Inquiry with Anything

Science Teaches You To Ask Questions. Right?

Objectives

1. Have students develop testable questions that can be answered by their own investigations
2. Develop activities to be completed in a short time frame based on student questions
3. Cover content as well as process
4. Enable students to develop their own unique investigations with simple materials
5. Recognize how student investigations are the same or differ from what scientists do
6. Have students ask and answer inquiry questions following or preceding cookbook activities

Material List

1. Any thing that you have *lots* of. Weird is good, I like devil's claws, sweetgum balls, floating paperclips, straw rockets, eggs.
2. Any type of equipment you have, including Popsicles sticks, baby food jars, peanut butter jars, beakers, graduated cylinders, spring scales, balances, etc.

Procedure

1. Present any phenomena, cookbook activity, or peculiar object to the students, e.g., Cartesian divers, floating paper clips, seed pods, dirt, flowers or just about thing. The key is to have enough materials for every student to investigate.

2. In groups of two or three, the students ask as many questions as they can about the object or phenomena you have shown them. I allow about 2 minutes for this. If some students know the "answer" I remind them that this can turn off their brain. For this reason I do not divulge anything about the phenomena.

3. Make a master list of student questions. Each group adds one question to the master list until every group has presented at least one question. I allow about 4 minutes, it is not necessary to list every single question, just enough for variety.

4. Group the questions into those that can be answered by looking in a book or asking an expert, and those they can only be answered by experimentation.
I just put a "B" by those that can be answered by looking in a book or asking an expert. I put an "I" by those that can be answered by an investigation. "G" by the really great essential questions that are looking for big ideas, but cannot be answered with a single experiment. These are the why questions. (Essential questions lend themselves to hypotheses, but that is another strategy.) "N" for questions not within the realm of science, they are opinion, or personal preference, like "are devil's claw flowers more beautiful than wild onion flowers?" Some might argue that these can be tested using survey's.

5. Students look for commonalities in the way questions are phrased. All of the questions that can be answered only by investigations tend to fall into certain patterns. This takes about 3 to 5 minutes.

If students do not come up with these questions I give them some question starters, for example will it...; what will happen if I ...; how will it react to ...; what are the effects of...; does it ... I have students complete a few of these orally. For example: "What will happen if I put soap in the water." With immature students the starters with the personal pronoun,I, seem to work best. Recall in journalism students are taught to ask who, what, where, when, and why. In science the question starters are a little more complex, but the starters can be taught. When students ask, "why" or "how does it..." I congratulate them. These are the questions that scientists really want to answer. However, only rarely can these questions be answered by a single experiment. It may take 100s or even 1000s of experiments and many years to find these answers. These are the great questions, but I want the students to ask questions that can be answered by investigating.

4. Have students make a master list of "Question Starters" for science investigations in their journals. They should add to this list throughout the year. This list of "Question Starters" is best kept at the back of their journal for easy retrieval. Examples: who; what; where; when; why; how; will it...; what will happen if I ...; how will it react to ...; what are the effects of.... This takes about 3 to 5 minutes. I have them use the last 3 or 4 pages of their notebooks so the questions will always be in the same place.

5. Students return to their groups. Using these question starters they generate a whole new set of questions that can only be answered by experimentation. I usually give them only 2 or 3 minutes. Remember, everything is to move quickly so students can see the whole.

6. The student groups (I prefer groups of two) chose one question that they can answer using the available equipment in one class period. It does not matter than some groups are trying to answer the same question. This takes about 1 or 2 minutes. For safety reasons I approve their procedure before they can proceed. I can do this as they are choosing since some students choose more quickly than others.

7. Each group completes the investigation. As they are completing the experiments I move around the room asking, how the experiment is related to the concept I am trying to teach.

I prepare my content questions prior to the activity and commit them to memory. For example if I am working with floating paper clips to study surface tension I provide information on surface tension in the form of a model before presenting the method of floating paper clips. Some student's will probably ask, "will two paper clips float." (they will and they usually join one another if the surface is relatively small). I will ask the students how does this behavior match with the model we have studied. Or if the student volunteers that that the paper clips do this because they are magnetic, I will ask how this hypothesis could be tested. Most students will notice that the water is not perfectly horizontal around the paper clip. I will ask how this observation could be explained by our model. Some students will ask, Will it float if I shake the water. I will ask, what does this indicate about the strength of surface tension. For older students I will have them explain this in terms of molecular interactions. I have done this activity with 2nd

graders and college students, the only difference was in the type of questions I asked and the sophistication of the answers I received. The observations and questions the students ask were very similar.
If I am working with seed pods. My questions focus on the advantages of shape, size, floating ability or anything else students investigated. I ask how their results are related to the adaptations of the plant. In other words, if they find that the seed pod will always fall a certain way I ask how this would be advantageous to the plant? Thinking of the questions ahead of time will enables me to relate what the students find to what I want them to learn. For me, this is the hardest part of the activity.

8. Each group reports on the results of their experiment, restating the question and providing an answer to that question.

9. Each group relates their results to a big idea that are related to the content being studied. If the students had "why" questions at the first of the activity, now is the time to see if there are some answers. Usually, I need to prompt them with my own questions. The students must provide the evidence for their answers. These reports generally last only a minute or two and are oral.

The most difficult part of this process is determining the prompt questions. This has to be done ahead of time. The more often you work with a given topic, the easier this is as you will be able to anticipate many of the things students will investigate.

10. Individual students reflect on the steps they took to in this investigation in their journal. They write the steps followed during this investigation and compare their own steps with the steps of other students.

In order to get students started I ask them, what is the first thing we did today. What did we do next? I prefer that students do this independently and in writing. (Students should come up with a list of steps that are essentially the same as the "scientific method." The difference, these steps are theirs, not something they have memorized.) Students will add to and subtract from these steps as they work with other activities. This will become their method of solving problems.
If your students are not familiar with this type of reflection, have them quickly draw a tree, not a specific tree just any tree. Then ask," what did you do first", "what did you do second", and so on. Different students will follow different steps, this is a good thing. In biographies and autobiographies of successful people from business people to scientists, there is an indication that most of them have internalized the steps to success and can easily articulate these steps. This type of reflection allows students to internalize what steps they are taking to be successful. Students need to repeat this process often enough to see the patterns of steps they use to complete different types of tasks.

11. Make a master list of steps asking different students to add to the list of steps. I like to let my weakest students go first so they will have something to contribute. This is best done using some medium that will allow you to add and modify steps as students report on the steps they use. steps or draw arrows to move steps. This will look very messy, but I use this to show students that everyone sees the process differently.
Students usually say something like, I did this first ..... Another might say , that was not what I

did first. That was the second thing I did. This shows students that each person can view the process as they see it. There is no set of steps that is the "correct" way.

12. Students compare their own work to the work done in science.

Questions I ask to encourage them to compare include the following:
How are the steps you did alike or different from the steps in the "scientific method" described in the book. How is what we did like are different from the way scientists work? If two groups did the same investigation, did they get the same results? Does this happen in science? (If they say yes this is good, it means they did the same thing in the same way. This is what scientists strive for. If they say no, this is good. This happens in science, it means the scientists need to go back to compare what they did differently.) The answers to these questions are from the students perspective, so all answers are acceptable.
This type of quick open-ended investigation can be used anytime you have enough materials for students to use. Be sure to approve all procedures before students begin their investigations. The demands on the students can be increased so you are leading students wherever they are ready to go. You might say, "You can chose only questions that produce quantifiable results." You might require more control over variables, the use of control groups, more precise measurements, graphing, statistical analysis of data to determine reliability, producing a hypothesis with justification, or anything else that is appropriate for your students. For more complex projects you can have the students write out their procedures requiring your sign off before they begin. You can add in a research component requiring the students to find the explanation for the phenomena in books prior to or after the investigation. No matter what they find, they should be able to supply some reasonable connection to their own experiment.

For the best results, do the complete procedure with an adult or older child ahead of time. One who does not "know the answer" is best. Note the type of questions that they are asking. Questions tend to be the same across age groups, especially if students are limited to the materials they can use.

For ideas using simply materials check out books on discrepant events, science magic, science for young children, or everyday science. There are hundreds of these available; most have interesting activities completed with inexpensive equipment.

Use this strategy throughout the year in each topic. Parts can be used with traditional labs. For example, after a traditional lab is completed ask students to use their question starter list and come up with more investigations. When studying abstract concepts like protein synthesis, have students complete some question starters even though they will be unable to complete the investigation. These short investigations allow students to see the process of science as a whole, rather than bits and pieces they will have to synthesize at a later date. These investigations allow students to lead. No matter how trivial an investigation appears to be it can added to the whole. This is what science is about.

Work toward written reports. The following was shared by a teacher.
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/InquiryWorksheet

Time for the science fair again, students should be able to come-up with investigations that are real investigations in one evening. They may not be the greatest, but they will certainly be less painful to the elementary teacher who is trying to get 24 second graders to do different projects or to the high school teacher who is trying to motivate 150 secondary school students to participate in a fair.

Extensions/Additional Comments

This type of inquiry must be used several times with different things before students "get it." Using this type of open-ended inquiry and increasing demands each time can lead students wherever they are ready to go. You might say, "You can chose only questions that produce quantifiable results." You might require more and more controls, more precise measurements, graphing, statistical analysis of data to determine reliability, or anything else that is appropriate for your students.
Follow up inquiry activities

acid and bases
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/Inquiryacidsandbases

diffusion
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/InquiryDiffustion

the mechanics of breathing
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/Breathing

on voodoo This one can easily lead to a discussion of variables.
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/InquiryWhoDoVoodoo

density
http://www.curriki.org/xwiki/bin/view/Coll_VirginiaMaloneet/IsyoureggrottenAdensitystudy

One activity is not enough to get across the point that different types of questions require different answering strategies. This is true for teachers as well as students. I have done this many times with teachers and students from grade 2 to college. The more activities they do the better they become at understanding the processes they use.

At science fair time students can come up with their own projects even if their parents are science illiterate. Since many students do their projects the night before, this allows them to choose something they can actually do the night before that is an inquiry type activity.

Assessment

Students produce questions and answer them when given an activity, phenomenon, or object.

Scoring

1. No questions are asked that can be answered by experimentation.
2. Questions can be answered by experimentation.
3. More than one question is stated and each indicates how the answer might be obtained i.e., look on the internet, experiment, ask an expert.
4. Any chosen question is actually answered by experimentation.