

The Spring Fair Cup Decision: Score It, Then Defend It

Investigation question: Using eight information cards of unequal credibility, which of four cup materials should the school's spring fair buy for 600 cold drinks, and what trade-off does that choice force the school to accept?

Data-driven decision

Groups of 4

1 session

Setup 5 · Activity 42 · Cleanup 3 min

MS-PS1-3 · assesses

MS-ETS1-2 · practice

Scientific purpose

Groups act as the committee that must buy cups for a three-hour school fair. They receive eight information cards: four describe the materials (PET plastic, paper lined with polyethylene, corn-based PLA and reusable polypropylene), one describes what happens inside a landfill, two describe the school's own facilities and budget, and one is an advertisement. Before scoring anything, students rate each card's credibility. They then score the four cups against three shared criteria and one constraint on the same matrix, choose, and write the trade-off they accepted. The lab is the lesson's standard in miniature: gather information about where synthetic materials come from and how they affect people and the environment, judge the sources, and make sense of it in words.

Why this helps students with this chapter

Students who have learned that PLA is 'made from corn' and PET is 'made from oil' tend to stop at the label. Scoring four real materials against where they come from, whether they hold up, and what actually happens to them at this school, with real limits on money and facilities, shows that the environmental answer depends on local conditions and that no option wins on everything. Rating the cards first also puts the lesson's source-evaluation practice to work on a decision that matters to the students.

Standards connections

MS-PS1-3 (assesses, the whole PE, limited to qualitative information): Students gather information from several sources about the natural resources each cup comes from, the chemical processes involved, and the effects on people and the environment, judge the credibility of the sources, and describe their reasoning in words. No life-cycle numbers are computed, so the assessment boundary is respected.

MS-ETS1-2 (practice, systematic comparison of competing solutions against shared criteria and a constraint): The scoring matrix is a systematic process for comparing four candidate solutions on the same criteria; the decision is qualitative and classroom-sized, so this builds the practice rather than fully assessing it.

Roles (rotate each session)

- **Card reader:** Reads each card aloud in full before any discussion, and rereads any sentence the group wants to rely on.

- **Fact checker:** Leads the credibility rating of each card using the four questions, and flags any claim the group is about to use from a low-rated card.
- **Scorer:** Fills the decision matrix cell by cell, writing the card number that supports each score, and adds the totals.
- **Spokesperson:** Writes the group's decision and the trade-off paragraph, and presents the choice to the class in under one minute.

Materials

Item	Quantity	Per	Note
Information card set (8 cards), printed on card stock and cut apart	1 set	group	Card text is in the recording sheet; print the cards without the answer key or the scoring rubric.
Recording sheet with credibility table, decision matrix and questions	1	student	
Calculator for the budget check	1	group	
Sample cups: one PET cold cup, one paper cold cup, one PLA cup, one thick reusable plastic cup	1 of each	class	Optional but worth it; look for the recycling code on the base (1 for PET, 7 for PLA, 5 for polypropylene). Ask the cafeteria or a coffee shop.
Large sticky notes or a shared board for posting each group's decision	1 per group	class	

Estimated cost: 3 to 5 per class (an estimate; Estimate. Card stock and printing for eight to ten card sets; laminate to reuse. Sample cups are usually free from the cafeteria or a coffee shop.)

Safety

- Paper cards only; no chemicals or equipment are used. Sample cups are for looking at, not for drinking from, since their history is unknown.
- Keep the discussion about materials and evidence, not about any student's family food, drink or money choices.

Teacher preparation and setup

1. Print and cut one card set per group from the text in the recording sheet. Shuffle each set so the advertisement is not always last.
2. Read the scoring rubric in the recording sheet and decide whether to keep the 0-1-2 scale or let groups write their own; the shared scale makes the class comparison fairer.
3. Check the cups you can find for recycling codes so the class can see the 1, 5 and 7 on the bases; PLA and PET cups look nearly identical, which is a point worth making.
4. If your own school has a composting program, a different recycling list or a different landfill situation, write a replacement Card 6 with your real facts and tell students which card is local and real. The lab works better with true local information.

5. Post the four credibility questions from the presentation (who wrote it and do they gain, is the claim specific and testable, is evidence cited, do independent sources agree) where every group can see them.

Investigation design

Independent variable	The cup material (PET, lined paper, PLA, reusable polypropylene)
Dependent variable	The score on each criterion (0 to 2), the total, and whether the budget constraint is met
Controlled	Same eight cards for every group; Same three criteria, constraint and 0-1-2 rubric for every group; Same event: 600 cold drinks over three hours at this school
Trials	One matrix per group; the class compares totals and choices across groups to see where judgment entered.
Comparison	Each cup against the others on the same criteria, and each group's choice against the other groups' choices.

Student procedure

1. The card reader reads all eight cards aloud before anyone scores or argues. Each person privately writes a first choice of cup in q1 and one reason.
2. Rate the cards. For each card, the fact checker asks the four credibility questions and the group records a rating of high, medium or low in the credibility table with a one-phrase reason. Any card rated low may be used only as an example of a claim to test, not as evidence for a score.
3. Read the three criteria and the constraint on the recording sheet. Agree as a group on what each score of 0, 1 and 2 would look like for each criterion, using the rubric callout.
4. Score the matrix one criterion at a time across all four cups, not one cup at a time; this keeps the comparison fair. Beside each score write the number of the card that supports it.
5. Check the constraint: compute what 600 drinks would cost with each cup from the budget card and mark pass or fail. For the reusable cup, work out how many cups you could buy within the budget and how many times each would need to be refilled to serve 600 drinks.
6. Add the scores. A cup that fails the constraint cannot be chosen no matter its total; mark it out.
7. Decide. If two cups tie or sit within one point, the group decides which criterion matters most for this event and says why. The spokesperson writes the decision and the trade-off paragraph: the cost or problem the school accepts by making this choice.
8. Post the decision and trade-off on the board. Listen to the other groups; if two groups chose differently from the same cards, note in q2 what they weighed differently.
9. Answer the analysis questions individually.

Expected observations

- Credibility: cards 2, 3, 5 rated high (public institutions, specific conditions, no product to sell); cards 1 and 4 medium (accurate but written by groups that benefit from selling plastics); cards 6 and 7 high for local facts (first-hand, specific numbers) though students should notice they are a scenario; card 8 low.

- Matrix: PET 0/2/1 = 3, pass (\$42); lined paper 1/1/0 = 2, pass (\$54); PLA 2/1/0 = 3, pass (\$66); reusable PP 0/2/2 = 4, pass only if the group buys about 120 cups (\$72) and refills each about five times. Groups that score paper's sturdiness as 2 or PET's end of life as 2 should be asked for the card that supports it.
- Decisions: a majority choose the reusable cup and name washing labor, water under drought rules and the petroleum origin as the trade-off; a minority choose PET for simplicity and name the nonrenewable origin and low real recycling as the trade-off. A group choosing PLA has usually missed card 6.

Likely difficulties

- Groups score PLA a 2 on end of life because it says 'compostable' on the card; the fact checker should send them to card 6 (no facility, no collection).
- Students treat 'recyclable' as 'recycled'; card 1's under-a-third figure and card 6's note about rejected loads are the correction, and criterion C's wording ('actually has') is deliberate.
- The reusable-cup budget needs a calculation (how many cups, how many refills), and some groups will mark it a fail at 600 times 60 cents; walk them through buying fewer cups and washing.
- Groups want to add a fourth criterion such as 'looks nice'; allow it only if the whole class adds the same one, or the comparison across groups breaks.
- Some students rate cards 1 and 4 low simply because they are about plastics; the rating is about the source and the claims, not about whether the student likes the material.

Structured debrief

1. Post every group's totals and choices side by side. Most groups end with the reusable polypropylene cup on top (typically $0 + 2 + 2 = 4$) and PET and PLA tied or close (3 each), with paper lowest. Ask the groups that chose PET or PLA what they weighed differently: usually the water rules and whether four volunteers will really wash 600 cups.
2. Walk the PLA case as a class: a cup that scores 2 on origin and 0 on end of life at this school. The lesson is that 'compostable' is a property that needs a facility, just as 'biodegradable' needs conditions. Ask what the score would be at a school 5 km from an industrial composter with a hauler that collects it.
3. Review the credibility ratings. Card 8 should be rated low by every group: a seller, vague claims ('earth-friendly'), no conditions, and one claim that cannot be true of any product ('chemical-free'). Cards 1 and 4 come from trade associations with products to promote; note that students should rate them medium and check them against cards 2, 3 and 5, which largely agree with them.
4. Point out the methane twist from card 5: if a cup did break down quickly in the landfill, the school would not have solved anything. That is why 'reused or actually recycled or composted' is the criterion, not 'breaks down'.
5. Close by tracing the four cups on the board with the class: petroleum and natural gas to PET and PP by cracking and polymerizing; trees to paper by pulping plus a petroleum lining; corn to PLA by enzymes, fermentation and polymerization. Every cup started as a natural resource; the choice was about what happens after.

Recording sheet: what students fill in

Lab 2 recording sheet: The spring fair cup decision

What is real and what is invented on these cards — Cards 1 to 5 describe real materials and real landfills; the facts on them are accurate in general terms. Cards 6 and 7 describe an invented school, invented prices and an invented event so that every group works from the same situation; they are a teaching scenario. Card 8 is an invented advertisement written to be rated, not believed.

Information cards (teacher prints and cuts apart; 8 cards)

Card 1

CARD 1. PET plastic cup. Source type: a material fact sheet published by a packaging trade association. PET (polyethylene terephthalate) is a polyester plastic. Its two building-block molecules are made from petroleum and natural gas by cracking and other chemical reactions, then joined into long chains. The chains make a clear, tough plastic that bends a little without shattering. PET carries the recycling code 1, and most U.S. curbside programs accept PET bottles; recycled PET is made into new bottles, fleece fabric and carpet. Even so, government figures show that under a third of PET bottles and jars in the United States were recycled in 2018, and the rest went to landfills or incinerators. PET does not biodegrade on any useful timescale; pieces that reach rivers or the ocean last for decades.

Card 2

CARD 2. Paper cup with a plastic lining. Source type: a state university extension fact sheet. A paper cold cup is made from wood pulp, a renewable resource when the forest is replanted, and lined on the inside with a very thin layer of polyethylene, a plastic made from petroleum or natural gas, so the drink does not soak through. The lining is what makes the cup hard to deal with afterward: most paper mills cannot separate it from the fiber, so most U.S. recycling programs do not accept lined cups, and the plastic lining does not break down in compost, so composting programs usually reject lined cups. Lined paper cups usually end up in a landfill. Over an hour or two, a cold drink softens the rim and seams of a paper cup.

Card 3

CARD 3. PLA cup. Source type: a state university extension fact sheet. PLA (polylactic acid) starts as corn starch. Enzymes break the starch into glucose, microbes ferment the glucose into lactic acid, and a chemical process joins lactic acid molecules into long chains. The cups are clear and stiff and look almost exactly like PET. PLA is certified compostable, but only at an industrial composting facility that holds it hot (around 58 °C) and moist for weeks; the standard it is tested against requires 90 percent of its carbon to be turned into carbon dioxide within 180 days. In a backyard pile, a landfill or a lake, PLA lasts for years. PLA carries the code 7 and must not go in with PET recycling, where it can spoil the batch. It softens above about 55 °C, so it is for cold drinks only, and it can crack when squeezed hard. Growing the corn for it uses farmland, water, fertilizer and fuel.

Card 4

CARD 4. Reusable polypropylene cup. Source type: a material fact sheet published by a packaging trade association. Polypropylene (PP, code 5) is made by joining propylene molecules, which come from petroleum and natural gas, into long chains. A thick-walled PP cup is tough, survives being dropped, and lasts through hundreds of trips through a dishwasher. Reuse is what changes its environmental footprint: studies that follow a cup through its whole life generally find that a reusable plastic cup must be used dozens of times, and washed efficiently, before it comes out ahead of single-use cups on energy and waste; washing each cup under a running hot tap can cancel the advantage. Fewer recycling programs accept PP than PET. A PP cup does not biodegrade.

Card 5

CARD 5. What happens inside a landfill. Source type: a county solid-waste agency web page. Trash in a modern landfill is compacted and covered with soil each day. Within about a year the buried layers run out of oxygen, and the bacteria that break down food, paper and yard waste there give off landfill gas, roughly half of which is methane, a greenhouse gas far stronger than carbon dioxide over its first decades in the air. Many large landfills collect part of this gas and burn it for energy; smaller or older ones may not. Plastics in a landfill mostly do not break down; they take up space and stay there. So a material that breaks down quickly in a landfill is not automatically a benefit, and a material that does not break down is not automatically harmless.

Card 6

CARD 6. Our school's situation (teaching scenario). Source type: a note from the custodian and the parent council. The fair runs for three hours on a Saturday in April, and 600 cold drinks will be served. The school's recycling bin takes items marked 1 and 2 (bottles, jugs and PET cups); the hauler has sent back loads with other plastics mixed in. The nearest industrial composting facility is 140 km away, and the hauler does not collect food waste or compostable packaging from the school. Trash goes to the county landfill, which collects some of its gas. The cafeteria has a three-basin sink and dish soap, and four parent volunteers have offered to run a wash station for the whole event. Water use is metered and the town is under drought rules this year.

Card 7

CARD 7. Budget memo (teaching scenario). Source type: the parent council treasurer. The council can spend at most \$75 on cups. Supplier quotes: PET 16-ounce cold cup, 7 cents each; lined paper cold cup, 9 cents each; PLA cold cup, 11 cents each; reusable polypropylene cup, 60 cents each. Reusable cups can be bought in any number, refilled during the event after washing, and kept for next year's fair. Soap and washing tubs are already owned by the cafeteria and cost nothing extra.

Card 8

CARD 8. Advertisement (invented, for rating). Source type: the website of a cup seller. EarthSip Cups: made from plants, not oil! Our cups are 100 percent natural and earth-friendly. When you are done, just toss them away and nature takes care of the rest. Chemical-free. Trusted by families everywhere. Choose the cup the planet would choose.

Credibility rating (complete before scoring)

Card	Who wrote it, and do they gain if you believe it?	Are the claims specific and testable?	Is evidence or a condition given?	Rating (high / medium / low)
1				
2				
3				
4				
5				
6				
7				
8				

Scoring rubric: 0, 1 or 2 for each criterion – Criterion A, renewable origin: 2 = made mostly from a resource that regrows within years; 1 = partly renewable, partly from petroleum or natural gas; 0 = made from petroleum or natural gas. **Criterion B, sturdy for the event:** 2 = holds a cold drink for the whole event with no softening or cracking; 1 = works but softens, cracks when squeezed or needs care; 0 = fails. **Criterion C, handled responsibly after use at this school:** 2 = reused, or recycled or composted by a program this school actually has; 1 = could be recycled here in principle but much of it will still be thrown away; 0 = goes to the landfill. **Constraint, budget:** 600 drinks served for \$75 or less, counting washing and refilling if the cup is reusable. Pass or fail; a fail cannot be chosen.

Decision matrix (write the score and the card number that supports it, for example '2 (card 3)')

Cup	A: renewable origin (0-2)	B: sturdy for the event (0-2)	C: handled responsibly here (0-2)	Total (0-6)	Budget: cost for 600 drinks and pass/fail
PET plastic cup					
Paper cup with plastic lining					
PLA cup					
Reusable polypropylene cup					

1. Before rating or scoring: which cup would you pick, and why, in one sentence?

Answer: Student-specific. Any cup with one reason earns credit; the answer is a commitment to compare with q2.

Why: Common first choices are PLA ('made from corn') and paper ('natural'); the matrix will test those reasons.

- Names a cup
- Gives one reason

2. Our group's decision and the trade-off we accepted (what the school gives up or has to deal with because of this choice). If another group chose differently from the same cards, what did they weigh more heavily than we did?

Answer: Group-specific. A strong answer: 'We chose the reusable polypropylene cup. It scored 4: it comes from petroleum (0), but it holds up for the whole event (2) and is washed and reused instead of going anywhere (2), and 120 cups at 60 cents is \$72, under budget, if each is refilled about five times. The trade-off: four volunteers wash cups for three hours, the school uses water during drought rules, and the cups are still made from a nonrenewable resource. A group that chose PET weighed the water rules and the washing labor more heavily than we did and accepted low real recycling instead.'

Why: Credit any decision that follows from the group's matrix and names a genuine cost. A decision for PLA that ignores card 6 does not earn full credit.

- Decision stated with the matrix total or the deciding criterion
- Trade-off names a specific cost the school accepts
- If another group chose differently, names what they weighed more

Analysis questions: answer key

3. Complete the trace for each cup: the natural resource it comes from, one chemical process on the way, and what happens to it after the fair at this school.

Answer: PET cup: petroleum and natural gas; cracking and joining small molecules into polyester chains; recycling bin accepts it, but much is still thrown out. Lined paper cup: trees (wood pulp) plus petroleum for the lining; pulping wood and polymerizing ethylene for the lining; landfill, because the lining blocks recycling and composting. PLA cup: corn starch; fermentation of glucose to lactic acid and polymerization; landfill, since there is no composting collection and it cannot go in PET recycling. Reusable PP cup: petroleum and natural gas; polymerizing propylene; washed and reused, kept for next year.

Why: This is the core trace for MS-PS1-3. Accept 'trees' for the paper cup with the lining noted separately, and 'fermentation' or 'joining into chains' as the process.

- Correct resource for all four
- A chemical process (not just 'made in a factory') for each
- End-of-life fate that matches card 6, not the card's ideal

4. Which card did your group rate lowest, and which two of the four credibility questions did it fail? Quote or describe one specific claim on it and explain what you would need to see to test that claim.

Answer: Card 8, the advertisement. It fails 'who wrote it and do they gain' (a seller) and 'is the claim specific and testable' ('earth-friendly', 'nature takes care of the rest' give no condition or time); it also cites no evidence. Example claim: 'just toss them away and nature takes care of the rest.' To test it you would need to know what the cup is made of, then bury or compost one under stated conditions and measure how much of it is gone after a stated time, as card 3 does for PLA. 'Chemical-free' cannot be true of any object, since everything made of matter is made of chemicals.

Why: The four credibility questions from the presentation are the rubric; two must be named. The 'chemical-free' observation is a bonus, not required.

- Identifies card 8
- Names two credibility questions it fails
- Describes a specific test for one claim

5. The PLA cup is certified compostable, yet it should score low on criterion C at this school. Explain why, using two cards, and describe what would have to change at the school for PLA to score a 2.

Answer: Card 3 says PLA breaks down only in an industrial composting facility kept hot and moist for weeks and lasts for years in a landfill; card 6 says the nearest such facility is 140 km away and the hauler does not collect compostable packaging, and the recycling bin cannot take PLA because it spoils PET batches. So at this school a PLA cup goes to the landfill like a PET cup, which is a 0 on criterion C. For a 2, the school would need a hauler that collects compostable packaging and delivers it to an industrial composter, plus separate bins and signs so PLA does not end up in the PET bin.

Why: This is the 'biodegradable depends on conditions' idea applied to a decision. Both cards should be cited.

- Cites card 3's conditions and card 6's missing facility
- States that PLA goes to the landfill here
- Names a concrete change (collection and a composting facility)

6. Card 4 says a reusable cup must be used dozens of times before it beats single-use cups. Use the numbers from cards 6 and 7 to work out how many reusable cups the budget allows and how many times each would be used at this fair. Does the fair alone reach 'dozens'? What else would have to happen?

Answer: $\$75 \div \$0.60 = 125$ cups at most; 120 cups cost \$72 and leave a little margin. $600 \text{ drinks} \div 120 \text{ cups} = 5$ uses per cup at the fair. Five is not 'dozens', so the fair alone does not reach the break-even point card 4 describes. To get there the cups must be kept and used at next year's fairs and other events (five uses a year reaches dozens only after many years, so weekly use at school events would be better), and they must be washed efficiently in the three-basin sink rather than under a running hot tap.

Why: Numbers: $75 \div 0.60 = 125$; $600 \div 120 = 5$. Accept any cup count from 100 to 125 with consistent refill arithmetic (for example 100 cups, 6 uses each).

Also acceptable: Accept 125 cups and 4.8 uses each, or 100 cups and 6 uses each, with the conclusion that the fair alone falls short of dozens.

7. Every material choice moves costs and benefits between groups of people. For the cup your group chose, name one group that benefits and one group that pays something (money, time, water, landfill space or risk), and explain.

Answer: Example for the reusable cup: the landfill and future students benefit (no 600 cups added to the trash; cups available next year), while the volunteers pay in three hours of washing and the town pays in water during a drought. Example for PET: the parent council benefits (cheapest, no washing), while the landfill, the ocean and future people pay for cups that are not recycled and last for decades. Example for PLA: corn farmers benefit from demand, while the school pays more per cup and the landfill still receives the cups.

Why: The standard's 'impact society' includes who gains and who pays; any accurate pairing earns credit.

- Names a group that benefits with a reason
- Names a group that pays with a specific cost

8. A classmate says, 'The paper cup is natural, so it is obviously the best choice for the environment.' Respond with evidence from at least two cards, and finish with a sentence about whether 'natural' by itself tells you how a material affects the environment.

Answer: The paper cup is mostly from trees, which is renewable (card 2), but it is lined with polyethylene made from petroleum, and that lining keeps it out of both recycling and composting, so it goes to the landfill (cards 2 and 6). In the landfill the paper part breaks down without oxygen and releases methane (card 5), while the lining stays. It also softens after an hour (card 2). So on this matrix it scores lowest of the four. 'Natural' describes where a material started, not what happens to it afterward or how it was processed; to know the effect on the environment you have to ask what it is made of, how it is made, whether it holds up, and where it ends up here.

Why: Repairs the 'natural means better for the environment' misconception with the cards' evidence. At least two cards must be used.

- Uses evidence from two or more cards (lining, landfill fate, methane, softening)
- Concludes that origin alone does not determine environmental effect
- Does not swing to 'synthetic is better'; the answer stays evidence-based

Individual evidence of learning

Each student submits their own credibility table, decision matrix with card numbers beside each score, q1 and q2, and individual answers to q3 through q8. The matrix with cited cards and q3 are the primary evidence for MS-PS1-3 (origins, processes and impacts described in words from sources); q4 and q8 are the evidence for evaluating sources.

Assessment criteria

Criterion	Proficient looks like
Gathering and citing information	Every score in the matrix is backed by a card number, and q3 traces all four cups from a natural resource through a chemical process to an end-of-life fate at this school.
Evaluating sources	Card 8 is rated low with two of the four credibility questions named; cards 1 and 4 are recognized as accurate but written by interested parties and checked against other cards.

Describing impacts on society and the environment	q7 and q8 name specific benefits and costs for specific groups of people or the environment, drawn from the cards, rather than general praise or blame.
Decision with a trade-off	The decision follows from the matrix and the constraint, and q2 names a real cost the school accepts, not just a reason the chosen cup is good.

Accessibility adaptations

- Print the cards in large type with the key sentence on each card in bold, and provide a bilingual word list for renewable, compostable, landfill, lining, polymer and constraint.
- Give students who need support a matrix with the PET row already scored and cited as a model row.
- Let the card reader role rotate to a student who benefits from reading aloud, or supply an audio recording of the cards; accept q2 and q8 as a recorded spoken answer.
- For students ready for extension, add a ninth card describing a school with an on-site composting program and ask them to rescore PLA and explain what changed.

Low-cost alternative

Project the eight cards on the board one at a time instead of printing sets, and have groups score on notebook paper. Sample cups are optional; a photo of the recycling codes on cup bases works.

Model limitations

The scenario school, the prices and the event are invented, and the 0-1-2 rubric compresses complicated questions into single scores; a real life-cycle comparison would measure energy, water, emissions and waste across each cup's whole life, which the assessment boundary for this standard does not require. The material cards are accurate in general terms but simplified: recycling rules, composting standards and manufacturing routes vary by place and by year, and the number of uses a reusable cup needs to break even depends heavily on how it is washed. This activity has not been physically tested by the authors; the timing and the expected scores are estimates.

Teacher notes

Grade the matrix for cited cards, not for matching the expected totals; a group that scores PET's end of life as 2 and cites card 1's 'most programs accept PET' has misread 'actually has', and a short conversation about card 6 fixes it. If you replaced card 6 with your school's real facts, rescore the expected observations before class. Keep card 8 in the set even though students see through it quickly; the 'chemical-free' claim is the fastest route to the idea that marketing words are not measurements. If a group finishes early, hand them the ninth card from the accessibility list.