Young Children’s Views of Science Questionnaire

Young Children’s Views of Science

Name: ________________________________

Grade Level: _____________

Date: ___________________

Instructions for a teacher / a researcher

• This questionnaire is designed for students who have limited reading and writing abilities.

• It is best to interview a small number of students (3-4) at a time. It is also recommended that the interviews take place during two meeting periods of 30-45 minutes each.

• Please record students’ responses to each question with notes and audio-taping.

• Remind the students that there are no “right” or “wrong” answers to the following questions.
PART I.

[This first set of questions is used to establish that the child has some knowledge of what Science is as opposed to other disciplines so that when their opinions are asked during the rest of the interview the interviewer has faith that the child is referring to science. They also serve to establish a conversational rapport with the students. Disregard the rest of a child’s responses if it becomes clear that the child’s opinions are about something they clearly have no knowledge about. If you are conducting these interviews over a two-day period then you can choose to not involve these students in the second part]

Can you tell me something you know about science?

Do you ever learn about science in school?

Can you tell me what you learned?

Have you ever learned about science somewhere else other than school? Where? What did you do?

How is science different from other things you learn about?

You have been telling me many things about science. So, “What is Science?”

What is a Scientist?

What do they **Do**?

**How** do they do their work?

Have you ever seen a scientist?

Do you know one?

What do they do?
PART II.

1. Tell the students that you are going to show them something and that you want them to watch very carefully. Drop the two different size paper helicopters one at a time (see attachment).

   Ask each child to make one observation and then one inference about what they just saw.

   Then ask: Was what you just watched a scientific investigation? Why? Why not?

   If they say it wasn’t, ask them what they would need to do to make it into an investigation.

2. There was a woman who loved birds. She traveled around the world to study them. As she traveled she noticed that birds had many differently shaped beaks. For example, some were long and thin, some were big and sharp, and some were tiny and short. She also observed that birds ate different types of food.

   She asked the question, “Is there a connection between birds’ beak shapes and the types of food they ate?”

   (a) Do you think she was working like a scientist? Why or why not?
   (b) Do you think her work was an experiment? Why or why not?
   (c) What should she do next to answer her question?

3. How many of you know something about Dinosaurs? (Students will immediately start telling you everything they know about Dinosaurs…you can get some control of the discussion by saying: Each of you tell me one thing you know about dinosaurs….then go on to ask the following questions)

   (a) How do scientists know that dinosaurs really lived since there are no dinosaurs around anymore and no one has ever seen them?

   (b) What do scientists think dinosaurs looked like? Why do scientists think they look this way?

   (c) Scientists don’t always agree on the reasons about what happened to make the dinosaurs all die away. Why do you think they don’t agree?

   (d) If your friend said that he knew the reason for what happened to the dinosaurs, what would he have to do to make scientists believe him? Why?

   [Alternative Question: If the students are too distracted by the dinosaur question then you might choose to use this one instead:]
How do the people who predict the weather on TV use science?

How do they decide what the weather will be today?

Weather reporters don’t always agree with each about the weather? Why do you think they disagree?

4. You have all told me know about a lot of different facts and ideas about science.
   
   (a) Do you think scientists will change their minds about these same science facts years from now? Why?
   (b) Can you give me an example of some science idea that might change in the future?

5. Do you think that scientists are creative when they do their work? Can you give me an example?

   When do you think they are creative when they are doing an investigation?
Directions for Paper Helicopters Used with Question #1

1. Cut out the pattern, cutting along all solid line.
2. Fold “A” inward.
3. Fold “B” inward.
4. Fold “C” upward.
5. Fold “D” backward.
6. Fold “E” forward.
7. Hold with flaps up and drop from a high place.
**Overview of Assessed Aspects of NOS and Scientific Inquiry**

<table>
<thead>
<tr>
<th>Tentativeness (NOS)</th>
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<tbody>
<tr>
<td><em>All scientific knowledge is subject to change.</em></td>
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<tr>
<td>Scientific knowledge is never absolute or certain. This knowledge is tentative and subject to change as a result of new observations and with the reinterpretation of existing observations. Scientific claims change as new evidence, made possible through advances in <em>theory</em> and technology, is brought to bear on existing theories or laws, or as old evidence is reinterpreted in the light of new theoretical advances or shifts in the directions of established research programs.</td>
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<tr>
<th>Subjectivity (NOS)</th>
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<tr>
<td><em>Scientific knowledge is partly a function of individuals’ backgrounds, beliefs, preferences, knowledge.</em></td>
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<tr>
<td>Scientific knowledge is subjective. Scientists’ beliefs, previous knowledge, training, experiences, and expectations actually influence their work. The development of questions, investigations and interpretations of data are filtered through the human minds of scientists. Subjectivity is apparent in the creativity scientists employ in designing investigations to answer their questions as well as in the organization and analysis of data.</td>
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<th>Observations vs. Inferences (NOS)</th>
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<tr>
<td><em>All scientific knowledge is composed partly of observation and partly of inference.</em></td>
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<tr>
<td>Observations are gathered through human senses or extensions of the senses. Inferences are interpretations of those observations.</td>
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<tr>
<th>Empirical Basis of Science (NOS)</th>
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<tr>
<td><em>Scientific knowledge is at least partially developed from reference to the empirical world.</em></td>
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<tr>
<td>Scientific knowledge is, at least partially, based on and/or derived from observations of the natural world.</td>
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<th>All investigations begin with a Question (SI)</th>
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<tr>
<td>Scientific investigations involve asking questions, answering a question and comparing the answer with what scientists already know about the world.</td>
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<tr>
<th>Scientists Collect Empirical Data to Answer their Questions (SI)</th>
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<tbody>
<tr>
<td>Science distinguishes itself from other ways of knowing through the use of empirical evidence as a basis for explanations about how the world works. Scientists concentrate on getting accurate data from observations of phenomena.</td>
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<tr>
<th>Data and Prior knowledge are used to Answer Questions (SI)</th>
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<tbody>
<tr>
<td>Scientists develop explanations using observations (evidence) and what they already know about the world (scientific knowledge).</td>
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<tr>
<th>There is No Single Scientific Method (SI)</th>
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<tr>
<td>No single set or sequence of steps characterizes all scientific investigations. In addition to classic Experimental design, Descriptive and Correlational investigations are also valid methods to develop scientific knowledge. Scientists use different kinds of investigations depending on the questions they are trying to answer.</td>
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<tr>
<td>Aspects of NOS and SI addressed:</td>
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<td>Tentativeness (NOS)</td>
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<td>Subjectivity (NOS)</td>
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<td>Observation vs. Inference (NOS)</td>
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<tr>
<td>Empirically-based (NOS)</td>
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<tr>
<td>Begin with a question (SI)</td>
</tr>
<tr>
<td>Collecting data to answer (SI)</td>
</tr>
<tr>
<td>Using data and prior knowledge (SI)</td>
</tr>
<tr>
<td>No single scientific method (SI)</td>
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### Categories of Understanding for Aspects of NOS and SI

Students’ views of Scientific Inquiry and Nature of Science aspects are categorized into naïve or informed based on the following criteria:

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<th>Naïve:</th>
<th>Informed:</th>
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<tr>
<td>Student’s response is not consistent with any part of NOS or SI aspect.</td>
<td>Student’s response is consistent and addresses most parts of NOS or SI aspect.</td>
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</table>
Detailed Explanation and Sample Responses

EACH QUESTION ON THE FOLLOWING PAGES IS FOLLOWED BY A DESCRIPTION OF WHAT IS BEING ASSESSED AND WHAT IS CONSIDERED TO BE AN ANSWER CONSISTENT WITH REFORM DOCUMENTS AND CONTEMPORARY VIEWS ABOUT SCIENCE. “SCORING” OF ANSWERS IS NOT MEANT TO YIELD A NUMERICAL VALUE, BUT RATHER A DESCRIPTION OF WHETHER THE RESPONDENT HAS A “NAÏVE” OR DESIRED “INFORMED” VIEW.

Young Children’s Views of Science

Name: ________________________________
Grade Level and /or Age: ___________________
Date: _________________________________

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- Please record students’ responses to each question with notes and audio-taping.

- Remind the students that there are no “right” or “wrong” answers to the following questions.
PART I.

Can you tell me something you know about science?

Do you ever learn about science in school?

Can you tell me what you learned?

Have you ever learned about science somewhere else other than school? Where? What did you do?

How is science different from other things you learn about?

This first set of questions is used to establish that the child has some knowledge of what Science is as opposed to other disciplines. Therefore, when their opinions are asked during the rest of the interview, the interviewer has faith that the child is referring to Science. They also serve to establish a conversational rapport with the students. Disregard the rest of a child’s responses if it becomes clear at this point that the child’s answers show they clearly have no knowledge of Science. If you are conducting these interviews over a two-day period you can choose to not involve these students in the second part.

A. You have been telling me many things about science. So, “What is Science?”

Complete responses should include references to both a body of knowledge (life, physical, earth and space content, etc.) and methods and process (observing, experimenting, measuring, etc.) for the development of the knowledge. Students’ responses often include the science content they are currently studying or happen to be interested in.

An informed response should refer to reliance on data from the natural world (empirical basis), and systematic or organized approach to collection of data. An example of an informed answer is, “In science you just don’t say something, you collect data and have to think about it and have to figure it out.”

It is common for students to focus only on the specific subject matter that is being studied at the time or objects about science that are on view in the classroom. They might also refer to something they have seen on television or at an informal site such as a zoo or museum especially if they had recently visited one of these places.

Students are likely to naively state that science is only about mixing, experimenting and blowing things up. That is it follows a single method (the scientific method).

Students will most likely not refer to anything related to epistemology or characteristics of the knowledge that results from the processes. Rarely do young children refer to science as a “way of knowing” nor is this expected at this age.
B. What is a Scientist?

What do they Do?

How do they do their work?

Have you ever seen a scientist?

Do you know one? What do they do?

This set of questions targets views of what scientists do when they “do science” and focus on students’ understanding of Scientific Inquiry. Typical responses describe activities that might include investigate, experiment, ask questions, make observations, collect and analyze data, and use what they know and found out come to conclusions. Informed answers also address scientists “thinking” about things they observe and coming up with “new ideas” and “inventions.”

Naïve responses that are too general include mixing up chemicals, blowing things up, or making potions.

Follow up should probe for more specific examples of what other types of investigations scientists (i.e., non-experiments like wolves in the wild) can do and how scientists go about finding answers.

PART II.

1. Tell the students that you are going to show them something and that you want them to watch very carefully. Drop the two different size paper helicopters one at a time (see attachment or Appendix C).

Ask each child to make one observation and then one inference about what they just saw.

Then ask: Was what you just watched a scientific investigation? Why? Why not?

If they say it wasn’t, ask them what they would need to do to make it into an investigation.

Students should be able to identify and distinguish between observations and inferences. Some examples of students’ observations include “the smaller one hit the ground first” or the smaller one “twirled faster than the larger one.” Inferences made include “the air kept the larger one up” and “the air made them twirl” or that the bigger one is “too heavy to spin fast.”

Students with informed views will recognize that this is not an investigation since this activity was not driven by a question. Students with naïve views will identify any hands–on activity or fun observation as an investigation. Student responses with informed views might include that a question is needed to begin an investigation and that they would need to collect data, make observations and try to answer their question with this new data and what they already observed about the paper helicopters.
2. There was a woman who loved birds. She traveled around the world to study them. As she traveled she noticed that birds had many differently shaped beaks. For example, some were long and thin, some were big and sharp, and some were tiny and short. She also observed that birds ate different types of food.

She asked the question “Is there a connection between birds’ beak shapes and the types of food they ate?”

(a) Do you think she was working like a scientist? Why or why not?
(b) Do you think her work was an experiment? Why or why not?
(c) What should she do next to answer her question?

Students should recognize that she was acting scientifically because she was making observations and inferences and collecting and analyzing data to help answer her question. Since all investigations begin with a question, her work was scientific because it was guided by her question.

This question examines students’ views of an experiment as being a general scientific activity or a specific scientific procedure. Experiment in science is that procedure that involves identification and manipulation of variables and use of controls. Experiments seek cause/effect relationships by changing only one variable in the system and measuring/observing the effect of that change. This example of beak shape and food selection is not an experiment; rather it is a Correlational investigation. There is no manipulation of the beak or food source. The correlation between the beak shape and food source is found through repeated observation, not experimentation. Young children probably won’t use this term but may say instead that there are “lots of ways scientists do their work...sometimes they just look at things for a long time to get answers to their questions.”

Students with naive views of investigations will describe this activity as experimental because observations and conclusions were made or may not consider this work scientific at all because it was not an experiment.

To support this scientist’s hypothesis, students’ suggestions should include situations that will add more empirical data to analyze such as traveling to other locations, comparing more birds or feeding them different types of foods. Students may mention making more observations and inferences, and adding this new information to what the scientist already knew to answer her question.
3. How many of you know something about Dinosaurs?

(a) How do scientists know that dinosaurs really lived since there are no dinosaurs around anymore and no one has ever seen them?

(b) What do scientists think dinosaurs looked like? Why do scientists think they look this way?

These questions focus on the roles of observation and inference in science and that they use the data and what they know to answer questions. Informed answers would include that scientists have some data, made observations and have inferred from this data what dinosaurs looked like. Informed answers include students talking about how scientists “use their brains to think more about what they observe” and that “they found these big bones and figures it had to come from a great big animal.”

Answers to 3a and 3b may also allow you to determine whether a student understands that the development of scientific knowledge (via inferences) involves scientists collecting data to answer their questions. Young children may naively say that the scientists saw pictures of the dinosaurs in books or on television so that is how they know what they look like. An example of a more informed answer is that “the scientists observed dinosaur bones or fossils and then tried to put them together like other animals they could see….if they saw different animals then they put them together like them.”

(c) Scientists don’t always agree on the reasons about what happened to make the dinosaurs all die away. Why do you think they don’t agree?

This question reflects students’ views about the subjective and tentative nature of science. The informed response would reflect some understanding that different scientists bring different backgrounds, experiences and ideas to the interpretation of data. An informed answer might be, “they are all different and know different stuff and don’t have the same brains” or that “they don’t have to agree, maybe they just look at the bones and think different about them and put them together in different ways.” Naïve responses include statements such as “they don’t like each other” or “somebody is right and tells the other scientists they are wrong and they get mad at each other” or “they don’t have to agree if they are friends.”

It is important to discern whether the student understands that different interpretations do not necessarily mean that someone is right and someone is wrong. This is a difficult idea for young students.

(d) If your friend said that he knew the reason for what happened to the dinosaurs, what would he have to do to make scientists believe him? Why?

The informed answers should reflect students’ understanding of the empirical nature of science, that scientists collect data to answer their questions and that data and prior knowledge are used to answer their questions. Examples of informed answers include, “he would have to find more bones or the whole
thing and show them” and “she would need to show them that her idea was better than theirs because it made more sense than theirs because she had more proof”. Naïve answers include “I’d tell him to go on television and tell them on the news” or “interview a caveman” or “no one will believe a little kid.”

4. You have all told me know about a lot of different facts and ideas about science.

Do you think scientists will change their minds about these same science facts years from now? Why?

Can you give me an example of some science idea that might change in the future?

This question focuses on the idea that all scientific knowledge is tentative or subject to change. So, you are looking for the students to agree that the knowledge will possibly change. Naïve answers involve students saying that “scientists are smart and they are always right” or “some things about science change like the weather everyday but the sun and moon won’t change.”

On a superficial level, most students will recognize that knowledge changes because we now know more due to additional experiments/investigations, new evidence or the availability of new technology. A more in-depth, but not common, answer would include the idea that knowledge changes because scientists view the same data in a different way than before.

Students’ examples of science knowledge include finding new ways to help other people, finding cures for diseases such as cancer, finding alien life on other planets or new technologies including new types of televisions or being able to time travel.

5. Do you think that scientists are creative when they do their work?

Can you give me an example?

When do you think they are creative when they are doing an investigation?

The desired answer here is “yes” and most students will answer this way. However, students’ responses to the other parts of this question will give you more information about the adequacy of students’ beliefs.

This question gives students another opportunity to talk about what they think scientists do and how they work. Students with informed views will talk about how scientists “ask questions and think about the things they observe or the data they collect and try to answer their questions or find new stuff out.” Naïve responses will include notions of “mad scientists” blowing things up and making potions.

Most students will only understand, or at least say, that scientists use their creativity and imagination in the planning of investigations. Few students in these grades will tell you that scientists use creativity and imagination during an experiment/investigation and in the interpretation of data and reporting of
results. However, informed students will say that “scientists observe and think about things and have their own ideas about things.”

This question relates back to students’ understanding of how creativity, subjectivity, and inference permeate all of science.