

Lesson 4-2: Writing a research question

| Time   | Engaging the Student (Entry Task)  | Developing the Ideas--Lesson               |  |   | Checking for Understanding (exit ticket)   |
|--------|--|--|--|---|--|
|        |  | Student Handout                            | Teacher/Lecture Notes  | Materials   |  |
| ~1 day | <p>List each team's research question on the board.</p> <p>Ask your class what makes a good research question? List their criteria on the board.</p> | <p><a href="#">Variables Worksheet</a></p> | <p>Guide the discussion on research questions. Scientists generally agree that a good research question is:</p> <ol style="list-style-type: none"> <li>1. Testable using science</li> <li>2. Specific</li> <li>3. Answer should be objective rather than subjective</li> <li>4. Able to be adapted into a hypothesis</li> <li>5. Should address a gap in scientific knowledge</li> <li>6. Not a question about a process because this should be addressed during the inception/engagement portions or can be done as background research. This would lead to reporting well-known information rather than drawing original conclusions.</li> <li>7. Answering the question must be feasible within the time constraints</li> </ol> <p>Give examples of bad and good research questions and characteristics of each</p> <p>Explain that the end goal of the research question is to guide research so that it will lead to original conclusions.</p> <p>Allow them to refine their research question using the variables worksheet.</p> <p>Have the students explain their research question and identify their independent and dependent variables to another team and have them respectfully critique each other's ideas.</p> | <p><a href="#">Examples</a> for teachers and students of the variables and study design worksheets.</p> <p>Guiding <a href="#">resource</a> for students or teachers on research question process</p> <p><a href="#">Source</a> for teachers on the</p> | <p>Each team's exit ticket should be a research question that is approved by the instructor.</p> <p><i>Journal Check-in:</i><br/>Spend a few minutes answering reflection questions in journals. "What was challenging about developing a research question? What made you choose your research question?"</p> |

|  |  |  |   |  |  |
|--|--|--|---|--|--|
|  |  |  | Here is a <a href="#">video</a> modeling how a conversation to narrow a research question might go. | difference between original research and reporting facts<br><br>Students' journals |  |
|--|--|--|---|--|--|

## Variables Worksheet

At this point in your research process, you have chosen a research question that will be the focus of the rest of this case study. In order to understand what you still need to look into to answer your research question, fill out this chart with what you know and what you need to know about each variable. The purpose of this worksheet is to understand the next steps in your research and what research methods will be required.

**Research Question:**

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**Independent Variable (The variable that you change and have control over):**

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|                |
|----------------|
| What you know: |
|                |

| What you need to know: | How to find it: (if online, what type of source?) |
|------------------------|---|
|                        |   |

**Dependent Variable (The variable that reacts to the independent variable and that you will measure):** \_\_\_\_\_

|                |
|----------------|
| What you know: |
|                |

| What you need to know: | How to find it: (if online, what type of source?) |
|------------------------|---|
|                        |   |

## Variables Worksheet

At this point in your research process, you have chosen a research question that will be the focus of the rest of this case study. In order to understand what you still need to look into to answer your research question, fill out this chart with what you know and what you need to know about each variable. The purpose of this worksheet is to understand the next steps in your research and what research methods you may need to use in order to do this.

### Research Question:

Which brand of dish soap, Dawn or Palmolive, would remove more motor oil from goose feathers?

**Independent Variable:** Type of dish soap

|   |
|---|
| What you know:  |
| Dish soap can get rid of dish grease<br>Dawn has an initiative where they clean animals that have been covered in oil from oil spills |

| What you need to know:   | How to find it: (if online, what type of source?)   |
|--|---|
| What in soap gets rid of grease?<br>What is different about each soap?<br>Does soap dissolve in water? | Ingredients list for each soap/dish soap website<br>Ingredients on soap containers<br>Website explaining soap |

**Dependent Variable:** Amount of grease removed from feathers

|   |
|---|
| What you know:  |
| Grease keeps birds from being able to fly<br>It cannot wash off in the water, cannot be dissolved |

| What you need to know:   | How to find it: (if online, what type of source?)  |
|--|--|
| How much grease gets on birds when there is an oil spill?<br><br>How long does the grease usually stay on for in seawater? | Oil spill info website<br><br>Looking at what makes up each type of grease<br>Animal rehabilitation websites |

## Study Design

This worksheet is meant to give students an organizer to develop their study and make sure they have thought through what they need to know in order to successfully do a study.

**Research Question:** Which brand of dish soap, Dawn or Palmolive, would remove the most motor oil from goose feathers?

**Independent Variable:** Type of dish soap

**Dependent Variable:** Amount of oil removed from feathers

**Type of study:** Experiment

**Procedure:** Write the steps for your data collection (this may be a great place to delegate tasks)

1. Measure and weigh a fixed amount of oil and weigh 10 feathers.
2. Douse a feather in the oil.
3. Use a fixed, weighed amount of one dish soap to clean the feather. Do this by scrubbing the feather from base to tip 5 times.
4. Immerse the feather in a beaker of water and allow to dry.
5. Repeat with 4 more feathers and 5 times with the other type of soap.
6. Once dried, reweigh each feather to evaluate the mass of oil lost through cleaning the feather.

**Materials needed:** (if applicable)

Goose feathers

Oil

Dawn and Palmolive soap

Beakers

Water

**Analysis plan:** Have some idea of how you will organize your data (this may change)

We will represent the mass of the oil removed in a bar graph and explained in words with pictures of the experiment.

## Variables Worksheet

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**Research Question:** Where in my town would a community garden be most utilized by families?

**Independent Variable:** Location

|  |
|--|
| What you know:   |
| Must be in a green area<br>Has access to sunlight and rain<br>Somewhat central to the town |

| What you need to know:  | How to find it: (if online, what type of source?)              |
|---|--|
| Where can be accessed by public transportation?   | City maps  |
| Does it need to be accessible to those walking?<br>Handicap accessible?<br>Parking lot? | Find from study results, look up legality of community gardens |
| Legally, where would a garden be allowed?   | Town hall website, city maps, employee at town hall            |

**Dependent Variable:** Number of potential users

|                              |
|------------------------------|
| What you know:               |
| Families will use the garden |

| What you need to know:  | How to find it: (if online, what type of source?)                  |
|---|--|
| Number of families in town?<br>What number of families would like to use a community garden?<br>How many families are able to use a car?<br>Where do the most families live who would use the garden? | Town census<br>Study results<br><br>Study results<br>Study results |

## Study Design

This worksheet is meant to give students an organizer to develop their study and make sure they have thought through what they need to know in order to successfully do a study.

**Research Question:** Where in my town would a community garden be most utilized by families?

**Independent Variable:** Location

**Dependent Variable:** Number of potential users

**Type of study:** Survey

**Procedure:** Write the steps for your data collection (this may be a great place to delegate tasks)

1. Write questions for survey from what is unknown about both of our variables
2. Distribute survey to families in our town
3. Collect data and tally answers to questions

**Materials needed:** (if applicable)

Printer and paper

Pens for survey participants to use

Location to hand out survey

**Analysis plan:** Have some idea of how you will organize your data (this may change)

1. Tally all answers and graph for each question (bar or pie graphs)
2. Overlay popular suggested locations and legally-possible locations on a map of the town
3. Make some final suggestions about where the community garden would be most utilized by families

## Variables Worksheet

At this point in your research process, you have chosen a research question that will be the focus of the rest of this case study. In order to understand what you still need to look into to answer your research question, fill out this chart with what you know and what you need to know about each variable. The purpose of this worksheet is to understand the next steps in your research and what research methods you may need to use in order to do this.

**Research Question:** Is it more cost-effective to switch all our cities' streetlights to LED bulbs immediately or as the current non-LED light bulbs burn out?"

**Independent Variable:** When streetlight bulbs are switched

|  |
|--|
| What you know:   |
| Some cities are switching to LED street lights<br>It costs money to change streetlights<br>Options are to switch all at once or as lights burn out |

|  |   |
|--|---|
| What you need to know:   | How to find it: (if online, what type of source?) |
| How many streetlights are in the city?<br>When were they last installed?<br>Were all of them installed at the same time? | City website/city employee                        |

**Dependent Variable:** The cost of switching immediately or as lights burn out

|  |
|--|
| What you know:   |
| It will cost more in energy to have the non-LEDs in<br>It will be a bigger upfront cost to put all LEDs in at once |

|  |   |
|--|---|
| What you need to know:   | How to find it: (if online, what type of source?)   |
| Labor prices in my town<br><br>Non-LED cost?<br>Energy used by non-LED bulbs?<br>Cost of energy?<br>LEDs cost?<br>Energy used by LEDs? | Look online at average costs of other maintenance work (.gov)<br>Ask town officials/power companies<br>Online on lightbulbs' website<br><br>Town's electricity grid website or employee |
| Which will cost less overall?  | Study results   |



## Study Design

This worksheet is meant to give students an organizer to develop their study and make sure they have thought through what they need to know in order to successfully do a study.

**Research Question:** Is it more cost-effective to switch all our cities' streetlights to LED bulbs immediately or as the current non-LED light bulbs burn out?"

**Independent Variable:** When streetlight bulbs are switched

**Dependent Variable:** The cost of switching immediately or as lights burn out

**Type of study:** Cost-benefit analysis

**Procedure:** Write the steps for your data collection (this may be a great place to delegate tasks)

1. Find data:
  - a. How much it costs for the LED lights and labor to put in per light
  - b. How much LED save vs lights used now per light
  - c. Other unknowns
2. Estimate how long each current light bulb has left before it needs to be replaced
3. Calculate the cost of replacing all at once or waiting till they burn out and compare to how much money would be saved

**Materials needed:** (if applicable)

None

**Analysis plan:** Have some idea of how you will organize your data (this may change)

A table that shows final cost of everything at the end of calculations

## Variables Worksheet

At this point in your research process, you have chosen a research question that will be the focus of the rest of this case study. In order to understand what you still need to look into to answer your research question, fill out this chart with what you know and what you need to know about each variable. The purpose of this worksheet is to understand the next steps in your research and what research methods you may need to use in order to do this.

**Research Question:** Do paper or plastic bags generate more greenhouse gasses over their life cycle?

**Independent Variable:** Type of grocery bag

|  |
|--|
| What you know:   |
| <p>Paper bags are produced from trees and therefore contribute to deforestation<br/>         Plastic bags are produced from oil<br/>         Both can be recycled<br/>         Some paper bags are thrown in landfills but some are littered<br/>         Both are produced in factories<br/>         Both need to be transported, raw material to factory, product to grocery store</p> |

| What you need to know:   | How to find it: (if online, what type of source?)  |
|--|--|
| <p>How many trees are cut down to make paper bags?<br/>           How far away are the trees cut down for plastic bags?<br/>           Can plastic bags be produced more locally than paper bags?<br/>           How many paper and plastic bags are recycled, reused, thrown out, and littered?<br/>           How are paper and plastic bags produced and recycled?<br/>           How much can paper and plastic bags hold?</p> | <p>Bag manufacturing website/bag employee<br/><br/><br/><br/><br/>           Production websites<br/><br/>           Test bags and production websites</p> |

**Dependent Variable:** greenhouse gas generation

|   |
|---|
| What you know:  |
| <p>Occurs when fossil fuels are burned<br/>         Occurs when waste breaks down<br/>         Can also be exacerbated by deforestation which impacts greenhouse gas levels in the atmosphere: less sequestration, greater production (deforestation machinery and transportation)<br/>         Occurs more the further something has to travel<br/>         Can occur during recycling processes</p> |

| What you need to know:  | How to find it: (if online, what type of source?)  |
|---|--|
| <p>How much CO<sub>2</sub> does a tree take out of the atmosphere?</p> <p>How much CO<sub>2</sub> is produced from cutting down a tree?</p> <p>How many more plastic bags can be transported by the same amount of fuel?</p> <p>How much greenhouse gases is produced during recycling processes?</p> <p>How much CO<sub>2</sub> is produced during decomposition?</p> <p>How much CO<sub>2</sub> is produced in factories?</p> <p>How much greenhouse gas is produced in paper bag production?</p> <p>How much greenhouse gas is produced in plastic bag production?</p> | <p>Greenhouse gas website</p><br><p>Bag manufacturing website/truck size data</p><br><p>Recycling website</p><br><p>Factory websites</p><br><p>Study results</p><br><p>Study results</p> |

## Study Design

This worksheet is meant to give students an organizer to develop their study and make sure they have thought through what they need to know in order to successfully do a study.

### Research Question:

Do paper or plastic bags generate more greenhouse gasses over their life cycle?

**Independent Variable:** Type of grocery bag

**Dependent Variable:** Production of greenhouse gases

**Type of study:** Retrospective/online research

**Procedure:** Write the steps for your data collection (this may be a great place to delegate tasks)

1. Look up which bag produces more greenhouse gases during the following processes:  
Extracting raw material, producing bag, transporting bag, recycling bag, throwing out the bag
2. Look up the percentage of time that paper and plastic bags are recycled and thrown out.
3. Look up the carrying capacity of each type of bag.

**Materials needed:** (if applicable)

Computer and internet

**Analysis plan:** Have some idea of how you will organize your data (this may change)

| Part of the process         | Paper   | Plastic   |
|-----------------------------|---|---|
| Extraction of raw materials | How many trees are cut down to make one bag?<br>How much CO <sub>2</sub> is produced to cut down a tree?  | How much CO <sub>2</sub> is produced to get the materials to make a plastic bag?  |
| Transportation              | How far is the tree transported?<br>How far is the bag transported?<br>What is the efficiency of transporting paper bags? I.e. how many bags per truck?<br>How much weight? | How far are the raw materials transported before they are turned into plastic bags?<br>How far is the bag transported?<br>What is the efficiency of transporting a plastic bag? |
| Production                  | How much greenhouse gases are produced when a paper bag is made from a tree into a bag?   | How much greenhouse gases are produced when raw materials are made into plastic bags?   |

|           |   |   |
|-----------|---|---|
| Use       | How much weight can a paper bag hold?   | How much weight can a plastic bag hold?   |
| Recycling | How much CO <sub>2</sub> is produced to recycle a paper bag? What percentage of paper bags are recycled?                                  | How much CO <sub>2</sub> is produced to recycle a plastic bag? What percentage of plastic bags are recycled?                                |
| Waste     | What percentage of paper bags are thrown out in the garbage or are littered? How much greenhouse gases are produced during decomposition? | What percentage of plastic bags are thrown out in the garbage or are littered? How much greenhouse gases are produced during decomposition? |

Once data is found in this chart, make a bar graph for greenhouse gas released by each type of bag.