

Who Says So? A Jigsaw on Sources, Origins and Impacts of Four Materials

Learning target: I can work with a team to gather information from several sources about where a synthetic material comes from and how it affects people and the environment, judge which sources are credible and which claims are supported, and defend our ratings.

Collaborative investigation

About 50 min

Jigsaw

MS-PS1-3 · assesses

collaboration

reading

discussion

Standards connections

MS-PS1-3 (assesses, gathering information from multiple sources, assessing their credibility, and describing origins and impacts qualitatively): Groups read twelve cards from different kinds of sources about polyester, corn ethanol, sucralose and PLA, record the natural resource, chemical process, benefit and cost for each material, and rate each source's credibility with reasons. This is the obtaining-and-evaluating-information practice the PE names, with qualitative products.

Purpose: practice · **Time:** about 50 minutes · **Format:** jigsaw

Answers with reasoning

Twelve source cards (sources labeled 'fictional' were written for this activity; all other cards state documented facts)

1 Card 1 (Set A): Encyclopedia entry, 'Polyester'

Polyester fabric is made from PET, a polymer first produced in England in 1941. Two small molecules obtained from petroleum are reacted and joined into long chains, which are melted and drawn into fibers. Polyester resists wrinkles and absorbs little water, so it dries quickly. It is the most widely produced clothing fiber in the world. Like other petroleum-based plastics it does not rot, and washing it releases tiny fibers into wastewater. Written by staff editors; sources listed at the end of the entry.

2 Card 2 (Set A): Clothing company web page (fictional)

EcoSoft Performance Tees are made of pure polyester, so no trees, no cotton fields and no animals are touched. That makes them the natural choice for the planet. Our fabric is engineered in a lab from scratch, with no raw materials wasted. Feels like nothing, lasts forever. Buy three, get one free.

3 Card 3 (Set A): Government agency report on waste

In 2018, about 17 million tons of textiles (clothing, sheets, towels, carpet) were thrown away in the United States. About 15 percent was collected for recycling; roughly 11 million tons went to landfills. Synthetic fibers such as polyester and nylon do not break down in a landfill on any useful timescale. The agency publishes these figures every few years and explains how it measured them.

4 Card 4 (Set B): Energy agency explainer, 'Ethanol'

Fuel ethanol in the United States is made mostly from corn. The starch in the kernels is broken into glucose, yeast ferment the glucose into ethanol and carbon dioxide, and the ethanol is distilled off and blended into gasoline. Nearly all gasoline sold in the country contains up to 10 percent ethanol (E10). A liter of ethanol carries about two thirds of the energy of a liter of gasoline. The leftover grain from ethanol plants is sold as livestock feed. Data tables and methods are posted with the explainer.

5 Card 5 (Set B): Fuel company billboard (fictional)

CORN POWER. 100 percent renewable. Zero pollution. Grown right here, so it never runs out and never hurts anyone. Fill up with Corn Power and drive clean, forever.

6 Card 6 (Set B): Agricultural economics summary of two studies

A 1995 federal agriculture study estimated that corn ethanol returned about 1.24 units of energy for every unit of fossil energy used to grow the corn and run the plant, and that the balance had recently turned positive. A 2016 university analysis found that the net energy gain had grown substantially by 2008 as farming and distilling became more efficient. Critics point out that corn for fuel uses farmland, fertilizer and water, and competes with corn for food and feed. The summary names both studies and says the result depends on the methods used.

7 Card 7 (Set C): Food regulator fact sheet, 'High-intensity sweeteners'

Sucralose was approved for use in food in 1998 after the agency reviewed more than 100 safety studies. It is made from sugar (sucrose) by a chemical process that replaces three oxygen-hydrogen groups with chlorine atoms. It is about 600 times sweeter than sugar, is not digested for energy, and generally does not raise blood sugar. The sheet lists the approved sweeteners and the year each was approved.

8 Card 8 (Set C): Social media post (fictional), 2,300 shares

WAKE UP. Sucralose is FAKE sugar made with CHLORINE, the same stuff they put in swimming pools. You are basically eating bleach. Natural sugar never hurt anybody. Share before they delete this!!!

9 Card 9 (Set C): History of science article

Saccharin, the first synthetic sweetener, was discovered in 1879 by a chemist working at a university laboratory in Baltimore. It became widely used during the First World War, when sugar was scarce and rationed and many people switched to saccharin; when sugar supplies returned after 1918, most people went back to sugar. Table salt, sodium chloride, has contained chlorine atoms for as long as people have eaten it, and so has sucralose since 1976; a chlorine atom bonded inside a compound behaves nothing like chlorine gas. The article cites letters, patents and newspapers from the period.

10 Card 10 (Set D): University extension bulletin, 'Bioplastics'

PLA is made from corn starch: the starch is broken into glucose, microbes ferment the glucose into lactic acid, and the lactic acid units are joined into long chains. PLA readily breaks down only in a commercial composting facility that keeps it hot (about 58 °C), moist and aerated; the industrial standard is 90 percent of its carbon converted to carbon dioxide within 180 days. It does not biodegrade in a landfill, a backyard pile or the ocean, and it should not go in recycling bins because it contaminates PET. Bio-based plastics are not necessarily biodegradable, and some petroleum-based plastics are. Written by university faculty with a reference list.

11 Card 11 (Set D): Cup maker's flyer (fictional)

Planet-Perfect cups are made from plants, so they are 100 percent biodegradable. Toss them anywhere and they vanish in 30 days. Finally, a cup with zero environmental cost. Ask your school to switch today.

12 Card 12 (Set D): Government agency figures on plastic waste

In 2018 about 9 percent of the plastic waste generated in the United States was recycled; about 76 percent went to landfills and most of the rest was burned for energy. For PET bottles and jars alone the recycling rate was higher, about 29 percent. The agency notes that what is accepted for recycling varies by community, so an item marked recyclable is not always recycled. Tables and methods are published with the figures.

Part A: Expert round (one set per person)

1. Your expert set: _____. For each of your three cards, write who produced it, what they wanted from the reader (to inform, to sell, to persuade), and whether it gives evidence or a way to check its claims. Then rank your three cards from most to least credible.

Answer: Set A: Card 1 (encyclopedia, informs, cites sources) and Card 3 (government agency, informs, publishes methods) are credible; Card 2 (company, sells, no evidence, contradicts Cards 1 and 3) is least credible. Set B: Cards 4 and 6 credible (agency with data; summary naming two studies); Card 5 (billboard, sells, no evidence, 'zero pollution' contradicted by Card 6) least. Set C: Cards 7 and 9 credible (regulator with study count; history article with cited sources); Card 8 (anonymous post, persuades, no evidence, contradicted by Card 9) least. Set D: Cards 10 and 12 credible (university bulletin with references; agency with methods); Card 11 (flyer, sells, '30 days anywhere' contradicted by Card 10) least.

Why: Each set contains two credible sources of different kinds and one fictional seller or post. Students should name the producer, the purpose and whether evidence is offered for each card.

Also acceptable: The order of the two credible cards may vary with a reason (for example, ranking the government report above the encyclopedia because it publishes methods).

- Producer, purpose and evidence noted for each card
- Ranking places the fictional card last with a reason

Part B: Home group task

1. Each expert teaches the group their material in two minutes: the natural resource, the chemical process, one benefit for people, one cost to people or the environment, and the most and least credible card.
2. Fill one row of the group record for each material. Use only facts from credible cards; if a fact appears only on a fictional advertisement or post, do not record it as a fact.
3. For each material, write the least credible card's number and the three signs that made you distrust it (for example: no author or evidence, trying to sell something, a claim that a credible card contradicts, vague words such as 'zero' or 'forever').
4. Find one claim on an untrustworthy card that is nevertheless partly true, and one claim on a credible card that surprised you. Be ready to explain both.
5. Prepare a one-minute defense of your least-credible ratings. Every member must be able to give it and to answer a challenge with a card number.

Group record (fill in)

Material	Natural resource	Chemical process (who or what does it)	One benefit	One cost	Most credible card and why	Least credible card and the three signs
Polyester						
Corn ethanol						
Sucralose						
PLA						

2. Group answer: Which card does your group rate least credible of all twelve, and what three signs told you? Which claim on that card is nevertheless partly true?

Answer: Most groups will choose Card 8 or Card 11. Card 8: anonymous, trying to alarm and get shares, no evidence, contradicted by Cards 7 and 9; partly true claim: sucralose does contain chlorine atoms and chlorine is used in pools. Card 11: no maker named, selling cups, 'vanish in 30 days anywhere' contradicted by Card 10 (industrial composter only, 180-day standard); partly true claim: the cups are made from plants, and PLA is biodegradable under the right conditions. Card 2 and Card 5 are also acceptable choices with their signs (selling, no evidence, 'engineered from scratch' and 'zero pollution' contradicted by credible cards; partly true: polyester does not use cotton fields; corn does regrow each year).

Why: Any of the four fictional cards can be rated least credible; grade the three signs and the partly true claim.

Also acceptable: Accept any fictional card with three accurate signs.

- Names one of the fictional cards
- Three specific signs
- A partly true claim identified

3. Group answer: Write the strongest challenge the neighboring group made to one of your ratings, and how you answered it using a card number.

Answer: Common challenges and good replies: 'Card 8 has 2,300 shares, so lots of people believe it' (shares measure popularity, not evidence; Card 9 explains why the chlorine argument fails). 'Card 2 is right that polyester does not use cotton fields' (true, but Card 1 and Card 3 show it uses petroleum and does not rot, so 'natural choice' is not supported). 'Card 6 is less credible because its studies disagree' (it names both studies and says the answer depends on methods, which is a sign of honesty; see q6). 'Card 11 is partly right because PLA is biodegradable' (yes, but only in an industrial composter per Card 10, so 'anywhere in 30 days' is false).

Why: Grade the record of a real challenge and a reply that cites a card number.

Also acceptable: Any reasonable challenge with an evidence-based reply earns credit.

- A specific challenge recorded
- Reply uses a card number and its evidence

Part C: Individual accountability (complete alone)

4. Choose a material you were NOT the expert on. Trace it from natural resource to product, naming the chemical process, and name the card you learned it from.

Answer: Examples. Polyester: petroleum, two small petroleum-derived molecules reacted and joined into long PET chains in a factory, then melted into fibers (Card 1). Corn ethanol: corn, starch broken into glucose, yeast ferment glucose into ethanol and carbon dioxide, ethanol distilled and blended (Card 4). Sucralose: sugar from sugarcane or beets, a chemical process that replaces three oxygen-hydrogen groups with chlorine atoms (Card 7). PLA: corn starch, broken into glucose, microbes ferment it to lactic acid, lactic acid units joined into chains (Card 10).

Why: The student must trace a material they learned from a teammate, which checks that the teaching round worked.

Also acceptable: Accept 'sugar' as the resource for sucralose without the plant source.

- Material is not the student's own expert set
- Natural resource, chemical process and product named
- Credible card cited

5. Card 8 says sucralose contains chlorine 'the same stuff they put in swimming pools.' Using Card 7 and Card 9, explain what is true in that sentence and what is wrong with the conclusion drawn from it.

Answer: True: sucralose contains three chlorine atoms (Card 7), and chlorine is used to treat swimming pools. Wrong: a chlorine atom bonded inside a compound does not behave like chlorine gas or bleach; table salt is sodium chloride and has always contained chlorine atoms (Card 9). The post also assumes 'natural' means safe, which is not a rule. Sucralose was approved after review of more than 100 studies (Card 7). Having an atom of an element in common does not make two substances behave the same.

Why: This is the chapter's structure-and-properties idea applied to a credibility question: properties belong to the whole molecule, not to one kind of atom in it.

Also acceptable: Accept 'water contains oxygen but is not the same as oxygen gas' as an equivalent example.

- Identifies the true part (chlorine atoms present)
- Explains that bonded chlorine atoms do not behave like chlorine gas, with the salt example
- Cites Card 7 or Card 9

6. Card 6 reports two studies that reached different numbers about ethanol's energy balance. Does disagreement between studies make the card less credible or more credible? Explain, and say what a reader should conclude from the card.

Answer: More credible. The card names both studies and their dates, reports their different numbers, gives the critics' points and says the answer depends on methods; that is how honest reporting of a measured, debated question looks. A reader should conclude that corn ethanol probably returns more energy than it takes to make, that the margin depends on how the corn is farmed and distilled, and that energy balance is only one of its costs (farmland, water, food and feed competition).

Why: Students often think disagreement means unreliability. The card models a credible summary of a contested finding, which is the accurate version of the textbook's flat claim.

Also acceptable: A student who says 'it depends; the card is credible but the question is still open' is correct.

- Says the card is more credible, with the naming-both-studies reason
- Conclusion is hedged and mentions method dependence

7. Write a four-line checklist your group could use on any new source about a material. Each line must be a question with a yes-or-no answer. Then apply your checklist to Card 11 and to Card 10 and show the results.

Answer: Sample checklist: 1. Does the source say who made it? 2. Does the maker gain money or attention if I believe it? 3. Does it give numbers, dates, methods or references I could check? 4. Does any credible source contradict it? Card 11: no, yes, no, yes (Card 10), so untrustworthy. Card 10: yes (university faculty), no, yes (standard, temperature, references), no, so credible.

Why: Each line must be answerable yes or no and the application must be shown for both cards.

Also acceptable: Accept 'Is the claim specific enough to test?' as one of the four lines.

- Four yes-or-no questions about source, purpose, evidence or agreement
- Applied to Card 11 and Card 10 with results

Scoring rubric

Criterion	4 • Exemplary	3 • Proficient	2 • Developing	1 • Beginning
Expert round	Each card's producer, purpose and evidence are identified; the ranking is justified; the expert can teach the material's resource, process, benefit and cost without notes.	Producer and purpose identified; evidence noted for two of three cards; teaching covers most elements.	Ranking given without reasons, or teaching covers only the resource and product.	Cards not read closely; ranking by length or appearance.
Group record	All four rows complete and accurate, using facts only from credible cards; three signs recorded for each least-credible card; the partly true claim identified.	Four rows complete with one inaccuracy or one row missing the three signs.	Two or three rows complete, or a fact from a fictional card recorded as true.	Record mostly blank or copied from advertisements.

Defense	Every member can state the ratings and answer a challenge with a card number and its evidence; the group distinguishes credible from correct.	Defense given by most members; challenge answered with a card number.	Defense restates ratings without evidence, or only one member can give it.	No defense or ratings changed under challenge without reason.
Individual accountability (Part C)	All four Part C answers accurate, cite cards, and show the student understands a material they did not study as the expert.	Three of four accurate with card citations; one thin.	Two accurate; others restate the group record without reasoning.	Part C mostly blank or inaccurate.

Teacher notes

Cards 2, 5, 8 and 11 are fictional and are labeled as such; everything on the other eight cards is documented: PET was first made in England in 1941 and polyester is the most-produced textile fiber; EPA figures for 2018 are about 17 million tons of textiles generated, about 15 percent recycled and 11.3 million tons landfilled, about 9 percent of plastics recycled with 76 percent landfilled, and 29 percent of PET bottles and jars recycled; nearly all U.S. gasoline is E10, ethanol carries about two thirds the energy of gasoline per liter, and distillers grains are sold as feed; the 1995 USDA estimate of 1.24 and the 2016 Iowa State analysis are the studies summarized on Card 6; FDA approved sucralose in 1998 after reviewing more than 100 studies, it is about 600 times sweeter than sugar, and it is made from sucrose by replacing three hydroxyl groups with chlorine; saccharin was discovered in 1879 at Johns Hopkins and sucralose in 1976; the PLA facts follow a University of Florida extension bulletin. Shuffle each deck before handing it out. In the debrief, make the two-part point explicit: a credible source can still be wrong, and a seller can say true things, so the group record asks for both the three signs and the partly true claim.

Scaffold offered to students: Three questions for any source

If credibility feels like a guess, ask three questions of each card: Who made it, and do they say? What do they gain if you believe it? Can you check it, because it gives numbers, methods, dates or references? A card with a named maker, nothing to sell and a way to check is usually credible; a card with no maker, something to sell and only big words usually is not. Being credible is not the same as being right, and a seller can say true things; that is why the group record asks for the partly true claim too.

Extension: The thirteenth card

Write a thirteenth card about a material of your choice from the chapter (paclitaxel, synthetic rubber, Blue No. 1, nylon) in the voice of a credible source: name the producer, give at least two checkable facts that are actually true (verify them in the chapter or a reference), and include one honest cost. Then write a fourteenth card in the voice of a seller that uses only true statements but still leaves a misleading impression. Trade with a partner and see whether they can tell which is which and explain how the honest-but-misleading card works.