Science Grade 05 Unit 12 Exemplar Lesson 02: Experimental Design - Report

This lesson is one approach to teaching the State Standards associated with this unit. Districts are encouraged to customize this lesson by supplementing with district-approved resources, materials, and activities to best meet the needs of learners. The duration for this lesson is only a recommendation, and districts may modify the time frame to meet students’ needs. To better understand how your district may be implementing CSCOPE lessons, please contact your child’s teacher. (For your convenience, please find linked the TEA Commissioner’s List of State Board of Education Approved Instructional Resources and Midcycle State Adopted Instructional Materials.)

Lesson Synopsis

Students will learn the importance of scientific investigations and how those investigations are driven by critical thinking through scientific inquiry. Students will plan, implement, and describe a simple experimental investigation based on a Grade 5 science topic or issue. Students will build on the experiences in experimental design they learned during Lesson 01 to design and implement a testable question. Students will then create a laboratory report that is a foundational experience for science inquiry skills used in later grades.

TEKS

The Texas Essential Knowledge and Skills (TEKS) listed below are the standards adopted by the State Board of Education, which are required by Texas law. Any standard that has a strike-through (e.g. sample phrase) indicates that portion of the standard is taught in a previous or subsequent unit. The TEKS are available on the Texas Education Agency website at http://www.tea.state.tx.us/index2.aspx?id=6148.

TEKS alignment coming soon.

Scientific Process TEKS

5.1 Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

5.1A Demonstrate safe practices and the use of safety equipment as described in the Texas Safety Standards during classroom and outdoor investigations.

5.2 Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:

5.2A Describe, plan, and implement simple experimental investigations testing one variable.

5.2B Ask well-defined questions, formulate testable hypotheses, and select and use appropriate equipment and technology.

5.2C Collect information by detailed observations and accurate measuring.

5.2D Analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence.

5.2E Demonstrate that repeated investigations may increase the reliability of results.

5.2F Communicate valid conclusions in both written and verbal forms.

5.2G Construct appropriate simple graphs, tables, maps, and charts using technology, including computers, to organize, examine, and evaluate information.

5.3 Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

5.3A In all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student.

5.3D Connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

5.4 Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

5.4A Collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, prisms, microscopes, pan balances, triple beam balances, spring scales, graduated cylinders, beakers, hot plates, meters, etchek, magnets, collecting nets, and notebooks timing devices, including clocks and stopwatches. Materials to support observations of habitats or organisms such as terrariums and aquariums.
Key Understandings

- Scientific investigations are driven by critical thinking through scientific inquiry.
  - How are scientific experiments designed?
  - Why are the constant variables so important?

Vocabulary of Instruction

- hypothesis
- variable
- control
- constant
- research
- procedure
- observations
- results
- data
- graph
- questions

Materials

- access to Internet resources or print material (to assist in gaining background information on topic, per class)
- calculator (1 per student)
- camera (to document student work, 1 per teacher)
- materials will depend on the student investigations

Attachments

All attachments associated with this lesson are referenced in the body of the lesson. Due to considerations for grading or student assessment, attachments that are connected with Performance Indicators or serve as answer keys are available in the district site and are not accessible on the public website.

Teacher Resource: PowerPoint: The Importance of Science and Research
Handout: Steps To Use In Experimental Design (1 per student)
Handout: Thinking Map (1 per student)
Teacher Resource: Possible Research Topics (1 for projection)
Handout: Experimental Design Approval (1 per student)
Handout: Laboratory Report Guide 2 (1 per student)
Handout: Experimental Design Rubric 2 (1 per student)

Resources

- Suggested Books:

Advance Preparation

1. Have materials from standard classroom supply list available.
2. Prepare attachment(s) as necessary.

Background Information

During this lesson, students will describe, plan, and implement simple experimental investigations testing one variable. After this unit, in Grade 6, students will progress to planning and implementing experimental, comparative, and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology.

For further information on scientific inquiry, please visit the following websites:

- [http://www.exploratorium.edu/ifi/resources/classroom.html](http://www.exploratorium.edu/ifi/resources/classroom.html)
### Instructional Procedures

**ENGAGE – Introducing Scientific Procedures and Research**

1. **Say/Ask:**
   - In our last science class, you used a gallery walk to review the work of each group.
   - As you analyze the posters, what was information that was common to all of them? It should be evident that each poster had information such as a title, the problem, a hypothesis, a material list, a procedure, the variables, the results, an interpretation of the results, and some form of conclusion or application of the results.
   - When these steps are assembled together, it is referred to as steps in a scientific method.
   - Some questions you should be thinking about as you progress through this lesson include:
     - How are scientific experiments designed?
     - Why is it important to follow a process that includes systematic observation, measurement, and testing?
     - Do the steps of a scientific process have to be done in a particular order?

2. Instruct students to write the three questions in their science notebook.

3. Project the PowerPoint: *The Importance of Science and Research*.

4. Facilitate a discussion about why following a procedure or process is important. (This could include procedures of all kinds, not just in reference to scientific investigations.)

5. Distribute the Handout: *Steps To Use In Experimental Design*.

6. Review the process, or flow, shown on the handout. Point out that the process is not linear, but sometimes, cycles back to a previous part. Answer any questions students may have about the steps. Explain that this handout will be an important reference as they conduct their new experimental design during this lesson. Students should affix this handout in their science notebooks.

7. **Say:**
   - Over the next few days, you will be participating in a new experimental design.
   - In the last lesson, you each worked on a team investigating the same problem - building a better solar cooker.
   - Now, you will get to choose a topic that is of interest to you.

8. Distribute the Handout: *Thinking Map*. Instruct students to think about science topics that are of interest to them. (It should be something somewhat related to content they have learned this year.)

9. Instruct students to write three science topics in which they are interested in creating an experimental design. These three topics should be written (in pencil) in the three ovals at the top of the Handout: *Thinking Map*.

10. **Say:**
    - In the rectangles directly under each of the topics, write a detail about the topic that is a more specific part of the topic you could research.
    - For example, one of my topics might be “plant adaptations”.
    - Two specific parts of this topic could be “vines that climb” and “surviving freezing weather.”
    - In the long rectangles near the bottom of the page, write specific details that could be turned into a testable question or problem.

11. Allow time for students to brainstorm ideas and complete the handout. If students are having difficulty choosing topics, project the Teacher Resource: *Possible Research Topics*. The topics include the content students have studied this year.

12. Instruct students to write down the topic they would like to research on a piece of paper. They also need to include their name. This paper should be turned in so the teacher can:
    - Verify that students have chosen an acceptable topic.
    - Determine that there are a variety of topics chosen.
    - Decide if some students who have the same topic would like to work in groups.
EXPLORE – Conducting Research

1. Inform students if you have approved their topic. Provide the opportunity for students to work in groups who would prefer that option.
2. Distribute the Handout: Experimental Design Approval. Remind students that each one is responsible for completing this handout, even if they are working in a group.
3. Allow students some time to research their topic and find enough information to develop a problem and hypothesis.
4. Instruct students to write down all of the information from their research into their science notebook. This should include information on the topic and what the results of an experiment might teach us.
5. Prior to the conclusion of class on day three, facilitate a discussion on what the students discovered during their research.
6. Correct any misunderstandings, and answer questions that might arise from the discussion.
7. Allow students to interact and share any ideas about possible experiments that may be developed from the topics that were researched.

EXPLAIN – Working on the Experimental Design

1. Inform students that they will be given the opportunity to test some of the information that they found in their research as they develop a simple experimental investigation.
2. Review and explain the process of experimental design. (Use the Handout: Experimental Design Approval as a guide.)
3. Remind students that the investigation they are designing needs to have one variable, constants, and a control set-up.
4. Review the need to follow safety guidelines when conducting an experiment. Safety notes should be included in the procedure of the experiment.
5. Inform students that the materials they need for the experiment (other than general classroom supplies) will be their responsibility to gather. (If it includes science tools that are readily available in the classroom, students should have access to these.)
6. Students should have the opportunity to plan their investigation, completing the Handout: Experimental Design Approval through the section “Conduct the Experiment”. In this section, they should only have drawn what the set-up for their investigation will look like.
7. At the conclusion of Day 6, Ask:
   - How are scientific experiments designed? Experiments are designed to answer a question or solve a problem.
   - Why are the constant variables so important? If the constants remain the same for all trials of the experiment, then this is one way we know that the change we are observing is the result of the independent variable.

ELABORATE – Conducting the Investigation

1. Students will be using the next two days to conduct their investigations. They should make careful observations and collect data in their science notebooks. Drawings, with labels, are important.
2. Say:
   - As you conduct your investigations remember to decide what a graph of the results will look like.
   - Your results should include a statement about whether the data does or does not support your hypothesis. Remember that in experimental design, we do not “prove” a hypothesis to be right or wrong.
   - In the Experiment Discussion, you should discuss your experimental design. In this section, you should include ideas for improving your experimental design and if there were any flaws in the set-up. This is your opportunity to share how you felt about the process.
   - In the Conclusion, you should write about why your experiment was important. Who could benefit from your results? Where could this information be applied?

Materials:
- access to Internet resources or print material (to assist in gaining background information on topic, per class)
- Handout: Experimental Design Approval (1 per student)
- Handout: Experimental Design Approval (from previous activity)
- camera (to document student work, 1 per teacher)
- Handout: Experimental Design Approval (1 per student)
- Handout: Experimental Design Approval (from previous activity)
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- Handout: Experimental Design Approval (from previous activity)

Science Notebooks:
The Handout: Experimental Design Approval should be affixed in the students’ science notebook so it will be available as a reference.

Materials:
- materials will depend on the student investigations
- calculator (1 per student)
- Handout: Experimental Design Approval (from previous activity)

Instructional Notes:
The teacher will need to monitor student investigations to ensure they are staying on-task. If students are working in groups the teacher should ensure that all members are participating. As an extension, students could calculate the cost of their investigation, using the calculator when necessary.
3. Allow time for students to conduct their investigations. Remind students that repeated investigations give more reliable results, so if there is time to conduct the investigation more than once they should do so.

### STAAR Notes:
It is essential that students have a clear understanding of the application of the science process skills. These skills will not be listed under a separate reporting category on the STAAR assessment. Instead, they will be incorporated into at least 40% of the test questions in reporting categories 1–4 and will be identified along with content standards.

### EVALUATE – Performance Indicator

<table>
<thead>
<tr>
<th>Grade 05 Science Unit 12 PI 02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design and implement an experimental investigation that includes formulating a testable problem, developing a hypothesis, writing procedures, selecting and using equipment, collecting data, and communicating valid conclusions. Create a laboratory report that follows the design of the experiment.</td>
</tr>
</tbody>
</table>

**Standard(s):** 5.2A, 5.2B, 5.2C, 5.2D, 5.1A, 5.2E, 5.2F, 5.2G<br>**ELPS:** ELPS.c.3H, ELPS.c.4J, ELPS.c.5F

1. Instruct the students to complete a laboratory report based on the simple experimental investigation they just completed. Each student must do their own laboratory report.
2. Distribute the Handout: **Laboratory Report Guide 2** to help the students create their laboratory reports.
3. Walk the students through each step, explaining what is required for each section. Give the students time to complete each section before moving on to the next section.
4. Distribute the Handout: **Experimental Design Rubric 2** so that they will know how the laboratory report will be evaluated.
5. Share Performance Indicator rubric or expectations with students prior to students beginning the assessment.
6. Answer any questions students may have regarding the assessment.

### Suggested Days 9 and 10

### Attachments:
- Handout: **Laboratory Report Guide 2** (1 per student)
- Handout: **Experimental Design Rubric 2** (1 per student)

### Instructional Notes:
Students can create a data chart and graph in Microsoft Excel or another computer program to affix in their laboratory report.

Show students that the laboratory report is similar to the poster that they had to create for the first lesson. The only difference is that during the introduction section, the students will have to define the science terms. **Laboratory Report Guide 2** has the introduction section highlighted so that you may show the students the difference between the poster and the laboratory report.
Steps to Use in Experimental Design

1. Define or Identify the **Problem**
2. **Conduct Research**
3. **Form a Hypothesis**
4. **Make Observations**
5. **Test Hypothesis, Perform Experiment**
6. **Organize and Analyze Data**
7. **Does the Data Support the Hypothesis?**
   - **Yes**
   - **No**
8. **Faulty Experiment?**
9. **New Experiment**
10. **Draw Conclusions, Suggest Applications**
11. **Communicate Results**
Possible Research Topics

<table>
<thead>
<tr>
<th>Conservation of Natural Resources</th>
<th>Recycling</th>
<th>Promotional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection/Refraction</td>
<td>Electromagnetism</td>
<td>Magnetism</td>
</tr>
<tr>
<td>Weather</td>
<td>Sound</td>
<td>Mechanical Energy</td>
</tr>
<tr>
<td>Conductors/Insulators</td>
<td>Gravity</td>
<td>Pollution</td>
</tr>
<tr>
<td>Electrical Energy</td>
<td>Sound Energy</td>
<td>Thermal Energy</td>
</tr>
<tr>
<td>Water Cycle</td>
<td>Force and Motion</td>
<td>Density and/or Buoyancy</td>
</tr>
<tr>
<td>Electrical Circuits</td>
<td>Friction</td>
<td>Sedimentary Rocks</td>
</tr>
<tr>
<td>Change by Water, Wind, or Ice</td>
<td>Biofuels</td>
<td>Wind energy</td>
</tr>
<tr>
<td>Weather</td>
<td>Water Cycle</td>
<td>Ecosystems</td>
</tr>
<tr>
<td>Structure and Function</td>
<td>Inherited Traits</td>
<td>Learned Behaviors</td>
</tr>
</tbody>
</table>
# Experimental Design Approval

<table>
<thead>
<tr>
<th>Experimental Process for (Write the title of your experiment.)</th>
<th>Teacher Approval (For teacher only)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identify the Problem</strong></td>
<td>Approved:</td>
</tr>
<tr>
<td>What are you trying to solve?</td>
<td>Notes:</td>
</tr>
<tr>
<td><strong>Form a Hypothesis</strong></td>
<td>Approved:</td>
</tr>
<tr>
<td>This communicates what you think will happen during the experiment. It is written in an If…then… statement. Example: If (the independent variable) is (increased, decreased, changed), then (the dependent variable) will (increase, decrease, change).</td>
<td>Notes:</td>
</tr>
<tr>
<td>Your hypothesis:</td>
<td></td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td>Approved:</td>
</tr>
<tr>
<td><strong>Determine Variables</strong></td>
<td>Notes:</td>
</tr>
<tr>
<td>Variable:</td>
<td></td>
</tr>
<tr>
<td>(This is the variable that you purposely change or manipulate. It will be the cause of the changes that you measure.)</td>
<td></td>
</tr>
<tr>
<td><strong>Constants:</strong></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>These are the variables that remain the same for all the trials.</td>
</tr>
<tr>
<td>Procedures</td>
<td>Developed Procedures</td>
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<tr>
<td>---------------------</td>
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<tr>
<td></td>
<td>Are all steps included?</td>
</tr>
<tr>
<td></td>
<td>Have you included all safety precautions?</td>
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<td></td>
<td>Are all materials and equipment listed?</td>
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<tr>
<td></td>
<td>The procedure is written for one variable?</td>
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<td></td>
<td>You have included repeated trials?</td>
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<td></td>
<td>You have checked your writing for spelling and clarity?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials</th>
<th>List Materials</th>
</tr>
</thead>
</table>

Approved:

Notes:
<table>
<thead>
<tr>
<th>Conduct the Experiment</th>
</tr>
</thead>
</table>

*Draw your set up in the space provided. Include labels and any observations.*

| Approved: |
| Notes: |
**Collect Data and Observe Results**

*Your results should include a statement about whether or not your data supports or does not support your hypothesis. Remember that in experimental design we do not “prove” a hypothesis to be right or wrong.*

<table>
<thead>
<tr>
<th>Data:</th>
</tr>
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<tbody>
<tr>
<td></td>
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<table>
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<tr>
<th>Graph:</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Discussion</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Experimental Discussion</strong></td>
</tr>
<tr>
<td><em>Your group should discuss the results. In this section, you should include ideas for improving your design.</em></td>
</tr>
</tbody>
</table>

**Approved:**

**Notes:**
# Laboratory Report Guide 2

<table>
<thead>
<tr>
<th>Lab Report Headings</th>
<th>Student Suggestions for Laboratory Report</th>
<th>Completed</th>
</tr>
</thead>
</table>
| **Title**           | • Be creative with the title.  
• The title should be related to the topic and grab the audience’s interest. |           |
| **Problem**         | • The problem should be stated as a question.  
• Use appropriate punctuation.  
• Make sure that the problem is clear. |           |
| **Introduction**    | • Introduce the topic of the experiment.  
• Define science terms that will be used on the laboratory report.  
• Identify the variable and constants (the things that will stay the same).  
• State your hypothesis.  
• Make sure that the hypothesis is a complete sentence in “if…then…” format. |           |
| **Materials**       | • List all of the materials that you will need to conduct the experiment. This includes safety materials that will be needed.  
• List the materials in columns, and specify the sizes and amounts. |           |
| **Procedure**       | • Number the steps in the procedure. Remember to include any safety precautions.  
• Write in complete sentences.  
• Write short, direct, one-step procedures.  
• Specify the sizes and amounts of materials used. |           |
| **Result**          | • Add data tables.  
• Add graphs.  
• Make and add calculations. |           |
| **Discussion**      | • Interpret and analyze the data and graphs from results.  
• Use data to back-up your statements.  
• Support your findings with data and graphs from results.  
• How could your results lead to future investigations? |           |
| **Conclusion**      | • State whether or not the data supported your hypothesis.  
• Keep it short – between two and three sentences.  
• Refer back to the problem. |           |
## Experimental Design Rubric 2

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
<td>Independently identified a question which was interesting to the student and could be tested or investigated</td>
<td>Identified, with adult help, a question which was interesting to the student and could be tested or investigated</td>
<td>Identified, with adult help, a question which could be tested or investigated</td>
<td>Identified a question that could not be tested or investigated, or suggested one that did not merit investigation</td>
</tr>
<tr>
<td><strong>Hypothesis Development</strong></td>
<td>Independently developed a hypothesis well-substantiated by a literature review and observation of similar phenomena</td>
<td>Independently developed a hypothesis substantiated by a literature review and observation of similar phenomena</td>
<td>Independently developed a hypothesis somewhat substantiated by a literature review or observation of similar phenomena</td>
<td>Needed adult assistance to develop a hypothesis or to do a basic literature review</td>
</tr>
<tr>
<td><strong>Variables</strong></td>
<td>Variable identified and the change expected is defined</td>
<td>Variable identified but the change expected is not clearly defined</td>
<td>With adult help, the variable is identified and the change expected is defined.</td>
<td>Adult help needed to identify and define the variable and the constants</td>
</tr>
<tr>
<td></td>
<td>All of the constants are listed.</td>
<td>Some of the constants are listed.</td>
<td>Most of the constants are listed.</td>
<td></td>
</tr>
<tr>
<td><strong>Description of Procedure</strong></td>
<td>Procedures were outlined in a step-by-step fashion that could be followed by anyone without additional explanations. No adult help was needed to accomplish this.</td>
<td>Procedures were outlined in a step-by-step fashion that could be followed by anyone without additional explanations. Some adult help was needed to accomplish this.</td>
<td>Procedures were outlined in a step-by-step fashion, but had one or two gaps that require explanation even after adult feedback had been given.</td>
<td>Procedures that were outlined were seriously incomplete or not sequential, even after adult feedback had been given.</td>
</tr>
</tbody>
</table>