GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

FOUNDATION SKILLS

PATHWAY: All Pathways

COURSE: All CTAE Courses

UNIT 4.4: Scientific Method

# INTRODUCTION

**Annotation:** Briefly describe the unit topics, tasks, methods, etc.

In this unit students will emphasize the use of the scientific method in experimentation.

**Grade(s):**

| | |
|---|---|
| X | 9th |
| X | 10th |
| X | 11th |
| X | 12th |

**Time:** One 50 minute period.

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**Additional Author(s):**

**Students with Disabilities:**

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation.

# FOCUS STANDARDS

**GPS Focus Standards:** Please list the standard and elements covered.

CTAE-FS-4 Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools

**GPS Academic Standards:**

**National / Local Standards / Industry / ISTE:**

ESS01.04: Demonstrate science knowledge and skills required to pursue the full range of post-secondary and career education opportunities.

ESS03 Problem-Solving and Critical Thinking: Solve problems using critical thinking skills (analyze, synthesize, and evaluate) independently and in teams. Solve problems using creativity and innovation.

# UNDERSTANDINGS & GOALS

**Enduring Understandings:** Enduring understandings are statements summarizing important ideas and have lasting value beyond the classroom. They synthesize what students should understand – not just know.

Students will understand that it is important for scientists to follow a standard procedure to be objective about scientific research.

**Essential Questions:** Essential questions probe for deeper meaning and understanding while fostering the development of critical thinking and problem-solving skills. Example: Why is life-long learning important in the modern workplace?

- Why is it important to follow the Scientific Method?
- When what are the differences between qualitative and quantitative results?
- Why is it important to organize and keep detailed records of procedures in experimentation?

**Knowledge from this Unit:** Factual information.

Students will explain the steps of the scientific method.

**Skills from this Unit:** Performance.

Students will use the scientific method in a laboratory setting.

# ASSESSMENT(S)

**Assessment Method Type:** Select one or more of the following. Please consider the type(s) of differentiated instruction you will be using in the classroom.

- ____ Pre-test
- ____ Objective assessment - multiple-choice, true- false, etc.
  - __ Quizzes/Tests
  - __ Unit test
- ____ Group project
- ____ Individual project
- _X_ Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
  - __ Self-check rubrics
  - __ Self-check during writing/planning process
  - __ Journal reflections on concepts, personal experiences and impact on one's life
  - __ Reflect on evaluations of work from teachers, business partners, and competition judges
  - __ Academic prompts
  - __ Practice quizzes/tests
- ____ Subjective assessment/Informal observations
  - __ Essay tests
  - __ Observe students working with partners
  - __ Observe students role playing
- ____ Peer-assessment
  - __ Peer editing & commentary of products/projects/presentations using rubrics
  - __ Peer editing and/or critiquing
- _X_ Dialogue and Discussion
  - __ Student/teacher conferences
  - _X_ Partner and small group discussions
  - __ Whole group discussions
  - __ Interaction with/feedback from community members/speakers and business partners
- ____ Constructed Responses
  - __ Chart good reading/writing/listening/speaking habits
  - __ Application of skills to real-life situations/scenarios
- ____ Post-test

**Assessment(s) Title:** Penny Experiment

**Assessment(s) Description/Directions:**

1. Distribute copies of the Scientific Method Worksheet to students.

2. Each student should be given one medicine dropper, penny, paper towels, plastic spoon and a cup of water. Have students place their penny on piece of paper towel. Tell the students to count how many drops of water can fit on the penny without spilling onto the paper towel. This is the observation phase of the Scientific Method. Have students write their results under the Observation section of their paper.

3. Ask students they think more drops or less drops will fit on the penny if they add soap to the water. Have students write this question *and* their response in the section for the Hypothesis. Help students to understand that a hypothesis is made up of two parts: the question asked and the possible outcome they believe will happen.

4. Have students add one spoonful of soap to the water and stir gently for one minute. Then, have students place their dried penny on a new dry sheet of paper towel. They will again use the dropper to put one drop at a time on their penny, counting how many drops they can fit onto the penny before the water spills onto the paper towel. Students must record each one of their steps in using the soap and water mixture. Have students also record the amount of water drops they were able to fit on the penny when soap was mixed with water. These steps are considered experimental procedure, and should be recorded under the Experiment section of their paper.

5. Students should be sure to use *quantitative* results, not *qualitative.* Explain to students that all experiments should be able to be repeated by someone else. A Qualitative result is similar to saying "a few drops fit" as opposed to "14 drops fit", which is a quantitative result. Quantitative results are the result of repetition. Have students proceed through the experiment once more to see if their results are similar both times. If they are similar, then the results are more quantitative.

6. Allow students time to discuss their results in pairs or small groups. They should compare the amount of water droplets with and without soap. Have students record the differences or similarities in the section of their paper marked Analysis. Students should also add whether or not their result matched their hypothesis. Did they guess the number of drops would increase and the numbers actually decrease? Record these results in the Analysis section as well.

7. Explain to students that a New Hypothesis would be created from this experiment. If the soap did not affect the number of drops of water, what other addition to water might affect the number of drops? They can write these possibilities under the New Hypothesis section of their paper.

8. If time allows, students can be given a number of additives to use in their water and be given a chance to re-try their experiment with a new additive. However, they should complete a new worksheet for each experiment.

9. Lead a discussion about experimentation
    1. Did anyone get different results?
    2. Did everyone follow the scientific method carefully?
    3. Why is it important to record your results?
    4. Is the experiment only affected by soap and water, or can the student as scientist make mistakes that affect the outcome of the experiment?

**Attachments for Assessment(s):** Please list.

Scientific Method Worksheet

# LEARNING EXPERIENCES

**Instructional planning: Include lessons, activities and other learning experiences in this section with a brief description of the activities to ensure student acquisition of the knowledge and skills addressed in the standards. Complete the sequence of instruction for each lesson/task in the unit.**

## Sequence of Instruction

**1.** Identify the Standards. Standards should be posted in the classroom for each lesson.

CTAE-FS-4 Problem Solving and Critical Thinking: Learners define and solve problems, and use problem-solving and improvement methods and tools

**2.** Review Essential Questions.

- Why is it important to follow the Scientific Method?
- When what are the differences between qualitative and quantitative results?
- Why is it important to organize and keep detailed records of procedures in experimentation?

**3.** Identify and review the unit vocabulary.

Analysis

Controlled variable

Dependent variable

Experiment

Hypothesis

Independent variable

Law

Observation

Qualitative

Quantitative

Scientific Method

Theory

**4.** Day 1: Show the attached presentation to the class. Be sure to fully explain each step. An example of application of the scientific method is included in the slideshow, but another suggestion is to offer an example of the scientific method in terms of the topics studied in your particular course.

**5.** Have students use the attached graphic organizer to take notes and create examples of their own.

**6.** Day 2: Introduction to assessment activity – read the experiment aloud to students, to allow them to first listen to the steps involved.

**7.** Go over the Scientific Method Worksheet and Sample Worksheet in class.

**8.** Have students to follow the group experiment either together as a class, or at their own pace.

**9.** Discuss results as a class.

**10.** Day 3: Assign Performance Task.

**Attachments for Learning Experiences:** Please list.

Scientific Method Presentation

Scientific Method Graphic Organizer

Scientific Method Worksheet

Sample Scientific Method Worksheet

**Notes & Reflections:** May include notes to the teacher, pre-requisite knowledge & skills, suggestions, etc.

If time allows, give students other possibilities to place in the water, or change the water's temperature. Some possibilities include salt, sugar or lemon juice. The water can also be heated or cooled depending on the time available for the lesson. Students can also choose which of the other water additives they wish to experiment with. This allows students to have individual results as well as the group experiment.

When allowing students to choose from various additives, you will have many different variations. Feel free to make this activity as much fun and creative as possible. Students should create an organized set of results for each experiment that they perform.

- "I haven't failed, I've just found ten thousand things that don't work" --- Thomas Edison
- "Observation is a passive science, experimentation is an active science" --- Claude Bernard

# CULMINATING PERFORMANCE TASK (Optional)

**Culminating Unit Performance Task Title:** Individual Scientific Method Exploration

**Culminating Unit Performance Task Description/Directions/Differentiated Instruction:**

Instruct students to observe things and processes around their homes, and formulate a question to solve. Using the Scientific Method Worksheet as a guide, they should develop a simple experiment and record their results. Students should be sure to complete each step of the scientific method in order. Students should submit a written or typed report to be graded.

Note to teacher: Be sure that students explicitly state in their conclusions whether the hypothesis was accepted or rejected, and suggestions for further experimentation.

**Attachments for Culminating Performance Task:** Please list.

Scientific Method Worksheet

## Rubric

| Grading Criteria | Superior 5 | Excellent 4 | Good 3 | Fair 2 | Poor 1 |
|---|---|---|---|---|---|
| Observations | | | | | |
| Hypothesis | | | | | |
| Defined Variables | | | | | |
| Procedure | | | | | |
| Analysis | | | | | |
| Conclusion | | | | | |

**Superior –** Meets all requirements; exhaustive coverage; completely understands problem and ability to apply solution; shows originality; few grammatical errors.

**Excellent** – Meets all requirements of task; well defined and documented; excellent understanding and ability to apply solution; shows evidence of creativity; few errors.

**Good** – Meets requirements; fairly well planned and documented; shows an understanding and ability to apply data to the solution of new problems; could show more evidence of creativity and more details; few grammatical/mechanical errors.

**Fair** – Uneven work; meets some requirements; poor coverage; little understanding and ability to apply data to problem solving; needs to improve in significant areas; many grammatical/mechanical errors.

**Poor** – Meets few if any requirements; little understanding and little application of solution; grammatical/mechanical errors significant.

# UNIT RESOURCES

**Web Resources:**

**Attachment(s):** Supplemental files not listed in assessment, learning experiences, and performance task.

**Materials & Equipment:**

Medicine droppers

Pennies

Paper towels

Plastic spoons

Cups of water

Liquid soap

Other liquids to test

**What 21st Century Technology was used in this unit:**

- ☐ Slide Show Software
- ☐ Interactive Whiteboard
- ☐ Student Response System
- ☐ Web Design Software
- ☐ Animation Software
- ☐ Email
- ☐ Graphing Software
- ☐ Calculator
- ☐ Desktop Publishing
- ☐ Blog
- ☐ Wiki
- ☐ Website
- ☐ Audio File(s)
- ☐ Graphic Organizer
- ☐ Image File(s)
- ☐ Video
- ☐ Electronic Game or Puzzle Maker