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# **Grade 9 Science: STEM Skills, Careers, and Connections**

# **A1. STEM Investigation Skills**

### **Overall Expectations**:

### apply scientific processes and an engineering design process in their investigations to develop a conceptual understanding of the science they are learning;

### apply coding skills to model scientific concepts and relationships.

## **Introduction**

🧠 **Welcome to STEM Investigation Skills!** Hey there, young scientist! Have you ever wondered how scientists make amazing discoveries or how engineers come up with innovative designs? It's all about investigation skills. Whether you’re curious about how things work, love solving problems, or enjoy building and creating, mastering STEM investigation skills is your gateway to exploring the world of science, technology, engineering, and mathematics.

In this lesson, we’re going to dive into the exciting world of STEM investigations. You’ll learn how to conduct scientific research, experiment like a pro, design and build like an engineer, and even use coding to solve problems. Ready to get started? Let’s go!

## **Engage**

🌟 **Getting Started: The Power of Curiosity** Curiosity is the spark that ignites discovery. Think about the last time you wondered about something. Maybe you asked yourself why the sky is blue, how a car engine works, or what makes plants grow. These questions are the beginning of scientific investigations. In this section, we'll explore how asking questions and seeking answers can lead to fascinating discoveries.

### **Activity: Observing the World Around You**

Grab a notebook and a pen. Take a walk around your home or look out the window. Write down three things you see that make you curious. Maybe it’s a bird’s nest, a plant growing in an unusual spot, or the way rain forms puddles. These observations are the first step in the scientific process.

#### **Example Observations**

1. **Bird’s Nest:** How do birds build their nests?
2. **Plant Growth:** Why is this plant growing faster than others?
3. **Rain Puddles:** What causes puddles to form in certain spots?

### **Reflection**

Think about your observations. What questions do they raise? How could you investigate these questions further? This process of observation and questioning is the foundation of scientific research.

## **Explore**

🔍 **Hands-On Activities: Dive Into STEM Investigation**

Now that you’re curious and ready to explore, let's dive into some hands-on activities that you can do independently. These activities will help you understand and apply the STEM investigation skills we've discussed. Get ready to discover and learn on your own!

### **🌿 Activity 1: Observing Plant Growth**

#### **Materials Needed**

* Small pots or containers
* Different types of soil (e.g., sand, clay, garden soil)
* Seeds (e.g., beans or sunflower seeds)
* Water
* Ruler
* Notebook for observations

#### **Steps**

1. **Planting the Seeds:** Fill each pot with a different type of soil. Plant the seeds in each pot, making sure to plant them at the same depth.
2. **Watering:** Water the plants equally and place them in a spot where they get the same amount of sunlight.
3. **Observing and Recording:** Every day, observe the plants and record their growth. Measure the height of each plant using a ruler and note any changes in your notebook.
4. **Comparing Results:** After two weeks, compare the growth of the plants. Which soil type supported the best growth? Why do you think that is?

#### **Key Concepts**

* **Observation:** Carefully watch and record the growth of the plants.
* **Variables:** The type of soil is the variable you are testing.
* **Data Collection:** Regularly measure and note the height of the plants.

### **🚀 Activity 2: Building and Testing Paper Airplanes**

#### **Materials Needed**

* Different types of paper (e.g., printer paper, newspaper, cardstock)
* Tape measure or ruler
* Stopwatch
* Notebook for observations

#### **Steps**

1. **Designing Airplanes:** Create three different paper airplanes using the different types of paper.
2. **Testing Flights:** Find an open space. Throw each airplane three times and measure the distance it flies each time. Use the stopwatch to measure the flight duration.
3. **Recording Data:** Write down the distance and duration of each flight in your notebook.
4. **Analyzing Results:** Compare the flight distances and durations. Which type of paper made the airplane fly the farthest and the longest?

#### **Key Concepts**

* **Experimentation:** Design and test different paper airplanes to see which flies best.
* **Measurement:** Accurately measure the distance and time of each flight.
* **Data Analysis:** Compare the performance of different airplane designs.

### **💧 Activity 3: Designing a Water Filtration System**

#### **Materials Needed**

* Plastic bottles (cut in half)
* Sand
* Gravel
* Charcoal
* Coffee filters
* Dirty water (mix soil with water)
* Clean container
* Notebook for observations

#### **Steps**

1. **Creating Filters:** Layer the materials (sand, gravel, charcoal) inside the top half of the plastic bottle, using the coffee filter as the bottom layer.
2. **Filtering Water:** Pour the dirty water through the filter and collect the filtered water in the clean container.
3. **Observing and Recording:** Observe the clarity of the filtered water. Write down your observations in your notebook.
4. **Improving Design:** Try changing the order or amount of the filtering materials to see if it improves the water clarity.

#### **Key Concepts**

* **Engineering Design:** Build and test a water filtration system.
* **Observation:** Note the clarity of the filtered water.
* **Iteration:** Improve the filter design based on your observations.

### **🧑‍💻 Activity 4: Coding a Simple Simulation**

#### **Materials Needed**

* Computer with internet access
* Access to a coding platform (e.g., Scratch, Code.org)

#### **Steps**

1. **Choosing a Simulation:** Decide on a simple phenomenon to model, such as the spread of a virus or the growth of a population.
2. **Writing Code:** Use the coding platform to write a program that simulates the chosen phenomenon. If you're new to coding, start with tutorials available on the platform.
3. **Running the Simulation:** Run your simulation and observe the results. Note any patterns or interesting behaviors.
4. **Modifying Parameters:** Change some parameters in your code (e.g., growth rate, infection rate) and observe how the simulation changes.

#### **Key Concepts**

* **Coding:** Write a program to simulate a scientific concept.
* **Modeling:** Use the simulation to model real-world phenomena.
* **Analysis:** Observe and analyze the results of your simulation.

### **⚠️ Activity 5: Understanding Safe Practices with WHMIS**

#### **Materials Needed**

* Access to WHMIS resources (e.g., online WHMIS training module or guide)
* Notebook for notes

#### **Steps**

1. **Learning About WHMIS:** Use the online resources to learn about WHMIS symbols, safe handling practices, and emergency procedures.
2. **Identifying Hazards:** Look around your home or school and identify any items with WHMIS labels. Note what the symbols mean.
3. **Creating a Safety Plan:** Based on what you’ve learned, create a simple safety plan for handling a common household chemical (e.g., bleach). Include proper storage, handling, and emergency procedures.

#### **Key Concepts**

* **Safety:** Learn about WHMIS and safe practices for handling hazardous materials.
* **Application:** Identify hazards and create a safety plan.
* **Awareness:** Understand the importance of safety in scientific investigations.

## **Explain**

📚 **Understanding STEM Investigation Skills**

In this section, we’ll dive deeper into the specific expectations of STEM investigation skills. We'll discuss each aspect in detail and provide activities you can do independently to reinforce your understanding.

### **🔬 A1.1 Apply a Scientific Research Process**

**Scientific Research** involves a systematic approach to discovering new information. Here’s a step-by-step guide to conducting scientific research:

1. **Identify the Problem:** Start with a question or a problem you want to solve.
2. **Form a Hypothesis:** Make an educated guess about the answer to your question.
3. **Conduct Experiments:** Plan and perform experiments to test your hypothesis.
4. **Analyze Data:** Collect and interpret the data from your experiments.
5. **Draw Conclusions:** Decide whether your data supports your hypothesis.

#### **Activity: Investigate Plant Growth**

1. **Identify the Problem:** How does the amount of sunlight affect plant growth?
2. **Form a Hypothesis:** Plants receiving more sunlight will grow taller.
3. **Conduct Experiments:** Grow three plants in different light conditions (full sunlight, partial sunlight, and no sunlight).
4. **Analyze Data:** Measure and record the height of the plants over two weeks.
5. **Draw Conclusions:** Determine which light condition resulted in the tallest plant growth.

### **🧪 A1.2 Apply a Scientific Experimentation Process**

**Scientific Experimentation** involves designing and conducting experiments to test your hypotheses. Here’s how you can apply this process:

1. **Design an Experiment:** Plan how you will test your hypothesis. Include a control group and variables.
2. **Control Variables:** Identify the independent (what you change) and dependent (what you measure) variables.
3. **Conduct the Experiment:** Follow your plan and carry out the experiment.
4. **Record Observations:** Take detailed notes on what you observe during the experiment.
5. **Analyze Results:** Look at your data to see if it supports your hypothesis.

#### **Activity: Test the Effect of Fertilizer on Plant Growth**

1. **Design an Experiment:** Use two groups of plants; one group gets fertilizer, the other does not.
2. **Control Variables:** Independent variable - fertilizer use; Dependent variable - plant height.
3. **Conduct the Experiment:** Grow both groups under identical conditions except for the fertilizer.
4. **Record Observations:** Measure the height of the plants every few days and note any differences.
5. **Analyze Results:** Compare the growth of both groups to see if the fertilizer made a difference.

### **🛠️ A1.3 Apply an Engineering Design Process**

**Engineering Design** is about creating solutions to problems through a structured process. Follow these steps:

1. **Define the Problem:** Clearly state the problem you want to solve.
2. **Brainstorm Solutions:** Think of various ways to solve the problem.
3. **Design and Prototype:** Create a detailed plan and build a model or prototype.
4. **Test and Evaluate:** Test your prototype and evaluate its performance.
5. **Refine the Design:** Make improvements based on test results.

#### **Activity: Design a Wind-Powered Car**

1. **Define the Problem:** How can you build a car powered by wind?
2. **Brainstorm Solutions:** Think of different designs for the car and its wind-catching mechanism.
3. **Design and Prototype:** Draw a design and build a small model using materials like cardboard, straws, and paper.
4. **Test and Evaluate:** Test your car by blowing on it with a fan or outside on a windy day.
5. **Refine the Design:** Make adjustments to improve its performance based on how well it moved.

### **💻 A1.4 Apply Coding Skills**

**Coding Skills** are essential for modeling scientific concepts and solving problems. Here’s how you can start coding:

1. **Choose a Programming Language:** Start with an easy language like Scratch or Python.
2. **Learn the Basics:** Understand variables, loops, and conditionals.
3. **Write Simple Programs:** Create programs to solve simple problems or simulate scientific phenomena.
4. **Test Your Code:** Run your programs to see if they work as expected.
5. **Debug and Improve:** Fix any errors and improve your code based on feedback.

#### **Activity: Code a Population Growth Simulation**

1. **Choose a Programming Language:** Use Scratch or Python.
2. **Learn the Basics:** Review tutorials on variables and loops.
3. **Write Simple Programs:** Write a program that simulates population growth over time with birth and death rates.
4. **Test Your Code:** Run the simulation to see how the population changes.
5. **Debug and Improve:** Adjust the rates and add more features, like different age groups or migration.

### **⚠️ A1.5 Apply Knowledge of Safe Practices**

**Safe Practices** ensure you conduct experiments and build prototypes safely. Here’s how to apply safe practices:

1. **Understand WHMIS:** Learn about the Workplace Hazardous Materials Information System symbols and their meanings.
2. **Use Personal Protective Equipment (PPE):** Always wear safety gear like goggles, gloves, and lab coats when necessary.
3. **Follow Safety Procedures:** Know and follow the safety procedures for the materials and equipment you are using.
4. **Emergency Preparedness:** Be aware of emergency procedures, like knowing the location of the fire extinguisher and first aid kit.

#### **Activity: Create a Safety Plan**

1. **Understand WHMIS:** Research WHMIS symbols and what they mean.
2. **Use PPE:** Identify the appropriate PPE for different activities, like handling chemicals or using sharp tools.
3. **Follow Safety Procedures:** Write a step-by-step safety procedure for a common experiment, like mixing baking soda and vinegar.
4. **Emergency Preparedness:** Make a list of emergency contacts and procedures for your home lab setup.

By mastering these STEM investigation skills, you are not only learning how to conduct scientific research and experiments but also preparing yourself for exciting careers in science, technology, engineering, and mathematics. Keep exploring, experimenting, and engineering your way to new discoveries!

## **Elaborate**

🔧 **Extend Your Understanding: Applying STEM Skills in Real Life**

In this section, you’ll extend your understanding of STEM investigation skills by applying them to real-world problems. These activities are designed to be done independently, allowing you to explore and deepen your knowledge at your own pace.

### **🌍 Activity 1: Investigate Environmental Changes**

#### **Investigate the Impact of Light Pollution on Local Wildlife**

#### **Materials Needed**

* Notebook for observations
* Camera or smartphone (optional)
* Internet access for research

#### **Steps**

1. **Research:** Start by researching light pollution and its effects on wildlife. Find information on how artificial light affects nocturnal animals, migration patterns, and ecosystems.
2. **Observation:** Spend a few evenings observing your local environment. Note the sources of artificial light (streetlights, buildings, etc.) and their intensity.
3. **Document:** Take photos or draw maps to document the areas with the most light pollution.
4. **Analyze:** Reflect on your observations. How might the light pollution you observed affect local wildlife? Are there areas with less light pollution where wildlife might thrive better?

#### **Key Concepts**

* **Research Skills:** Gathering and synthesizing information from various sources.
* **Observation:** Making detailed observations about the environment.
* **Analysis:** Connecting your observations to broader ecological impacts.

### **🏠 Activity 2: Design a Sustainable Home**

#### **Design an Energy-Efficient Home Model**

#### **Materials Needed**

* Cardboard or sturdy paper
* Scissors
* Glue or tape
* Markers or colored pencils
* Ruler
* Notebook for planning

#### **Steps**

1. **Research:** Look up different energy-efficient home designs and the principles behind them. Focus on aspects like insulation, solar panels, and natural lighting.
2. **Plan:** Draw a detailed plan of your sustainable home. Consider how you can use materials and design elements to reduce energy consumption.
3. **Build:** Create a model of your home using the cardboard or paper. Be sure to include features like solar panels, energy-efficient windows, and proper insulation.
4. **Reflect:** Write a short explanation of how your design conserves energy and what features make it sustainable.

#### **Key Concepts**

* **Engineering Design:** Applying principles of energy efficiency to building design.
* **Creativity:** Designing and constructing a model based on research.
* **Sustainability:** Understanding and implementing sustainable practices.

### **🌊 Activity 3: Create a Water Conservation Plan**

#### **Develop a Plan to Reduce Water Usage at Home**

#### **Materials Needed**

* Notebook for planning and observations
* Access to water usage data (e.g., water bills or a water meter)
* Internet access for research

#### **Steps**

1. **Assess Current Usage:** Track your household’s water usage for a week. Identify areas where water is used the most (e.g., showers, dishwashing, lawn watering).
2. **Research:** Find tips and strategies for conserving water. Look into low-flow fixtures, rainwater harvesting, and efficient irrigation systems.
3. **Plan:** Create a detailed water conservation plan. Include steps you can take to reduce water usage in different areas of your home.
4. **Implement and Monitor:** Start implementing your plan. After a month, compare your water usage data to see if there’s a reduction.

#### **Key Concepts**

* **Data Analysis:** Tracking and analyzing water usage data.
* **Problem-Solving:** Developing practical solutions to reduce water consumption.
* **Sustainability:** Promoting sustainable water use practices.

### **🧪 Activity 4: Experiment with Renewable Energy**

#### **Build a Simple Solar Oven**

#### **Materials Needed**

* Cardboard box
* Aluminum foil
* Plastic wrap
* Black construction paper
* Tape
* Scissors
* Ruler
* Notebook for observations
* Food item to cook (e.g., s’mores)

#### **Steps**

1. **Construct the Oven:** Line the inside of the cardboard box with aluminum foil. Place black construction paper at the bottom to absorb heat. Cover the opening with plastic wrap, securing it with tape.
2. **Place the Food:** Put the food item inside the solar oven.
3. **Position the Oven:** Place the oven outside in direct sunlight. Angle it to maximize exposure to the sun.
4. **Observe and Record:** Monitor the temperature inside the oven and the cooking process. Record your observations in your notebook.
5. **Reflect:** Write a short explanation of how the solar oven works and the principles behind solar energy.

#### **Key Concepts**

* **Renewable Energy:** Understanding and utilizing solar energy.
* **Scientific Experimentation:** Constructing and testing a solar oven.
* **Observation:** Monitoring and recording the experiment's progress.

### **🧑‍💻 Activity 5: Code a Weather Prediction Model**

#### **Create a Simple Program to Predict Weather Patterns**

#### **Materials Needed**

* Computer with internet access
* Access to a coding platform (e.g., Scratch, Code.org, Python IDE)
* Notebook for planning and observations

#### **Steps**

1. **Learn the Basics:** If you’re new to coding, start with tutorials on the basics of the chosen programming language.
2. **Research:** Find out how weather prediction models work. Focus on key factors like temperature, humidity, and wind speed.
3. **Plan Your Model:** Outline the variables and conditions you’ll include in your model.
4. **Write the Code:** Create a program that takes input data (e.g., current weather conditions) and predicts future weather patterns.
5. **Test and Refine:** Run your program with different sets of data to test its accuracy. Make adjustments as needed.

#### **Key Concepts**

* **Coding Skills:** Writing and refining a weather prediction program.
* **Modeling:** Simulating real-world phenomena with code.
* **Data Analysis:** Using input data to make predictions.

By applying these STEM skills in various real-world contexts, you not only reinforce what you’ve learned but also discover the practical applications of science, technology, engineering, and mathematics. Keep exploring and experimenting to uncover new insights and solutions!

## **Evaluate**

📝 **Assess Your Understanding: Testing Your STEM Skills**

In this section, you’ll assess your understanding of the STEM investigation skills you've learned. You’ll complete a series of activities and quizzes to evaluate your knowledge and application of scientific processes, experimentation, engineering design, coding, and safe practices.

### **📊 Self-Assessment Activities**

#### **📒 Activity 1: Reflect on Your Learning**

1. Write a summary of the key concepts you’ve learned in this module.
2. Describe how you applied the scientific research process in one of your activities.
3. Reflect on an experiment you conducted and discuss what you learned from it.
4. Explain how you used the engineering design process to solve a problem.
5. Describe your experience with coding a simulation or model. What did you find challenging? What did you enjoy?

### **🧪 Activity 2: Practical Application**

1. Choose one of the activities you completed (e.g., plant growth investigation, solar oven experiment).
2. Write a detailed report including your hypothesis, experimental procedure, observations, data analysis, and conclusions.
3. Include photos or drawings of your setup and results.

### **🧠 Quiz: Test Your Knowledge**

#### **Easy Questions**

1. What is the first step in the scientific research process? a) Analyzing data  
   b) Forming a hypothesis  
   c) Identifying a problem  
   d) Conducting experiments
2. What does controlling variables in an experiment help ensure? a) Accurate measurements  
   b) Fair testing  
   c) Faster results  
   d) Larger data sets
3. In the engineering design process, what comes after brainstorming solutions? a) Testing prototypes  
   b) Drawing conclusions  
   c) Creating prototypes  
   d) Refining the design
4. Which of the following is a renewable energy source? a) Coal  
   b) Natural gas  
   c) Solar energy  
   d) Nuclear energy
5. What is the purpose of WHMIS? a) To conduct experiments faster  
   b) To ensure safe handling of hazardous materials  
   c) To provide instructions for coding  
   d) To define engineering problems
6. What is a hypothesis? a) A detailed report  
   b) An educated guess  
   c) An experimental variable  
   d) A research tool
7. Which material is often used to make a solar oven? a) Glass  
   b) Aluminum foil  
   c) Plastic  
   d) Wood
8. What does PPE stand for in a laboratory setting? a) Personal Protective Equipment  
   b) Primary Protection Ensemble  
   c) Personal Protective Engineering  
   d) Primary Protective Equipment
9. What is the main role of coding in STEM? a) Writing essays  
   b) Building structures  
   c) Modeling scientific concepts  
   d) Mixing chemicals
10. In a scientific experiment, what is the dependent variable? a) The variable you change  
    b) The variable you measure  
    c) The variable you keep the same  
    d) The variable you discard

#### **Moderate Questions**

1. What is the role of the control group in an experiment? a) To provide accurate measurements  
   b) To serve as a standard for comparison  
   c) To test the hypothesis  
   d) To introduce new variables
2. In coding, what is a loop? a) A sequence of instructions that repeats  
   b) A variable that changes  
   c) A condition that is true  
   d) A part of the hardware
3. Which step involves improving a design based on test results in the engineering design process? a) Brainstorming solutions  
   b) Creating prototypes  
   c) Refining the design  
   d) Drawing conclusions
4. How does black construction paper help in a solar oven? a) It reflects light  
   b) It absorbs heat  
   c) It insulates the food  
   d) It provides structural support
5. What is the primary benefit of using renewable energy sources? a) They are cheaper to produce  
   b) They generate more power  
   c) They have a lower environmental impact  
   d) They are easier to store
6. Why is it important to wear goggles in a laboratory? a) To improve vision  
   b) To protect eyes from hazards  
   c) To look professional  
   d) To enhance concentration
7. What is the main goal of analyzing data in scientific research? a) To collect more data  
   b) To draw conclusions  
   c) To form a hypothesis  
   d) To conduct experiments
8. In the water filtration activity, which material helps to remove large particles? a) Charcoal  
   b) Sand  
   c) Gravel  
   d) Coffee filter
9. Which of the following is an example of an independent variable in an experiment? a) The growth of plants  
   b) The type of soil used  
   c) The amount of sunlight  
   d) The height of the plants
10. How can coding be used to model scientific concepts? a) By creating physical models  
    b) By solving mathematical problems  
    c) By writing programs that simulate phenomena  
    d) By recording observations

#### **Hard Questions**

1. What is the significance of the scientific method in conducting reliable experiments? a) It ensures faster results  
   b) It minimizes bias and error  
   c) It guarantees successful outcomes  
   d) It simplifies complex procedures
2. How can the principles of energy efficiency be applied in home design? a) By using more electronic devices  
   b) By increasing insulation and natural lighting  
   c) By reducing the size of windows  
   d) By using non-renewable energy sources
3. What does analyzing the results of an experiment involve? a) Repeating the experiment multiple times  
   b) Comparing data with the hypothesis  
   c) Changing the experimental variables  
   d) Drawing the experimental setup
4. In the coding activity, what role do conditionals play in a program? a) They loop the instructions  
   b) They set conditions for actions  
   c) They store values  
   d) They organize data
5. How does light pollution affect nocturnal animals? a) It improves their vision  
   b) It disrupts their natural behaviors  
   c) It has no effect  
   d) It helps them find food
6. What is the main purpose of refining a prototype in the engineering design process? a) To reduce costs  
   b) To improve functionality  
   c) To simplify the design  
   d) To increase production speed
7. Why is it important to understand WHMIS symbols? a) To create new chemicals  
   b) To handle materials safely  
   c) To speed up experiments  
   d) To reduce costs
8. What is a practical application of coding in environmental science? a) Designing physical models  
   b) Simulating climate change scenarios  
   c) Writing research papers  
   d) Conducting field surveys
9. How does using different soil types help in a plant growth experiment? a) It increases the plant's lifespan  
   b) It tests the effect of soil composition on growth  
   c) It reduces the need for watering  
   d) It enhances the color of the plants
10. In the water conservation plan, why is it important to monitor water usage? a) To identify areas of waste and improve efficiency  
    b) To increase water bills  
    c) To complicate daily routines  
    d) To reduce the quality of water

### **📝 Answer Key**

#### **Easy Questions**

1. c) Identifying a problem
2. b) Fair testing
3. c) Creating prototypes
4. c) Solar energy
5. b) To ensure safe handling of hazardous materials
6. b) An educated guess
7. b) Aluminum foil
8. a) Personal Protective Equipment
9. c) Modeling scientific concepts
10. b) The variable you measure

#### **Moderate Questions**

1. b) To serve as a standard for comparison
2. a) A sequence of instructions that repeats
3. c) Refining the design
4. b) It absorbs heat
5. c) They have a lower environmental impact
6. b) To protect eyes from hazards
7. b) To draw conclusions
8. c) Gravel
9. b) The type of soil used
10. c) By writing programs that simulate phenomena

#### **Hard Questions**

1. b) It minimizes bias and error
2. b) By increasing insulation and natural lighting
3. b) Comparing data with the hypothesis
4. b) They set conditions for actions
5. b) It disrupts their natural behaviors
6. b) To improve functionality
7. b) To handle materials safely
8. b) Simulating climate change scenarios
9. b) It tests the effect of soil composition on growth
10. a) To identify areas of waste and improve efficiency

By completing these activities and quizzes, you’ll be able to assess your understanding of STEM investigation skills and identify areas for improvement. Remember, the goal is to reinforce your knowledge and apply what you’ve learned to real-world situations. Keep exploring and experimenting to enhance your STEM skills!