

LESSON 1

There is no such place as “Away”

(A Lesson Series about Litter)
Grade Band: Middle School (6-8)



SERIES INTRO

This lesson series is anchored in the fundamental ecological principle of ecosystem interconnectedness, which offers a framework to support student inquiry into how human activity impacts the natural environment. The series also includes a summative assessment plan to check for student understanding at the culmination of the three lessons. The lesson series follows a trajectory centered on place-based learning, inquiry, and taking action: First, students define litter and explore the prevalence and impact of this phenomenon on a local ecosystem of their choosing. Second, students explore what happens to litter when it is properly and improperly disposed of and research how litter impacts different ecosystems. Third, using their litter survey findings, students identify a problem in their local context, research and draw inspiration from solutions others have implemented in the past, and determine a way to take action.

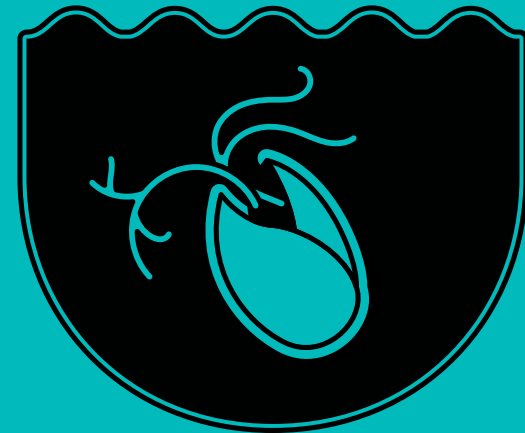
In Lesson 1, students explore litter as a concept and phenomenon. In addition, students will engage in place-based learning by conducting a local litter survey and exploring human impacts on a local ecosystem. In Lesson 2, students explore what happens to litter, where it goes, and the impacts it has on different ecosystems. In Lesson 3, students identify a local litter problem, derive a solution, and take action.

Enduring Understanding(s):

This lesson supports student exploration of two questions: What is litter? Where does it come from? Students also learn how to conduct an ecosystem survey to gather data about litter. Students will make maps of selected areas such as a playground or park that indicates the location and type of all litter present. Students will also share their survey data – which is analogous to an ecosystem count – with other schools for comparison across diverse regions and to [national statistics](#).

Lesson 1 Summary Description:

In this first of three lessons, we start with the complex problem of litter. Students are introduced to fundamentals of environmental stewardship – conservation, ecosystem health, and sustainability – through an examination of the definition and origins of litter. Students identify an area to explore, create a map of the area, and conduct an ‘ecosystem count’ to identify all of the litter in that area, including its location, to create a Litter Map. They then examine the litter (*either directly or via photographic artifacts in cases where litter was not collected directly*), describing its characteristics, hypothesizing about its origins and identify features and trends in the litter location data as illustrated by the litter map.



Background Information for Teachers:

- 1 **Ecosystems** (*Kahn Academy*)
- 2 **Litter** (*Wikipedia*): definitions, characteristics, prevalence in the environment, sources, effects on the biosphere
- 3 **Litter** (*Keep America Beautiful.org*)
- 4 **Coastal Litter Survey** (*A Duke of Edinburgh Award project*)

NGSS Standard: ESS3-4 - Students who demonstrate understanding can construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems. (NOTE: This lesson centers on identifying and collecting data that could be used as evidence).

DCI: ESS3.C – Human impacts on Earth Systems

Crosscutting Concept – Graphs, charts and images can be used to identify patterns in data.

Science and Engineering Practices – Asking questions and Defining Problems; Analyzing and Interpreting Data

Observable features of the student performance by the end of the series:

Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Specifically, this lesson series supports the following:

2.a.ii. (*Identifying Information*): Students identify evidence to support a claim about per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.

4.a.i. (*Reasoning and Synthesis*): Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe a chain of reasoning that includes the concept that increases in the size of the human population or in the per-capita consumption of a given population cause increases in the consumption of natural resources.

OBJECTIVES

1

Distinguish between natural and human-made features and objects in a geographical area.

2

Recognize and identify characteristics of litter and identify the characteristics that define it as litter.

3

Develop and execute a plan to gather data about the types and location of litter in a given geographical area *(e.g. on school grounds or in a local context).*

4

Create a visual representation of data to identify and convey features and patterns about litter *(e.g. location, litter types, etc.)*

MATERIALS

- 1** Tape measure or string/rope of a known length to measure selected area.
- 2** One field notebook per group to take notes about litter location and description
- 3** Butcher paper or equivalent (e.g. a large section of whiteboard.) on which to draw map. Alternatively, a map can be created using an online map-making app (e.g. *National Geographic Mapmaker*) or drawing software (e.g. *Adobe Illustrator*, *Sketch-up for Web*)
- 4** Bags - one per group to hold any litter appropriate for collection by students (e.g. pencil stubs, paper, plastic candy wrappers, etc.)
- 5** Cameras - one per group - to take image of litter not appropriate for collection by students (e.g. broken glass, anything that might be contaminated by bodily fluids (e.g. cigarette butts, syringes, etc.))
- 6** Stick-on flags, tape, or the like, for labeling all individual pieces of litter the students collect
- 7** Latex gloves to protect children's hands
- 8** (Optional) Magnifying glasses, scales, microscope, etc., to aid in examining individual pieces of litter.

TEACHING PLAN

The suggestions provided in the boxes below follow the 5E lesson format.

ENGAGE

Teacher begins by posing the open-ended questions for students to discuss
(~3-5 minutes):

- a. *When you hear the word “litter” what comes to mind?*
- b. *What do you know about litter?*
- c. *What defines something as “litter?”*
- d. *Where might you find it?*

Teacher then asks students to create a list of words or phrases that capture their thinking about litter. (3-5 minutes)

Teacher then mediates a discussion of the resulting list(s)

EXPLORE

With teacher guidance, students identify an area to map
(*e.g. a portion of the playground, a nearby park, etc.*).

A

Using direct field observation and/or photographic/satellite images available online via Google Earth or the like, students identify major features of the selected area (*e.g. fence lines, playground equipment, plantings and ground coverings, etc*). This can be done as a whole class or in small groups.

B

Students use this data to create a scale map of the selected area. The map should be large enough to identify and differentiate the locations of individual pieces of litter. A map that allows for resolution of about a meter or less will suffice. The map should also contain grid lines to help with noting the location of litter (*see below*). A piece of butcher paper that is a meter or more on the smallest dimension will suffice.

C

With Teacher guidance, students explore the mapped area for the presence of any items they identify as litter. Again, teachers can organize this litter search - which is analogous to an ecological survey - as a whole-class or in small groups.

D

Students label each piece of litter they find with a stick-on flag, tape and marker, or the like, using an appropriate notation system that captures who found it and where, such as a student name/number/map grid location combination (*e.g. Lopez-1-B2, Lopez-2-B4, Lopez-3-, etc*).

E

If the litter search is conducted as a whole class activity, students and the teacher may find it efficient to note the location of their finds directly on the classroom map as they collect it. If the search is conducted in small groups, it may be more efficient for each group to use a sketch of the map to note the locations of their finds and transfer that data to the classroom map afterward, during the Explain phase.

F

For each piece of litter identified but not collected, students will record its location and description. Teacher may decide to direct students to take a photograph of it or describe it in writing.

EXPLAIN

Teacher engages students in a data-sharing discussion:

- a. **If students collected/identified litter in small groups, this phase begins with each group adding their data (location and description) to the class map.**
- b. **If the class collected/identified data as a whole, this phase begins with a discussion of the map data itself.**

Guiding questions to support this discussion include:

- a. *What kind of litter is common?*
- b. *What kind of litter is uncommon?*
- c. *Is the litter evenly distributed or are there any locations where litter seems to be more common?*
- d. *Where do you think various pieces of litter came from?*
- e. *Do you recognize any patterns in the data? If so, what hypotheses do those patterns suggest?*

Target explanations (with examples drawn from the Explore phase):

- a. **Litter is a waste product that has been discarded in an undesirable way, usually in a public location or a location used for a collective purpose.**
- b. **Data about litter, such as counts, descriptions, and locations, can provide support for claims about where it may have come from, why it can be more readily found in one place rather than another, and its source (both in terms of the source of manufacture and the litterer).**
- c. **Visual representations of data can often help scientists make connections, suggest hypotheses, and support claims.**

EVALUATE

(including student self-assessment opportunities)

1 Using the class map and field notes, students - individually, in groups, or as a whole class - describe selected pieces of litter in terms that distinguish them as litter, using the definition of litter developed in the Explore phase.

Students - individually, in groups, or as a whole class - examine the class litter map and field notes to identify the following:

- 2**
- a. *major features or patterns of interest in the data*
 - b. *locations of the most common type(s) of litter*
 - c. *descriptions of particular pieces of data*

3 **Students revisit the opening question and express** *(verbally or in writing)* **how their ideas about litter have changed, identifying particular experiences** *(e.g. examining litter closely, creating and studying the litter map)* **that led to those changes.**

EXTEND / ELABORATE

Extend

1 Teacher provides instructions and support for students to carry out a similar ecosystem litter count and produce another litter map for a location used for a different collective use. Students will compare and contrast the two maps and articulate claims about litter (*type, origins, etc.*) that might be supported by the data.

Extend

2 Teacher invites school custodial staff/groundskeepers to class to share their experiences with litter. With teacher assistance and supervision, students engage with custodial staff/groundskeeper to formulate a plan for more extensive long-range data collection about the types and location of litter. For example, students might decide to ask groundskeeping staff to save all litter they pick up for a week, keeping litter found at specific locations (*e.g. the parking lot, the pick-up area, the softball field, the snack area, etc.*) in separate bags/containers. Students could then examine the litter from each area to look for trends.

Extend

3 Teacher and students share their maps with other classes/schools, comparing and contrasting different maps. Students then articulate claims about litter (*type, origins, etc.*) that might be supported by the data.

Elaborate

4 Teacher poses the following questions and mediates a discussion about them (*either in pairs, small groups, or whole class*): What do you think happens to litter if it is not picked up and disposed of properly? Alternatively, what do you think might happen to litter if it is picked up and disposed of properly? Can some of the discarded items be re-used or recycled, or does all of it enter what is known as the waste stream? Additional things: Share maps, data, and definitions with other schools.

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

[note: the categories below are offered merely as planning guides; it is acknowledged that the categories are neither complete nor discreet].

Cognitive:

Linguistic:

Behavioral:

Affective:

Other:

LESSON 2

What's the Story with Litter?

(A Lesson Series about Litter)
Grade Band: Middle School (6-8)



SERIES INTRO

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In Lesson 1, students explore litter as a concept and phenomenon. In addition, students will engage in place-based learning by conducting a local litter survey and exploring human impacts on a local ecosystem. In Lesson 2, students explore what happens to litter, where it goes, and the impacts it has on different ecosystems. In Lesson 3, students identify a local litter problem, derive a solution, and take action.

Lesson 2 Enduring Understanding(s):

This lesson supports student exploration of two questions: “What happens to litter when we throw it away? How does litter impact ecosystems? Students examine the litter they collected and/or documented in lesson 1, identifying, to the extent possible, what it is made of and how amenable it is to reuse or recycling, and identify possible pathways it might take in the waste stream.

Lesson 2 Summary Description:

This second of three lessons builds on lesson one in the series. In this lesson, students select a particular component (*or components*) of their litter collection - or litter they want to learn more about (*e.g. fishing line or single-use plastic shopping bags*) - to research further. For example, students might decide to examine the impact of cigarette butts (the most littered item in the world) on birds or other wildlife, the impact of organic litter decomposition on lakes, streams, and waterways, or the impact of fishing line on fishes and marine mammals. Students then create a narrative storyline from the perspective of the littered object, taking the position of the litter in order to explicate various events and possibilities in the path of the littered object, from point of manufacture to point of improper discard, to eventual degradation, landfill containment, or reprocessing.



Background Information for Teachers:

Writer's Workshop

NGSS Standard: ESS3-4 - Students who demonstrate understanding can construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems. (NOTE: This lesson centers on analyzing evidence and investigating the nature of the impact of consumption on Earth's systems).

DCI: ESS3.C– Human impacts on Earth Systems

Crosscutting Concept – All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Science and Engineering Practices – Asking questions and Defining Problems; Analyzing and Interpreting Data

Observable features of the student performance by the end of the series:

Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Specifically, this lesson series supports the following:

2.a.ii. (Identifying Information): Students identify evidence to support a claim about per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.

4.a.i. (Reasoning and Synthesis): Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe a chain of reasoning that includes the concept that increases in the size of the human population or in the per-capita consumption of a given population cause increases in the consumption of natural resources.

OBJECTIVES

1 Identify aspects of the material composition of litter (what it is made of), where it goes when properly and improperly disposed of, and its impact on natural ecosystems

2 Investigate the impact of specific types of litter on biotic components of ecosystems

3 Demonstrate an understanding of the “cradle-to-grave” pathway of litter through the medium of story or narrative.

MATERIALS

TEACHING PLAN

1

A collection of litter (from Lesson 1 in the series)

2

A field notebook about the location of litter and its description (from Lesson 1).

3

A litter map (from Lesson 1)

4

Access to age-appropriate research materials (e.g. school library resources or internet access)

The suggestions provided in the boxes below follow the 5E lesson format.

ENGAGE

Teacher begins by posing open-ended questions for students to discuss (~5+ minutes):

- a. *What do you think happens to litter if no one picks it up?*
- b. *What do you think happens to litter if it's picked up and put in a trash can or recycling bin?*
- c. *How do you think litter might affect the ecosystem or living things?*

Teacher then asks students to create a number of possible responses to those questions that capture their thinking about litter. (10-15 minutes)

Teacher then mediates a discussion of student responses, suggesting possible resources students could use to explore what happens to litter under various circumstances, and how it affects ecosystems in general.

Teacher then introduces the lesson's major task: create a story from the perspective of a piece of litter in which the piece of litter is the main protagonist and describes the path of a piece of litter from cradle to grave (*i.e. from manufacture to decomposition*). Each story should contain or address a number of specific areas, listed in the Explore and Evaluate sections, below.

For example, a story could begin with the manufacture of a cigarette butt, the most commonly littered object in the world. In this story, the cigarette butt looks forward to a life of helpfulness as a device meant to shield humans from some of the dangerous components of toxic cigarette smoke. Composed of cellulose acetate plastic, it is designed to withstand heat and rough handling. After it is made, it is installed on the end of a cigarette and packaged with 19 others just like it. After weeks in the dark sitting on a shelf in a convenience store, someone removes it, sets the cigarette on fire, and begins pulling toxic smoke through it! The cigarette butt finds this to be a terrible experience, even though it's the very task it is designed for, because all manner of dangerous chemicals become trapped in it. After a few minutes, and much to its dismay, the smoker is in a hurry when the bus arrives and, finding no trashcan handy (*even though there's one not three meters away!*) flicks the butt unceremoniously into a gutter near a rainstorm grate where the next rainstorm carries it, now laden with toxic chemicals, toward the sea. Ending 1 might be a description of a group of volunteer middle-schoolers finding it in the sand and picking it up for proper disposal. In this ending, the story continues with a description of the butt's journey to its final resting place: a landfill. Ending 2 might be a description of how a seagull finds it and, thinking it food, swallows it, where it harms the seagull's digestive tract, or (*believe it or not!*) winds up in the nest of a finch, where its cocktail of toxic chemicals dissuades pests from invading the nest but also potentially harms the baby birds. This story ends, ultimately, with the bird nest falling into disuse and all the organic materials (*twigs, leave matter*) being reclaimed by nature, leaving the cellulose acetate to linger, lonely and forlorn, for decades.

EXPLORE

To initiate the Explore phase, the teacher helps students (*individually or in pairs/small groups*) revisit the list(s) they created in the Engage phase, examine the litter they found in Lesson 1, and based on those considerations, choose a piece of litter about which to create a story.

With teacher guidance, students then explore resources - in print at the school library and/or online - to inform their stories about the origins and outcomes of litter, in particular the type of litter they chose to write about. The list of parameters for each story (*see below and in the Evaluate section*) is designed to provide useful structure for student research.

The teacher may decide to start by having students brainstorm and outline their stories, and then structure the Explore phase as a series of research projects intended to inform the writers about information needed to create a story that accurately captures what happens to litter at each stage of the story outline.

Alternatively, the teacher may decide to have students research the origins and outcomes of litter first, using the story parameter list as a guide, and then brainstorm and outline their stories.

Each story should contain or address the following parameters:

A

What the piece of litter is made of and how it was made

B

The circumstances by which it came to be discarded improperly and thus became litter

C

What typically happens to similar litter

D

How similar litter might affect wildlife or the environment

E

What happened (or will happen) to the particular piece of litter (e.g. will it find its way into the belly of a sea creature or the nest of a bird? Will its chemicals leach into a stream and contaminate the food chain?)

F

Optional: Teacher requires that each story contains two potential endings: (i) a happy ending in which the litter finds its way into a waste stream that minimizes its impact on the environment, and (ii) a troubling ending in which the litter finds its way into a waste stream that causes harm to wildlife or the environment.

EXPLAIN

As the teacher engages students in a writer's workshop approach to the development of their stories, students take part in discussions about content-accuracy in particular. (More info about the writer's workshop approach [here](#), or [here](#), or [here](#)). Specifically, teacher supports students to support the plausibility of the events and occurrences in their stories by citing source material.

Target explanations (guided by the storylines produced in the Explore phase):

- a. *Students accurately address each of the parameters in the list.*
- b. *Students refer to viable source material to support the accuracy of facts and plausibility of scenarios in their storylines.*

EVALUATE

(including student self-assessment opportunities)

The evaluation of content mastery takes place in the context of a series of writer's workshops (see Explore phase, above) in which individuals or teams of writers support each other in the creation of narrative pieces.

Alternatively, or afterward, the teacher and students may decide to hold a writer's showcase, in which students are given the opportunity to share their work to a wider audience (e.g. peers, students from other classes or grades, family and community members)

Each story should contain or address the following parameters:

A

What the piece of litter is made of and how it was made

B

The circumstances by which it came to be discarded improperly and thus became litter

C

What typically happens to similar litter

D

How similar litter might affect wildlife or the environment

E

What happened (or will happen) to the particular piece of litter (e.g. will it find its way into the belly of a sea creature or the nest of a bird? Will its chemicals leach into a stream and contaminate the food chain?)

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Optional: Teacher requires that each story contains two potential endings: (i) a happy ending in which the litter finds its way into a waste stream that minimizes its impact on the environment, and (ii) a troubling ending in which the litter finds its way into a waste stream that causes harm to wildlife or the environment.

EXTEND / ELABORATE

Extend

1 Students combine their stories into a class volume (e.g. “*The Life and Times of Litter; Collected Works of Dr. Swanson’s Sixth Grade Science Class*”). With scheduling and outreach help from the teacher, students visit public officials to present them with copies of their works and, using the stories as a starting point, exchange ideas about what to do to combat the problems associated with litter.

Extend

2 Students create graphic novel versions of their stories.

Elaborate

3 Students combine aspects of several stories to write and produce a screenplay. With help from the fine arts and/or drama teacher, students present their play to the school and community as part of an Earth Day celebration, which occurs on April 22 each year.

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

[note: the categories below are offered merely as planning guides; it is acknowledged that the categories are neither complete nor discreet].

Cognitive:

Linguistic:

Behavioral:

Affective:

Other:

LESSON 3

Time to Take Action

(A Lesson Series about Litter)
Grade Band: Middle School (6-8)



photo by Evan Halleck

SERIES INTRO

This lesson series is anchored in the fundamental ecological principle of ecosystem interconnectedness, which offers a framework to support student inquiry into how human activity impacts the natural environment. The series also includes a summative assessment plan to check for student understanding at the culmination of the three lessons. The lesson series follows a trajectory centered on place-based learning, inquiry, and taking action: First, students define litter and explore the prevalence and impact of this phenomenon on a local ecosystem of their choosing. Second, students explore what happens to litter when it is properly and improperly disposed of and research how litter impacts different ecosystems. Third, using their litter survey findings, students identify a problem in their local context, research and draw inspiration from solutions others have implemented in the past, and determine a way to take action.

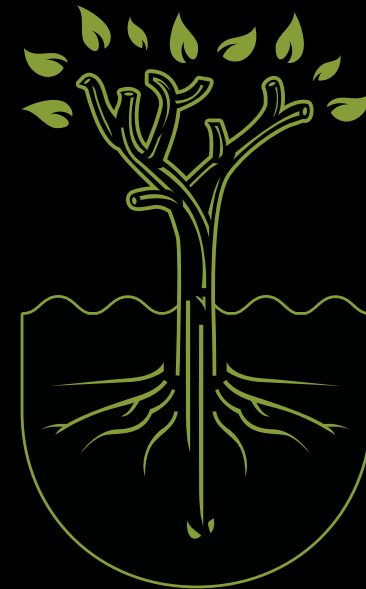
In Lesson 1, students explore litter as a concept and phenomenon. In addition, students will engage in place-based learning by conducting a local litter survey and exploring human impacts on a local ecosystem. In Lesson 2, students explore what happens to litter, where it goes, and the impacts it has on different ecosystems. In Lesson 3, students identify a local litter problem, derive a solution, and take action.

Lesson 3 Enduring Understanding(s):

This lesson supports student exploration of the essential question: “What can individuals do to combat the problems associated with litter? Based on the litter maps they made in lesson 1 and the facts about litter and its impacts they learned about in lesson 2, students plan and carry out a potential solution to a local litter problem.

Lesson 3 Summary Description:

This third in the series of three lessons engages students in experiential place-based learning. Using their litter survey data to identify a specific litter problem, students conduct research to derive a potential solution, and then implement, test, and refine their solution. Throughout this lesson, students engage in the engineering design process. First, students revisit their Litter Map to identify a specific litter problem they want to address, along with any constraints they might face. Second, students conduct research to find approaches that have been used to solve similar problems in other contexts, both locally, nationally, and globally. Third, students brainstorm how to adopt or adapt one or more of these possible solutions to address the local problem they identified in step 1. Students then create a detailed plan of action, create/build a prototype or model (*if their proposed solution requires it*). Finally students test their approach and/or prototype, evaluate its effectiveness, and improve on their proposed solution.



Background Information for Teachers:

The NGSS Engineering and Design Process

NGSS Standard: ESS3-4 - Students who demonstrate understanding can construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems. (NOTE: This lesson centers on analyzing evidence and investigating the nature of the impact of consumption on Earth's systems).

DCI: ESS3.C– Human impacts on Earth Systems

Crosscutting Concept – scale (*taking action at broad and local levels*)

All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Science and Engineering Practices – Asking questions and defining problems;
Analyzing and interpreting data; Make claims based on evidence;
Obtain/evaluate/communicate information

Observable features of the student performance by the end of the series:

Students make a claim, to be supported by evidence, to support or refute an explanation or model for a given phenomenon. Specifically, this lesson series supports the following:

2.a.ii. (*Identifying Information*): Students identify evidence to support a claim about per-capita consumption of resources by humans in a given region or ecosystem over a given timespan.

4.a.i. (*Reasoning and Synthesis*): Students use reasoning to connect the evidence and evaluation to the claim. In their arguments, students describe a chain of reasoning that includes the concept that increases in the size of the human population or in the per-capita consumption of a given population cause increases in the consumption of natural resources.

OBJECTIVES

- 1** Identify and characterize a specific problem of litter based on the litter survey they conducted in Lesson 1
- 2** Research solutions at local, national, and global scales that have been or are currently employed and use these ideas as inspiration to address their own problem.
- 3** Derive and implement a solution/plan of action that addresses the identified local litter problem.
- 4** Outline steps to take action at the state or national level.

MATERIALS

1

Litter map from lesson 1

2

Other materials TBD by the potential solutions the students identify (*see below*)

TEACHING PLAN

The suggestions provided in the boxes below follow the 5E lesson format.

ENGAGE

Teacher begins by asking students to revisit and review the class litter map from Lesson 1. Working in groups, students are directed to look for patterns, make observations, and ask questions about their litter survey data. The teacher then mediates a classwide discussion about some of the patterns and observations students made.

After the review, the teacher poses the following open-ended questions for students to discuss (~10+ minutes):

- a. *What patterns did you notice in the data?*
- b. *Based on the information displayed in our litter map, what do you think are the biggest litter problems we face in our local context?*
- c. *How does the litter map information support your idea(s)?*
- d. Do you know of other places that face similar problems?
- e. Do you know of other places that have implemented solutions to similar problems?

Teacher then asks students to create a number of possible responses to those questions that capture their thinking about the biggest litter problems they see in their local context. (10-15 minutes)

Teacher then mediates a discussion of student responses with the goal of identifying a specific problem for the class to address.

Teacher then introduces the lesson's major tasks: Identify a range of possible solutions, conduct research to inform decision-making about which possible solution is most viable, develop a plan of action, implement the solution, and test its effectiveness by collecting relevant data, and improve the solution in whatever way the data suggests would be most effective.

EXPLORE

Resources useful to inform steps 1-4, below, will depend on the specific problems students identify. Examples of online resources include - but are certainly not limited to - the following (*these are provided merely as examples*):

[Can I Recycle That?](#)

[Sharing: The New Recycling!](#)

[The Cleanest Line](#)

[Recycling Is Broken. Now What?](#) (*creative corporate solutions to litter/trash*)

[Perfect Storm Hits U.S. Recycling](#) (*original recycling efforts/solutions to litter in Berkeley, CA*)

Step 1: Identify Problem and/or Need

In step 1, the teacher helps students, either as a whole class or in small groups, identify a problem or need to explore further. The driving question directing this exploration includes:

- a. *Based on the information displayed in our litter map, what do you think are the biggest litter problems we face in our local context?*

Step 2: Research Viable Solutions

In step 2, students research different solutions that have been or are currently implemented locally, nationally, and globally. The teacher helps students, either as a whole class or in small groups, decide which among a number of potential solutions is the most viable for addressing their identified problem. The driving questions directing this part of the exploration include:

- a. *What solutions have been used to address problems of litter similar to the one we identified?*
- b. *In what ways do those solutions address the context in which they were used?*
- c. *How is our local context similar to the contexts in which they were used? How does it differ?*
- d. *Can you justify your responses to part c, above, using information from the litter map?*

Step 3: Identify and Create a Specific Solution

In step 3, the teacher helps students, either as a whole class or in small groups, identify in detail the steps that need to be taken in order to create/build and implement the solution identified in step 2. The driving questions directing this part of the exploration include:

- a. *What solutions have been used to address problems of litter similar to the one we identified?*
- b. *In what ways do those solutions address the context in which they were used?*
- c. *How is our local context similar to the contexts in which they were used? How does it differ?*
- d. *Can you justify your responses to part c, above, using information from the litter map?*
- e. *What features of the solution under consideration seem doable? Why?*
- f. *What features of the solution under consideration seem challenging? Why?*
- g. *What changes might we make to address those challenges?*

EXPLAIN

The teacher engages with students in each of the four steps in the Explore phase, above, helping mediate discussion toward target explanations implied by each of the four steps. Because of the stepwise nature, the teacher should not proceed from one step to the next until students have internalized the reasoning behind each of the steps. Specifically:

The teacher engages with students in each of the four steps in the Explore phase, above, helping mediate discussion toward target explanations implied by each of the four steps. Because of the stepwise nature, the teacher should not proceed from one step to the next until students have internalized the reasoning behind each of the steps. Specifically:

Step 1

Students make connections between the local context and other contexts.

Step 2

Students make reasonable claims about potential solutions, using evidence to support their claims.

Step 3

Students develop viable plans of action appropriate in scope and scale.

Step 4

Students engage in appropriate data collection and analysis and leverage that analysis in reasonable ways to improve their solutions.

EVALUATE

(including student self-assessment opportunities)

Evaluation centers on the *NGSS Engineering Design Process*: problem identification and characterization followed by solution development, implementation, testing, and improvement.

The teacher may decide to have students, either individually or in groups, produce an artifact (e.g. a drawing or a piece of writing) to illustrate understanding of particular aspects of the engineering design process by describing how they operationalized that process as they developed, implemented, and improved their solution.

Alternatively - or afterward - the teacher might decide to have the students present their solution and describe each step of the engineering design process they engaged in to a wider audience (e.g. peers, students from other classes or grades, family and community members).

EXTEND / ELABORATE

Extend

1 Students expand implementation of their solution to other similar sites, such as other schools, or other public places with similar litter problems. For example, students could focus on shifting individual behavior and choices (e.g., stop using single use plastic; create a school wide ‘no single use plastic challenge’)

Elaborate

2 Students explore how they can address the issue on a larger scale. For example, students could create an online “Awareness Campaign” about their project and use appropriate social media tools (e.g. Twitter, Instagram) to showcase their solutions and encourage others to join in. In addition, students could contact city and/or national policymakers and advocate for change.

DIFFERENTIATION PLANS

In this space, include notes about how you will differentiate your instruction to meet the needs of any individual students in your class who may need particular adaptations or accommodations

[note: the categories below are offered merely as planning guides; it is acknowledged that the categories are neither complete nor discreet].

Cognitive:

Linguistic:

Behavioral:

Affective:

Other: