

Questioning through the Statistical Problem-solving Process

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 Published: October 2021

Overview of Lesson

This lesson uses photographs as data to tell a story about the class's favorite outdoor spaces. A starting prompt for using the statistical problem-solving process is photographs of the class's favorite outdoor spaces. Students pose statistical investigative questions to explore about favorite outdoor spaces, they collect data from the class, the data is analyzed, and a story is shared (interpret results) about the class's favorite outdoor spaces. The activity allows for a variety of investigations, limited only by the students' imaginations. This lesson was written to demonstrate how students might engage in the Statistical Investigation Cycle at Level B as detailed in the *preK-12 Guidelines for Assessment and Instruction in Statistics Education II (GAISE II)* (Bargagliotti et.al., 2020). This lesson also connects to two other STEW lessons written by Sheri Johnson and Leticia Perez, both of which explore different ways teachers might help students use data to tell stories about their favorite outdoor spaces. *Using CODAP to tell different stories* introduces students to the overall statistical investigation process and highlights how to use CODAP for data interpretations. *Using technology to create data elements* dives deep into collecting data from the photograph itself, including pixel color proportions.

Type of Data

- More than two variables
- Data generated and collected as a class

Learning Objectives

- Implementing the statistical problem-solving process using photographs as data
- The role of questioning throughout the statistical problem-solving process
- Engaging with exploratory data analysis
- Using technology to analyze the data
- Communicating findings to peers and others

Audience

- Grade 6-9 students
- Could be adapted for other grade levels above or below.
- *Prerequisites:* Prior to this lesson, students should have experience with collecting and displaying categorical and discrete quantitative data. Students should have experience with using data analysis software to make graphs, e.g., Common Online Data Analysis Platform (CODAP <https://codap.concord.org/>).

Time Required

Three or four 50–60-minute sessions with 15-20 mins initial set up a week before.

Technology and Other Materials

- *Technology*: statistical software to analyze the data e.g., CODAP
- *Technology*: access to online survey tools e.g., Google forms
- Printed copies of photographs – ideally the same height – enough for one set of photographs (the number of photographs will depend on the number in the class) per group of 3-4 students

Lesson Plan

This lesson uses student's favorite outdoor spaces as a context for generating data to tell a story about the class's favorite outdoor spaces. The initial data collection activity involves the students taking a photograph of their favorite outdoor space. These photographs are shared and through exploring the photographs students generate ideas that they want to explore further. Students pose statistical investigative questions, they collect data, analyze the data, and interpret results to tell a story about the class's favorite outdoor spaces. Findings can be shared with friends and family.

More traditional data forms include tables of variables that can be summarized into counts and numbers, graphed, and then described. This activity explores the possibilities that using photographs as data, a non-traditional data source, can add to statistical problem-solving.

Setting the scene – the week before (15-20 mins)

In preparation for the lesson – maybe a week earlier – the teacher sets the scene by asking the students to share with their neighbor information about their favorite outdoor space (5-10 mins).

Students talk freely about their favorite outdoor space or may be given specific pieces of information to share with one another. Ideas for sharing, if needed, could include:

- Where is the outdoor space?
- How do you get there?
- How long does it take to get there?
- How often do you go there?
- What activities do you do at your favorite outdoor space?
- What is one word you would use to describe your favorite outdoor space?
- *Any other question prompts you can think of to encourage students to share about their favorite outdoor space.*
- *Question prompts could be generated by the students by asking them “what they would want to share/describe about their favorite outdoor space”.*

Capture the ideas/topics that the students shared onto a big sheet of paper or in an online space that can be referred to later in the unit. (5-10 mins)

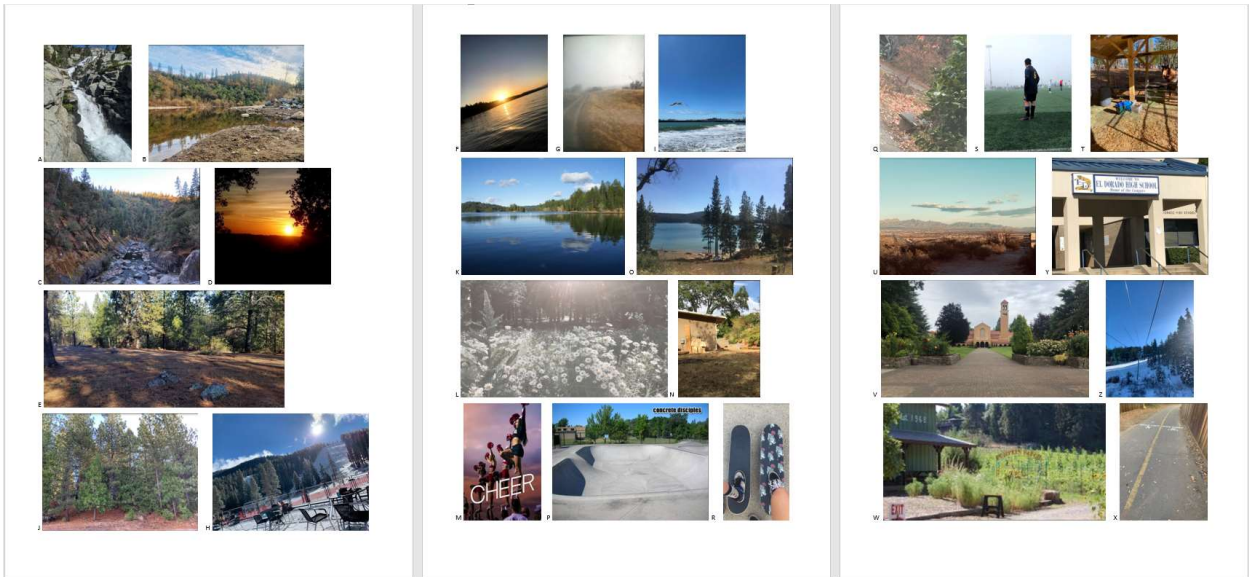
The teacher lets the students know that in a week (*or appropriate time frame*) that they will be exploring further their favorite outdoor spaces so that they can tell a story about the class's favorite outdoor spaces. In preparation for the session on [*give date*] the teacher asks the students to take a photograph or find a photograph of their favorite outdoor space and send it to the teacher, electronically if possible (a printed copy is also fine if this is not possible), by a date (*at least one day before the actual lesson is planned*).

In preparation for the first session the teacher collates the photographs into an electronic document.

- The photographs should all be the same height – this can be adjusted by clicking on the photograph and setting the height through the picture format tool (in Word).
- Photographs maybe portrait or landscape – either way make them the same height (which means that the landscape photos will be wider, this is ok).

Figure 1

Example of photographs collated into a single document and the same height (a table with a single column was used and the photographs were pasted into the row, then the table borders were hidden, photo heights were adjusted before pasting into the table)



Print off enough copies of the photographs for a set between 3-4 students. Depending on what you like to do, the students could cut the photographs up in the lesson to use, or you could pre-cut them ready for the session.

Using photographs as data to tell stories

The teaching sequence is written up as a single plan, however it is likely to take three to four 50–60-minute class sessions to complete. Possible breaks in the plan are indicated, teachers should plan to take the break with their class where it is appropriate as some activities will take longer with some groups and less with others.

SESSION ONE

Consider data (~25 min)

Explain to the students that today we are going to start to explore the photographs of their favorite outdoor spaces with the end goal of telling the class's story about their favorite outdoor spaces.

Hand out the sheets of photographs and scissors (or the cut-up photographs) and get the students to cut the photographs up.

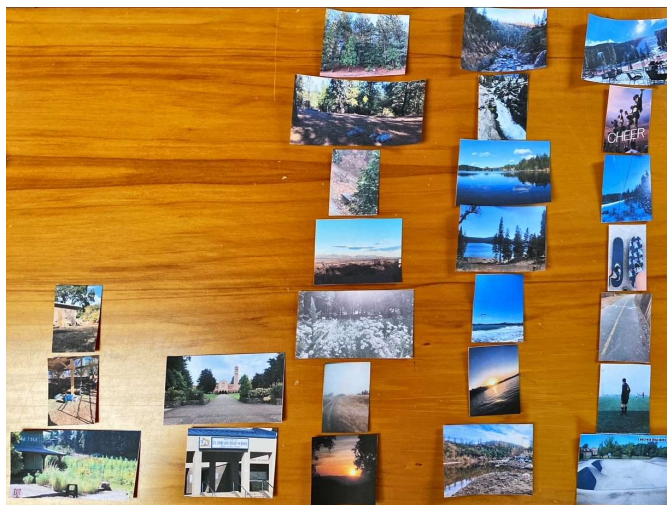
1. Ask the students in the group to find their photograph and then to share with the rest of their group about their favorite outdoor space (1-2 mins each). At the end get them to reflect on what questions they asked of one another to find out more – capture these ideas, adding them to the ideas captured in the setting the scene session. (5-10 min)

2. Ask the students to now consider all the class photographs and to sort the photographs into groups according to a category of their choosing. Allow them to struggle with this a bit but expect them to have sorted the photographs. As the teacher wanders about the class observing, they can ask students questions about:
 - a. What categories are they are sorting the photographs into?
 - b. How are they deciding which category each photograph goes into?
 - c. Are there any photographs that are hard to fit into the categories they have chosen?

(5-10 min)

Figure 2

Example of one group’s sorting of the pictures. Their categories were based on the type of space:
 farm or similar | school | outdoors no water | outdoors water | sporting



3. Once they have sorted their set of photographs allow the students to wander around and have a look at other group’s displays. While they are wandering around, they should be asking themselves at each display:
 - a. What do I notice?
 - b. What do I wonder?
 - c. What might I want to explore to tell the class story?

(5 min)
4. Get the students back to their groups and ask them to record their ideas and thoughts for each of the three prompts. This could be done either on a sheet of paper or electronically in an online document that they can share with the teacher and the class.

(5 min)
5. Gather all the ideas together from the scene setting activity and parts 1 and 4. These are ideas that can be used to generate statistical investigative questions to answer as they work to tell the class story.

Formulate statistical investigative questions (~35 min)

Background information about posing statistical investigative questions

Arnold's (2013, p. 110–111) research identified six criteria for what makes a good statistical investigative question. The six criteria are:

1. The variable(s) of interest is/are clear and available or can be collected
2. The group of interest is clear
3. The intent is clear (e.g., summary, comparison, relationship [association], time series)
4. The [statistical] investigative question can be answered with the data (e.g., question is specific, data can be collected, ethics)
5. The [statistical] investigative question is one that is worth investigating, that it is interesting, that there is a purpose
6. The [statistical] investigative question allows for analysis to be made of the whole group (e.g., Who is the tallest? is not an investigative question as it is about an individual rather than considering the whole group of interest; What are the heights of the students in our class? considers the whole group of interest – our class).

Types of [statistical] investigative questions - intent (Arnold, 2013)

Summary investigative questions ask about the overall distribution of the data or what **are** typical and reflects the population/group for which conclusions can be drawn.

Comparison investigative questions clearly identify the population or groups to be compared. Many comparison situations are considering if one group tends to be bigger, longer, higher than the other group so the investigative questions should include the idea of tendency, e.g., the investigative question includes words or phrases such as tends to, on average, generally.

Relationship (association) investigative questions can explore paired numerical data. They clearly identify the group for which the paired numerical data has been collected from. The investigative question uses language that signals a relationship (association) is being explored. This might be through a description of the relationship (e.g., if tall people have long arms) or through using the word relationship (e.g., if there is a relationship (association) between height and arm span).

Time series investigative questions explore patterns over time. Time series situations involve two numerical variables, one of which is time.

For a further discussion on the different types of questions within the statistical problem-solving cycle see Arnold and Franklin (2021).

Class activity

In this activity the students will choose areas for investigation and then interrogate their chosen areas for investigation. Following this they will pose statistical investigative questions to explore using the statistical problem-solving cycle with the end aim of telling the class story about favorite outdoor spaces.

In this activity the teacher is *using the six criteria for what makes a good statistical investigative question* to interrogate student ideas for areas of investigation and their posed statistical investigative questions. Note the teacher is modeling using the criteria to support student development in posing

statistical investigative questions and then using the criteria to check/critique student posed statistical investigative questions.

1. Get students to select two or three areas, from the ideas generated so far, that they would like to explore further to answer the overarching problem of *telling a story about the class's favorite outdoor spaces*.

Once they have selected their areas, support the students to *interrogate* each of the areas that they have chosen to explore. Questions they could ask about each area include:

- A. Is this an area that the students in our class would be happy to share their information with everyone? If not reject the idea [ethics] (Criteria 4).
- B. Can we collect data to answer a statistical investigative question based on this area of interest? If not reject the idea [ability to gather data to answer the statistical investigative question] (Criteria 4).
- C. What would be the purpose of asking about the idea that we have? Do we think it will provide interesting information to help us tell the class's story? If it is not interesting or purposeful then reject the idea [purposeful or interesting] (Criteria 5).
- D. Would the statistical investigative question we pose to explore this area involve everyone in the class? If not, then reject the idea [involving the whole group] (Criteria 6).

For example: two areas that students might decide to investigate could be the type of location and how often they visit their favorite outdoor space.

- A. Would our class be happy to describe the type of location? We think so.*
- A. Would our class be happy to tell us how often they visit their favorite outdoor space? We think so.*
- B. Can we collect data to answer statistical investigative questions based on these two areas? Yes, for both location and how often they visit.*
- C. Interesting, would this add to our class story – yes as it will be interesting to see how the different types of locations vary across the class and if there is one type of location that is more popular than others, also for the number of times they visit, maybe their favorite outdoor space isn't local so they can't go there so often – maybe we might even want to find out about whether the outdoor space is local or in another county or state.*
- D. These two areas would involve everyone in the class. To tell the class story it is important to include everyone.*

(10-15 mins)

2. Students develop statistical investigative questions based on their ideas, they will likely have 2-3 questions, at least one for each area. These are the questions they will answer using the data; the questions they will be exploring using the statistical problem-solving cycle.

At this level students are likely to be asking summary, comparison, and association questions. To help get them started with posing statistical investigative questions the following prompts can be used:

- What is the variable(s) that you want to ask about? (Criteria 1)
- Describe the group that you are asking about? (Criteria 2)

Model for students an example to give them an idea of what a statistical investigative question looks like.

3. Check the statistical investigative questions that students have posed. Gather them in, e.g., write on the board, type into a google doc or write on paper to be pinned up. As a class check some of the statistical investigative questions for the variable (Criteria 1) and the group (Criteria 2) and the remaining criteria:
 - Is it clear that the question is a summary question (or a comparison question, or an association question)? This criterion deals with the intent and signals the type of analysis that will be undertaken. (Criteria 3)
 - Is the question one that we can collect data for? This criterion should have been addressed in the generating ideas for the investigation stage. (Criteria 4)
 - Is the question purposeful? This criterion should have been sorted out in the generating ideas for the investigation stage. (Criteria 5)
 - Is the question about the whole group? Check that the question is not just finding out about an individual or smaller group of the whole class. This criterion should have been sorted out in the generating ideas for the investigation stage. (Criteria 6)

For example: for the type of location, we would start by identifying that:

- *the variable is the type of location of the favorite outdoor space*
- *the group is the **students in our class**.*

A possible statistical investigative question is (note: this is a summary statistical investigative question; we are summarizing one variable for the whole group):

- *What types of locations are the favorite outdoor spaces of the students in our class?*

(5 mins)

For example: Two statistical investigative questions were posed by students. Each one is critiqued using the six criteria for what makes a good investigative question and updated.

- *How often do students visit their favorite outdoor space?*
 1. *Variable of interest – how often do students visit their favorite outdoor space.*
 2. *Group of interest – students in our class (need to update this).*
 3. *Intent – summary.*
 4. *Can we collect the data – yes, we can use a survey question about this.*
 5. *Is it interesting – yes, we wonder how much variation there is in the different types of favorite outdoor locations?*
 6. *Is it about the whole group – yes, our class.*
- *Updated: How often do the students in our class visit their favorite outdoor space?*
- *Do students whose favorite outdoor space is local go there more often than students whose favorite outdoor space is not local?*
 1. *Variable of interest – how often students visit their favorite outdoor space.*
 2. *Group of interest – students in our class (need to update this).*
 3. *Intent – comparison but need to consider if all local spaces are visited more often*

Get students to critique and update their own statistical investigative questions. Collect in or collate electronically the statistical investigative questions posed and who posed them. Check the student posed statistical investigative questions before the next session. A poorly posed statistical investigative question can inhibit students being able to complete their investigation.

- than all not local spaces, or do local spaces tend to be visited more often.*
4. *Can we collect the data – yes, we can use the same information for the frequency of visits as above but will need to define the locations as local or not local, so we will need to find out this information too.*
 5. *Is it interesting, yes, we think those who have local favorite spaces will visit them more often, but we are now wondering if those who have non-local favorite spaces visit them for a longer amount of time when they visit them?*
 6. *Is it about the whole group – yes, our class.*
- *Updated: Do students in our class whose favorite outdoor space is local tend to go to their favorite outdoor space more often than students in our class whose favorite outdoor space is not local?*

(20-25 mins)

In the following session(s) students will develop data collection questions, collect the data, graph the data, and answer their statistical investigative question(s).

SESSION TWO

Collect data

In this session we will plan for and collect the data to answer our statistical investigative questions.

1. In their groups, students brainstorm what they need to know about the favorite outdoor spaces so that they can answer their statistical investigative questions. This will include defining any measures that they need e.g., what is local?

For example:

- *How often do the students in our class visit their favorite outdoor space?*
- *Do students in our class whose favorite outdoor space is local tend to go to their favorite outdoor space more often than students in our class whose favorite outdoor space is not local?*

Students discuss that they need to know how often students go to their favorite outdoor space to answer the first question and in addition whether the space is local to answer the second question.

They discuss how they will define “how often students go there”. They initially think about asking how often they went in the last year but decide that is too hard to remember for a whole year. They also discuss how one of their group goes to

their favorite outdoor space once a year but for one month, does this count as one visit or 30 visits? They discuss that if the space is local students might go there at least once a week during term time and if it is not local then they might not go there at all during term time. They think this will help with deciding on how to define more often. They also discuss the length of time that people spend at their favorite outdoor space and wonder if this might help them answer their statistical investigative questions.

Then the students discuss how they will define local, is local within the town limits, within ten miles of home, or some other boundary. In the end they define local as within 20 miles of their house. They decide to find out how far away the favorite outdoor space is and then classify the responses once they are in.

(5-10 mins)

2. Once students have decided what data they need to collect, they develop data collection questions that will be asked of students in the class to get more information about their favorite outdoor spaces to find the answers to the statistical investigative questions they have posed.

The teacher checks in with groups as they are developing their data collection questions and through strategic questioning – asking interrogative questions – supports the students to develop purposeful data collection questions that will give them useful data to answer their statistical investigative questions.

For example (continuing previous example):

The students develop three data collection questions to ask each student about their favorite outdoor space:

- *How many times in the last seven days did you enjoy this space?*
- *Thinking about when you visit your favorite space, how long do you usually stay?*
- *How far is your favorite outdoor space from your house?*

The students and the teacher check in on the suggested data collection questions and the teacher asks some interrogative questions to help the students to finetune their data collection questions. For example:

- *In your first question what do you mean by this space? – clarifying that we are wanting to find out about favorite outdoor spaces not some other space.*
- *In your first question what about if I went to my favorite space but I did not enjoy it that day for some reason, e.g. I fell off my bike and hurt myself? – checking in on the term enjoy and checking this will give the response that the students were hoping for*
- *In your first question, what if I go many times in one day, are you meaning how many days?*
- *How do you want to collect the information for the second question, are you wanting hours, minutes, days? – thinking about the variation of possible responses and how they might collate the information that comes in*
- *When you say how far in the last question, do you mean how far in miles or how far in time? – the teacher knows that the students wanted to collect distance in miles, but*

the question was not clear and could potentially have given answers in time, especially as the previous question was about time.

Students update their data collection questions:

- *How many of the last seven days did you go to and use your favorite outdoor space?*
- *Thinking about when you visit your favorite space, how long do you usually stay? (If it is less than a day – give the time to the nearest quarter of an hour, if it is more than a day – give the time to the nearest quarter of a day)*
- *How far in miles is your favorite outdoor space from your house? (Give your answer to the nearest mile)*

(20-25 mins)

3. As a class decide how to collect the data from all the class. There are several options that could be employed and depending on what the teacher wants to have as their pedagogical goal around data collection will depend on which option they use with their class.

Option 1: Each group goes around and asks the other students their data collection questions and records them.

This option provides opportunities for students to experience good and bad data collection methods, for example, they might just record the information in a table and find at the end they have three responses missing, e.g., 25 responses for 28 students in the class. Because they have not noted the names and the responses, they do not know who they have missed. As teachers we need to allow these sorts of learning experiences as they allow students to discover ideas about collecting data for themselves.

Option 2: Each student gets all their pictures back and all the class data collection questions are recorded on the board (or similar). Students answer each of the data collection questions on the back of their picture and then repeats this across all their pictures. Pictures are handed back to the groups to work with.

Option 3: The data collection questions are collated into an online survey form e.g., Google Forms, SurveyMonkey. Each student in the class fills in the online survey.

Figure 3

Example data collection questions typed into a Google Form as part of a class questionnaire

How many of the last seven days did you go to and use your favorite outdoor space?

0

1

2

3

4

5

6

7

Thinking about when you visit your favorite space, how long do you usually stay?
(If it is less than a day – give the time to the nearest quarter of an hour, if it is more than a day – give the time to the nearest quarter of a day)

Your answer _____

How far in miles is your favorite outdoor space from your house? (Give your answer to the nearest mile)

Your answer _____

Data is collected through the students: collecting the data or recording their responses on the back of their picture or completing the class questionnaire. (15-20 mins)

SESSION THREE

Analyze data (30-35 mins)

Depending on previous decisions will depend on what the next step is, but for the purpose of describing next steps it is assumed the data has been collected using a tool and is downloadable into a .csv file.

In preparation for the session where the data is analyzed, the class data has been downloaded into a .csv file and has been imported into an online statistical analysis tool. The examples given in this

lesson plan are based on using the Common Online Data Analysis Platform (CODAP www.codap.concord.org) and assumes the students are familiar with using the tool to make graphs.

Students explore the data through making data displays and connecting different variables together to see what story is in the data they collected with the aim of answering their specific statistical investigative questions. In the process of sorting their data they may decide to recategorize the data, for example, grouping responses into larger categories if this helps to tell the story better (see Figure 6 in the attached example of student work for an example of this). Another way of recategorizing data is to rename the value of the variable, for example, the students decided to compare local favorite outdoor spaces with not local favorite outdoor spaces. In this example the students decided to collect the distance to the outdoor space and then to recategorize the distance into local or not local once they had collected the data (see Figure 8 in the student example).

Once they have made their displays, they should describe what they see. Using the starter “I notice…” is a good way to start to describe data displays. Another good starter is to jointly develop a set of analysis questions that can be asked of displays. Analysis questions tend to be specific to the type of display. The “I notice” statements are often the answer to an analysis question. For example, analysis questions could include:

- For categorical data
 - What is the most common response?
 - What is the least common response?
 - What surprised me about the responses?
 - How many people like category X?
- For quantitative data
 - What is the shape of the distribution?
 - What is the median?
 - What is the highest value, the lowest value?
- When comparing across groups?
 - Is one group shifted to the right/left more than the other group?
 - How do the shapes of the distributions compare?

Analysis questions provide prompts for what we should attend to when describing our displays. These can be developed in conjunction with students and should attend to key features and characteristics of displays (Arnold & Pfannkuch, 2014).

Check descriptions to ensure that students have included the variable, the group, any values, and units. Descriptions can be written in a text box in CODAP, or students can copy or export the graphs from CODAP into an electronic document then type their descriptions.

Students should be encouraged to notice and wonder as they start to analyze their data to support answering their statistical investigative question(s). Often in describing (noticing) they have wonderings and software such as CODAP allows them to quickly explore these wonderings. It is important to model this process with students and for students to capture their data story.

CODAP has a plug-in called story builder that can be used to do this. For more on using story builder see: <https://concord.org/blog/building-data-stories-with-codap/> . To add story builder to a CODAP session, import the following URL https://codap.concord.org/~bfinzer/story_builder_v7/ .

Interpret results (20-25 mins)

As the students work through the analysis, they will find information that supports answering their statistical investigative question(s) and information that does not. They will also make some surprising finds which may or may not be related to their statistical investigative question(s). All of this can be captured in the analyze data phase, but the final interpret results phase is where the statistical investigative question(s) is answered.

Encourage students to pull of the key information from their analysis and to draft a report to share with the class (family and friends) about what they have found. The report could be a slide presentation, and teachers may choose to put a limit on the number of slides per statistical investigative question so that there is a selection process rather than students giving all their analysis. Making key selections from their analysis to answer the statistical investigative question is a skill to learn.

An outcome in the interpret results is that students might also wonder about how the results might look different in another circumstance, for example, they might wonder if the number of days that the favorite outdoor space was used in the last seven days would be different if the seven days were in the holidays, or how this might compare from summer to winter. Often these wonderings can spark a new statistical problem-solving cycle.

A detailed example of analyze data and interpret results is in the attached materials.

Attached Materials

- Student example with a focus on analyze data and interpret results

Reflections and Additional Recommendations (optional)

- See associated STEW lessons that also have using photographs as data as the starting point, but with different approaches to the investigation
 - *Using technology to create data elements*
 - *Using CODAP to tell different stories*
- Some of the students downloaded a picture of their favorite space as they either could not travel to the space in the time allocated or they were not able to get a picture for other reasons.
- We discussed whether people should be in the pictures and agreed that ideally not, the investigation is about the outdoor space and not people.

Examples of other activities that use photographs as data include:

- Dollar Street <https://www.gapminder.org/dollar-street> “People in other cultures are often portrayed as scary or exotic. This has to change. We want to show how people really live. It seemed natural to use photos as data so people can see for themselves what life looks like on different income levels. Dollar Street lets you visit many, many homes all over the world. Without travelling.” (Dollar Street, n.d.).
- GAISE II (Bargagliotti et. al., 2020) <https://www.amstat.org/asa/education/Guidelines-for-Assessment-and-Instruction-in-Statistics-Education-Reports.aspx>
 - Level A, Example 3: *What do Ladybugs Look Like* uses photo cards as the data source (pp.31-34)
 - Level B, Example 8: *Dollar Street – Pictures as data* gives an example of how to use the Dollar Street resource (pp.62-67)
- How to use CODAP
 - Getting started with CODAP activity <https://codap.concord.org/app/static/dg/en/cert/index.html#file=examples:Getting%20started%20with%20CODAP>
 - CODAP help menu <https://codap.concord.org/help/>
 - Pip’s CODAP help videos she has made <http://karekareeducation.co.nz/category/codap/>
 - Awash in Data – Tim Erickson, Getting started with CODAP chapter <https://codap.xyz/awash/getting-started-chapter.html>
 - ESTEEM project introduction <https://www.youtube.com/watch?v=aD5tLWld98w>

References

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Arnold, P., & Franklin, C. (2021). What Makes a Good Statistical Question?. *Journal of Statistics and Data Science Education*, 1-11. <https://www.tandfonline.com/doi/full/10.1080/26939169.2021.1877582>

Arnold, P., & Pfannkuch, M. (2014). Describing distributions. *Sustainability in statistics education. Flagstaff, AZ: International Statistical Institute*. Retrieved from

Statistics Teacher/Statistics Education Web: Online Journal of K-12 Statistics Lesson Plans <https://www.statisticteacher.org/> or <http://www.amstat.org/education/stew/>

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Contact Author for permission to use materials from this lesson in a publication

http://icots.info/icots/9/proceedings/pdfs/ICOTS9_8G1_ARNOLD.pdf

Bargagliotti, A., Franklin, C., Arnold, P., Gould, R., Johnson, S., Perez, L., & Spangler, D. (2020). *Pre-K-12 Guidelines for Assessment and Instruction in Statistics Education (GAISE) report II*. American Statistical Association and National Council of Teachers of Mathematics.

<https://www.amstat.org/asa/education/Guidelines-for-Assessment-and-Instruction-in-Statistics-Education-Reports.aspx>

CODAP – Common Online Data Analysis Platform <https://codap.concord.org/>

Dollar Street. (n.d.). *About*. Retrieved March 30, 2021 from <https://www.gapminder.org/dollar-street/about>

Finzer, W. (2021). *Building data stories with CODAP*. Blog post retrieved from <https://concord.org/blog/building-data-stories-with-codap/>

Story builder – CODAP https://codap.concord.org/~bfinzer/story_builder_v7/

Attached material – example student response

Pose statistical investigative questions

1. How often do the students in our class visit their favorite outdoor space?
2. Do students in our class whose favorite outdoor space is local tend to go to their favorite outdoor space more often than students in our class whose favorite outdoor space is not local?

Collect data

- How many of the last seven days did you go to and use your favorite outdoor space?
- Thinking about when you visit your favorite space, how long do you usually stay? (If it is less than a day – give the time to the nearest quarter of an hour, if it is more than a day – give the time to the nearest quarter of a day)
- How far in miles is your favorite outdoor space from your house? (Give your answer to the nearest mile)

Analyze data

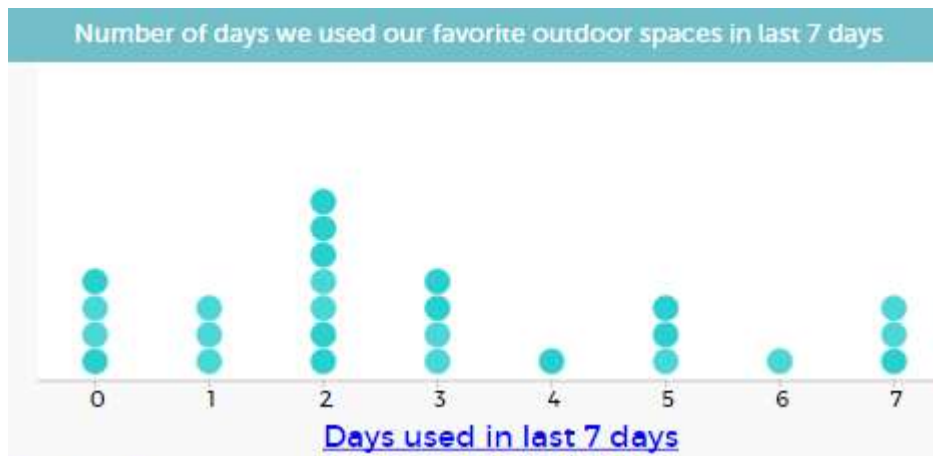
Exploring two of statistical investigative questions generated earlier in the examples.

1. How often do the students in our class visit their favorite outdoor space?

The students initially make two graphs, one showing how many days in the last seven days they visited their favorite outdoor space (Figure 4) and one showing how long they spend at their favorite outdoor space when they go there (Figure 5).

Figure 4

Graph showing the number of days the students in our class used their favorite outdoor space in the last seven days



I notice...

- The most common number of days students in our class visited their favorite outdoor space in the last seven days was two with seven students in the class selecting this.
- Three students visited their favorite outdoor space every day.
- Four students did not visit their favorite outdoor space at all in the last seven days.

Figure 5
Graph showing how long we usually spend at our favorite outdoor spaces



I notice...

- That the most common amount of time spent at our favorite outdoor space is 1.5 hours.
- That the median time spent at our favorite outdoor space is 2 hours.
- That one person usually spends 10 days at their favorite outdoor space when they go there.

Students decide to recategorize the responses for time spent to reduce the number of categories. They recategorize into four categories: (1) less than two hours; (2) two to four hours; (3) more than four hours, but less than eight hours; and (4) more than eight hours and then plot the data (Figure 6).

Figure 6
Updated graph showing how long we usually spend at our favorite outdoor spaces with a reduced number of categories



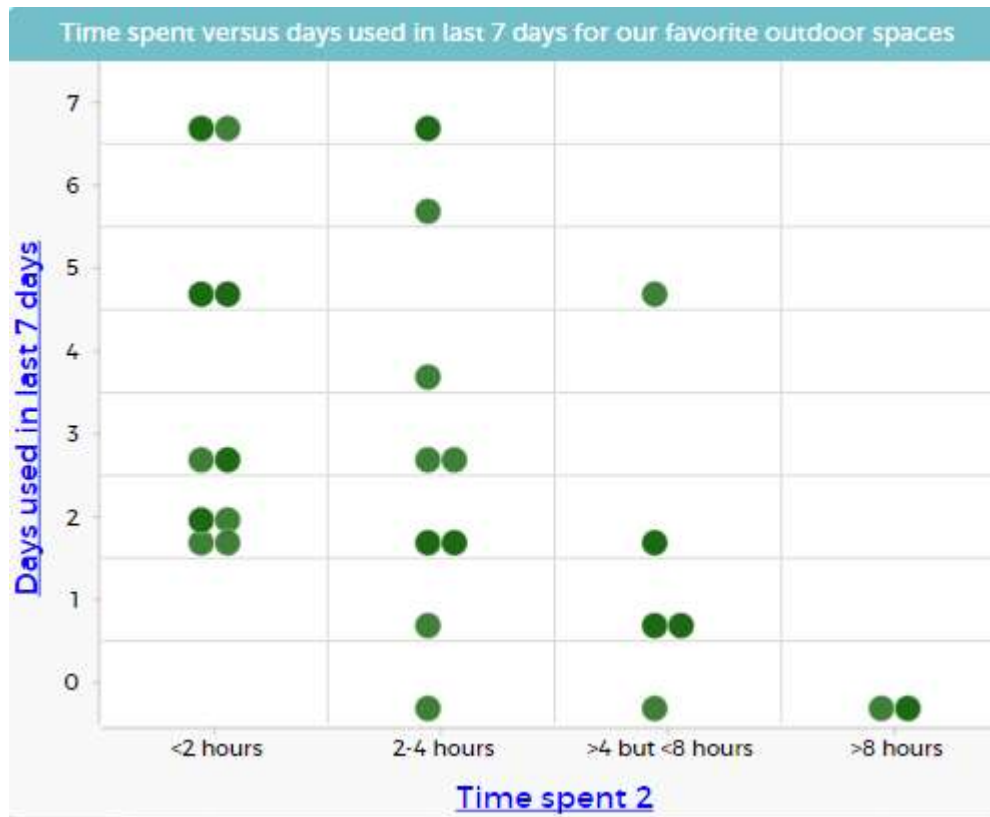
I notice...

- Most students in our class spend less than four hours at their favorite outdoor space.
- The most common amount of time is less than two hours spent at our favorite outdoor space.

Students decide to see what happens when they combine the two variables on the same graph (Figure 7).

Figure 7

Graph showing time spent at favorite outdoor space sorted by the number of times our class has visited the space in the last seven days



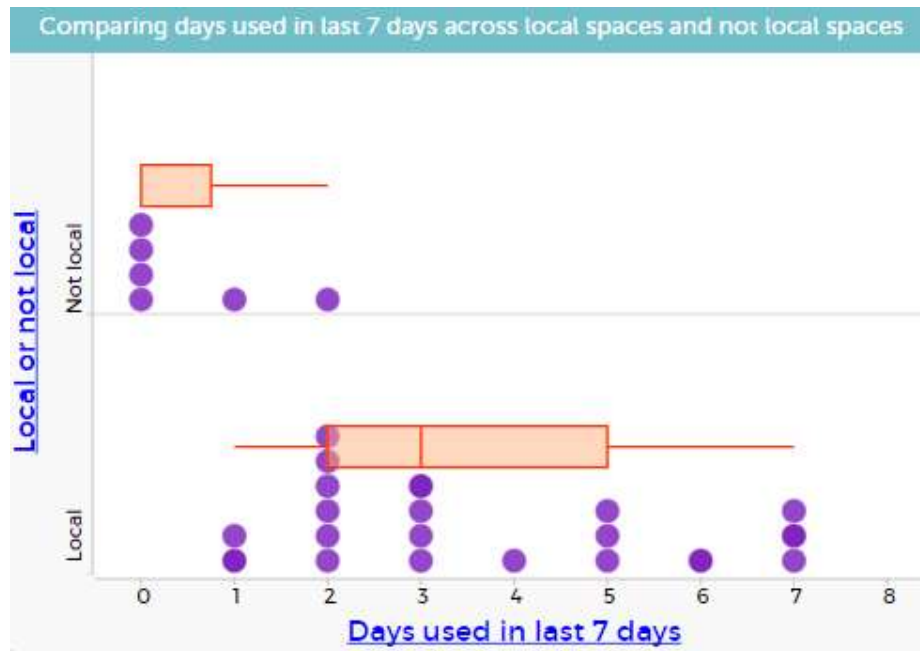
I notice...

- The students in our class who spent the most time usually at their favorite outdoor space did not go there in the last seven days.
2. Do students in our class whose favorite outdoor space is local tend to go to their favorite outdoor space more often than students in our class whose favorite outdoor space is not local?

Students recategorize the data from *how far is it to your favorite outdoor space* as local or not local. They make a graph of the number of times the favorite outdoor space was used in the last seven days and then compare across whether the favorite outdoor spaces were local or not local (Figure 8).

Figure 8

Graph showing how often students in our class used their favorite outdoor space in the last seven days split by whether the space is local (20 miles or less from home) or not local (more than 20 miles from home)



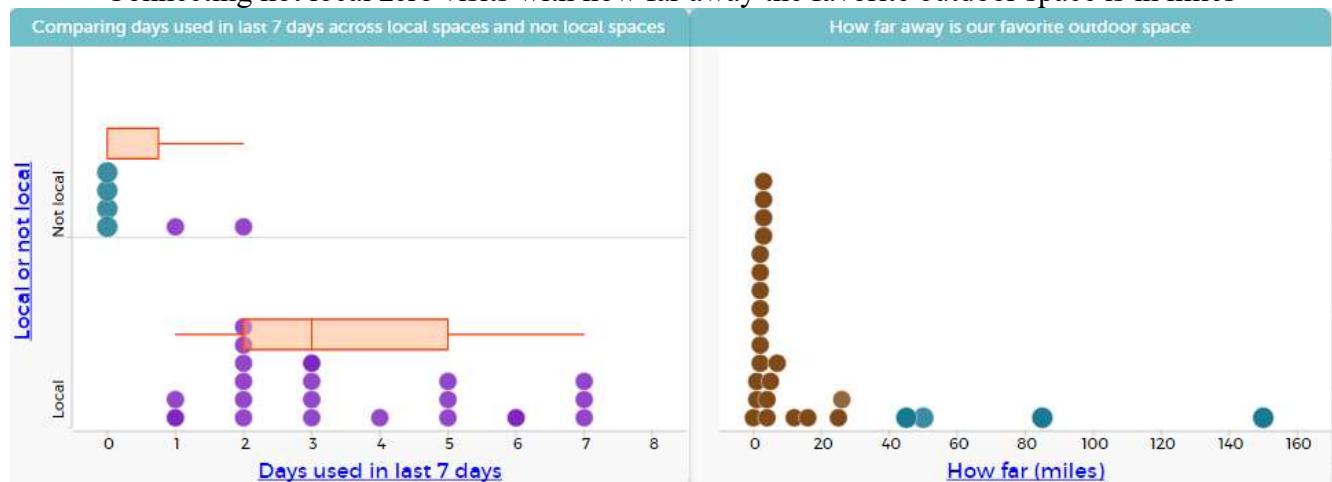
I notice...

- Local favorite outdoor spaces are more likely to have been visited in the last seven days.
- Local favorite outdoor spaces have a higher frequency of use in the last seven days.
- Four of the not local outdoor spaces were not visited in the last seven days.
- The median days used for local favorite outdoor spaces is three days, whereas the median days used for not local favorite outdoor spaces is zero days.

We wonder how far away these outdoor spaces with no visits are, so we will make graphs and highlight these data points to see how far they are (Figure 9).

Figure 9

Connecting not local zero visits with how far away the favorite outdoor space is in miles



I notice...

- That the four not local spaces that had zero visits in the last seven days were all more than 40 miles away.

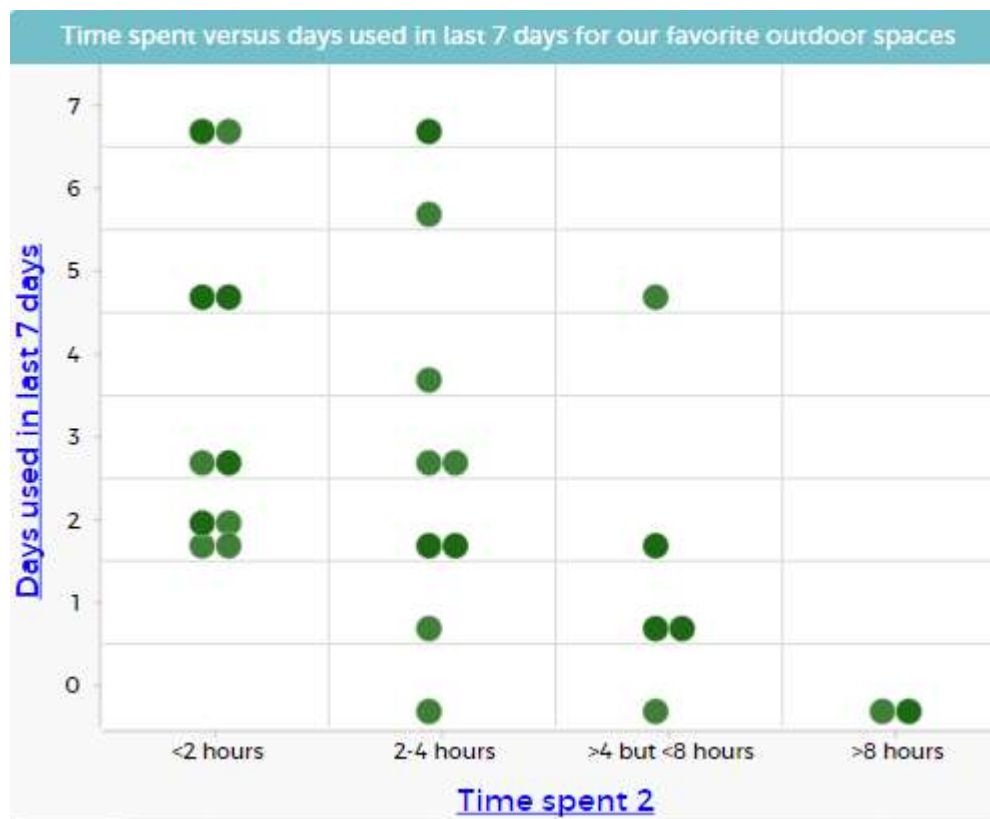
Interpret results

How often do the students in our class visit their favorite outdoor space?

The most common number of days that our class used their favorite outdoor space in the last seven days is two. All but four of the students in the class visited their favorite outdoor space at least once in the last seven days. Three students visited their favorite outdoor space every day.

Figure 10

Display chosen to use in the interpret results phase for the first statistical investigative question



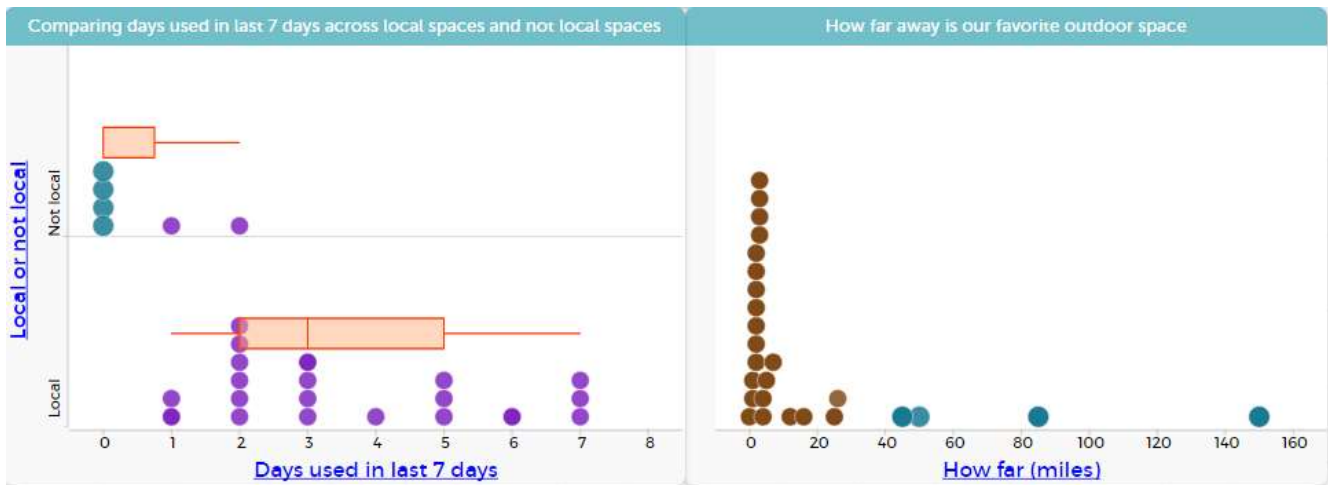
When students in our class visit their favorite outdoor space, they are most likely to spend between one and four hours there. The most common amount of time spent at their favorite outdoor space was 1.5 hours.

Do students in our class whose favorite outdoor space is local tend to go to their favorite outdoor space more often than students in our class whose favorite outdoor space is not local?

Students tend to visit local favorite outdoor spaces more frequently than students whose favorite outdoor space is not local.

Figure 11

Display chosen to use in the interpret results phase for the second statistical investigative question



The first graph above shows both the number of days the favorite outdoor space was used in the last seven days compared across whether the space was local or not local. The second graph shows how far away the favorite outdoor space is in miles.

From the graphs you can see that generally the local favorite outdoor spaces were more frequently used in the last seven days (median is 3 times for local, 0 times for not local and $\frac{3}{4}$ of the local days used are greater than all but one of the not local days used).

It is interesting to note that all the zero days used, the favorite outdoor spaces are more than 40 miles away suggesting that when your favorite outdoor space is more than 40 miles away you are less likely to visit it, compared with spaces that are closer to home.

We wonder if we were doing the survey at another time of the year if the results would be different, or if the seven days we looked at were in the holidays.