Inquiry Based Field Science in the Schoolyard:
Outline for a Guided Inquiry Investigation Lesson

Adapted from **Olympic Park Institute's** field science curriculum in the Old Growth Forest of the Olympic National Park

In the past teachers were trained to create meaningful experiences for students in the science classroom by introducing "discrepant events" that raised questions for students to investigate using laboratory experiments with manipulated and controlled conditions. Often, there was a known answer and the experimental results had a right and wrong outcomes. This method of training teachers and teaching students sometimes required hours of prep time for teachers but resulted in minimal engagement from students.

Many teachers now know there is a "laboratory" right outside their classroom walls, the surrounding outdoor environment, which is always set up and ready for investigation. With minimal tools and guidance, new and experienced teachers are finding exciting ways to engage students in outdoor investigations. Some teachers take students to natural areas such as the Olympic National Park to conduct multi-day field studies; others are finding it entirely possible to provide meaningful experiences for their students in their own schoolyard.

Use this recommended lesson outline (pages 1 and 2), examples of field science investigations (pages 3 and 4) and tips for using the schoolyard as a classroom (page 5), to design your own schoolyard investigations. Be brave! There is a rich and exciting laboratory just outside your classroom walls and beyond where students can become engaged in explorations and motivated to tackle real world problems

Overview and Objectives:
This guided inquiry lesson outline has students conduct a **comparative investigation** focused on a **responding/dependent variable** which changes with the **manipulated/independent variable** of location. Throughout the lesson, students will develop abilities necessary to complete scientific inquiry. The objectives of the lesson are for students to:

- Use simple field equipment to gather data in a field investigation
- Develop descriptions, explanations, and predictions using evidence
- Think critically and logically to make the relationships between evidence and explanations
- Communicate scientific procedures and explanations.

Based on the **National Science Education Standards: Content Standard for Science as Inquiry**, this type of investigation should develop for all K-12 students:

- Abilities necessary to complete scientific inquiry
- Understandings about scientific inquiry.

This lesson gives opportunities for multiple abilities and understandings related to scientific inquiry to develop for all three grade spans (K-4, 5-8, and 9-12).

Part 1: Preparing students for a schoolyard investigation (Day 1)

1. Set up the context for this field investigation by telling a story to introduce an **essential question**, a broad question that cannot be answered with a single investigation.
2. Introduce the chaperone who will accompany your class outdoors.
3. Describe/brainstorm **safety rules** for being in an outdoor classroom.
4. Explain the first outdoor activity, a five minute silent observation of the outdoors. Students make a data table or use the one provided.
5. Walk to the schoolyard where the investigation will take place. Gather in a class circle.
6. Ask students to face away from the center of the circle, take three steps away from the circle and silently record **observations** in their notebooks, including sights, sounds, feelings and smells.
7. After five minutes, students return to the class circle, share observations and return to the classroom.
8. Debrief and solicit student feedback for a more successful second trip.

Part 2: Setting up the investigation in the schoolyard (Day 2)

9. Introduce the **investigative question** in which the **conclusion** will be used to provide supporting information to answer for the **essential question**.
10. Ask students how they might go about answering the **investigative question**.
11. Introduce available tools.
12. Develop or introduce a **procedure** that identifies **manipulated**, **responding** and **controlled variables** and includes **multiple trials**, **data table**, **materials,** and **safety** considerations.
13. Allow students as much input as possible in designing their own investigation.
14. Students record all parts of the investigation in their notebooks.

Part 3: Conducting the investigation in the schoolyard (Day 3)

15. Review any necessary procedures, routines or safety rules before leaving the classroom.
16. Walk to the schoolyard where the investigation will take place. Students bring tools and notebooks.
17. Gather in a class circle and identify the physical boundaries where the investigation will take place.
18. Working in small groups, students collect and record data.
19. When the investigation is completed, gather students in a class circle to debrief.
20. Return to the classroom.
21. Students meet in small groups to share data with every group member.
22. Create a class **data bank** for students to copy into their notebooks.
23. Students analyze data. Discuss factors that could have influenced their findings.
24. Introduce components of a complete conclusion.
25. Students write conclusions in their notebooks and write a reflection about their investigation.

Part 4: Extending the outcomes of the schoolyard investigation (Day 4)

Students may use the results of this investigation to:

1. Identify new questions that arise as a result of the completed investigation.
2. Develop additional field investigations related to this essential question.
3. Recognize alternative explanations for results.
4. Communicate and defend the investigation's conclusion to peers or an audience outside the classroom.
5. Use technology to analyze data, communicate results, and/or present completed investigation.
6. Repeat this field investigation with different tools, modified procedure or improved techniques.
7. Repeat this field investigation in a nearby natural area, state or National Park.
8. Identify areas in the schoolyard environment that could benefit from stewardship activities.
9. Organize and participate in stewardship activities that benefit the local environment.

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Examples of Field Science Investigations in Two Locations

Adapted from **Olympic Park Institute's** field science curriculum in the old growth forest

Manipulated/Independent Variable		Responding/Dependent Variable		Tools	Investigative Question
Location A and Location B		Biotic Factor	Abiotic Factor		
Open soil (grassy area)	Sheltered soil (mulched area)	Insect density/diversity		Quadrat + hand lens + trowel	Are there more Insects in the open grass or in a mulched area?
Open soil (grassy area)	Sheltered soil (mulched area)		Soil Moisture, pH or temperature	Soil moisture meter + pH kit+ thermometers	Which has higher moisture/pH/temperature: open grass or mulched area?
Tree trunk	Tree drip line	Leaf density on the ground		quadrat	Do more leaves fall closer to the trunk or to the drip line?
Tree trunk	Tree drip line		% canopy cover	densiometer	Will there be greater canopy cover near the trunk or under the drip line of a tree?
Deciduous shrub	Evergreen shrub	Insect density		Hand lens	Do more insects live on deciduous or evergreen shrubs?
Deciduous shrub	Evergreen shrub		Soil pH		Is pH higher under a deciduous or evergreen shrub?
South surface (building/tree/ pole)	North surface (building/tree/ pole)	Moss density		Quadrat + hand lens	Does more moss grow on the north surface of the building than on the south?
South surface (building/tree/ pole)	North surface (building/tree/ pole)		Temperature	Thermometer	Is the temperature higher on the south or north facing surface of a structure?
Open area (schoolyard perimeter)	Sheltered area (near school building)	Tree circumference or height		Tape measure + stick or clinometer	Do larger trees grow in the open areas or in sheltered areas?
Open area (schoolyard perimeter)	Sheltered area (near school building)		Wind speed	Anemometer + compass	Does the school building change the speed and direction of the wind?
Play field	Garden or border planting	Plant density or diversity		Quadrat + hand lens	Is the diversity of plants greater in the playfield or in the garden?
Playfield	Garden or border planting		Permeability of soil	Cylindrical can + container of water + timer	Is the soil more permeable in the playfield or in the garden?
Rainwater in play ground puddles	Rainwater dripping from leaves	Density of organisms		30X microscopes	Are there more living things in a puddle in the playground than in fresh rainwater?
Rainwater in playground puddles	Rainwater dripping from leaves		Clarity	Test tube + plastic pipette	Is the clarity of rainwater collected on the ground less than rainwater collected from the leaves of plants?

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Examples of Field Science Investigations Using a Transect Line*

Adapted from **Olympic Park Institute's** field science curriculum in the old growth forest

*A transect line is a distance defined by measuring tape or length of rope marked in regular increments. The transect line can be any length; however, in the Old Growth Forest 50 m lines are most commonly used. Responding variables are measured along the line at regular or random intervals.

Manipulated/Independent Variable	Responding/Dependent Variable		Tools	Investigative Question
Distance	Biotic Variables	Abiotic Variables		
			Transect Line +	
Transect from tree trunk past drip line of tree	Leaf density on the ground		Quadrat;	Is leaf density greater close to the tree trunk or farther away?
Transect from tree trunk past drip line of tree		Soil permeability	Cylindrical can + timer	How does soil permeability change along a path from the trunk to the drip line of a tree?
Transect across garden to grassy area	Evidence of animal life		Quadrat + hand lens	How does animal presence change from the garden to the grassy area?
Transect across garden to grassy area		Rock hardness	Mohs hardness test kit	Are there different kinds of rocks found between the garden and the grassy area?
Transect from building to street	Plant density		Quadrat+ hand lens	Is diversity of plants greater near the building or near the street?
Transect from building to street		Surface temperature	Thermometer	How does the temperature of the surface of the ground change as we move from the building to the street?
Transect from sidewalk into stand of trees	% canopy cover		Densiometer	How does the % canopy cover change as we move from the sidewalk into a group of trees?
Transect from sidewalk into stand of trees		Diversity of Sound		How does the diversity and intensity of sound change as we move from the sidewalk into a group of trees?
Transect from parking lot to garden	Plant diversity		Quadrat + hand lens	Is the diversity of plants greater near the parking lot or near the garden?
Transect from parking lot to garden		% impervious surface	Quadrat	How does the amount of impervious surface change from the parking lot to the garden?
Transect from top to bottom of slope	Plant diversity		Quadrat + hand lens	Is there a greater diversity of plants at the top of the slope or at the bottom?
Transect from top to bottom of slope		Elevation change	Two meter sticks + string	What is the profile of elevation change along the the steep slope in the school yard.

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Tips for Using the Schoolyard as a Classroom:

Adapted from **Olympic Park Institute's** Natural Connections Program in Seattle Public Schools

Pre-trip planning

- Identify the area in the schoolyard best suited for the investigation, potential distractions and safety concerns.
- Find out if other students will be using the schoolyard for recess, gardening, etc. during your investigation.
- Plan the route you will use with the class. Check for doors that are locked during school hours to prevent your class being locked out when they return to the building.
- Identify a different route for students with special needs if necessary.
- Check the schedule for specialists who may work with students during the time of your trip outdoors; make arrangements for supervision of these students if they return to the room when you are gone.
- Ask for an additional adult (parent volunteer, special education assistant if appropriate) to accompany you outdoors; this is especially important for the first few trips until students have learned the routine.
- Plan an outdoor circle game your students could use if time allows, e.g. rock cycle or earth people.
- Decide whether your students would benefit from a short introductory outdoor activity that prepares them for the longer outdoor investigation.

Materials

- Gather materials for the investigation and a container to hold them if students don't carry them outdoors.
- Bring your cell phone with the number of the school office and any other adult accompanying you.
- Wear a watch to keep track of time
- Bring a still or video camera to record student activities or to for students to use for documentation.
- Bring two plastic bags to scoop animal waste that interferes with the investigation.
- Find a set of clip boards to hold student papers or notebooks: one/student or one/small group
- Gather a set of clear plastic sheet protectors for the top cover on a clip board to protect student work from the rain. Pencils can slide inside for easy access.

Student preparation

- Let students know several days in advance that you will be using the schoolyard for a classroom. Ask them to come prepared to be warm and dry outdoors.
- Introduce **guidelines for safety and respect**: All classroom rules apply in the outdoor setting. In addition all students should:
    - Stay together when walking between the classroom and schoolyard.
    - Conduct the investigation within the boundaries defined by the teacher
    - Work respectfully within their assigned groups (3 or 4 students per group)
    - Refrain from engaging the attention of students in any other group or class.
    - Use science equipment only as instructed.
    - Avoid horse play (pushing, shoving, climbing, etc.)
    - Follow principals of leave no trace practice including
        - Leave no trace: if you bring something outside, bring it back to the classroom
        - Do no harm: be respectful of plants and animals
        - Any samples collected from the schoolyard should be safely returned.
- Let students know that some activities will be silent. Describe how that looks and sounds.

- Inform students about any additional adults who will be supervising the class on the day outdoors.
- Identify members of small groups of 3 to 4 students. Establish roles for group members if appropriate.

Investigation day

- Let the office staff know where you are going and when you will return.
- Put a note on your door telling visitors where you have gone and when you will return.
- Lock the door to your room so students can leave personal items in the classroom.
- Take all science and/or supporting materials with you. See list above.
- On the walk outdoors make a “student sandwich” with one adult in the front and one in the back.
- Gather students into a class circle at the beginning and end of the activity and for any refocusing needs.
- Be aware of conditions that impact students’ ability to stay on task. These include: students from other classes, traffic, extreme weather conditions (high wind, significant rain, snow, ice, extreme temperatures, although these can be great conditions to investigate), animal waste, unusual litter, etc.
- After the outdoor activity is completed, debrief with students. Ask students what they enjoyed about the outdoor classroom; build those elements into your instruction.