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PRE-REVIEW INAUGURAL ISSUE



How much solar energy could Pakistan’s schools generate?

A modelling study across five cities, plus eight student features

MONTHLY | ENGLISH | FOR SCHOOL STUDENTS

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Science begins with a question

Welcome to the pre-review inaugural issue of **NexSolveAI Young Scientist Pakistan**. This monthly English-language magazine is being developed for school students who want to understand the world, investigate questions and explain what they discover.

The nine category drafts offer different starting points. A comparative solar-energy study uses a public modelling service. Everyday materials invite questions about heat. Paper bridges, a proposed drip waterer and a soil-moisture monitor connect design with measurement. A waste-audit guide asks what happens after collection. A scientist profile introduces a career in photonics, while the school science-club plan and puzzles invite students to take part.

Across the issue, we encourage readers to separate observations from explanations and predictions from results. A model estimate is not a measured school output. A proposed device is not a tested invention. An interesting photograph does not replace a method, a record or a clear account of uncertainty.

Teachers and mentors can help students choose manageable questions, plan safe activities and keep useful records. Students can contribute through careful writing, drawing, coding, making or checking an explanation. An unexpected result can be the beginning of a better question.

How to read this review copy
This compilation is not peer reviewed, accepted or published. January 2027 is the planned issue designation. The article-specific notices distinguish modelled information, constructed teaching data and activities that have not been carried out. The scientist profile is based on the subject’s public CV and awaits his factual approval.

Before publication
The editorial team must complete review and corrections, confirm author identities, affiliations, contributions and approvals, resolve acknowledgements and declarations, and check source and image permissions. AI assistance is disclosed in the drafts. The corresponding author should confirm the submission undertaking with the authors’ approval. This draft editorial is unsigned pending approval.

We invite young readers to ask a question they can investigate, explain what the evidence supports and be open about what remains unknown.

Solar Energy Potential for Schools in Five Pakistani Cities

A comparative assessment using PVGIS

Research Paper | January 2027 inaugural issue candidate | Pre-review draft

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Author names, affiliation, contributions and consent require confirmation before submission. This draft is not peer reviewed or approved for publication. All numerical results below are calculated from retrieved PVGIS outputs; no school installation was measured.

Abstract

Schools considering rooftop photovoltaics need comparable estimates of energy generation before commissioning a site survey. This study compares a hypothetical 5 kWp crystalline-silicon system at representative coordinates in Lahore, Karachi, Islamabad, Peshawar and Quetta. PVGIS 5.3 was queried with the ERA5 radiation dataset for its reported 2005–2023 period. All sites used a fixed 30° south-facing array, free-standing mounting and 14% user-specified system losses. Estimated mean annual generation ranged from 7,880.89 kWh in Peshawar to 9,402.55 kWh in Quetta; specific yields ranged from 1,576.18 to 1,880.51 kWh/kWp/year. Quetta exceeded Peshawar by 19.31% under these assumptions. PVGIS-reported annual standard deviations corresponded to coefficients of variation of 1.33–2.06%. Monthly profiles differed substantially, and the month with the greatest total generation did not always have the greatest average daily generation. The results provide a reproducible educational screening comparison, not a school energy audit, financial feasibility assessment or forecast of actual site performance.

Keywords: rooftop photovoltaics; schools; Pakistan; PVGIS; ERA5; specific yield; seasonal variability

1 Introduction and research question

A solar array can produce different amounts of electricity at different locations even when its rated capacity is identical. A school-level comparison should therefore hold the technical settings constant and explain both annual totals and seasonal variation. Here, “for schools” describes the planning and educational audience; the five locations are representative city coordinates, not surveyed school rooftops.

The research question is: how do estimated annual generation, specific yield, monthly patterns and reported interannual variability differ for an identical 5 kWp reference system in five Pakistani cities? The working hypothesis is that these outputs vary by location despite identical equipment assumptions.

Photovoltaic system overview

Figure 1 introduces the energy pathway represented by the reference scenario. Photovoltaic cells convert incident light into electrical energy. Modules are connected into an array that supplies direct current (DC); an inverter converts this into alternating current (AC) for school equipment and a grid connection.

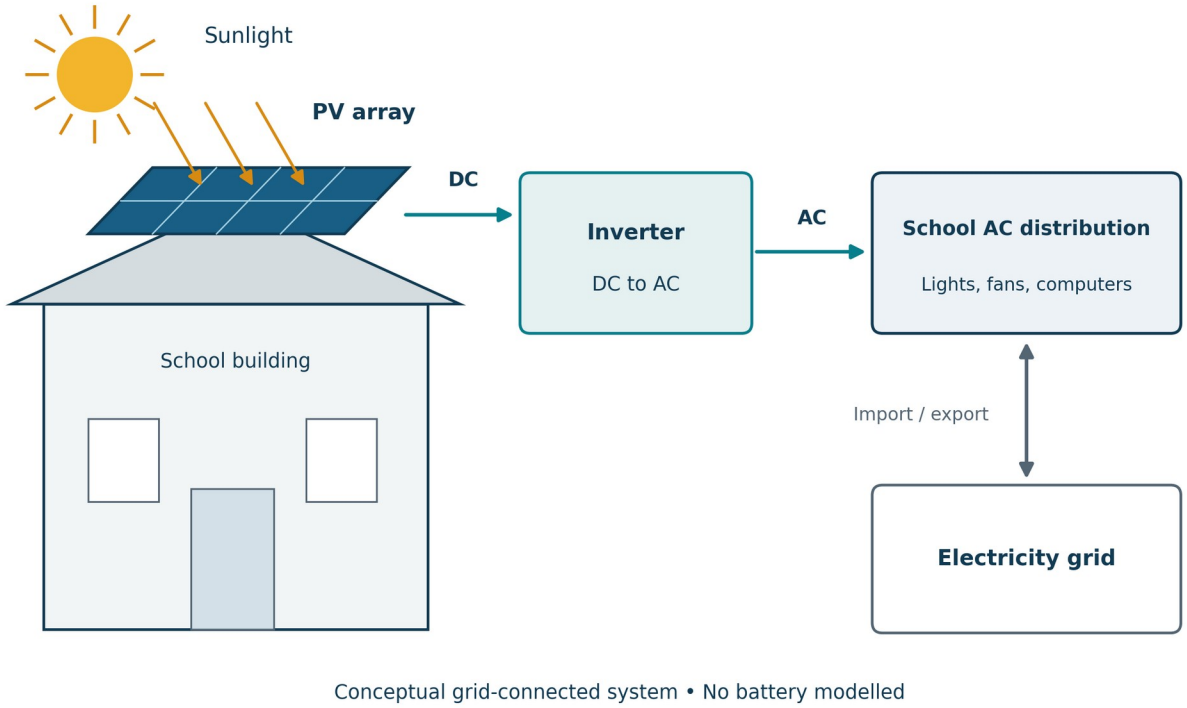


Figure 1. Conceptual rooftop photovoltaic system for a school. Sunlight reaches the PV array; its DC output passes to an inverter, which supplies AC to school loads. The bidirectional grid connection represents possible import or export, subject to the actual interconnection arrangement. This original schematic is explanatory and is not a wiring or installation drawing. It does not depict a surveyed school, measured energy flows or the physical layout of a PVGIS simulation. No battery is modelled.

The diagram shows components and energy conversion, not the amount of electricity a school can use. This study estimates generation under common PVGIS assumptions. It does not model school demand, self-consumption, export limits or battery storage. Ordinary grid-connected PV alone should not be assumed to provide electricity during a grid outage; that requires an appropriately designed backup system.

2 Research gap and contribution

Khatri et al. [1] assessed Pakistan's solar potential and diffusion using the System Advisor Model and other methods. This paper contributes a reproducible school-facing comparison linking common assumptions to annual yield, seasonality and variability. It does not claim the first city comparison or a new PV model.

The practical gap addressed is translating resource modelling into an accessible comparison for school science groups. This is an application and communication contribution; the literature check does not establish that no equivalent school-focused study exists.

3 Materials and methods

3.1 Locations and source data

Five representative coordinates were selected as analysis points, without claiming they represent every rooftop in each city (Table 1). Unmodified JSON responses were downloaded from the European Commission Joint Research Centre PVGIS 5.3 PVcalc endpoint on 8 November 2026 Pakistan time (7 November UTC). Each response identifies PVGIS-ERA5 and a common 2005–2023 period [2,3]. ERA5 is a meteorological reanalysis, combining a physical model and observational information [4].

Table 1. Coordinates and PVGIS-reported elevation for the analysis points.

City	Latitude °N	Longitude °E	Elevation m
Lahore	31.5204	74.3587	220
Karachi	24.8607	67.0011	10
Islamabad	33.6844	73.0479	525
Peshawar	34.0151	71.5249	348
Quetta	30.1798	66.9750	1649

3.2 Reference system and scope

All cities use a hypothetical 5 kWp crystalline-silicon array, fixed at 30° from horizontal and facing south (PVGIS aspect = 0°), with free-standing mounting, 14% user-specified losses and terrain horizon enabled [2]. Tracking, angle optimisation, storage and economics are excluded. Five kWp is a reference size, not a school-specific recommendation.

PVGIS includes irradiance and module-temperature effects in addition to the assumed user losses [5,6]; do not deduct the 14% again. Local soiling, obstructions, outages and school loads are not individually modelled. The documented SARAH-3 extent ends at 65°E, west of all selected points, motivating the common ERA5 dataset [3].

3.3 Derived metrics and quality checks

Let Ey be mean annual generation in kWh/year, P0 the rated capacity in kWp, SDy the PVGIS-reported standard deviation of annual generation, and Em mean generation in month m. The derived metrics are:

$$\text{Specific yield} = Ey / P0 \quad (1)$$

$$\text{Annual coefficient of variation} = 100 \times SDy / Ey \quad (2)$$

$$\text{Monthly share} = 100 \times Em / Ey \quad (3)$$

All five response hashes and input metadata were checked. Each city has 12 finite, nonnegative monthly records; their energy sum agrees with the annual value within 0.02 kWh, consistent with output rounding. Comparisons are descriptive. The source SD is retained as interannual variability, not a confidence interval, statistical significance test or complete model uncertainty estimate.

4 Results

4.1 Annual generation and specific yield

Table 2 gives the retrieved annual model outputs and derived specific yield and coefficient of variation. Under the common scenario, generation follows the order Quetta, Karachi, Lahore, Islamabad and Peshawar. Quetta produces an estimated 1,521.66 kWh/year more than Peshawar, a relative difference of 19.31%. Source outputs: [7].

Table 2. Annual modelled performance for the hypothetical 5 kWp system.

City	Energy kWh/year	Specific yield kWh/kWp/year	Annual SD kWh	CV %
Lahore	8,017.42	1,603.48	147.96	1.85
Karachi	8,592.24	1,718.45	113.88	1.33
Islamabad	7,963.40	1,592.68	163.46	2.05
Peshawar	7,880.89	1,576.18	162.53	2.06
Quetta	9,402.55	1,880.51	152.54	1.62

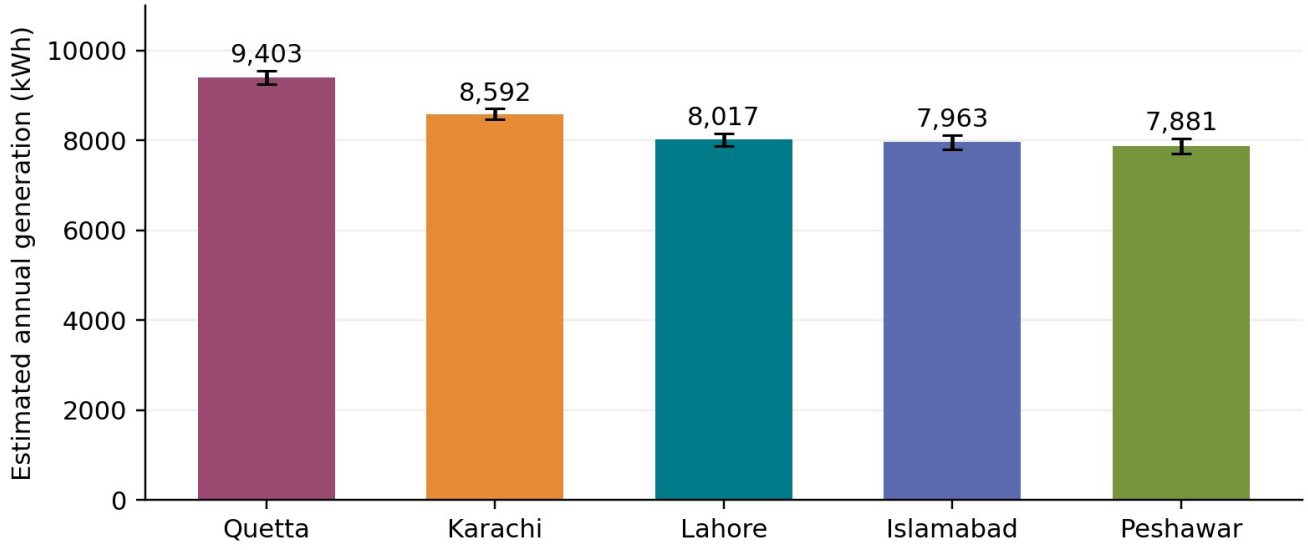


Figure 2. Estimated mean annual generation from PVGIS. Error bars show the reported standard deviation of annual generation over the source period; they do not represent the full uncertainty of actual school generation. The bars describe modelled 5 kWp systems, not measured installations.

Lahore exceeds Islamabad by only 54.02 kWh/year, or 0.68% relative to Islamabad. This small difference should not be interpreted as a dependable advantage for a particular rooftop. Local shading, mounting, maintenance and model bias could outweigh it. Peshawar and Islamabad are likewise close in this scenario.

4.2 Reported variability

Annual coefficients of variation range from 1.33% in Karachi to 2.06% in Peshawar. These percentages summarise variability between modelled years. They do not demonstrate that a future school system will generate within 2.06% of its estimate, nor do they quantify sensor error or the accuracy of ERA5 for these sites. Individual annual time series were not downloaded, so trends and paired year-by-year city differences were not tested.

4.3 Monthly and seasonal patterns

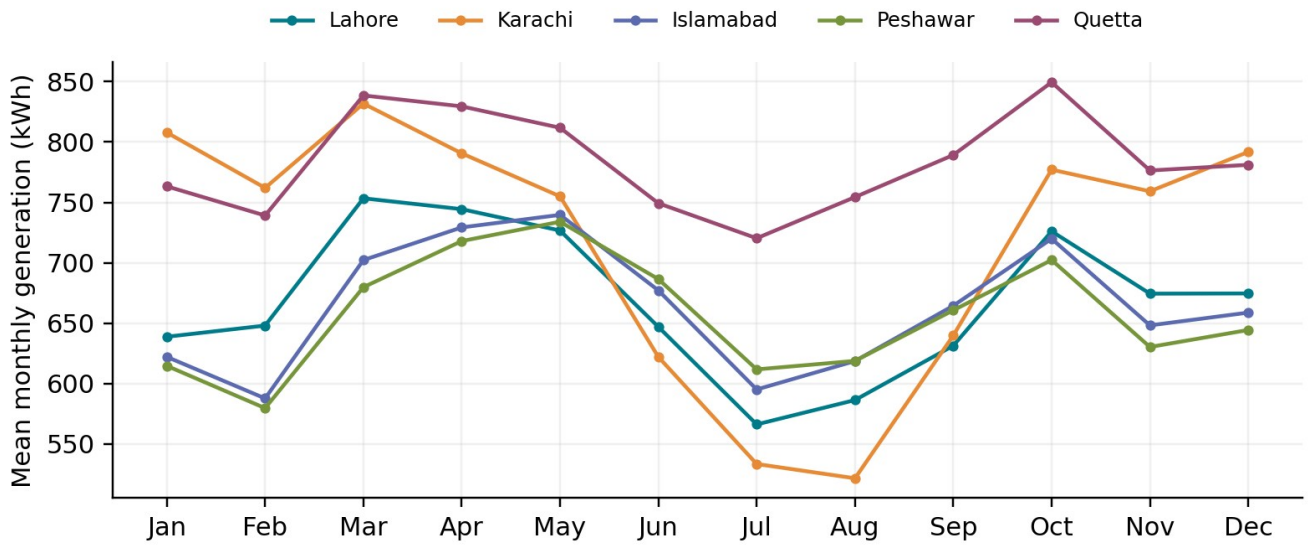


Figure 3. Mean monthly generation for each city under the same 5 kWp system settings. Values are monthly totals and therefore reflect month length as well as daily resource and modelled performance. Curves connect monthly averages; they are not observations from a single year.

Table 3. Mean monthly generation in kWh for the reference system.

Month	Lahore	Karachi	Islamabad	Peshawar	Quetta
Jan	638.78	807.86	622.12	614.69	763.30
Feb	648.03	762.01	587.73	579.67	739.14
Mar	753.41	831.79	702.26	679.81	838.56
Apr	744.40	790.59	729.31	717.99	829.51
May	726.71	754.99	739.68	733.99	811.79
Jun	646.96	622.06	677.15	686.51	749.28
Jul	566.21	533.42	595.13	611.74	720.32
Aug	586.36	521.59	618.65	618.79	754.41
Sep	631.40	639.83	664.48	660.69	789.24
Oct	726.08	777.11	719.92	702.30	849.48
Nov	674.45	759.19	648.20	630.31	776.41
Dec	674.63	791.79	658.77	644.38	781.12

The highest monthly totals occur in March for Lahore and Karachi, May for Islamabad and Peshawar, and October for Quetta. Their respective lowest months are July, August, February, February and July. Across these five points, July–August output is generally below the spring peaks, but this comparison alone does not isolate cloud, temperature or aerosol causes.

Month length matters. For Quetta, October has the largest monthly total (849.48 kWh), while April has the highest average daily value (27.65 kWh/day). The archived monthly CSV therefore includes both daily and monthly outputs. School holidays and time-of-day demand were not included, so these patterns cannot establish self-consumption or backup availability.

5 Discussion and limitations

5.1 Implications for school planning

The comparison shows why rated capacity alone is insufficient when discussing school solar generation. Under one consistent model, the same nominal system produces different annual and monthly outputs at the five locations. The larger Quetta–Peshawar difference warrants further site-specific investigation; the much smaller Lahore–Islamabad difference should not drive procurement decisions by itself.

A school science group can reproduce the annual energy calculation, divide by rated capacity to obtain specific yield, and compare daily averages with monthly totals. This provides an accessible exercise in units, reproducibility, seasonal reasoning and the distinction between model predictions and observations. An independently checked meter record would be needed to test actual system performance.

The data can inform an initial conversation about where and when solar electricity may be generated. They do not show what fraction a school can use. A school may close during sunny periods, have substantial evening demand or experience grid interruptions. Demonstrating savings, reliable backup, or emissions reductions would require additional demand, technical, tariff and counterfactual information. No payback or avoided-emissions claim is made here.

5.2 Limits of the comparison

First, one coordinate per city and a gridded radiation dataset cannot represent variations among school rooftops. ERA5 radiation has an approximately 31 km grid in the cited PVGIS 5.3 dataset description [3]; a coordinate is a model sampling point rather than a site survey. Terrain horizon modelling does not resolve every nearby tree, parapet or building.

Second, 30° tilt provides a controlled comparison, not a site-specific optimum. The free-standing mounting assumption represents a ventilated rack and may differ from an actual roof assembly. The generic crystalline-silicon model and 14% user loss value do not characterise a selected product or local maintenance regime. Site-specific soiling and obstruction measurements are absent.

Third, the historical 2005–2023 source period is not a forecast of future climate or future equipment output. Interannual SD describes one part of variability; uncertainty from radiation bias, PV model structure and local conditions is not propagated. No independent ground irradiance or operating-system measurements were used for validation.

Finally, monthly averages conceal hourly timing, extremes and correlations between cities. The study does not measure roof area, structural suitability, electrical safety, electricity demand or economics. Follow-up work should compare alternative tilts and loss assumptions, download hourly series, and validate an actual school installation before drawing investment conclusions.

6 Conclusions

For the fixed 5 kWp scenario, PVGIS-ERA5 estimates annual generation of 7.88–9.40 MWh across the five selected coordinates. Quetta has the largest modelled output and Peshawar the smallest; their difference is 19.31%. Monthly profiles vary, and monthly totals should be distinguished from average daily generation. The study offers an auditable school-level comparison and a basis for more detailed investigation, with no claim of measured school generation, guaranteed savings or a new PV model.

Acknowledgements

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Declarations

Status and authorship: This is a pre-review manuscript for editorial and author assessment. The proposed authors and supplied affiliation must be verified, all authors must approve the manuscript, and the corresponding author must confirm the submission undertaking on their behalf. No peer-review completion or acceptance is claimed.

Author contributions: Individual roles have not been confirmed and must be stated truthfully by the named authors before submission. This draft does not assign fieldwork, data collection or analysis roles to any individual.

AI assistance: AI tools assisted with literature searching, retrieving public PVGIS responses, writing and executing analysis code, producing figures, and drafting and formatting this manuscript. Named authors must inspect the archived responses, reproduce and check the calculations, verify sources and approve the final text.

Funding and competing interests: These declarations require confirmation from the proposed authors before submission; absence of funding or competing interests is not assumed.

Ethics: The analysis uses public model outputs and selected coordinates. No human participants, identifiable student records, interviews or animal experiments are included. No ethics approval is claimed.

Data and code availability: The accompanying NYSP Solar Study Reproducibility Package contains the five original JSON responses, request URLs, UTC retrieval timestamps and SHA-256 hashes in data/manifest.json, derived annual and monthly CSV files, figures, download_data.py, analyse.py and draw_pv_system.py. No public repository DOI has been assigned. The package must accompany editorial review and should be deposited or hosted with the final article. This is secondary analysis of public model outputs, not original field measurement.

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Why a Metal Spoon Feels Colder Than a Wooden One

Science Around Us | Intended readers: approximately ages 11–16

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Pre-review educational article. Author details and consent require confirmation. The activity is proposed; no student observations or experimental results are reported here.

One room and two different feelings

Imagine two clean spoons lying together on a shaded kitchen table: one metal, one wood. Neither has just been washed, heated or taken from the refrigerator. After both have settled to the room's conditions, touch them briefly. The metal will usually feel colder. Does that prove it has a lower temperature? No. Two objects can have the same temperature and still feel different against your skin. [1]

Your skin notices a change

In a room cooler than your skin, energy transfers from your warmer fingers into either spoon. The important difference is how quickly this happens. Metal carries thermal energy away from the contact region more readily than wood. Your skin near the metal loses energy faster, producing a stronger cold sensation. Touch therefore gives clues about the interaction between your skin and a material, rather than a reliable measurement of the object's temperature. [1,4]

Scientists call energy transfer caused by a temperature difference heat transfer. Transfer through contact and within a material is called conduction. A material's thermal conductivity describes how readily it conducts heat; metals generally conduct well, whereas wood is a poorer conductor. In the spoon example, energy travels from your skin into the cooler object—not from a supply of "cold" inside the spoon. [2,3]

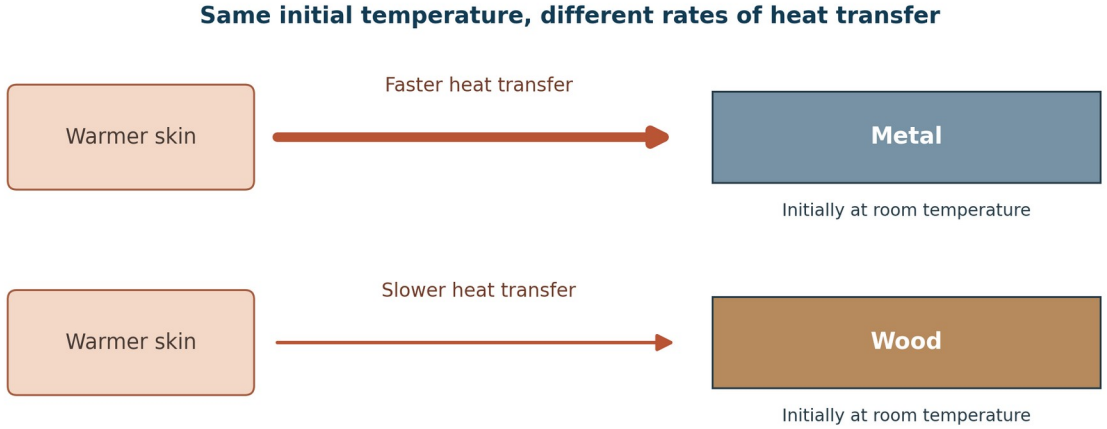


Figure 1. Qualitative comparison for brief contact when both objects start at the same room temperature below skin temperature. The thicker arrow indicates a faster transfer, not a numerical measurement. The separated blocks show the energy pathway schematically; physical contact is required. Original illustration.

Try a room-temperature observation

You need a smooth metal spoon, a smooth wooden spoon or clean wooden utensil, a shaded indoor table and a notebook. A teacher-supervised contact temperature probe is optional. Use only objects an adult has checked are safe and at ordinary room temperature; avoid hot, refrigerated, sharp or splintered objects.

1. Place both objects together away from sunlight, heaters, fans and recent washing. Allow them to settle to the same surroundings. If a suitable contact probe is available, wait for stable readings on each object and record them; allow for the instrument's uncertainty.
2. Before touching, write your prediction: will they feel alike, and does a colder feeling necessarily mean a lower temperature?
3. With dry hands, briefly touch one object and then the other using a similar area of your fingertips. Do not grip either for a long time. Reverse the order once after allowing your fingers and the objects to recover.
4. Record your own observations honestly. Write the material, how it felt and any stable probe reading. Separate what you observed from your explanation. If you have no temperature measurement, do not claim that you proved the temperatures were equal.

This is a qualitative observation, not a precise measurement of thermal conductivity. Different shapes, contact areas and previous handling can influence the comparison. A shiny metal surface can also mislead some non-contact infrared thermometers, so a casual infrared reading is not a reliable check unless the instrument and surface conditions are suitable. [5]

Look around your home

The same reasoning helps explain why bare feet may feel colder on tile than on carpet in the same room. It also explains why good heat conductors are useful for transferring energy during cooking, while poorer conductors are useful in handles and insulating layers. No handle material makes an object automatically safe to touch: its temperature and conditions still matter. [2,3]

Now reverse the temperature difference. If a metal object is hotter than your skin, it can transfer energy into your fingers rapidly and feel hotter than a poorer conductor at the same temperature. Do not test this with heated objects. The direction of heat transfer depends on which body is warmer. [4]

A question to take away

If a spoon and your skin were at exactly the same temperature, would there be net heat transfer between them solely because of a temperature difference? In the idealised case, no. A temperature difference is needed for that net transfer. The useful lesson is simple: "feels colder" and "has a lower temperature" are not interchangeable statements. [2]

Sources and editorial notes

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Which Paper Bridge Holds the Most Weight

Explore and Experiment | Intended readers: approximately ages 11–16

Proposed authors: Muhammad Rehan, Muhammad Talha, Muhammad Saleh and Muhammad Hassan Sayyad*
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Pre-review investigation guide. This experiment has not been carried out for this article. The results table is intentionally blank. Authors and affiliation require confirmation before submission.

Can a fold change what paper can support

A flat sheet can bend easily across a gap. Folding the same amount of paper changes its cross-section—the shape seen when looking along the bridge. Some folded designs resist bending better, without adding material. Engineers use structural shape to make materials work effectively. Paper-bridge activities offer an accessible way to explore this idea. [1–3]

Your question is: which of three one-sheet designs supports the greatest central load across a 15 cm gap under the same testing rules? Predict a winner and explain why before testing. A prediction guides the investigation; the measurements decide whether it is supported.

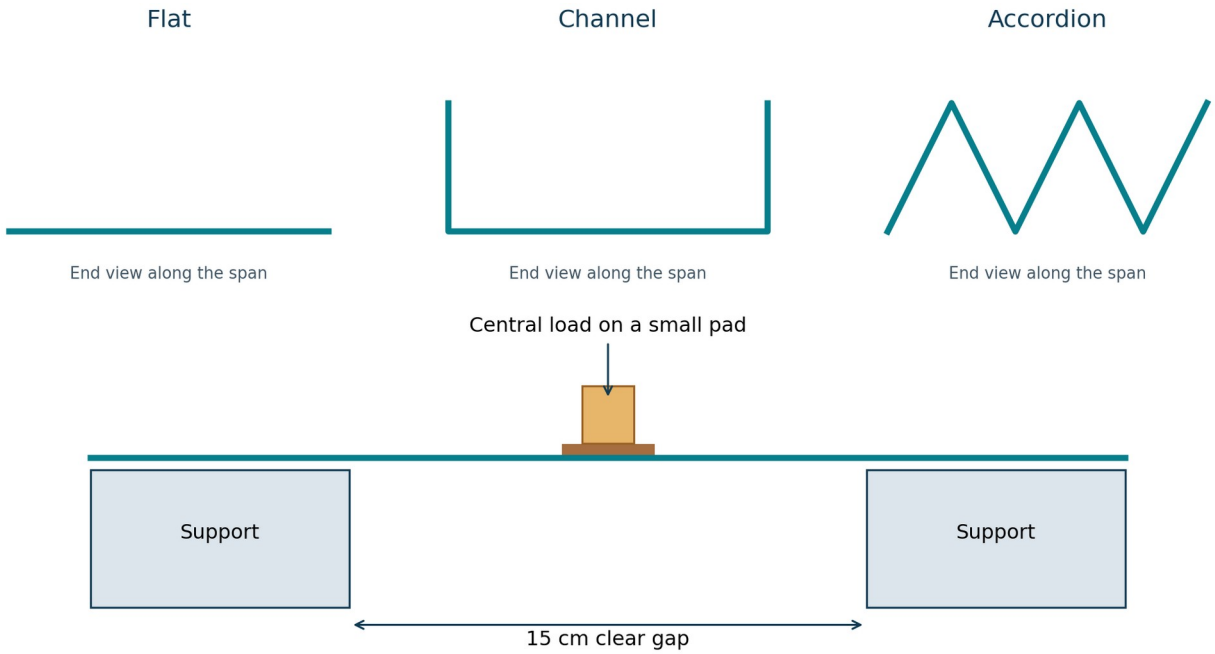


Figure 1. Three illustrative cross-sections and the common test arrangement. Folds run parallel to the span. The upper sketches are not to scale and do not specify the number of accordion folds; use the construction instructions. The lower diagram is a side view with a central loading pad. Original illustration; no test results are depicted.

Build three designs with equal paper

Materials: nine fresh sheets of the same A4 paper from one pack; two stable, equally high supports with straight edges; a ruler; pencil; timer; a small stiff loading pad and lightweight container; identical small test masses; and a balance if recording mass in grams. Work with a teacher on a low, clear surface. Keep fingers away from falling loads and small objects away from young children. Agree a modest maximum load before starting; never stand on a model bridge.

Orient each sheet so its 29.7 cm length crosses the gap. Keep that length unchanged. Do not cut, glue, tape or laminate the paper. Prepare three fresh specimens of each design:

- Flat: use one unfolded sheet.
- Channel: mark a line 3 cm in from each long edge. Fold both 3 cm edge strips upward to approximately 90°, leaving a 15 cm wide deck between them. Both creases run along the full 29.7 cm length.
- Accordion: divide the 21 cm width into seven 3 cm strips. Make six creases parallel to the 29.7 cm length, alternating mountain and valley folds. Set the fold depth to approximately 1.5 cm using the same end-profile template for all three specimens, and record the finished width and depth. The drawing shows the principle, not the exact six-crease pattern.

Use the same gap, supports, paper, pad, container, load increments and waiting time for all designs. The folded designs have different finished widths: this is a comparison of complete designs made from equal paper, not an isolated test of shape with every dimension held constant. Record width and depth so another group can reproduce your designs.

Test slowly and consistently

1. Set the clear distance between the inner support edges to 15 cm. Centre the sheet length over the gap so both ends overlap equally. Mark the central loading point. Keep the supports stationary throughout.
2. Use a 6 cm square stiff card pad that bridges adjacent accordion ridges and sits stably without squeezing the folds flat. Use that same pad and container for every trial. Include their mass in every total load measurement.
3. Apply the initial pad and container carefully. Add one identical mass at a time at the centre, waiting five seconds after each addition. Note sagging, twisting or sliding. Do not support the bridge with your hands.
4. Stop when the bridge collapses, the loading pad drops, or the centre has sagged 20 mm below its unloaded position. Also stop at the teacher’s agreed load cap. Measure deflection from the side; do not put your face or fingers under the load.
5. Record the largest total mass supported for the full five seconds and the next mass that caused the stopping criterion, if reached. If the initial load fails, record “below initial load.” If the cap is reached without failure, record “at least this load.”
6. Use a fresh specimen for each trial. Test all three designs once in each round, varying their order, until you have three trials per design. If a support moves or the loading pad slips accidentally, mark that trial invalid and repeat with fresh paper.

Record and interpret your evidence

Table 1. Student results sheet. No values have been supplied. Record total load in grams, including pad and container. Without a balance, record the number of identical added objects and identify the pad/container; do not invent gram values. Use one consistent reporting method.

Design	Trial	Largest load held for 5 s	First stopping load or cap	What happened
Flat	1			
Flat	2			
Flat	3			
Channel	1			
Channel	2			
Channel	3			
Accordion	1			
Accordion	2			
Accordion	3			

Also record: paper type or grammage _____; span _____; load increment _____; initial pad/container mass _____; cap _____; finished width/depth for each design _____; date and conditions _____.

What do your measurements show

Compare the three largest-supported-load values for each design, reporting their mean and range only when comparable numerical values are available. State your increments: the true stopping threshold lies between the last passed load and the first stopping load, rather than being known exactly. Do not treat “at least” or “below initial load” entries as exact maxima. If no design fails before the cap, report that limit instead of claiming equal strength.

Draw a labelled chart of the measured supported loads, showing all three trials for each design. Explain unexpected outcomes: uneven creases, different fold depths, paper damage or a shifting load may matter. A folded design can still buckle or twist. Your results apply to these paper models and test rules, not directly to full-size bridges.

Write a conclusion that matches the evidence

Complete this statement using your own measurements: “Under our test conditions, _____ supported the greatest measured load. Across three trials, its recorded values were _____. Our prediction was _____. The main limitation was _____.” If evidence is inconclusive, say so. As an extension, change only the span for one fixed design while retaining the other testing rules.

Sources and editorial notes

[1] Australian National University. Paper Bridge Challenge: Science of Strong Shapes. https://science.anu.edu.au/engagement/science-lab-experiments-home-school/paper-bridge-challenge-science-strong-shapes

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[3] PBS. Building Big: Paper Bridge Educator Ideas. https://www.pbs.org/wgbh/buildingbig/educator/act_paper_ei.html

Sources accessed 8 November 2026. The investigation uses the established paper-bridge teaching idea with a specified NYSP protocol and original illustration. AI assisted source checking, drafting, illustration and formatting. No measurements or completed experiment are claimed. Named authors must verify the protocol, their details and declarations, and approve the final article.

Designing a Gravity Fed Drip Waterer for a School Garden

Young Inventors | Intended readers: approximately ages 11–16

Proposed authors: Muhammad Rehan, Muhammad Talha, Muhammad Saleh and Muhammad Hassan Sayyad*
Proposed affiliation: NexSolvAI Online School, Lahore, Pakistan
*Correspondence: nysp@nexsolveai.net

Pre-review design article. This is a proposed prototype, not a tested invention. No water-saving, plant-growth or reliability results are claimed. Author details require confirmation before submission.

Start with a problem you can investigate

A school garden needs watering when somebody is available to do it. Pouring a large amount at once may create runoff, while an unchecked drip can continue after a pot has received enough. Could a small, inspectable gravity-fed device deliver a chosen volume slowly to one pot? That is a useful design challenge, provided the device is tested before anyone relies on it.

Drip irrigation applies water through small outlets near the root zone. A raised reservoir can supply flow without an electric pump, but the available pressure and the choice of tubing, filter and outlet matter. Many commercial emitters need more pressure than a small elevated container provides. Gravity-fed irrigation is established technology; the challenge here is to improve a school-scale implementation rather than claim a new principle. [1,2]

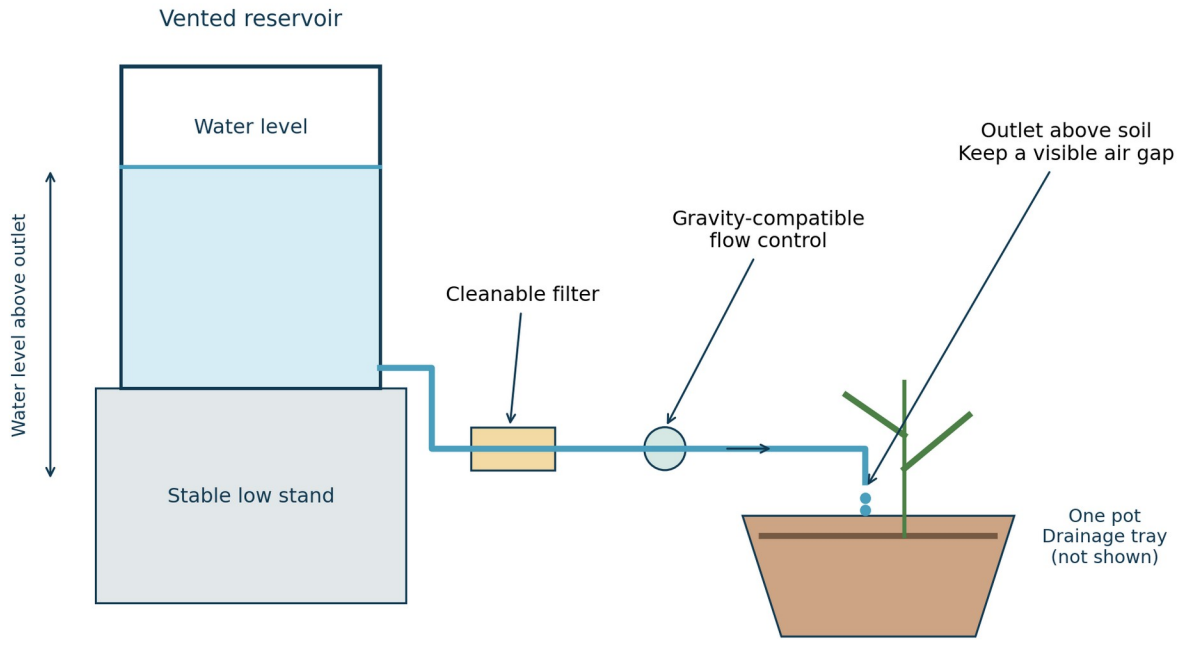


Figure 1. Proposed single-pot layout. The vented reservoir sits on a stable low stand, with its water surface above the outlet. Water passes through a cleanable filter and a gravity-compatible control before dripping above the soil. The drawing is conceptual, not to scale; no flow rate, dimensions or tested performance are implied. Original illustration.

Define what success would mean

Before building, agree a target volume and watering duration with a teacher or gardener for the particular pot, plant and soil. The target is a design input, not a universal plant requirement. Success means delivering close to that volume, without leaks, instability or unintended drainage. Record a local parts budget using actual prices instead of assuming a cost.

A useful first prototype needs a clean small reservoir with a purpose-made outlet, a vented cover, a secure stand, suitable tubing, a cleanable filter, a gravity-compatible shut-off and flow control, a tube holder, one pot and a drainage tray. A measuring cylinder or graduated jug and a timer are needed for tests. Select fittings together so their tubing sizes and operating conditions match.

Use fresh clean water for this demonstration, not fertiliser solutions or household wastewater. An adult should assemble any outlet fittings and handle any cutting or drilling. Never pressurise the reservoir or connect this prototype to mains water or electricity. Keep the reservoir low, secure and supervised; close the valve after each test and empty the container afterwards.

Design around the changing water level

The height difference between the reservoir's water surface and the outlet provides the driving head. As a reservoir empties, that height can fall and alter the flow. A gravity-compatible valve or adjustable restrictor therefore needs testing over the intended water-level range. Do not assume a labelled emitter rate applies at the small pressure available in this design. [1]

Small passages can clog. Filtration helps control particles, but it cannot eliminate every possible blockage; water quality and maintenance also matter. Make the filter and tube easy to inspect and clean. Keep the outlet above the soil and secure it against movement. An air gap makes the dripping visible and avoids burying the open tube in wet soil. [2,3]

Test delivery before testing plants

1. Assemble the system over a tray, with the reservoir secured and the valve initially closed. Add a small volume, check all joints for leaks, then prime the tube and release trapped air as appropriate to the selected fittings.
2. Fix the reservoir, tube and outlet positions. Record the vertical distance from the water surface to the outlet. Open the control and set a gentle drip. Keep the control at the same setting for the water-level comparison.
3. Collect the outlet water in a graduated vessel for ten minutes. Record the volume and calculate mean flow as volume divided by time. For millilitres collected over ten minutes, multiply by six to express the average in mL/hour; do not claim that rate stays constant for an hour.
4. Repeat three times at each of three marked starting water levels: high, middle and low. Refill to the relevant mark before each trial. Record start and end head, because the level may fall during collection. If the reservoir empties early, record the actual elapsed time and flag the trial.
5. Inspect for leaks and blockages, and test whether closing the control stops the flow. Only then perform a supervised single-pot trial, using the selected target volume and collecting any drainage. Stop if the pot floods, the reservoir shifts or a joint leaks.

Use measurements to improve the design

Table 1. Blank collection-test record. This table contains no experimental data. Use the same ten-minute duration unless the reservoir empties early, in which case record the actual duration. “Head” means water-surface height above the outlet.

Start level	Trial	Start/end head cm	Duration min	Volume mL	Mean flow mL/hour
High	1				
High	2				
High	3				
Middle	1				
Middle	2				
Middle	3				
Low	1				
Low	2				
Low	3				

Mean flow (mL/hour) = collected volume (mL) × 60 / duration (minutes). Keep the original readings and note spills or early emptying. If a trial is invalid, explain why and repeat it rather than replacing its value silently.

What would you change next

Compare the three trials at each starting level and plot the individual measured flows. If lower levels give a different rate, try a narrower operating range or a different gravity-compatible control. If the tube clogs, inspect the water, filter and fittings. Change one design feature at a time, keeping a drawing and notes for every version.

Your own contribution might be a more stable base, a clearer refill indicator, a removable cleaning connection or an outlet holder that stays in place. Explain the problem each feature addresses, credit existing designs, and test whether it improves performance. A useful improvement does not need to be a world-first invention.

To claim water savings later, compare against a defined watering method using comparable pots, plants, soil, weather and an agreed plant-health outcome over an adequate period. A slower drip by itself does not establish lower water consumption or healthier plants. This article makes neither claim. Finish your design report with actual costs, measured delivery, limitations and the next revision.

Sources and editorial notes

[1] New Mexico State University. Low-Pressure Drip Irrigation for Small Plots and Urban Landscapes. Research Report 773. https://pubs.nmsu.edu/research/agmech_eng/RR773/index.html

[2] FAO. Small-scale irrigation for arid zones: Criteria and options for appropriate irrigation methods. https://www.fao.org/4/W3094E/w3094e05.htm

[3] FAO. Water quality for agriculture: Water quality and localized irrigation. https://www.fao.org/4/T0234E/T0234E06.htm

Sources accessed 8 November 2026. AI assisted source checking, drafting, illustration and formatting. This is a design proposal with a blank test record, not a report of construction or measured performance. Named authors must verify the design, their details, contributions and declarations before submission.

A Soil Moisture Monitor for a School Garden

Computing and Robotics | Intended readers: approximately ages 12–16

Proposed authors: Muhammad Rehan, Muhammad Talha, Muhammad Saleh and Muhammad Hassan Sayyad*
Proposed affiliation: NexSolvAI Online School, Lahore, Pakistan
*Correspondence: nysp@nexsolveai.net

Pre-review build guide. The hardware has not been assembled or tested for this article. No measured sensor performance, plant-growth benefit or water saving is claimed. Authors and affiliation require confirmation.

From a sensor signal to a useful question

A pot can look dry on top while conditions deeper in the soil differ. A sensor offers another observation, provided we understand what its numbers mean. This project connects a capacitive probe to an Arduino UNO R3 and prints readings on a computer. It is a local monitor, not an internet-connected system, and it does not operate a pump.

The selected sensor is the DFRobot SEN0193. Its manufacturer specifies a 3.3–5.5 V supply and an analogue output up to 3.0 V. The UNO R3 uses a 10-bit analogue reading, normally returning 0–1023 with its default reference. An ADC count is a voltage-related number, not a direct water-content percentage. These wiring instructions are specific to this sensor and board; do not assume every look-alike module is identical. [1,2]

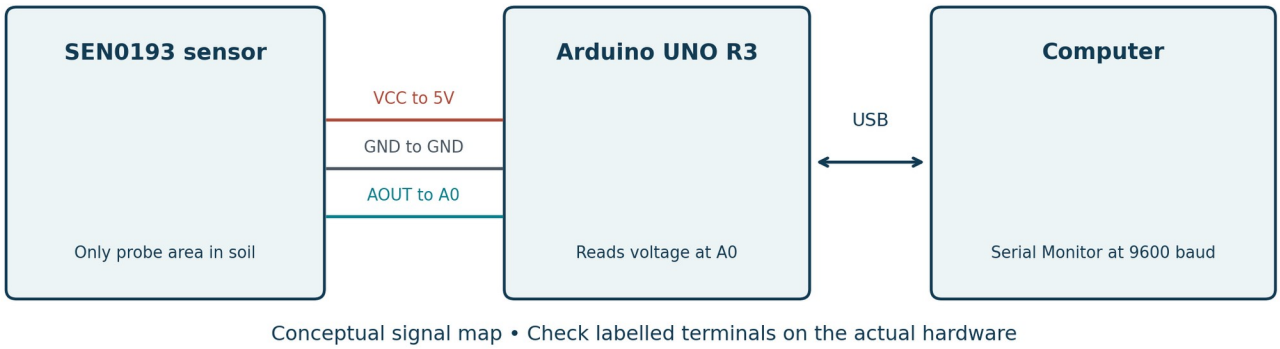


Figure 1. Functional connections for an SEN0193 and UNO R3. VCC connects to the board's regulated 5V pin, GND to GND, and AOUT to A0. USB powers and communicates with the UNO. This original schematic is not a photograph or physical pin-position diagram. No pump or mains-water interface is included.

Connect with power removed

You need the named sensor and its matching cable, an UNO R3, a USB cable, a computer with Arduino IDE, two samples of the same soil, and a dry work tray. Disconnect USB before wiring. Identify terminals from their labels and the manufacturer's diagram, rather than wire colour alone. Keep the UNO, USB connector and sensor electronics dry. Insert only the permitted sensing area; the whole sensor is not waterproof. Have a teacher check connections before powering it. [1]

Calibrate in the soil you will monitor

First upload the sketch below unchanged and open Serial Monitor at 9600 baud. It starts in RAW MODE and prints ADC counts only. Use a relatively dry sample and a separately watered, drained sample of the same soil. Keep probe depth, orientation and soil packing consistent. Wait for readings to settle, collect at least ten printed values in each sample, and calculate the two means. These define classroom dry and wet references; they are not certified zero-water and saturation points.

Replace DRY_ADC and WET_ADC with your rounded measured means, then set CALIBRATED to true and upload again. Never copy reference readings from another probe. The code maps the dry reference to 0 and wet reference to 100, clipping outside values to that range. This relative index is not volumetric water content or relative humidity. A two-point scale does not prove a linear relationship between the probe signal and soil water content. Soil-specific calibration needs care. [3]

The alert enters CHECK SOIL below index 30 and clears above 40. Between those thresholds it retains its previous state; this hysteresis reduces repeated switching near one threshold. The numbers are demonstration settings, not watering advice. At start-up the state is MONITOR until a reading below 30 occurs. The sketch averages ten ADC samples; it cannot automatically diagnose a disconnected or faulty probe.

```
// UNO R3 and DFRobot SEN0193; display only, no pump output.
const int SENSOR_PIN = A0;
const bool CALIBRATED = false; // Set true only after calibration.
const int DRY_ADC = 0;         // Replace with your dry-soil mean.
const int WET_ADC = 0;         // Replace with your wet-soil mean.
bool dryAlert = false;
int readMean() {
  long total = 0;
  for (int n = 0; n < 10; ++n) {
    total += analogRead(SENSOR_PIN);
    delay(20);
  }
  return total / 10;
}
float relativeIndex(int raw) {
  if (DRY_ADC == WET_ADC) return 0.0f;
  float span = float(DRY_ADC) - float(WET_ADC);
  float x = 100.0f * (DRY_ADC - raw) / span;
  if (x < 0) x = 0;
  if (x > 100) x = 100;
  return x;
}
void setup() { Serial.begin(9600); }
void loop() {
  int raw = readMean();
  Serial.print("ADC="); Serial.print(raw);
  if (!CALIBRATED || DRY_ADC == WET_ADC) {
    Serial.println(" | RAW MODE: calibrate first");
    delay(1000); return;
  }
  float index = relativeIndex(raw);
  // Demonstration thresholds, not plant watering requirements.
  if (index < 30) dryAlert = true;
  else if (index > 40) dryAlert = false;
  Serial.print(" | Relative index="); Serial.print(index, 1);
  Serial.print(" | ");
  Serial.println(dryAlert ? "CHECK SOIL" : "MONITOR");
  delay(1000);
}
```

Check the monitor before trusting its messages

Table 1. Blank classroom record. Use repeat readings from dry, intermediate and watered-drained samples of the same soil. Record the reference means, probe depth and sample preparation separately. Repeated readings from one pot do not constitute independent plant trials.

Soil condition	Repeat	Mean ADC	Relative index	Displayed message
Dry reference	1			
Dry reference	2			
Dry reference	3			
Intermediate	1			
Intermediate	2			
Intermediate	3			
Wet reference	1			
Wet reference	2			
Wet reference	3			

Dry reference mean _____; wet reference mean _____; probe depth _____; soil description _____; date _____. Store the original raw readings as well as averages. If the reference means are identical, the code remains in raw mode to avoid division by zero. If they are very close relative to reading variation, improve the calibration rather than interpreting a greatly amplified index.

What to investigate next

Does reinserting the probe change the reading? Does changing insertion depth change the result? Investigate one factor at a time and log what you changed. Compare a set of repeated readings before and after smoothing, while keeping the soil condition stable. Smoothing reduces short-term fluctuations but does not correct calibration bias or make a reading more accurate by itself.

A useful extension is to log timestamps and raw ADC values to a file for plotting. An automated irrigation system would need additional electrical design, sensor-fault handling, watering limits and supervised testing. Do not connect a motor directly to an Arduino pin. This article stops at a displayed alert, so CHECK SOIL means inspect the pot and evidence; it does not establish that irrigation is required.

Sources and editorial notes

[1] DFRobot. Gravity: Capacitive Soil Moisture Sensor, SEN0193. Specifications and calibration guidance. https://wiki.dfrobot.com/sen0193/ and https://wiki.dfrobot.com/sen0193/docs/18037

[2] Arduino. UNO R3 documentation and Analog Read Serial tutorial. https://docs.arduino.cc/hardware/uno-rev3/ and https://docs.arduino.cc/tutorials/uno-rev3-smd/AnalogReadSerial

[3] Characterization of Low-Cost Capacitive Soil Moisture Sensors for IoT Networks. Sensors. 2020;20(12):3585. https://doi.org/10.3390/s20123585

Sources accessed 8 November 2026. The original NYSP sketch is supplied separately as an .ino file. Its calculation and alert logic were checked using simulated host inputs; no Arduino-target compilation or hardware validation is claimed. AI assisted source checking, coding, illustration, drafting and formatting. Named authors must verify the build, their details, contributions and declarations before submission.

Where Does Our School's Waste Go

Our Environment | Intended readers: approximately ages 11–16

Proposed authors: Muhammad Rehan, Muhammad Talha, Muhammad Saleh and Muhammad Hassan Sayyad*
Proposed affiliation: NexSolvAI Online School, Lahore, Pakistan
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Pre-review environmental investigation guide. No school has been audited for this article. The recording sheet is blank, and no local collection service, recycling rate or disposal destination has been verified. Author details require confirmation.

The story does not end at the bin

A notebook page, a lunch container and a leftover meal may leave a classroom in different ways. A bin label tells us what somebody intends to collect, but it does not establish where the material finally goes. To understand a school's waste, we need to ask two questions: what is being discarded, and what happens after collection?

A waste audit is a structured record of a defined waste stream during a defined period. School food-waste audit guidance shows how measurement can reveal opportunities for prevention. Our proposed activity begins more simply, with a teacher-approved observation of selected school materials and interviews conducted by staff with the collector. It is not a report of completed fieldwork. [1]

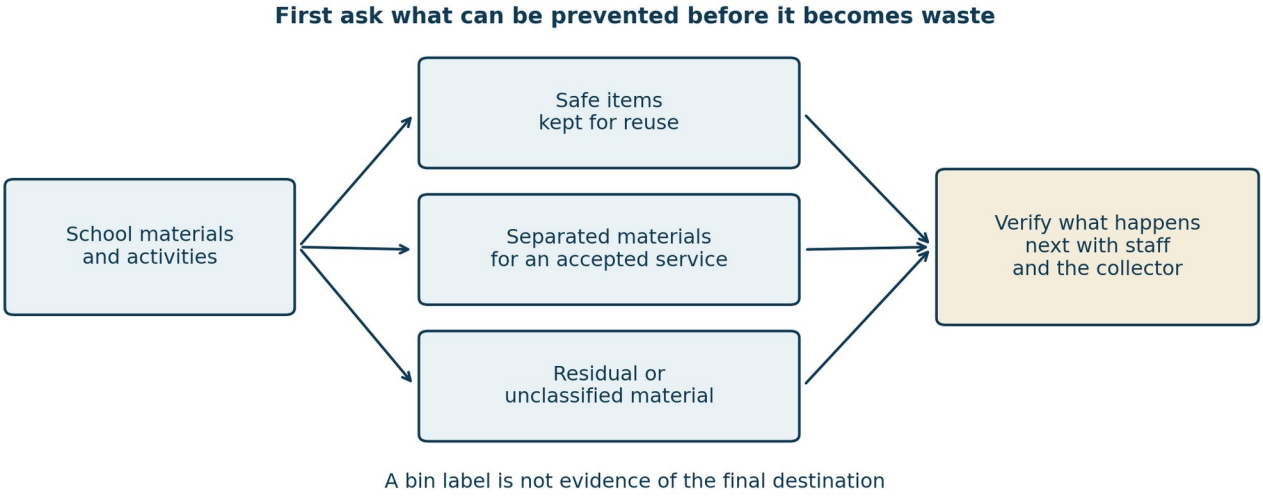


Figure 1. Questions to investigate in a school waste pathway. The branches are possible handling routes, not verified outcomes at any particular school. A collection label or a separate container does not establish that material was reused, recycled or treated. Original illustration.

Prevention comes before a better bin

Before adding containers, ask why material is being discarded. Can a worksheet be used on both sides? Could a reusable item replace a disposable one where hygiene and school rules allow? Would clearer communication reduce unnecessary printing? A material that is genuinely avoided does not need collection or processing. Any claimed reduction must still be measured within a clearly stated scope.

Plan an audit students can do safely

Obtain school permission and appoint a supervising teacher. Agree the location, dates, materials, weighing method and who will handle each stream. Begin with a small area, such as clean classroom paper and empty, clean packaging separated at the point of use. Students can observe, label records and analyse data without opening mixed-waste bags.

Do not ask students to search general bins or handle unknown waste. Exclude sanitary waste, medical or laboratory waste, sharps, broken glass, batteries, electronic waste and chemical containers. Trained school staff should manage excluded materials under the school's procedures. A food-waste audit needs its own staff-led hygiene and handling plan; the food-audit source is background, not permission for unsupervised sorting. [1]

Students must not visit disposal sites, follow collection vehicles, burn waste or perform informal recycling treatments. Keep the activity within the approved school area. Do not record students' names, photograph identifiable people or shame individuals for what they discard. Report patterns in the selected material stream.

Measure a defined stream

1. Choose a consistent observation period, for example the same classroom period on several ordinary school days. State exactly which rooms, materials and times are included. Count attendance or users in aggregate if needed, with permission.
2. Agree material categories before starting. For a small classroom audit these might be clean paper/card, clean empty packaging, and other approved material. "Packaging" is a description, not a claim of recyclability. Record excluded or unmeasured streams as outside scope.
3. Use the same labelled collection containers. A staff member checks each approved separated stream before measurement. Never mix material categories or count the same item twice.
4. If using a balance, record its resolution and check it with a suitable known mass. Weigh the empty container, then the container plus approved material. Net material mass equals gross mass minus container mass. Use consistent units.
5. Keep a separate destination note: who collects the material, whether streams remain separate, and what evidence supports the next destination. Ask school staff to obtain this information. Mark the destination unknown when it cannot be confirmed.

If no suitable balance is available, count defined items consistently and report item counts. Do not convert counts to kilograms using guessed masses. A small paper-and-packaging sample cannot establish the school's total waste production or its whole-school recycling percentage.

Make the collection route visible

Ask staff: Is there a reuse point? Which materials does the actual collector accept? Does a second contractor handle them? Is there a collection record or written confirmation of the receiving facility? Local acceptance differs; a recycling symbol or material name alone is not enough. Do not import another country's bin colours or accepted-material lists as rules for Pakistan. [2,3]

Keep a record that another group can understand

Table 1. Blank record for teacher-approved separated materials. Enter one row per day and category; add rows as needed. Leave unknown destinations as unknown. No sample measurements are supplied.

Date and period	Category and area covered	Container mass g	Gross mass g	Net mass g	Next destination and evidence

Balance resolution _____; included rooms/streams _____; excluded streams _____; aggregate users _____; staff supervisor _____. Net mass (g) = gross mass (g) − empty-container mass (g). Retain the original readings and flag missing or invalid records.

Turn observations into a practical change

Look for a problem your evidence actually supports. If the approved paper stream contains unused sheets, a supervised scrap-paper tray might help. If a collector accepts a particular clean material, a clearly labelled collection point may help keep it separate. Use signs that match the actual service and ask who will maintain them. Do not assume that simply adding a recycling bin changes the final outcome. [2,3]

Choose one change and repeat the same audit afterwards over comparable days. Record attendance, special events, the observation duration and other differences. Compare like with like: if appropriate, divide the measured mass by the aggregate number of users and report grams per user for that defined period. Fewer people or a shorter collection period can create an apparent reduction without a change in behaviour.

A measured reduction in discarded paper within the sampled classroom period is a defensible finding. A claim that the whole school became “zero waste” would need much broader evidence. Do not equate material placed in a recycling container with material confirmed to have been recycled. A short before-and-after comparison can suggest improvement, but cannot by itself establish that the intervention caused it.

A useful conclusion includes what remains unknown

Write what was included, how it was measured, what changed and where the evidence stops. Report unknown destinations and missing streams openly. Your first achievement may be discovering that the route after collection needs clarification. That is a useful starting point for better decisions, rather than a reason to invent a destination or a recycling percentage.

Sources and editorial notes

[1] US EPA, USDA and University of Arkansas. A Guide to Conducting Student Food Waste Audits: A Resource for Schools. https://www.epa.gov/sustainable-management-food/guide-conducting-student-food-waste-audits-resource-schools

[2] US EPA. Frequent Questions on Recycling. https://www.epa.gov/recycle/frequent-questions-recycling

[3] US EPA. Standardized Terms for Materials Accepted by Municipal Recycling Programs. https://www.epa.gov/circulareconomy/standardized-terms-materials-accepted-municipal-recycling-programs

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Meet Dr Muhammad Hassan Sayyad

A journey through physics photonics and teaching

MEET A SCIENTIST | AGES 11–16

Proposed profile writers
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Photograph supplied by the subject

Pre-review profile based on the subject's public CV. This is not an interview. No quotations or personal recollections have been invented. The subject and named contributors must approve the facts, roles and final text before publication.

A career studying light and materials

How can light help us study a material, carry information or generate electricity? These questions connect school physics with photonics, the science and technology of light. Dr Muhammad Hassan Sayyad's published CV describes a career combining teaching with research in this field. It identifies him as a former Professor of Photonics and former Dean of the Faculty of Engineering Sciences at GIK Institute, Topi, Pakistan. [1]

From Lahore to Dublin and back to teaching

His qualifications include an MSc in Physics with a specialization in Electronics from Government College University, Lahore, in 1983, and a PhD in Applied Physics from Dublin City University, Ireland, in 1994. These subjects connect the behaviour of matter with the circuits and instruments used to investigate it. [2]

His experience summary records teaching in Lahore before doctoral study, further teaching in Pakistan afterwards, and an appointment at GIK Institute beginning in 2002. He later served there as Professor and, from 2017 to 2019, as Dean. The record includes teaching and supervising undergraduate, MS and PhD students. [3]

Research needs places to ask questions

A scientific idea becomes testable when researchers have suitable instruments and a method. His CV lists laboratory development in organic electronics, solar-cell fabrication and characterization, optical communication, and photonics innovation. These facilities represent different ways to connect a physical question with an experiment. The listing is the subject's own account; this profile does not independently audit the laboratories or their current operation. [4]

How photonics connects to everyday technology

Optics studies light and its interactions with matter. Photonics applies this knowledge through sources, optical components and detectors. A solar cell converts absorbed light into electrical energy; an optical communication link uses light to carry information; a light-based sensor uses a detectable optical change to investigate its surroundings. These are general examples, not claims that the subject invented each technology. [5]

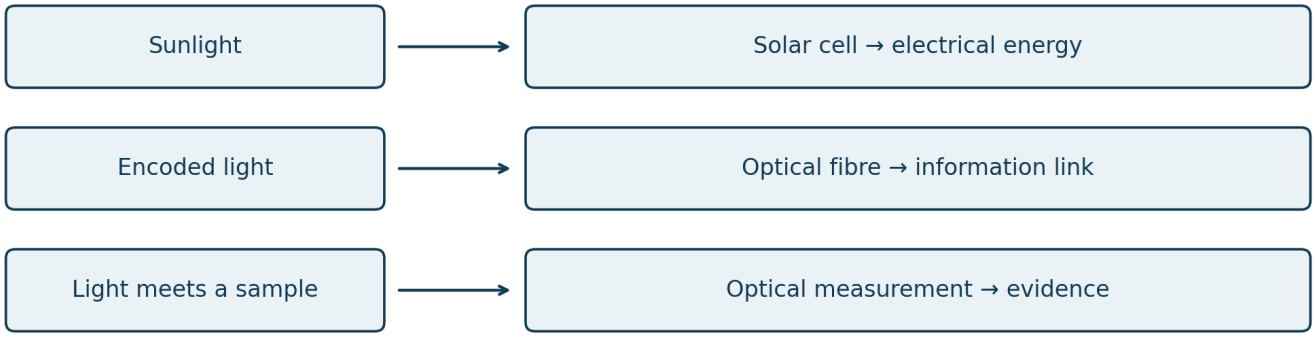


Figure 1. Three ways light can serve technology. This conceptual illustration shows functions, not experimental results or a complete device design. Original diagram. [5]

What can students learn from this work

The research-skills section of the CV includes making and measuring emerging solar cells, studying organic semiconductors, analysing spectra and collecting data with computers or microcontrollers. [6] For a young reader, the connection is practical: a measurement is only useful when we know what was measured, how the instrument was checked and what uncertainty remains.

You can practise that reasoning at school. With teacher approval, shine a low-power LED torch through different clean, transparent materials onto a white card. Keep the torch, card and material positions fixed. Record visible differences and possible explanations. Without a calibrated detector, report observations rather than numerical transmission or efficiency. Do not use lasers or look at the Sun.

Questions for a future conversation

These are proposed questions, not answered interview questions: Which school experience first drew you towards physics? What was difficult about learning to build and use research instruments? How do you recognise an unreliable measurement? What advice would you give a student whose first experiment does not work? Responses should be added only after the subject supplies and approves them.

Sources and editorial notes

[1] Profile homepage — CV of Dr Muhammad Hassan Sayyad. https://sites.google.com/view/cvdrmuhammadhassansayyad/home

[2] Qualifications — CV of Dr Muhammad Hassan Sayyad. https://sites.google.com/view/cvdrmuhammadhassansayyad/qualifications

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[6] Details of Research Skills — CV of Dr Muhammad Hassan Sayyad. https://sites.google.com/view/cvdrmuhammadhassansayyad/details-of-research-skills_1

[5] Optica. What is Optics. https://www.optica.org/about/what_is_optics/

Sources accessed 8 November 2026. Biographical information is attributed to the subject's self-published CV and awaits his factual approval. The proposed contributor roles and school affiliation require confirmation. AI assisted source checking, drafting, illustration and formatting. No interview, experimental dataset, funding statement or individual contribution declaration is represented as verified. Acknowledgements, funding, interests and contributor details must be completed truthfully before submission.

The School as a Living Laboratory

A science club plan for investigating everyday school questions

School Science Spotlight | Intended readers approximately ages 11–16

Proposed authors: Muhammad Rehan, Muhammad Talha, Muhammad Saleh and Muhammad Hassan Sayyad*
Proposed affiliation: NexSolvAI Online School, Lahore, Pakistan
*Correspondence: nysp@nexsolveai.net

Pre-review initiative guide. This article proposes a club programme; it does not report an existing club, a completed school event or measured student achievements. Names, affiliation and contributor roles require confirmation before publication.

Give curiosity a regular meeting place

A science club can begin with a question small enough to investigate in one classroom. Which paper shape makes a stable bridge? How does a transparent material change the light seen on a screen? What evidence would help us improve an everyday design? The programme below is an original suggested format for schools to adapt. It requires school approval and a supervising teacher before activities begin.

The aim is to produce a short, understandable account of one investigation. A working model can be useful, but the record matters too: another group should be able to understand the question, repeat the method and see why the conclusion follows from the observations.

Agree how the club will work

Ask a teacher to approve the activity, room, materials, supervision and storage. Keep participation accessible: use shared materials, rotate practical and recording duties, and offer ways to contribute through drawing, discussion, measurement or writing. A student should not need to purchase a kit to take part in this suggested programme.

Each group can rotate four duties: coordinate the plan, manage approved materials, record observations and check the evidence. The supervising teacher retains responsibility for permissions and safety. Students should pause and ask for help whenever an activity differs from the approved plan.

Choose a first investigation that stays manageable

One possible starting question is whether folding a sheet of paper changes how much load a short bridge can support. Agree the paper size, span, support positions, loading method and stopping rule before comparing designs. Use a low setup over a tray and small, teacher-approved loads; keep hands and faces clear of falling items. A teacher should decide the safe limits. No construction outcome or load capacity is supplied here.

Changing paper type, span and folding pattern together would make it difficult to explain a difference. Begin with one planned change, repeat the comparison where practical and retain all readings. A result that does not match the prediction still gives the group something useful to explain.

Build the programme over four meetings



Figure 1. Proposed meeting sequence. Schools can allow additional sessions when preparation, repetition or accessibility needs more time. This is a planning diagram, not a record of meetings held. Original illustration.

Meeting	What the group does	What it keeps
1 Plan	Choose one question. Explain a prediction and agree a fair comparison with the teacher.	An approved plan with materials, variables and stopping rules.
2 Investigate	Follow the approved method. Record what happened, including changes and unexpected observations.	Dated raw notes, labelled drawings and measurements with units.
3 Check	Repeat where practical. Compare readings and look for mistakes or alternative explanations.	A checked table or graph and a short account of limitations.
4 Share	Explain the finding to another group. Invite questions and propose one next step.	A short report separating observations, interpretation and unanswered questions.

Make the spotlight report accurate

After the programme actually takes place, the school can turn its records into a Spotlight article. Give the school's approved name, the activity dates, the question and the method. Describe what students did and what the evidence shows. Include a labelled figure or photograph only when permission covers its use. Avoid publishing student contact details or identifiable images without the required school and guardian permissions.

Report attendance, costs, awards or improvements only when records support them. A photograph of a bridge does not establish its capacity, and a lively meeting does not establish improved science attainment. Include unsuccessful attempts where they help explain a design decision. Do not copy the proposed programme into the past tense as if it has already happened.

Before sending the article to NYSP

Confirm the category is School Science Spotlight. Check the school and contributor details, dates, captions and units. Retain the original observations. Credit sources and borrowed material, obtain permissions where needed and disclose AI assistance. The corresponding author should confirm the submission undertaking on behalf of the authors, with their approval. All named contributors should review the final text.

Editorial status and acknowledgements. This is an original educational planning article, not a report of fieldwork. No participants, attendance figures, quotations, photographs of school activities or experimental results are claimed. No external source is used to substantiate a particular school event. AI assisted drafting, illustration and formatting. Actual acknowledgements, funding, competing interests and author contributions must be completed truthfully before submission.

The Young Scientist Challenge

Six puzzles and a paper tower design task

Challenges and Quizzes | Intended readers approximately ages 11–16

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Pre-review educational activity. All numerical datasets below are constructed for these puzzles, not measurements from a school or research study. Contributor details and final content require author approval.

Try the questions before reading the explanations on page 3. Show your reasoning and units. A calculator is optional. Some questions ask you to recognise what the evidence cannot establish.

1 Follow the energy

A small solar-powered lamp receives sunlight during the day, stores energy in a rechargeable battery and shines at night. Name the main energy changes from sunlight to the light seen at night. Does the battery store sunlight itself?

2 Check the balance

An empty collection container has a mass of 125 g. The same container with clean paper has a mass of 365 g. What is the paper's net mass? If 12 students used the classroom during that collection period, what is the collected paper mass per student for that period?

3 Read the results without overclaiming

A hypothetical group tests two paper-bridge designs under the same stated loading procedure. The recorded stopping loads are shown below. These invented numbers illustrate variation; they are not safe loading limits or real bridge capacities.

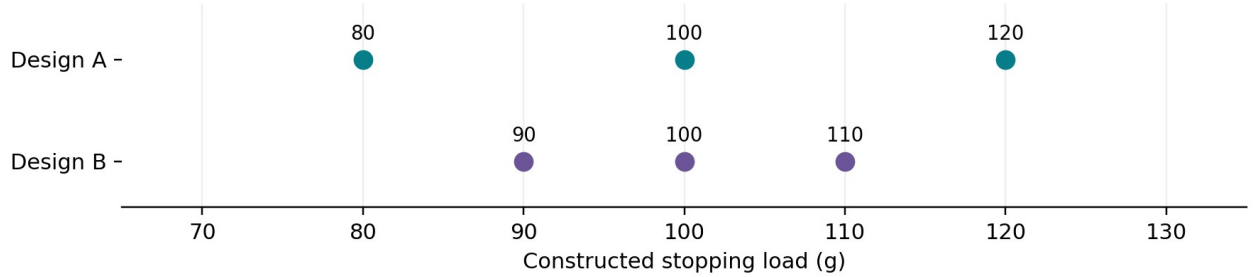


Figure 1. Three constructed readings per design. Each dot is one invented test reading; horizontal position shows the load. Original plot.

Calculate each mean and range. Which design has less spread in these readings? Do these three tests prove that either design will always carry a larger load?

4 Spot an unfair comparison

Group A uses thin paper over a 10 cm span. Group B uses thick card over a 20 cm span. They use different folding patterns too. Can a difference in stopping load be attributed to folding alone? Name two conditions to keep the same in a fairer comparison.

5 Turn a sensor reading into an index

A teaching sensor uses index = 100 × (800 − reading) ÷ (800 − 400). What index corresponds to a reading of 600? Does that number establish the soil's true water content as a percentage?

6 Separate a plan from an outcome

A school puts a bin labelled "Recycling" in a corridor. No collection records or destination checks are available. What can you state as a fact, and what evidence would you need before saying its contents were recycled?

Paper tower design task

With teacher approval, build the tallest free-standing tower you can using one A4 sheet of paper and up to 20 cm of adhesive tape. Use no other structural materials. It must stand on a level tabletop, unsupported by hands or nearby objects, for 10 seconds. Measure vertical height from the tabletop to its highest point. This is an original challenge, with no supplied winning design or tested performance.

Agree the paper type, tape allowance, measurement method and permitted tools before starting. Work at table height; do not climb or add heavy loads. If scissors are allowed, use them under the teacher's rules. Sketch a design, test it, note how it failed or remained stable, then revise it. Keep records of both attempts, including unsuccessful ones. Repeat where materials permit, using a fresh sheet of the same type for each comparison.

Share the question, a labelled sketch, material dimensions, measured heights, standing times and one limitation. Explain the trade-off between a wide stable base and the paper available for height. A photograph alone does not verify the height or the standing time. There is no single numerical answer to this task.

Answers and explanations

1 Energy pathway. Sunlight is radiant energy. The solar cell converts some of it to electrical energy; charging stores energy chemically in the battery. During use, the battery supplies electrical energy to the lamp, which produces light and heat. Some energy becomes heat at other stages too. The battery stores chemical energy, not sunlight as light.

2 Net mass. Paper mass = 365 − 125 = 240 g. For the stated period, 240 ÷ 12 = 20 g per student. This is collected paper in one defined sample, not total waste per student or a daily rate unless the period and coverage justify those descriptions.

3 Mean and spread. Design A: (80 + 100 + 120) ÷ 3 = 100 g; range = 120 − 80 = 40 g. Design B: (90 + 100 + 110) ÷ 3 = 100 g; range = 110 − 90 = 20 g. B has less spread in this constructed sample. Equal means do not imply identical behaviour. Three trials do not prove that one design always performs better, or establish reliability under other conditions.

4 Fair comparison. No. Paper material, span and folding pattern change together. Keep paper type and size, support spacing, loading method and stopping criterion the same while changing only the planned folding pattern. Repeated trials help reveal variation; they cannot repair a comparison in which several intended variables change together.

5 Sensor index. 100 × (800 − 600) ÷ 400 = 50. This is a dimensionless index defined by two reference readings. It is not a validated measurement of 50% soil water content. Its interpretation depends on the sensor, reference method, soil and conditions. The numbers in this question are constructed.

6 Recycling evidence. You can say a labelled bin was installed. You cannot yet say the material was recycled. Useful evidence would identify the accepted materials, show what was actually collected and confirm the subsequent handling and destination. A label describes an intention; it does not verify the outcome.

How to use the challenge

Teachers may award two points per puzzle: one for a correct answer and one for a sound explanation, for a suggested total of 12. This is an optional classroom scheme, not a validated assessment. Discuss alternative well-supported answers. For the tower, recognise clear records, a fair comparison and an evidence-based revision as well as height.

Editorial notes and acknowledgements. These questions, the constructed data and the diagram were prepared for this educational draft. Arithmetic was checked during preparation. No classroom trial, student score, physical sensor calibration or tower test has been carried out for this article. AI assisted drafting, plotting and formatting. Named authors must verify the science and approve the text; affiliations, contributions, acknowledgements, funding and competing interests must be confirmed truthfully before submission.