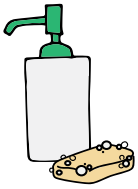
Can natural indicators help you write and read invisible messages?

You will need:

Lemon juice

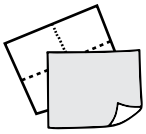


Vinegar

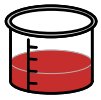


Soap solution

Chuna mixed in water



A few sheets of blank white paper (one sheet can be cut into 2-4 pieces)



A natural indicator that you have prepared

Thick paintbrush or a small spray bottle

4 pieces of a stick (each the size of your pen) OR 4 pencils.

4 Paper cups

Notebook

Send a secret message to your friend:

1. Take 4 pieces of blank white paper. Label them 1, 2, 3, and 4.
2. Pour lemon juice, vinegar, soap solution, and *chuna* mixed with water in 4 different paper cups. Label the cups 1, 2, 3, and 4 in any order. Make a note in your notebook about the solution that matches each number. For example, Cup 1: Vinegar, Cup 2: Soap, etc. Do not show this to your friends.
3. Decide what message you want to send to your friend. Break it up into 4 parts. Label the four pieces of paper 1, 2, 3, and 4.
4. Dip a stick/the back end of a pencil in the solution in Cup 1 and write the first part of your message on Paper 1. Dip the second stick/pencil in the solution in Cup 2 and write a message on Paper 2. In the same way, use the solutions in Cup 3 and Cup 4 to write messages on Paper 3 and Paper 4. Remember: It is important to use different sticks for each solution.
5. Let the 4 paper pieces dry. Since the 4 solutions are colorless, the messages you write with them will be 'invisible'. Nobody will be able to see your messages. Give the four pieces of paper to

your friend and invite them to find out what you have written.

Read a secret message from your friend:

1. Your friend will give you 4 pieces of paper with their secret message. Dip the paintbrush into the natural indicator and paint the entire surface of Paper 1 with it. Repeat this for Paper 2, 3, and 4.
2. What do you see? Can you read all 4 parts of your friend's message? Write down your observations in the table below.

Observe and record:

Colour of indicator:

Paper No. (1,2,3, or 4)	Could you read the message? (Y/N)	If Y, what is the colour of the message (with indicator)?	Is the invisible ink acidic or basic? Your guess.

Think about and discuss:

Q1. Ask the friend who gave you the secret message if the invisible ink they used for your message is acidic or basic. Is your guess correct? What observations helped you make this guess?

Q2. Were there any messages that you could not read? What might be some reasons for this?

Q3. Once the messages become visible, do they stay that way? Think and discuss possible explanations for your observation.

i wonder...
Rediscovering school science

Contributed by:
Ankita Chaturvedi who works as a science resource person and teacher educator at Azim Premji Foundation, Bhopal. She can be contacted at: ankita.chaturvedi@azimpremjifoundation.org.

i wonder...
REDISCOVERING SCHOOL SCIENCE

WRITE FOR US

i wonder... is a magazine 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 government school teachers can use in classroom instruction.

What kind of subject knowledge, pedagogical approaches, and perspectives to school education would such teachers need to meet grade-appropriate curricular goals and build related competencies in their students? If you are a practicing science teacher, teacher educator, or researcher engaged in exploring this question, share your experience with us.

Requirements:

1. Choose a topic from the latest edition of the preparatory-stage EVS and middle-stage science textbooks (NCERT, 2024-2025). These are freely available here: https://ncert.nic.in/textbook.php. Highlight explicit connections to the content of these chapters. Allow the grade-appropriate learning outcomes for these subjects to guide the scope, complexity, and level of abstractness of your draft.
2. The National Curriculum Framework for School Education (NCF-SE) 2023 recommends specific curricular goals for preparatory-stage EVS and middle-stage science education. This document is freely available here: https://education.gov.in/sites/upload_files/mhrd/files/ncf_2023.pdf. Teachers are expected to meet these goals in ways that help their students develop and practice certain competencies in their real world. Present your article and/or resource from a perspective that supports teachers in this task.
3. Context plays an important role in what teachers can do in their class. Where possible, share how teachers can apply or adapt your article or classroom resource to meet the requirements and constraints of their own contexts. Design activity ideas and teaching guides with materials that government school teachers and students can find easily, locally, and inexpensively.

Your submissions:

- Need to be original. Include references and acknowledgements to indicate contributions from others.
- Need to be as concise as you can make them. They can be as short as 800 words. Try not to exceed 1500 words.
- Need to be written in simple non-academic language. Do show us why the ideas in your draft matter to you.

Share your pitch with us:

Write a brief outline that tells us what you want to write about and the key questions you hope to address. Also, tell us how your article:

- Supports the content of the grade-appropriate NCERT textbook.
- Aligns with the stage-appropriate curricular goals in the NCF-SE 2023.
- Can be used by teachers in their classroom instruction.

Include a brief bio (< 50 words) that tells us something about your background in science and/or science education, and areas of interest in school science.

Send your pitches and drafts to: iwonder@apu.edu.in. We accept submissions (in English, Hindi, or Kannada) throughout the year.

FEEDBACK FROM READERS

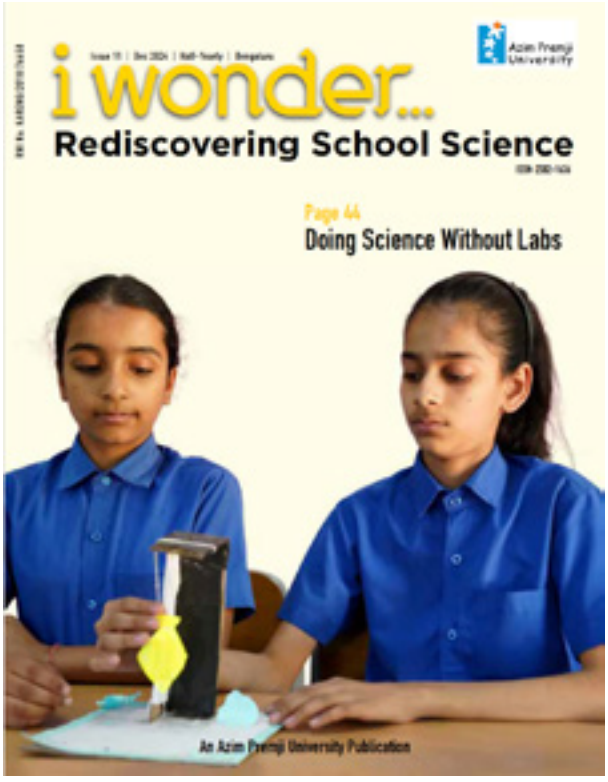
"The activity sheets are effective and can make learning more interactive and engaging for students. Case studies can be included on how teachers adapt to specific challenges in the classroom. A follow-up article can be added in the next issue on how teachers implemented the articles and worksheets in their classrooms and their experiences."—Shalom Sunaina, Azim Premji Foundation, Vijayapura, Karnataka.

"As a teacher, I often find myself facing a barrage of questions from curious students. To address this, I propose a column in the magazine that serves as a valuable resource for providing fact-based answers to their queries."—Anuradha Jhala, Azim Premji Foundation, Sirohi, Rajasthan.

"The articles and detachable classroom resources are useful for practitioners. Some sections/content could be included like, curiosity corner (in which we can add brainstorming questions, science puzzles, etc.), new research in science, etc. We can also give space to teachers' work (could be pictures or videos related to doing science in schools, handwritten notes, worksheets, etc.). Link/QR code could be used to add this section. Section name could be 'resources from school science'. The article on assessment in science education ('The Importance of Asking for Questions in Different Ways') was insightful."—Avneesh Shukla, Azim Premji Foundation, Uttarkashi, Uttarakhand.

"The articles are really good. They share different pedagogical practices for a good science classroom environment."—Amrita Masih, Azim Premji Foundation, Sehore, Madhya Pradesh.

"The materials are effective and could make the learning experience even more engaging and relevant. Specifically, the article 'Doing Science Without Labs' is very useful in the field, providing ideas for teachers with limited resources who are eager to engage students in experiments and activities. Unlike before, most of the activity sheets are directly usable in the



classroom and offer more ideas for engaging students through different pedagogical approaches. I expect more such ideas, where rural/remote teachers with limited resources can easily conduct activities that are both engaging and effective. Request that future issues address more ideas on pedagogy for biology topics such as 'Respiration' and 'Human Reproduction'."—Sumangala, Azim Premji Foundation, Koppal, Karnataka.

"It would be great if you could add more ground-level articles and the experiences of teachers/educators and those who are working on science with marginalized students." —Mahima Yadav, Azim Premji Foundation, Khargone, Madhya Pradesh.

"The issue shares a lot of activities along with articles

that can be linked to the science classroom."—Manisha Singh, Azim Premji Foundation, Udham Singh Nagar, Uttarakhand.

"Heartfelt thanks for the 'Activity Sheet: Make your own Pinhole Camera'. While I have made them before, the beauty of your procedure is the simplicity and how quickly one can make a working model. This ensures more time for experimentation leading to amazing inquiries, thus the focus remains on science and not too much time spent in crafting. The 'The Pedagogy of Making: Pinhole Camera' also gives good pointers on how to go about the scientific inquiry on this concept, which I felt gives good leading pointers when teachers do similar activities on other concepts too." —Deepak R, freelance science educator in Chennai working with middle-school students and government school teachers.

"The articles with teacher's guides are very helpful as they can be used directly in the classroom with some modifications as per the classroom."—Archana Dwivedi, Azim Premji Foundation, Haridwar, Uttarakhand.

"i wonder... already covers school-level science well, but it could be more comprehensive by including more materials related to Grades XI and XII. Adding specific segments for teachers and learners at this level would help ensure that the magazine covers the full spectrum of school science education."—Anurag Tiwari, Azim Premji Foundation, Chamoli, Uttarakhand.

"More innovative content related to the topics of 'Reflection' and 'Acids, Bases, and Salts' can be added."—Sanyam Giri, Azim Premji Foundation, Pauri, Uttarakhand.

"Articles describe the process along with content very well, but the difficulty for some new teachers is how to start. We can add some suggestive steps anyone can follow to directly deal with students. If possible, availability in both languages can help more teachers."—Alka Tiwari, Azim Premji Foundation, Tonk, Rajasthan.

"If more case studies can be added, it will help us to understand the classroom teaching-learning process more and plan accordingly. Sometimes we face challenges that are specific to the contexts we work in. For example, one topic is about the natural resources in forests. In some parts of Rajasthan, it is not easy for a teacher to visit a nearby forest. So, we may have to think of an alternative way to teach that lesson."— Debabrata Dutta, Azim Premji Foundation, Raigarh, Chhattisgarh.

"I found that almost all articles directly or indirectly addressing the classroom align with NCF-SE and the aims of education. It is nice to have the opportunity to read an article written by a university professor that directly addresses the classroom. Also, to read articles written by our Foundation members. If possible, the magazine could be published quarterly and address more classroom issues."—Debal Mandal, Azim Premji Foundation, Janjgir-Champa, Chhattisgarh.

"The biodiversity/EVS content was commendable and highly practical. Furthermore, the material effectively utilizes examples from everyday life, which significantly aids teachers' and students' comprehension and engagement."—Akshat Uniyal, Azim Premji Foundation, New Tehri, Uttarakhand.

Share your feedback

Have you tried a pedagogical approach from our Dec 2024 issue in your classroom? For example, what prompts have you used to invite your students to ask scientific questions? How did your students respond to them?

Have you designed a different activity to teach a topic addressed in our Dec 2024 issue? For example, have you used a different model of a pinhole camera in your classroom? What role did students have in refining its design?

Have you and your students discovered something new from your explorations? For example, did the exercise on documenting birds in your neighbourhood help your students learn about a bird species that has disappeared from it in the last few years? How did the elders in the community respond to this exercise?

Would you like to share anything from your classroom experiences that would help other teachers use the articles and resources from our Dec 2024 issue more effectively in their classroom practice? Tell us.

You can share your feedback for the:

- English edition of our Dec 2024 issue here: https://forms.gle/8saQ8Qnm4zGujZ5A8.
- Hindi edition of our Dec 2024 issue here: https://forms.gle/q6c4eVH9xCpiUFCHA.
- Kannada edition of our Dec 2024 issue here: https://forms.gle/ZVD4qPUEojVAvpCUA.

You can also write to us at: iwonder@apu.edu.in.

Connect with Us

Read

Catch three issues a year: in Dec, Apr, and Aug. Every issue is available in **English, Hindi, and Kannada**. Each issue features a combination of articles and detachable classroom resources (like Activity Sheets, Concept Builders, Teacher's Guides, Booklets, Posters, and Field Guides). These are included under sections like: The Science Educator at Work, Life in your Backyard, Annals of History, The Science Lab, Perspectives, Resource Review, Teaching as if the Earth Matters, and Ask A Question. All **our content is CC-licensed and freely available** on our website.

Ask and discuss

Share your questions with authors in our free, live, online discussions. Here are some examples:

- Soil in the Science Classroom with Santosh Kumar and Radha Gopalan.
- How do Children Know the Earth is Not Flat? with Anand Narayanan and Amol Anandrao Kate.
- Why Science Matters with Anil Kumar Challa, Reeteka Sud, and Vinay Suram.
- An Inquiry-Based Approach to Germination with Dhanya K and Radha Gopalan.
- Exploring Motion through a Balloon's Flight with Anish Mokashi and Vinay Suram.

Find us

To **download full issues (English) and subscribe to receive free hard copies,** visit our magazine page.

To **download individual articles (English)**, visit our repository page.

To **download individual articles (Hindi and Kannada)**, visit our translations repository page.

To **watch recordings of our online discussions**, visit our Publications playlist.

To **get updates** on upcoming issues and online discussions, register here.

Printed and published by Sharad Sure, Registrar, on behalf of Azim Premji University. Survey No 66, Burugunte Village, Bikkanahalli Main Road, Sarjapura, Bengaluru, Karnataka 562 125.
Printed at Lakshmi Mudranalaya, # 117, 5 th Main Road, Chamrajpet, Bengaluru, Karnataka 560 018.
Editor: Chitra Ravi.

Postgraduate Diploma Programmes in Education

Azim Premji University

For practicing professionals in the field of Education

Flexible | Blended Mode

APPLY NOW

Early Childhood Education	Inclusive Education	Teaching Children with Learning Disabilities

Key Features of the Programmes:

- The programme is aligned to the credit structure as defined by the National Credit Framework (NCrF) issued by UGC in April 2023.
- Course content and pedagogy lays emphasis on relevant theories, practice and hands on skills required for building expertise in the respective areas of early childhood education, inclusive education and teaching children with learning disabilities.
- Become a member of a community of reflective practitioners through our alumni network.
- Participants have the flexibility of joining the PG Diploma Programme or taking one or more Certificate Programmes individually.

Admission Process:

Participants can enter into the PG Diploma Programme through any of the Certificate Programmes.

The two steps of the process are :-

Step 1: Online application form with Statement of Purpose.

Step 2: Panel Interview in online mode.

Fees and Financial Assistance:

- Fee details are available on the website.
- The University will offer financial assistance to deserving candidates based on their income. This financial assistance will be partial waivers of the fee component and will be awarded at the sole discretion of the University. The University will ask for documentary proof as required. Admission available to participants requesting financial assistance is limited.

Scan the QR code to know more:

ACKNOWLEDGEMENTS

We thank Vinay Suram for making it possible for us to learn from Azim Premji Foundation's work with preparatory-stage Environmental Studies (EVS) and middle-stage science teachers in government schools in peri-urban Bengaluru.

A special thank you to Sreenivasa TG and Chithra P for introducing us to some of the schools and teachers they work with. We thank Venkatesh Reddy sir (Head Teacher-In-Charge) and Mohd. Suheel Ahmed sir from Govt. Urdu English Higher Primary School, Adigarakallahalli; Rajshekhar sir (Head Teacher), Sowbhagya madam, Praveen sir, and Manasa madam from Govt. Model Girls Higher Primary School, Sarjapura; Lakshmi madam and Teerthamani madam from Govt. Model Higher Primary School, Gunjuru; and Pavithra madam from Govt. Higher Primary School, Maragondanahalli for sharing their experience of teaching science at the middle stage. We saw some ways in which these teachers use materials and technology to sustain their students' enthusiasm for science learning. We learnt of some ways in which the social backgrounds of students in a class shape the priorities of their teachers. For example, in schools where many students are from migrant labour families, the focus of all teachers, including those who teach science, is on finding ways of bridging differences in language skills. We saw how a well-equipped library or lab can only support learning when teachers help students take ownership of these spaces. We also heard of some ways in which this sense of ownership can extend to the science classroom.

Credits: Vijeta Raghuram. License: CC BY-NC-ND.

Credits: Vijeta Raghuram. License: CC BY-NC-ND.

Many thanks to Sowmyashree NJ, Baseera Khanum C, Chithra P, Sarasij RC, Deepika Hebbar, Archana S, Arfa Sultana Bargir, Supriya Narayankar, S Vijayakumar, and Radha M for generously making the time and effort to travel from different parts of Bengaluru to meet us. We learnt about some of the collaborative and context-specific ways in which they support the teaching practice of government-school EVS and science teachers. Our thanks to the team for also sharing feedback on articles from past issues that they have found relevant to their work.

—Radha Gopalan, Vijeta Raghuram, and Chitra Ravi.

FORM IV

1. **Name of publication:** i wonder...

2. **Place of publication:** Azim Premji University Survey No. 66, Burugunte Village, Bikkanahalli, Main Road, Sarjapura, Bengaluru, Karnataka - 562125

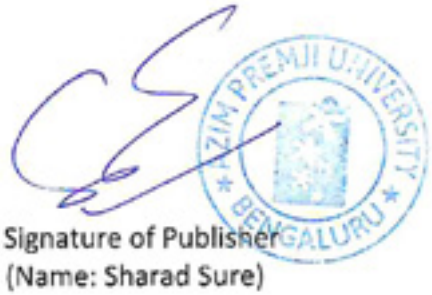
3. **Periodicity of its publication:** Triannual

4. **Printed & Published by:**
   Name: Sharad Sure (Registrar, Azim Premji University, Bengaluru)
   Nationality: Indian
   Address: Azim Premji University Survey No. 66, Burugunte Village, Bikkanahalli, Main Road, Sarjapura, Bengaluru, Karnataka - 562125

5. **Editor's Name:** Chitra Ravi
   Nationality: Indian
   Address: Azim Premji University Survey No. 66, Burugunte Village, Bikkanahalli, Main Road, Sarjapura, Bengaluru, Karnataka - 562125

6. **Name of the owner:** Azim Premji Foundation
   Address: #134 Doddakannelli, Next to Wipro Corporate Office, Sarjapur Road, Bengaluru, Karnataka - 560035

I, Sharad Sure, hereby declare that the particulars given above are true to the best of my knowledge and belief.

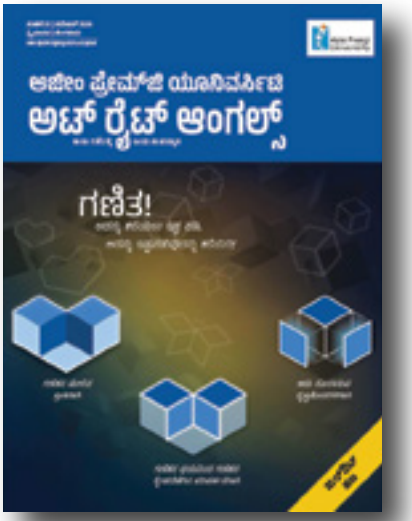


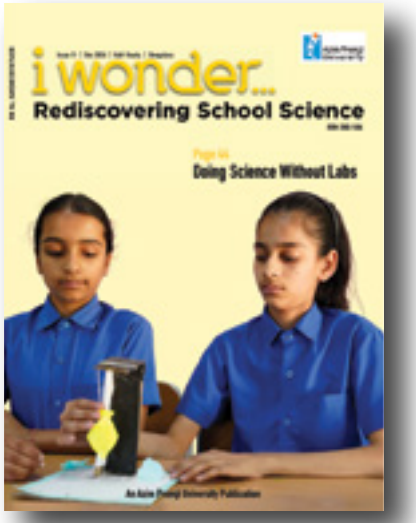
Date: 1st April 2025

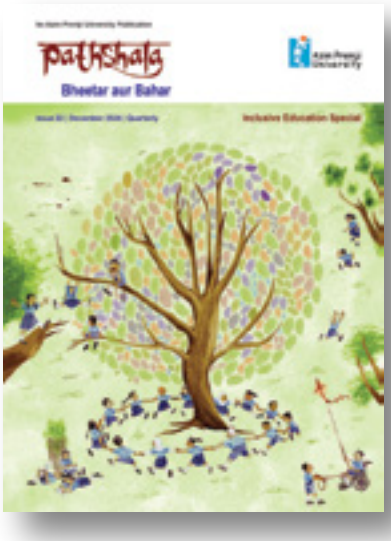
Signature of Publisher
(Name: Sharad Sure)

Azim Premji University

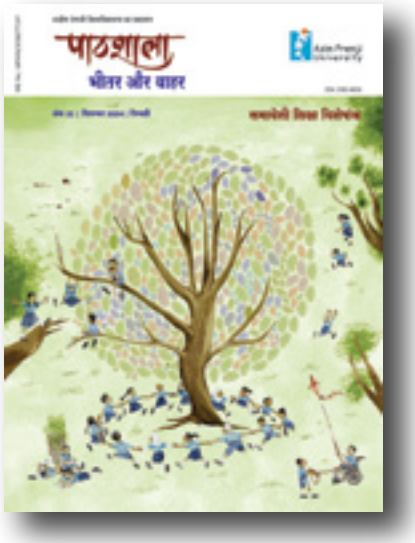
Magazines for School Education

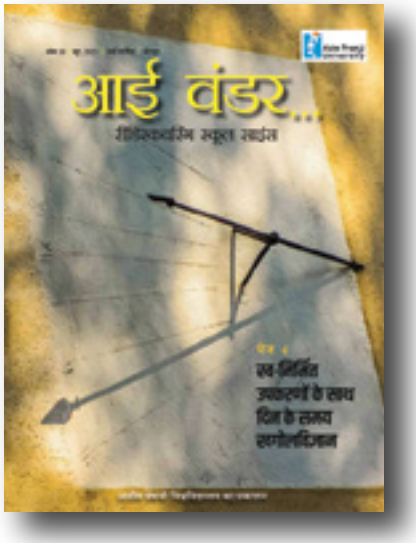


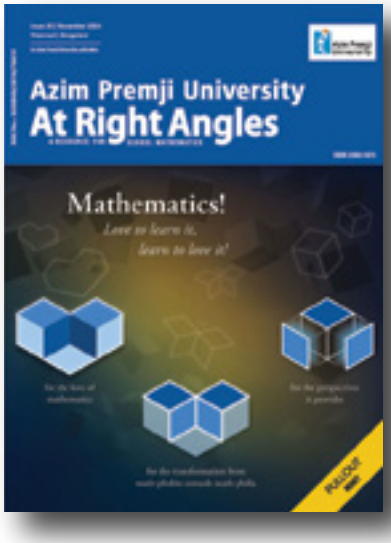




Scan here to SUBSCRIBE to i wonder... Magazine







To know more about other publications, contact us at: publications@apu.edu.in

"If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement, and mystery of the world we live in."

—Rachel Carson.

Catch our next issue in Aug 2025.

Azim Premji University
Survey No 66, Burugunte Village, Bikkanahalli
Main Road, Sarjapura, Bengaluru 562125.
Facebook: /azimpremjiuniversity
Instagram: @azimpremjiuniv
www.azimpremjiuniversity.edu.in
X: @azimpremjiuniv