To Seek or Not to Seek?

Purpose

In this Thread, we will begin our experience with the tools of scientific inquiry. We will be observing our world, inside and outside of the classroom, looking for changes, perspectives, and patterns. We will begin to use measuring tools as simple as our feet and fists and move on to more complex devices such as microscopes and scales. This is the first step in our journey to build learning from direct experiences.

The National Science Education Standards stress that students of all ages should be learning science from an inquiry-based approach. The passing of the seasons and the characteristics of the natural world should be observed and known, as well as how a changing environment affects life on the Earth. Students should become familiar with the history and nature of science. The Standards also stress that recording data and measuring specimens from nature are crucial for the science student. The vocabulary which can be used to help us talk about our experiences are words such as observe, experience, curious, theory, pattern, change, detail, evidence, data, nature, science as inquiry, sight, hearing, touch, smell, and taste.

You will need: journals, pencils and crayons, plastic sample bags, microscopes, scales, and rulers.

The visits outside or around the school will vary according to the ages of the students. We recommend that there be enough time during a session for each student to draw a certain aspect of his observations and/or write a short description of the area he viewed (or even a list of the relevant features observed). Repeat visits to the sites need to be made at intervals of about three weeks. Additional time will be spent talking about what change the class has seen between visits. Gathering materials for this Thread should not be difficult, as most of the equipment should be available at the school.

Teacher Background

Ultimately, the purpose of this adventure is to watch Autumn happen, although we don't want to say that from the start! We want to invite inquiry into the classroom by *leaving* the classroom! Looking around outside will reveal many interesting things about the world around us. The trees will soon change, relying on their sap and ground water to survive during the cold months. This process can be seen during the next few months as the leaves change from green to brown and then detach from the tree entirely. The colder temperatures and decreased sunlight will cause many plants to die altogether. Most plants will develop seed pods which will fall and provide a new generation of plants in the spring. Over time, certain insects will become active while others will disappear. The fur on some critters gets thicker, while other animals go into hibernation.

Having students make observations on this first day is key. There is no book telling us what the outside of our school looks like. We must explore it ourselves. We must look around with care, draw what we see, describe what we see, and keep a neat record of this world outside our classroom. When we bring the students out again in a few weeks, we need to be able to return to these same spots outside and observe again. There will be some changes, and we will find as many of them as we can. If your school is surrounded by asphalt, a walk to a park or garden will work quite well.

Collecting samples to bring back to the classroom will, hopefully, also bring the inquiring mind into the classroom. Using tools such as microscopes and scales to measure and record what we have found will allow us to keep more than just pictures and words from our observations. We can use this empirical evidence later when we compare our first finds to those we pick up on later visits. Bringing data inside also is a good way of demonstrating that observation is more than just looking around; it is learning about something which is in front of you in any manner which is possible: touching it and smelling it, as well as weighing it and measuring it.

The skills of good record keeping also should be introduced with this exploration, perhaps not on the first trip out, but on the second. We may think, "If only I had made a better record, I would know what had changed." Find moments during the investigations to ask your students these questions: Why should we date our records? Could we record in which direction we were looking? Does the time of day make a difference in what we see?

For the teacher, it is important also to realize that here we are asking things of the students which may have never been asked of them before. There is an atmosphere we create in inquiry-based learning which is most likely unfamiliar to them, and we should be sensitive to that. We are asking our students to do most of the talking, instead of us, and we also are not giving many answers -- *they* will find them. We are only collecting data and comparing it with what we gathered before. We are learning how to observe the world around us and make some inferences about what we see. We need to make students comfortable with this, instill some confidence in their ability to observe, gather data, and make connections. Students in this age

group will not be used to having this much control over the learning process, and we need to understand that it will take time before they grow assured enough to begin probing deeper into patterns and predictions.

Within two months after the beginning of school, autumn's changes will become readily apparent in the world outside of the classroom. By then, we should have established a comfortable environment for inquiry and students should be at ease with exploring everything they encounter, from math to moths, using the tools of scientific inquiry.

> "It is here we must begin to seek the wisdom of the children."
>
> — John Denver, *Rhymes and Reasons*

> "Well, what is the answer? But, what, then, is the question?"
>
> — Gertrude Stein

> "An investigative or inquiry-based approach...can indeed help students learn the important concepts, processes, and habits of mind of science, and also something more. The students experience firsthand what science is—an ongoing, complex enterprise of the mind, conducted collaboratively with practical consequences for human welfare. They learn this by doing what scientists do—applying intellectual processes to the task of producing and testing knowledge about the natural world. Students are not only introduced to the body of ideas called scientific knowledge, but also themselves become thinkers about the unknown and builders of knowledge."
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> — John Layman, *Inquiry and Learning*

Kindergarten through Second Grade

Developmental Issues

This Thread resonates with kindergarten through second graders in many ways. It invites observation of change, a concept that fits well with students' own explorations. They have been growing and changing a great deal themselves, and this activity invites a natural extension of noticing such patterns in a broader world. There are also natural links to using all of our senses, as well as learning how to frame questions.

Children in this age group are often capable of and interested in using their emerging understandings of logic and order in helping them make sense of the world. For example, they often enjoy sorting objects into sizes or classifications and watching cause and effect. They may enjoy starting elaborate collections of things. This Thread offers opportunities for them to do all of these things within the framework of learning to observe their world and record what they find. It will provide ways for them to build their increasing knowledge of words and numbers along with the skills of scientific inquiry.

In this activity, this age group will find out that they observe many patterns that they cannot easily explain. There will be many unanswered questions after this investigation. Beginning the process of experimentation without knowing all of the answers is an important lesson in learning to think as scientists do.

Teachers will need to help children consider the difference between cause and effect and correlation in concrete instances. For instance, some children might think that it is the leaves turning color that makes them fall from the tree. What are the key causal factors and what are correlational ones? The Everyday Classroom Tools Project can help all students think deeply about key causal factors (the tilt of the Earth resulting in shorter daylight time, thus less warmth) and the multitude of correlated effects (birds flying south, leaves dropping, plants making seed pods). It is unlikely that the youngest children will be able to make all of these connections, but their teachers can help them see particular instances when a pattern is correlational as opposed to causal (i.e. The leaves turning color will not "make" the birds fly South, the increasing cold causes both.)

Inquiry Introduction

Many of us have questions about our world. What makes a day happen? What are the stars? How do birds fly? Why is the sky blue? Where do we usually go for answers? Many students will say their parents. Where do parents go for answers? Many will say to books or TV. Where did books and TV get their answers? And so on until we realize that someone somewhere – and some *when* – discovered those answers because he or she had the same questions. If there can be a someone who had the same questions as us, doesn't it follow that if he found the answers, so can we? All we'd have to do is think of a plan for finding that answer. It would probably start with observing the richness of the world.

Inquiry Investigation

What does it mean to look at something? How many students in the classroom could tell you what the sky looked like when they got to school this morning? Why is the number so few? Is it important to observe the world around us? Why do we only do so when there may be danger, such as crossing the street? Let's pick a question such as what does our world look like right now and go answer it. How do we start? Well, first we go outside!

Outside the classroom is a wealth of information. Where do we begin? As explained in the background information, we want the students' data to show the real changes as we go from summer to fall. So, once outside, you may want to encourage the students to look at their world closely, giving examples of the trees and plants as good things to draw or record. They should feel free to observe whatever they wish, as long as the observations of plant life are present somewhere.

What does the sky look like today? Is it a nice day? What colors can we see around us? How big is a tree compared to a grass blade or to us? What things could we pick up and which things are too heavy? Are there bits of our world which we could bring back to the classroom? What might we be able to learn from them? What tools could we use to learn more about them? It's a good time to gather objects. Plastic lunch baggies for collection should be handed out with journals and pencils, and students should be encouraged to record their observations in whatever manner they understand.

In the classroom, break the students into groups seated at different tables. Let's spill the contents of our baggies on our group's table and look at what we've got. In what ways could we sort these objects? What things about them are the same or different? Size, color, dryness, function, and shape are all good ideas for categories.

Encourage students to try all different ways of sorting. Older students could record the number of objects which fit into each group or fit each category. Younger students could show you what they have done once they have sorted in one way, and then you might suggest they try to find yet another way to sort their collections.

What is change? Does the world outside of our classroom change at all and, if so, in what ways? How would we see those changes? How could we know for sure that things had changed? Would asking our parents about our observation site in the school yard give us any answers? Why not? The answer is that they are not here and it was our observation not theirs. Hopefully, students will see that they would need to go back outside and check to see if things change.

The next time you take your students outside, bring them to the same spot they went to before. Ask them very specific questions, such as "Were there that many leaves on the ground last time?" and "Did that plant have seed pods?" They probably will not have made a very careful record of their first visit and may not be able to answer definitively.

Here is where we can discuss the importance of recording. This is not to say we need be boringly precise in our drawings and text. This is just to point out that had our questions been very explicit, our records should have been as well. However, our questions were broad, and so were our discoveries. But what if we had wanted to know the answer to a question such as "What will happen to the trees?" Where would we start?

We could pick a tree out here which we could watch all year. We would make careful records of it when we came outside. We could even name our tree and collect leaves from it. We should never fail to observe the world around the tree. Observing just a tiny piece of our view makes it difficult to talk about the whole view. We should recognize that there is more to observing than just looking at tiny bits. Choosing some good times to repeat this Investigation, such as the first snow or the coming of spring, would be beneficial for getting a good chronology of the changes taking place outside.

"Remember to always think for yourself and listen to your ideas, even if they sound crazy at first."
—Sarita M. James

"Trust your feelings, Luke."
— Obi-Wan Kenobi, *Star Wars*

Second Grade through Fourth Grade

Developmental Issues

Students in this age group are growing increasingly able to think about abstractions. Inferring abstract patterns from concrete instances, as called for in this Thread, fits well with their developing reasoning skills. They can reflect on their thinking and can consider whether their reasoning follows from the evidence that they have collected. While second to fourth graders have the skills to answer more of their questions than younger children, they will find that science is a continuing process of seeking answers, an important lesson for all learners! Teachers can help students of this age make a distinction between cause and effect and correlation (i.e. The leaves turning will not make the birds fly South. Instead these are correlated and the increasing cold causes both.) Teachers can introduce the words, "causal" and "correlational" to help students think about how events are related.

Often children at this age want to be given "real" and "grown-up" things to do. Beyond this, their growing cognitive capacity enables them to hold many possibilities in their minds at once and to consider alternative explanations and scenarios. Therefore, for this age group, we will approach this Thread very seriously and talk more about mysteries and puzzles — the answers for some even we do not know! We will tell them we are stepping back to explore their questions with the tools we have available to us. Consider having the students work in groups for investigation. Exploring the ideas of others is an important source of learning and capitalizes upon this age group's budding social interests.

Inquiry Introduction

Close the window shades or drapes (or whatever) and ask the students some questions. How many of you students can tell me what the sky looks like right now without peeking outdoors? How many of you think it is cloudy? Those who say "yes" should all meet at one place in the room. What about sunny? They should go to another part of the room.

Address each group in turn. What clues or evidence did your group use to make this claim? Did you guess? Is it OK to guess? Sure, but it is best if we made an edu-

cated guess or one based on clues we put together. Making an educated guess means we are thinking and puzzling. How could we know for sure what the sky looks like right now? Look at it, of course! Open the shades. Who was right? What is the evidence?

Close the shades once more. Ask students to tell you something about the ground near a big tree or other obvious object in the yard. How are we supposed to know that? you may hear. Well, the shades were open and the world was there to see. But you asked us about the *sky*! Here is another key element about observing our world. So often we simply look at the one thing which is immediately important but neglect to view the rest. For example, we look both ways at a cross street, because we don't want to get hit by a car or bicycle. This is a very good reason to look around, but why not just look around because the world is pretty cool?

Inquiry Investigation

Outside, what things can we see that are alive? What things are not alive? What things may change in a year or a week? What could we watch through the year that might go through some clear and obvious changes? Trees are a good choice. We could even take a photograph or draw a picture of what it looks like now. How long do we think it might take before we see some kind change? And what kind of change might that be?

What things can we find on the ground? Seeds? Dead leaves? Weeds and flowers? Will these be here in a week? In a month? Why or why not? Have the groups collect those things on the ground around the tree, keeping a record in a journal. How do these things relate to the tree, if at all?

What other things in this school yard could we watch? What about the wildlife, if there is any? What kinds of critters seem to live around this tree? What do these critters do in the yard? Bees which gather pollen and help flowers grow are an example. Will bees be around when the flowers are gone?

Return to the outside area around the tree (or wherever you started) and repeat the gathering of data by collecting bags of samples and making pictures of the area. In the classroom, create stations with scales and rulers. Allow teams with their data collection bags to analyze what they have in terms of weight, size, color -- whatever they decide are characteristics. They should keep this data in their journals, maybe even staple or tape their baggies on to pages of the journal. Have students explain their findings to the other teams.

How might these findings change over time? Let's plan to go outside again and test some theories about what we think may happen out there.

Fourth Grade through Sixth Grade

Developmental Issues

This Thread may seem like a silly exercise to students at this age; they do not like to look stupid or take risks, especially in the sixth grade. At this age, students are establishing their individuality and gaining a sense of who they are. An important message this lesson can convey to them is that multiple perspectives and observations help us to have a fuller, increasingly objective account of what is happening. Stressing the importance of different kinds of perspectives and observations increases the level of engagement of all students and suggests to them that it is okay to be yourself. Therefore, this investigation should not seem like a race or a contest. However, as this is the very first introduction to Inquiry-based learning for many of them, encouraging independent thinking within a group situation is key.

These students also are becoming increasingly introspective. This is a good age to do related writing activities focused on topics, such as how one feels about the changing seasons. Perhaps letting them go out with a journal is a more private means of letting them explore. Talking about what is written is often easier than asking them to call out. As students grow more accustomed to inquiry-based approaches, their verbal participation should increase. For teachers who already use inquiry-based approaches, it's likely that your students are less reticent than others.

Inquiry Introduction

What was the sky like yesterday? How many birds live in the tree across the yard? How many cars were parked in the lot when you got to school? How are we supposed to know *that*? What was the Moon like four days ago? When will a hurricane hit Florida? How do cancer cells grow? What is a tadpole? All of these things require observation.

In teams, have the students pick one of these questions above and brainstorm about the things one would need to do to answer them. The key to answering these puzzles is knowing that all of them require watching something for a period of time. For example, if you looked in a pond and saw a bunch of tadpoles, you would think they were the local critters in the pond. If you looked again in three months and they were gone, you might be very confused. Where did they go? If you looked and found them nowhere, you would be alarmed, perhaps, especially since there are now a bunch of frogs hanging around. Did the frogs come in and eat the tadpoles? Of course not. Everyone *knows* that tadpoles are baby frogs, but *how* did someone ever learn that?

You need to watch carefully and repeatedly the changes that happen around you and be aware of cause and effect. You also need to isolate the important details

from the fluff. What things do you need to watch in order to discover if a hurricane is going to hit Florida? Do you need to watch soap bubbles in your sink? No, you would need to watch the weather reports and storm fronts. What if you wanted to watch the seasons turn from summer to fall? Would you watch a shoe? What would you watch? What kind of data could you gather?

Inquiry Investigation

With journals and plastic bags, let's begin exploring the world outside the classroom. What are the things out here which could change first? Which things probably will not change until later? Are there things which may never change in our life times? What could we collect as evidence of what we are seeing out here? What are we seeing out here anyway? In your journals, write some thoughts about the world out here. Pick a spot you want to watch for a while during the year that you think will change fairly impressively. Draw it as you see it and gather some bits from the area that represent what you see. Do you have any predictions about which parts will change and which will not? Why? Why not?

Why is it important to pay attention to things in our world? What if you never looked both ways when you crossed a street? What might happen to you? How about if you never checked the weather from a window or door before you went out? There are some practical aspects of keeping an eye out on the world, aren't there? Are there things you have watched grow for your own pleasure? Are there things you have checked in on every once in a while to see how they are doing, like a chicken's nest, tadpoles, a sleeping baby sister, or crystals?

On what scales do things change? Is change always obvious to our unaided eye? Does the Sun change? Do the wings on a gnat change? What tools would we need to observe these kinds of changes? Using a microscope for tiny specimens is possible in an elementary school. Using a telescope for more distant changes may not be. Inviting an astronomer with a telescope and sun filter would be a good means of watching the Sun. However, do not try to do this without an expert. Looking at the Sun through a telescope will instantly, painfully, and permanently blind the observer!

Talk to the students about what the tools of inquiry are: Asking questions like these to fuel understanding, being curious and using science to guide you to answers, is known as the Spirit of Inquiry. There are many things we could ask here about the world outside, such as how do trees survive the winter or where do the birds really go and when? Let us make some lists of questions we would like answered about changes in the world. For how many of these do we really think we might find answers?

How do people find answers to questions? Many people ask other people or read books. Others look on the Internet or watch a television program about it. And still others, scientists, create ways of discovering answers by careful observation. We will be scientists, by going outside and experiencing things for ourselves, so that when we do find answers, they are our own. We must be able to think about things and not be afraid to ask questions about them. Without a question, there is no inquiry. Without inquiry, there is only reading someone else's data from books.