

TEACHER INFORMATION

Leading Students to Develop Their Own Questions and Perform Investigations

Within the unit, students are asked to come up with a testable question (a question that can be answered scientifically) and set up an investigation. The following are steps and examples for guiding student-led experimentation.

1. Gain knowledge

Through the use of the Schoolyard Review, students gain knowledge about their schoolyard. The Schoolyard Review is designed to help students observe where water flows at their school, recognize and identify the influence of land pollution, wasted water, and the presence of harmful substances.

Students continue to gain information by reading Information Sheet A about water quality issues in California, and relating their observations to what they read, thus driving students to investigate the issues further.

2. Develop a testable question

Students use what they observed and what they have learned to formulate testable questions relating to water quality. After completing the Schoolyard Review, ask students how what they observed may impact local water quality. Use these answers to help develop testable questions.

The testable question can be written in the form of “How does ____ affect ____?” The blanks represent the independent variable (first blank) and dependent variable (second blank).

Variables are the factors in an investigation that could affect results. They are the things that could vary from one sample to the next. Work with students to choose an “independent” variable – the one variable that changes. The “dependent” variable changes as a result of, or in response to, the change in the independent variable.

Some sample testable questions:

- How does the number of students using the trashcan at lunch affect the amount of trash in the street outside the school?
- How does the number of waste water sources at the school affect the amount of water that flows into the street from our school?
- How does the number of students dropping their trash on the ground affect the amount of trash that goes into the street next to the school?
- How does the location of where “hosing” is happening affect the amount of water and topsoil going into the street?
- How does the amount of lawn watering affect the amount of water and topsoil going into the street?
- How does the amount of trash found on the ground affect the amount found in the street outside the school?

3. Make a hypothesis

Discuss with the students what they can investigate to find the answer to their questions. Use what they learned from Information Sheet A to help formulate ideas for investigations.

After listing ideas, have students write an if-then statement of what they think may happen in the investigation based on what they have observed and learned so far.

Sample hypotheses:

- If a greater number of students use the trashcan at lunch, then there will be a decrease in the amount of trash that ends up in the street outside the school.
- If three out of the five sources of water at the school (faucets, hoses, sprinklers, downspouts, and drinking fountains) are found to waste water, then they will contribute to the amount of water that flows into the street from our school.

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- If more students drop their trash on the ground, then there will be more trash that goes into the street next to the school.
- If the grounds manager hoses next to grass or permeable areas, less water will go into the street than if he/she hoses next to large concrete areas.
- If the grounds manager keeps the sprinklers or hoses on for a long period of time, then more water will go into the street.
- If there is more trash found on the ground on a given day, then there will be more trash found in the street outside the school on that day.

4. Design an investigation

How will your students test whether their predictions are right? Facilitate a group discussion that leads students to figure out what they can measure that will lead to an answer to their question. It should involve gathering data over time.

Example questions and measuring tools:

- I predict that on days when less students drop their trash on the ground, there will be less trash that goes into the street next to the school.

Audit the number of students that use the trashcan at lunch and later audit the amount of trash found in the street closest to the lunch area.

- I predict that three out of the five sources of water at the school (faucets, hoses, sprinklers, downspouts, and drinking fountains) will contribute to the amount of water that flows into the street from our school.

Audit the different sources of water for leakage and water flow.

- I predict that on days when more students drop their trash on the ground, there will be more trash that goes into the street next to the school.

Audit the number of students using the trashcan and later the amount of trash in the street closest to the lunch area.

- I predict that when the grounds manager hoses next to grass or permeable areas, less water will go into the street than when he/she hoses next to large concrete areas.

Audit the location and direction of water flow when the grounds manager is using the hose.

- I predict that the longer the grounds manager runs the sprinklers or hoses, the more water will go into the street.

Audit the time and amount of water going into the street when the grounds manager is using the hose and sprinklers.

- I predict that on the days that more trash is found on the ground, the more trash will be found in the street outside the school.

Audit the amount of trash on the ground at school and later in the street outside the school.

5. Design procedures

Have students develop and follow a specific method/protocol that helps assure reliability and validity of their results. Help them consider, if necessary, how to:

- Do a procedure the same way every time
- Consider the independent variable in planning data collection
- Use tools and supplies that are available
- Be accurate

6. Design a recording system

Help students design the most appropriate way to record the data they are gathering. They should use this method consistently to ensure they are accurate. This will help in analyzing the data more effectively. Recording systems include:

- Date and time of observation
- Space for written observations
- Space for illustrations and drawings
- Columns for separating information
- Using tally marks for counting
- A place for questions or thoughts to be followed up in the future

7. Data analysis and conclusion

Students describe their results in the clearest way possible. In Part 5, students use the Our Conclusion worksheet to restate their question, prediction, and write a summary of the data they collected. The summary should be a statement that is supported by evidence and identifies the pattern or trend of the data collected during the investigation.

Students are also asked to graphically display their data to show whether the data supports their prediction or not. Show students a variety of graphs, tables, and charts to determine which would be the best one to use. Explain that the graph, table, or chart is a picture of the information they gathered. Graphs, tables, and charts make it easier to make comparisons and draw conclusions. Ask students to name some places where they have seen graphs – in newspapers, magazines, TV news, etc. Show samples of the

basic types of graphs, tables, and charts:

- Pictograph
- Bar graph
- Charts and tables
- Circle graph
- Line graph

If students are measuring the sources of the land pollution found, they could use a bar graph. The bottom of the graph would show the sources and the side would have amounts. The bars would indicate the amounts of trash found for each source. The highest bar would indicate the source of the most land pollution found.

Finally, the Our Conclusion worksheet asks students to explain what they learned about water quality at their school and how their data does or doesn't support their prediction. This is an ideal time to discuss why they made the prediction that they did, or how they may conduct their investigations differently, if given the chance to "do it again."

8. Communicate results

In Part 7, students are asked to reflect on what they have learned and write a news article about water quality issues. Students use this method to communicate their results connecting their investigations to the schoolyard or community. It includes their thoughts about what they have learned about water quality, and any concerns they may or may not have.

These articles will be used as a way to formulate ideas for their service learning project.