Science Teacher Inquiry Rubric (STIR)

Directions: Reflect on the science lesson that you taught today. In your reflection, consider each of the following categories and the six statements on the left, written in bold. After looking at each bold statement, assess today's science instruction based on the categories delineated for statement. Place one "X' in the corresponding cell for each bold-faced statement. If there is no evidence of one of the statements in today's lesson, place a slash through the bold-faced statement. When you are finished, you should have 6 total responses.

Learner Centered ⟷ Teacher Centered

Learners are engaged by scientifically oriented questions.					
Teacher provides an opportunity for learners to engage with a scientifically oriented question.	Learner is prompted to formulate own questions or hypothesis to be tested. ☐	Teacher suggests topic areas or provides samples to help learners formulate own questions or hypothesis. ☐	Teacher offers learners lists of questions or hypotheses from which to select. ☐	Teacher provides learners with specific stated (or implied) questions or hypotheses to be investigated. ☐	No evidence observed. ☐
Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.					
Teacher engages learners in planning investigations to gather evidence in response to questions.	Learners develop procedures and protocols to independently plan and conduct a full investigation. ☐	Teacher encourages learners to plan and conduct a full investigation, providing support and scaffolding with making decisions. ☐	Teacher provides guidelines for learners to plan and conduct part of an investigation. Some choices are made by the learners. ☐	Teacher provides the procedures and protocols for the students to conduct the investigation. ☐	No evidence observed. ☐
Teacher helps learners give priority to evidence which allows them to draw conclusions and/or develop and evaluate explanations that address scientifically oriented questions.	Learners determine what constitutes evidence and develop procedures and protocols for gathering and analyzing relevant data (as appropriate). ☐	Teacher directs learners to collect certain data, or only provides portion of needed data. Often provides protocols for data collection. ☐	Teacher provides data and asks learners to analyze. ☐	Teacher provides data and gives specific direction on how data is to be analyzed. ☐	No evidence observed. ☐

Learners formulate explanations and conclusions from evidence to address scientifically oriented questions.					
Learners formulate conclusions and/or explanations from evidence to address scientifically oriented questions.	Learner is prompted to analyze evidence (often in the form of data) and formulate own conclusions/ explanations. ☐	Teacher prompts learners to think about how analyzed evidence leads to conclusions/explanations, but does not cite specific evidence. ☐	Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to draw conclusions and/or formulate explanations. ☐	Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to lead learners to predetermined correct conclusion/explanation (verification). ☐	No evidence observed. ☐
Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.					
Learners evaluate their conclusions and/or explanations in light of alternative conclusions/ explanations, particularly those reflecting scientific understanding.	Learner is prompted to examine other resources and make connections and/or explanations independently. ☐	Teacher provides resources to relevant scientific knowledge that may help identify alternative conclusions and/or explanations. Teacher may or may not direct learners to examine these resources, however. ☐	Teacher does not provide resources to relevant scientific knowledge to help learners formulate alternative conclusions and/or explanations. Instead, the teacher identifies related scientific knowledge that could lead to such alternatives, or suggests possible connections to such alternatives. ☐	Teacher explicitly states specific connections to alternative conclusions and/or explanations, but does not provide resources. ☐	No evidence observed. ☐
Learners communicate and justify their proposed explanations.					
Learners communicate and justify their proposed conclusions and/or explanations.	Learners specify content and layout to be used to communicate and justify their conclusions and explanations. ☐	Teacher talks about how to improve communication, but does not suggest content or layout. ☐	Teacher provides possible content to include and/or layout that might be used. ☐	Teacher specifies content and/or layout to be used. ☐	No evidence observed. ☐

MATTER INQUIRY UNIT

Grade Level: 2^{nd} Grade (ages 7-8 years)

National Standards:

Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Physical Science

- Properties of objects and materials
- Position and motion of objects

Connecticut Standards: Development of *wonder* about the natural world and the ability to observe, describe and apply basic process skills

Inquiry: How is scientific knowledge created and communicated?

- Scientific Inquiry (PK-2)
- Scientific Literacy (PK-2)
- Scientific Numeracy (PK-2)

Properties of Matter: How does the structure of matter affect the properties and uses of materials?

- Properties of Objects (K.1)
- Properties of Materials (2.1)
- States of Matter (3.1)

Forces and Motion: What makes objects move the way they do?

- Position and Motion of Objects (1.1)

Process Skills:

- Observe
- Classify
- Measure
- Communicate
- Predict
- Estimate
- Draw Conclusions
- Record data
- Interpret Data

Vocabulary:

- Matter
- States of Matter
- Solids
- Liquids
- Gases
- Properties
- Mass
- Volume
- Buoyancy
- Density
- Mixture
- Dissolve

Unit Outline: *Through the 5E learning cycle the students will ENGAGE, EXPLORE, EXPLAIN, ELABORATE, and EVALUATE. After reading from their textbooks and discussing appropriate material and vocabulary, these inquiry lessons facilitate learning on different levels for different learning styles. Through inquiry, students are able to engage with classmates and develop understanding with hands-on learning. With subtle shifts these inquiry lessons are student-centered, teacher-centered, or a combination of both to support different objectives for learning.*

Engage: Mystery Matter

Students will develop their sense of wonder and use their senses of sight, touch, and hearing to describe mystery objects in bags and on slides under the microscope. Students will record their observations in their science notebook.

Time: *2 classes of 40 minutes*

Explore: Dancing Raisins

Students explore raisins and grapes bobbing up and down in club soda. Students will make observations of the club soda and then predict what will happen to the raisins and grapes when they are added. Students will discover why the raisins and grapes dance in the soda.

Time: *40 minutes*

Explain: Properties of Matter

Students will learn to identify and categorize matter into different groups. Students will categorize matter by shape, size, weight, and understand the different properties of matter. Students will use different scientific tools to measure matter and observe their properties. Students will discover that liquids take the shape of their container and objects sink and float.

Time*: 3 classes of 40 Minutes (or 4 classes of 40 minutes with extension lesson)*

Elaborate: Mixing Matter & Reactions

Students will discover that when different kinds of matter are mixed they can have a reaction with each other. Students observe that when Mentos are added to diet soda gases are released quickly. Students also discover that when different ingredients are mixed together and heat is added, a new kind of matter is formed.

Time*: 3 classes of 40 Minutes*

Evaluate: Science Journal Evaluations

To evaluate students progress and understanding of the concepts covered.

Science Notebook Assessment Sources

- **www.sciencenotebooks.org**
  Self-Assessment & Scoring Rubric
- **www.exploratorium.edu/ifi/workshops/assessing/index.html**
  Exploratorium Institute for Inquiry: Assessing for Learning

Engage: Mystery Matter

Students will develop their sense of wonder and use their senses of sight, touch, and hearing to describe mystery objects in bags and on slides under the microscope. Students will record their observations in their science notebook.

Time: 2 classes of 40 minutes

Introduction: (10 -15 minutes)
As students gather, either on a rug or at their tables, introduce the concept of matter to the students. Quickly discuss that matter is everything around us as the pieces of material that make up things. Name things around the room and ask the students if it is matter. Soon students will understand that everything is matter. Solid things, liquid things, and even the air we breathe. On the board, have students create a list of items that can be categorized as Solids, Liquids, and Gases. Then give the general plan for the activity. The set-up around the classroom or on the tables will develop a sense of wonder for each student. Tell them they will be working in pairs, using their senses, to discover different kinds of matter. They will travel around the classroom to the 8 – 10 stations and record their thoughts and observations in their science notebook. Remind them not to look at items in the paper bags. They should use their sense of touch, hearing and smell. As for the stations with microscopes, inform the students that these are the only stations where they can use their sense of sight, but they are not allowed to remove the items from the microscope slides. Set Science Notebook expectations.

- ✓ Focus: Mystery Matter – Record the # at each station
- ✓ Date
- ✓ Observational drawing and ideas– labeled and add detail
- ✓ Prediction: What is the mystery matter?

Safety Rules: Do not put objects in mouth. Do not open container with liquid. Don't peak inside the paper bags.

Inquiry Activity: (20-25 minutes – 5 to 8 minutes @ each station)
Materials:

- 7 paper bags labeled with Mystery Matter # and clues**
- Classroom items for each paper bad (paper clip, measuring cup, ball, yo-yo, Velcro)
- 1 small filled balloon
- 2 microscopes
- Slide with salt crystals taped onto it and labeled with Mystery Matter #
- Slide with pieces of a leaf taped onto it and labeled with Mystery Matter #
- Container with tight lid
- Liquid (oil, colored water, vinegar, juice, etc.)
- Mystery Matter signs for items without paper bags

** You can write clues on paper bags and Mystery Matter signs to help students focus their observations. Feel free to change the Mystery Matter items, just make sure you have solids, a liquid and something with a gas.**

Give each student a Mystery Matter Science Notebook. Assign the pairs to a station and tell them they have 5-8 minutes at each station. Remind them to use their senses, except they cannot peak into the paper bags. Give a 2 minute warning before students move to the next station so that they can write down their final thoughts and observations. Rotate the groups around the class so that the groups follow in numerical order (#1 to #2, #2 to #3, #3 to #4 … #10 to #1). This activity will take two classes. Open the container with the liquid and allow students to safely smell it by wafting the sent up to their nose with their hands. You will have to demonstrate this to the students. On the second day have the groups go to the next station. Stations should be set up in the same places.

Sharing: (5 minutes)
Briefly ask students some descriptive words that can describe what they felt, heard, smelt, or saw without telling their predictions for each Mystery Matter. Form a list of words and inform the class that these are the properties of the items. Discuss the properties of matter and inform that they will continue to discover what the rest of the Mystery Matter is next time. At the end of the second day form another list of properties and announce each Mystery Matter. Make sure to conclude that matter is anything that takes up space and has weight. Review the vocabulary solids, liquids, and gases. Make sure students understand that solids have their own shape and size, liquids take the shape of their container, and gases always fill the space inside a container. Have students complete the last page of their Mystery Matter science notebook, where they answer the question “What is matter?” and list the different phases of matter and their properties.

Example of Mystery Matter Science Notebook page

Investigator________________ Log Date _______

Mystery Matter #________
Draw what you see, hear, smell, or feel

Describe what you see, hear, smell, or feel
____
____
____
____
____
____

What do you think is your Mystery Matter?
____

Investigator________________ Log Date _______

What is matter? ____________________________
____

What are the three main phases of matter?
1. __________________
2. __________________
3. __________________

What are the properties or characteristics of each phase of matter?
Solid______________________________________
____
____
Liquid ____________________________________
____
____
Gas ______________________________________
____
____

Explore: Dancing Raisins

Students explore raisins and grapes bobbing up and down in club soda. Students will make observations of the club soda and then predict what will happen to the raisins and grapes when they are added. Students will discover why the raisins and grapes dance in the soda.

Time: 40 minutes

Introduction (5-10 minutes)
Gather the students and introduce the general plan for the activity. Tell them they will be working in pairs so observe different kinds of matter. Hint that there may be some surprising things happening they need to be very observant. You don't need to tell them anything about the club soda or raisins and grapes. They will figure out what the items are by their observations. This will also develop the sense of wonder for the students. Set Science Notebook expectations.

- ✓ Focus: Dancing Matter
- ✓ Date
- ✓ Observational Drawing – labeled and add detail
- ✓ Prediction: What is the liquid? What do you think will happen when solids are added to the liquid?
- ✓ 'I notice' & 'I wonder' statements: What do you notice? What do you wonder?

Safety Rules: Do not put objects in mouth. Do not tip over the glass.

Inquiry Activity (20-25 minutes)
Materials:

1 clear glass or container per group
Club soda (1 can with label covered per group or poured by teacher from larger bottle)
Raisins cut in half (3 or 4 raisin pieces per group)
1 or 2 grapes per group
Additional items: small dry pasta, lentils, buttons, beads, corn, etc.

If soda has not been poured already, have students pour the soda into their cups. Meanwhile ask the students about the bubbles. What are the bubbles? What are they made of? Encourage students to draw what they see and write their 'I notice' and 'I wonder' statements. (*The bubbles are pockets of gas that are in the soda.)*

Hand out the pieces of raisins to each group. Have the students predict what the raisins are and what will happen to them in the liquid. Let the students drop the raisins into the glass. What happened to the raisins? Ask the students to think about why they went to the bottom. Encourage students to draw what they see and write their 'I notice' and 'I wonder' statements. (T*he raisins should first sink to the bottom because they are heavier than the water. You can discuss density if it is appropriate with your grade level.*)

Encourage the students to keep their eyes on the raisins. Ask them what's happening? Go to each group and discuss what they have observed happening in their container. Make sure they are on the right track and if they aren't guide them with some additional questions. Encourage students to draw what they see and write their 'I notice' and 'I wonder' statements. (*The raisins should pop up as the bubbles of gas surround each raisin. The bubbles carry the raisin up to the top of the soda. When they are on the top of* *the soda the bubbles pop and the raisin loses its lift. They will then drop back down to the bottom. This will continue for a while.)*

Hand out the grapes to each group and do the same thing as with the raisins. The students will notice that even larger objects behave the same way when put in the soda.

If you have time, have the students dump out the first glass of soda and pour fresh soda into their glass. Give them additional items to test on their own, or continue this at a different time with additional items listed above.

Share Observations (10 minutes)
Gather students away from activity or remove activity from the tables. Ask students to share their observations. Ask each student to share something they noticed and something they wondered. Encourage each student to share in some way or another.

Adapted from PBS Kids Zoom
http://pbskids.org/zoom/activities/sci/dancingraisins.html

Explain: Properties of Matter

Day 1: Station: How can you sort matter?

Station: How can you measure matter?

Students will learn to identify and categorize matter into different groups. Students will categorize matter by shape, size, weight, and understand the different properties of matter. Students will use different scientific tools to measure matter and observe their properties.

Time: 40 minutes

Plan: 2 Stations with 2 set ups for each (Class divided into 4 groups)

Introduction: (10 minutes)
Gather the students away from the activity set up if possible. If not, cover the activity the best way you can. This will develop the sense of wonder for each student. Introduce the general plan for the activity to the students. Explain to the students that they will be working with a group to discover the properties of matter. Review with the students that a property of matter is a characteristic that describes matter. Review the list of things that described the Mystery Matter that were observed. Set Science Notebook expectations. Observational drawings can be used as a 'challenge' as student enrichment.

- ✓ Focus: Each station will have a card identifying the focus
  - How can you sort matter?
  - How can you measure matter?
- ✓ Date
- ✓ Prediction: Try and answer the focus question
- ✓ I notice & I wonder statements: What do you notice? What do you wonder?
- ✓ *Observational Drawing – labeled and add detail*

Safety Rules: Don't put objects in mouth.

Explain to the students that they will spend 10 minutes at each station and that each station has a sign with the focus question on it. Encourage students to share their observations with their classmates and work cooperatively to answer the focus question.

Inquiry Activity (20 minutes)
Materials:

Make sure you have enough materials for your students to share
Variety of items of different colors, shapes, and textures such as pipe cleaners, Velcro, marbles, blocks, balls, cups, crayons etc.
2 Balances
Plastic cm cubes
Gram weights of different sizes
Liquid and dry measuring cups of different measures
Graduated cylinders
2 containers – one filled with water and one filled with rice or sand
How to measure matter? Challenge Cards

Divide the class into 4 groups and have them find a station. While students sort matter encourage them to organize the objects in different ways. Challenge students to find objects on the counter while closing their eyes and their partner describes the object's properties. While students measure matter they will naturally explore the balance by putting different kinds of objects together. Encourage them to count how many cubes each object needs to make the balance equal on both sides. Challenge students to find different measurements of matter with the Challenge Cards. They will discover that different shaped items weigh the same amount and that the same amount of liquid looks different in different measuring cups. Move the students to each station after 10 minutes.

Example of Challenge Cards

CHALLENGE CARD
How to measure matter?

Find something weighs the same as 50 cm cubes
Find something weighs the same as 20 cm cubes
Find something weighs the same as 10 grams
Find something that weighs the same as 200 grams

CHALLENGE CARD
How to measure matter?

Measure 1 cup of water. Estimate how many ml is this equal to?
Measure 1 ½ cups of water. Estimate how many ml is this equal to?
Measure ½ cup of rice. Estimate how many ml is this equal to?
Measure ¼ cup of water. Estimate how many ml is this equal to?

Share Observations (10 minutes)
Gather students away from activity or remove activity from the tables. Ask students to share their observations. Ask each student to share something they noticed and something they wondered. Go through what they discovered after completing the Challenge Cards. Encourage each student to share in some way or another.

Explain: Properties of Matter
Day 2: What happens when oil and water mix?
Students will discover that liquids take the shape of their container and objects sink & float.

Time: 40 minutes

Introduction: (10 minutes)
Introduce the general plan for the activity to the students. Explain to the students that they will be introduced to three different liquids. Introduce vocabulary of 'liquid' as a phase of matter that takes the shape of its container. Create a list of different liquids. Have students come up with a list of properties of these liquids. Set Science Notebook expectations.

- ✓ Focus: What happens when different liquids mix?
- ✓ Date
- ✓ Prediction: Try and answer the focus question
- ✓ Observational Drawing – labeled and add detail
- ✓ I notice & I wonder statements: What do you notice? What do you wonder?

Safety Rules: Don't spill the liquids.

Inquiry Activity: (20 minutes)
Materials:

Safety goggles for each student
Cup of oil for each group
Cup of colored water for each group
Jar with lid for each group
Cup of dish soap
Pipette

Divide the class into groups and place the cup of water in front of each group. Ask the students to guess what the liquid is and share some properties of the water. They can make their observations in their science notebook. *(Water is a clear, odorless liquid)*

Then place the cup of oil in front of each group. Encourage the students to make observations of the liquid and share some properties that they observed. *(Oil is a thicker liquid that can have a yellowish color)*

Students can now put these two liquids together into the jar and close the lid. Remind them to be careful not to spill the liquids on the table. Go around to each group and make sure the lids are tightly secure. Let the students shake the container and take turns to make sure the liquids are really 'mixed' together. Students should observe what happens to the oil and water after they are shaken together. Ask them to record and describe what they observed in their science notebook. *(The oil and water will not mix; rather the oil will break apart and return to the top)*

While the students are working collect the empty cups. Ask why they thought the water and oil did not mix together? Have the students infer the inability of water and oil to mix by making observations.

Finally, ask the students to carefully open their jars and with a pipette drop a few drops of the dish soap inside. Don't tell them what this third liquid is yet. The students will observe the soap sink to the bottom as a 'blob'. Encourage the students to add more observations to their science notebook. Have the students tighten the lid on again and shake, shake,

shake. The oil, water, and soap will combine and the oil will turn into tiny droplets. Ask the students if they know what the third liquid was. You can bring the cup around for them to smell. The students will identify it as soap. Ask what the soap did to the oil and water. As a class, discuss how the soap was able to break up the oil into tiny droplets. Explain that this is why we use soap to clean dishes. Challenge the students to go and wash the dishes at home!

Share Observations (10 minutes)
Gather students away from activity or remove activity from the tables. Ask students to share their observations. Ask each student to share something they noticed and something they wondered. Encourage each student to share in some way or another.

Explain: Properties of Matter
Day 3: Does it sink or float?
Students will discover that liquids take the shape of their container and objects sink & float.

Time: 40 minutes

Introduction: (10 minutes)
Introduce the general plan for the activity to the students. Explain to the students that they will be introduced to different objects to test in water. Introduce vocabulary of 'liquid' as a phase of matter that takes the shape of its container. Ask students to tell you what it means to sink and float. Create a list of different objects they know float and sink. Set Science Notebook expectations.

- ✓ Focus: Does it sink of float?
- ✓ Date
- ✓ Prediction: Try and answer the focus question
- ✓ Observational Drawing – labeled and add detail
- ✓ Today in science I…
- ✓ I think the items sank because…
- ✓ I think the items floated because…

Safety Rules: Don't spill the water and if there are spills clean them up.

Inquiry Activity: (20 minutes)
Materials:

Gather a variety of different materials of different colors, shapes, and textures for each group.

Ping pong balls, golf balls, pencils, pens, markers, marbles, bouncy balls, cotton balls, Velcro, toy cars, pipe cleaners, tissues, paper towels, dish towel, silver spoons, plastic spoon, wooden spoon, plastic cup, glass cup, waxed cup, etc.
Container filled half way with water for each group
Laminated chart (see below for example) for each group
Markers for each group

Example of laminated chart

Sink or Float?

Object	**Predict**	**What happens?**
eraser	*Float*	*sink*

Before the students start, suggest sorting objects into piles of objects they think will float and sink. Ask students how they divided the objects into two groups. Encourage them to predict what they think will happen on the laminated chart with the markers. Students can test each item and list the objects that float and sink.

After completing the activity, encourage the students to describe the objects that float and the objects that sink. Encourage the students to compare their predictions with their observations. Did the objects they expected to float actually float?

Give the students an opportunity to reflect on the data, or evidence, they have gathered in the investigation. Have students use the evidence gathered to develop their explanations in their science notebooks. Check that children correctly list which items float and which items sink. Children should relate the shape, size, and weight of the object to whether it floats or sinks.

Share Observations (10 minutes)
Gather students away from activity or remove activity from the tables. Ask students to share their observations. Ask each student to share something they noticed and something they wondered. Encourage each student to share in some way or another. Inevitably students will conclude that weight is important and that something is pushing up on the items that float. It is important that you develop this understanding with a buoyancy activity later on, such as building a boat or plankton.

Inquiry Extension:
- Have students build a small boat or raft that will float from a variety of classroom and household items.
- During lessons on ocean habitats, have students design plankton that will float.

Elaborate: Mixing Matter & Reactions
Day 1: Diet Coke & Mentos

Students will discover that when different kinds of matter are mixed they can have a reaction with each other. Students observe that when Mentos are added to diet soda gases are released quickly.

Time: 40 Minutes
If possible set up Diet Coke and Mentos experiment outside before class.

Introduction: (5 minutes)
Show the students a bottle of soda and ask them what phase of matter is in it. Students will identify it as a liquid. Now open the bottle and ask them what they heard and observe. Discuss why the soda fizzes and introduce that carbon dioxide is added in the factory to make soda bubbly. Now ask the students again what phase of matter is in the bottle of soda. Students will not identify it as a liquid and a gas. Ask the students what happens then they add ice into the soda. Discuss their answers and tell them that they will be putting a solid into a glass of soda. They will need to predict what will happen and record their observations in their science notebooks. Set Science Notebook expectations.

- ✓ Focus: Soda Experiments
- ✓ Date
- ✓ Prediction: What happens when you put a solid in soda
- ✓ Observational Drawing – labeled and add detail
- ✓ I notice and I wonder statements
- ✓ Today in science I…

Safety Rules: Don't spill the water and if there are spills clean them up.

Inquiry Activity: (20 minutes)
Materials:

Cup inside a bowl for each student
Salt
2 Large bottles of Diet Coke
Half a pack of Mentos
Geyser tube (optional but makes things much easier)

Have students sit with partners and give each partner a cup. As the students set up their science notebook, pour some soda in each cup. Have them make observations. Ask them what they notice forming on the sides of the cup, and where are the bubbles of carbon dioxide? Then go around and give each student some salt in their hand. Tell them they will be adding the salt into the soda, but only when you tell them to. The reaction is quick, so everyone needs to be ready at the same time. On the count of three tell them to pour the salt into their cup of soda. The soda will fix up and over the cup. Have students record their observations in their science notebook. Ask the students to share what they observed.

Next show the video of the *Mythbusters* performing and explaining the science behind the Diet Coke and Mentos experiment. Run time is 8:08 minutes.
http://www.bing.com/videos/watch/video/mythbusters-file-4-explanation-of-the-diet-coke-mentos/04a3493a6db0fea3a61804a3493a6db0fea3a618-820432209043?q=mythbusters+diet+coke+and+mentos&FROM=LKVR5&GT1=LKVR5&FORM=LKVR4

If you have time show the *EepyBird.com* Diet Coke and Mentos Domino Effect Video. Run time is 3:01 minutes.
http://www.eepybird.com/featured-video/the-extreme-diet-coke-mentos-experiments-ii-the-domino-effect/

Explanation of Reaction: This reaction is formed by the combination of carbon dioxide and sugar substitute in the Diet Coke and the little dimples found on Mentos candy pieces.

Carbon dioxide is pumped into the soda when they bottle the drink at the factory. It doesn't get released from the liquid until you open the lid and pour it into a glass. Students can relate to the fizzy bubbles in soda from previous experiences when soda is shaken before it's opened. There is a lot of carbon dioxide gas just waiting to escape the liquid in the form of bubbles.

When something is dropped into the Diet Coke this speeds up this process of the carbon dioxide being released. It both breaks the surface tension of the liquid and allows the bubbles to form on the surface area of the Mentos. Mentos candy are also covered in tiny dimples, like a golf ball. This increases the surface area and allows a huge amount of bubbles to form.

Gather students outside where you have a large open area where it's ok to get Diet Coke everywhere. Do not do this inside! Make sure the Diet Coke set up is on a flat surface. Have students stand about 3 paces away from the set up.

Take the cap off the Diet Coke and stand upright. Screw on the geyser tube with half a package of Mentos. If you do not have the geyser tube, put half a package of Mentos in a funnel or tube which the Mentos can fall from easily. To release the Mentos into the Diet Coke, make sure you have space to stand back away from the geyser that will erupt. To do this part may be tricky if you don't have the specially designed geyser tube. Pull the pin from the geyser tube, or put the funnel or tub onto the bottle opening. Back away quickly.

Elaborate: Mixing Matter & Reactions
Day 2: Cooking is Science Making Pancakes

Students also discover that when different ingredients are mixed together and heat is added, a new kind of matter is formed.

Time: 40 minutes
This activity could be done as a full class demonstration with volunteers measuring, pouring, and mixing. The ingredients and equipment can also be divided into four groups, so that each group can read through the recipe and make their own pancake batter. Cooking must be done by the teacher.

Introduction: (5minutes)
Inform the students that they will be making pancakes in class. Review the different phases of matter and what happens when matter is mixed. Discuss how sometimes nothing happens when matter is mixed; however sometimes a reaction occurs. Show them the ingredients and cooking tools they will be using. Show them how to use the measuring spoons and cups to measure the correct amount of each ingredient. Ask them to organize these ingredients into solids and liquids. Tell them they will need to be very observant as there may be a reaction occurring in the mixing bowl and while you cook the pancakes. Introduce the topic of heat energy and inform the students that you will be cooking the pancakes, but everyone will be able to see what is happening one at a time while the pancakes cook.

Cooking Activity: (35 minutes)

Materials: based on 5 groups
- Handout of recipe – see below
- 5 Eggs
- All-purpose flour - 3 bags students share between groups.
- Milk - 5 cartons from cafeteria or small milk containers
- Sugar divided into 5 bowls
- Vegetable oil – 3 small bottles students share between groups
- Baking powder
- Salt - divided into 5 bowls
- 5 mixing bowls
- 5 liquid measuring cups - 3 can be shared between groups
- Measuring cups for dry ingredients - ½ cup and 1 cup measure
- Measuring spoons - 1 tablespoon and ½ teaspoon
- Mixing spoons
- Paper towels
- Ladle
- Electric griddle or frying pan
- Extra oil for cooking surface
- Spatula
- Hand sanitizer

Have students sit with their groups and take turns to read the ingredients, cooking tools, and what they will do to make pancakes. While they do this give each student some hand sanitizer. Once they have read the instructions then they can work together to measure and mix the pancake batter. Remind them that if they spill anything they need to use the paper towels to clean as they go. When they are finished they can bring their bowl over to you to cook. While pancakes are cooking have students watch as bubbles form. Explain to them why this is happening and for groups that are waiting, have them clean off the table and encourage them to make observations in their science notebook. Science notebook work is going to be unstructured, but it gives students the opportunity to record their thoughts. Once pancakes are cooked have students come get some more hand sanitizer and their pancake with a paper towel. Enjoy!!

Recipe for students:

How to make pancakes

Ingredients:
1 egg
1 cup all-purpose flour
3/4 cup milk
1 tablespoon sugar
2 tablespoons vegetable oil
1 tablespoon baking powder
1/2 teaspoon salt

Cooking tools:
Liquid measuring cup
Dry ingredient measuring cup
Measuring spoons
Mixing bowl
Mixing spoon
Paper towels

What to do:
Measure each ingredient carefully and put into the mixing bowl. Carefully mix all of the ingredients together with the mixing spoon. Make sure to break up any lumps. Bring your batter to the teacher to pour batter onto a hot griddle. The teacher will flip the pancakes when the edges appear cooked and the batter bubbles on top. Enjoy!

Elaborate: Mixing Matter & Reactions
Day 3: Pretzel Bites

Students also discover that when different ingredients are mixed together and heat is added, a new kind of matter is formed.

Time: 40 minutes
This activity works best as a full class demonstration with partners measuring, pouring, and mixing the ingredients like an assembly line. This gives the teacher the ability to form pretzel bites out of the premade, risen dough. An additional batch of dough must be made prior to class so that it has risen properly. Preheat toaster oven to 500°F.

Introduction: (5minutes)

Inform the students that they will be making pretzel bites in class. Show them the ingredients and cooking tools they will be using. Put the yeast in a bowl and show the students what it looks like. Add the warm water and sugar and discuss how these two ingredients help 'wake up' the yeast so that it can grow. Remind the students that today the reaction during cooking is going to take place because of the yeast making gas bubbles in the dough. Encourage the students to be observant as they record what they see in their science journals. Show them the premade, risen dough and tell them that their dough is going to look very different from this.

Cooking Activity: (35 minutes)
Remember to make 2 batches of dough
Ingredients:

- 1 cup warm water (98 degrees F)
- 1 package active dry yeast
- 2 ¾ cups all-purpose flour
- 2 tablespoons butter, softened
- ½ teaspoon salt
- 1 tablespoon sugar
- Extra flour
- Oil or oil spray
- Kosher salt & Honey

Cooking tools:

- Toaster oven
- Small bowl for yeast
- 2 Mixing bowls
- Mixing spoon
- Dry ingredient measuring cup
- Measuring spoons
- Aluminum foil

While students are mixing the dough prepare pretzel bites. Divide into pieces and roll into balls. Have extra pretzel bites formed for second batch. On the greased toast oven tray lay out the dough evenly so they do not touch. Spray the pretzel bites with oil and sprinkle them with kosher salt. Cook for about 10 minutes.

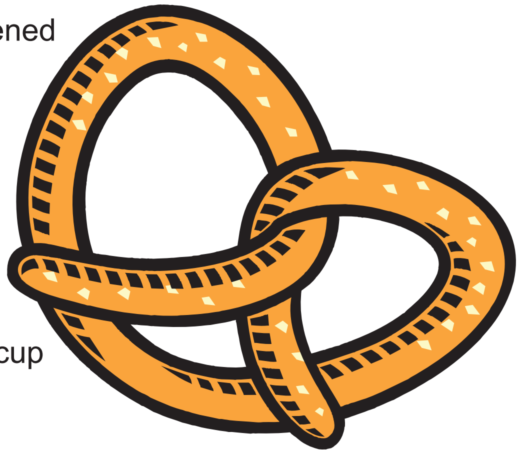
.
Have the first 2 groups measure 1 cup of flour each and add it to the mixing bowl. Have them pass the bowl to the next pair to add the butter. Pass the bowl so the next pair can add the salt, sugar, and yeast mixture. Keep the bowl going onto the next group and have them mix the dough for 3 minutes. This can be fun for the whole class to keep track of as they count down the time. Have the final group stir in the remaining ¾ cups of flour. By this time the first batch of pretzel bites should be cooking. Turn the dough out onto a floured sheet of aluminum foil. Call on each student to come knead the dough once. The dough should no longer be sticky. Put the dough in a greased bowl and let it rise covered until it doubles in size, about 45 to 50 minutes. (If you have a second class this dough can be used for that class).

Have the class clean off the tables and make observations in their science notebooks. For this activity the science notebook work is unstructured. This allows students to record their observations in their own way. While they are making observations the pretzels should finish and a second batch of pretzels can be started. Pass them out to the students and tell them they can add honey to them if they would like. Most of them will do this.

Recipe for students:

How to make pretzel bites

Ingredients:
1 cup warm water (98 degrees F)
1 package active dry yeast
2 ¾ cups all-purpose flour
2 tablespoons butter, softened
½ teaspoon salt
1 tablespoon sugar



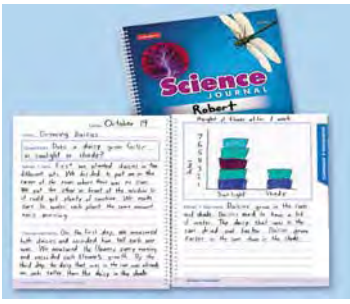
Cooking tools:
Toaster oven
Small bowl for yeast
2 Mixing bowls
Mixing spoon
Dry ingredient measuring cup
Measuring spoons

What to do:
Measure 2 cups of flour and add it to the mixing bowl. Add the butter, salt, sugar, and yeast mixture. Mix the dough for 3 minutes. Stir in the remaining ¾ cups of flour. Turn the dough out onto a floured sheet of aluminum foil. Knead the dough so that it's no longer sticky. Put the dough in another mixing bowl so that it can rise. When the dough is double its size, roll into balls and bake for 10 minutes @ 500°F. Sprinkle with salt and drizzle with honey. Enjoy!

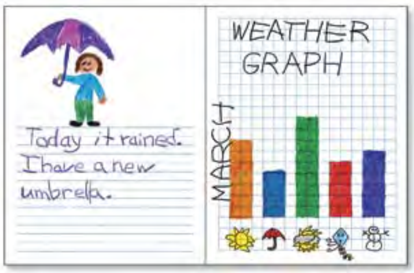
Science Notebook Sources

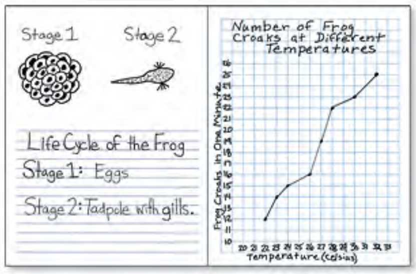
- www.sciencencampanion.com
  Free Weather Science Notebook Sample
  www.sciencecompanion.com/wp-content/uploads/2011/04/Weather-Digital-Sampler.pdf

- **Lakeshore Learning**
  www.lakeshorelearning.com
  Questions ask students What I did, what I saw, what happened, and what I learned



- **Delta Education**
  www.delta-educaiton.com





- **ScienceKit**
  www.sciencekit.com
  Journal has left-hand pages with work area and lined space for writing. Right-hand pages have lined space and a sheet of 1cm-grid graph paper.

- **SchoolSpecialty**
  www.schoolspecialty.com

Composition notebooks with 50 pages of appropriately lined paper for grades 1-3 (ages 6-9)

Promoting Inquiry-Based Science Instruction: The Validation of the Science Teacher Inquiry Rubric (STIR)

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Abstract

The National Science Standards recognize that inquiry-based instruction holds significant promise for developing scientifically literate students. The Science Teacher Inquiry Rubric (STIR) was developed based upon the National Science Education Standards' essential features of inquiry instruction (National Research Council, 2000). A pilot using a purposive sample of 10 science teachers was conducted to establish the rubric as both an observation tool and a self-reflection instrument. While the overall correlation of the instrument (r=.58) does not support its use as a self-assessment instrument, a perfect correlation between two raters (r=1) established the STIR as an effective observation tool. Additionally, the validation of the instrument provided various insights into the teaching of inquiry in science classrooms.

Introduction

Scientific literacy has become a critical issue for all citizens of the United States. To gain the status of lifelong literacy, it is no longer enough to have reading and writing skills. Science and technology have become so important in modern life that the ability of citizens to understand and use science can spell the difference between prosperity and decline, between security and vulnerability (National Research Council, 1996). Helping students to develop into scientifically literate citizens is a perennial objective noted in recent science education reform initiatives (American Association for the Advancement of Science [AAAS], 1990, 1993; National Research Council [NRC], 1996; National Science Teachers Association, 1982). Scientific literacy is often recognized as the knowledge of significant science subject matter, the ability to apply that knowledge and understandings in everyday situations, and an understanding of the characteristics of science and its interactions with society and personal life. Scientific literacy as defined by AAAS's Project 2061(1990) addresses the understandings and habits of mind that enable people to grasp what those enterprises are up to, to make some sense of how the natural and designed worlds work, to think critically and independently, to recognize and weigh alternative explanations of events. According to the National Science Education Standards (NRC, 1996) [henceforth *Standards*], the development of scientifically literate students involves providing classroom learners with a science curriculum that teaches science as a body of knowledge and as a way of knowing about the natural world based on evidence from observation and experimentation.

Implementing a standards-based science curriculum is a formidable challenge for elementary teachers, most of whom are not science specialists. Furthermore, science, as a separate subject, is generally given a smaller amount of instruction time in comparison to other subjects. A survey conducted by Fulp (2002) showed that "grade K-5 self-contained classes spent an average of 25 minutes each day in science instruction, compared to 114 minutes of reading/language arts, 53 minutes in mathematics and 23 minutes in social studies" (p.11). In addition to the limited instructional time spent on science, there are other factors that influence science teaching in elementary school classrooms including:

(a) teacher perception of the importance of science in an elementary curriculum,

(b) limited content knowledge held by elementary teachers,

(c) limited experience through formal coursework in participating in and presenting hands-on science, and

(d) lack of administrative support for the teaching of science

(Abell & Roth, 1992).

Science educators have long recognized that teaching science is a complex subject. Successful science teachers strive to help their students understand and apply scientific concepts, participate in scientific inquiry and understand the nature of science. Furthermore, the *Standards* call for a pedagogical shift from a teacher-centered to a student-centered instructional paradigm. Teacher-centered instructional strategies such as large-group instruction, recitation, drill and opportunities for independent practice are successful for tasks that demand rote memorization; they have not been shown to be effective for teaching higher-order thinking and problem solving (Anderson, 1997). The *Standards* advocate a change in emphasis from students memorizing facts and terminology to students investigating nature through active learning that will result in making science accessible to all students and lead to a more scientifically literate citizenry.

Inquiry-based Teaching and Learning

Science educators have long recommended that learning with inquiry be placed at the core of science instruction to actively engage learners in the processes of science (DeBoer, 1991; AAAS, 1993; NRC, 1996). As early as the 1960s, Schwab (1962) suggested that the teaching of science inquiry be a priority in science education, that teachers teach students both to conduct investigations in inquiry and to view science itself as a process of inquiry. More recently, the Standards include science inquiry as one of eight categories in their content standards.

One of the NRC's reasons for advocating inquiry mirror the rationales offered by Schwab: Instruction in inquiry promotes student understanding of the nature of science. Currently, the Standards present a description of inquiry instruction that includes the nature of science as well as "science as a process," in which students learn skills, such as observation, inference, and experimentation. According to the Standards:

"Inquiry teaching requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science. Engaging students in activities of and discussions about scientific inquiry should help them to develop an understanding of scientific concepts; an appreciation of 'how we know' what we know in science; understanding of the nature of science; skills necessary to become independent inquirers about the natural world; and the dispositions to use the skills, abilities, and attitudes associated with science." (p. 6)

The inquiry process, however, is a multi-faceted approach and its emphasis has important pedagogical implications for science educators. Inquiry is a complex process that encompasses many different dimensions including fostering inquisitiveness (a habit of mind) and providing teaching strategies for motivating learning (Minstrell & van Zee, 2000). Scientific inquiry refers to "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (NRC, p. 23). Teaching students, science as inquiry (AAAS, 1993), involves engaging them in the kinds of cognitive processes used by scientists when asking questions, making hypotheses, designing investigations, grappling with data, drawing inferences, redesigning investigations, and building as well as revising theories. Whereas the Standards offer several examples of inquiry-based instruction, they do not provide specific prescriptions for how to conduct inquiry in the classroom.

The Standards do, however, define five essential features of inquiry-based teaching:

> Learners are engaged by scientifically oriented questions.
>
> Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
>
> Learners formulate explanations from evidence to address scientifically oriented questions.
>
> Learners evaluate their explanations in light of alternate explanations, particularly those reflecting scientific understanding.
>
> Learners communicate and justify their proposed explanations. (NRC, p. 14)

These features may be incorporated into the science classroom in a highly structured format, with teachers and/or materials that direct students towards known outcomes, or they may take the form of open-ended investigations that are learner-centered. Current teaching and learning techniques that use inquiry include engaging students with authentic questions for local and global investigations (Crawford, 2000; Feldman, Konold, & Coulter, 2000), project-based science instruction (Krajcik, Blumenfeld, Marx, & Soloway, 1994; Krajcik, Czerniak, & Berger, 1999), or role-playing debate simulations (Bodzin & Park, 1999). These techniques seek to engage students with meaningful questions about everyday experiences, emphasize using a method of investigation to evaluate some form of evidence critically, and engage learners in a social discourse to promote the knowledge-construction process. The proponents of such inquiry-based approaches argue that they provide learners with the opportunity to learn scientific practices by actually engaging in them. In addition, implementing inquiry-based curricula may result in higher average student achievement, making it a powerful vehicle for students to learn scientific content (Schneider, Krajcik, Marx & Soloway, 2002).

Implementing inquiry-based instruction, particularly in the elementary classroom, demands a significant shift in what teachers typically do in a science lesson. Orchestrating this kind of nontraditional, inquiry-based instruction is complex, and many teachers have not embraced the essence of this mode of learning in which students begin to think scientifically (Fradd & Lee, 1999). Therefore, it is important to provide teachers with professional development and other kinds of support to implement the essential features of inquiry-based instruction into the classroom.

Loucks-Horsley (1987) recognized the importance of professional development in assuring that teachers had the appropriate skills, knowledge and instructional strategies to help students achieve science standards. The challenge of professional development for teachers of science is to create optimal collaborative learning situations in which the best sources of expertise are linked with the experiences and current needs of the teachers. "Whenever possible, the context for learning to teach science should involve actual students, real student work, and outstanding curriculum materials. Trial and error in teaching situations, continual thoughtful reflection, interaction with peers, and much repetition of teaching science content combine to develop the kind of integrated understanding that characterizes expert teachers of science" (NRC, p. 9).

There have also been attempts to develop inquiry instruments for teachers to use in these professional development settings. These instruments have focused on various aspects of constructivist learning models of science instruction (Burry-Stock, 1995; Yager, 1991). Another group used the Standards to develop rubrics to assist in identifying the characteristics of classroom instruction that are anchored in inquiry (Council of State Science Supervisors[CSSS], 2002). While these instruments help teachers to see the 'big picture' of inquiry-based instruction, they portray this type of pedagogy as a daunting task, in some cases, specifying 20 or more descriptors.

The Science Teacher Inquiry Rubric (STIR)

To assist teachers in understanding and implementing inquiry-based science instruction into their classrooms in a comprehensive, yet manageable way, a Science Teacher Inquiry Rubric (STIR) was developed (see Figure 1). This instrument was developed to serve as a self-assessment tool for elementary school teachers to understand how they implement the essential features of inquiry into their classroom instruction.

INSERT FIGURE 1 ABOUT HERE

The STIR was derived from the Web-based Inquiry for Learning Science [WBI] Instrument (Bodzin & Cates, 2002). The WBI instrument was designed to identify and classify Web-based inquiry activities for each of the five essential features of classroom inquiry and their variations based on the amount of learner self-direction and direction from materials (NRC, 2000). This continuum of essential features of inquiry instruction continues to provide the framework for the development of a rubric to be used as a teacher observation tool. Many of the indicators in each cell serve as descriptions of teacher behaviors. Additionally, this continuum describes the instruction of classroom learning environments that ranges from teacher-centered instruction on one end to student-centered learning on the other end.

While each of these essential features may vary in the scope of their implementation, science instruction that makes full use of inquiry embeds all five of these features. As described in *Inquiry and the National Science Education Standards* (NRC, 2000), each of these features provides an important aspect of instruction to the inquiry process. The STIR was designed to translate each of these features into descriptors that capture the essence of the feature; a format mirroring the WBI instrument. While a complete and thorough explanation of each essential feature is not included on the rubric, it gives teachers a springboard definition for beginning the inquiry process in the classroom. For example, the STIR supports the use and analysis of data in the formulation of explanations. Yet, conclusions and/or explanations should be more than simple data analysis and reporting. Scientific explanations are based on reasoning. "They provide causes for effects and establish relationships based on evidence and logical argument" (NRC, 2000, p.26).

The language of the STIR, while simplistic, was designed for a wide range of audiences. It was primarily intended to accompany inquiry-based science professional development. Yet, teachers with a limited knowledge of the inquiry criteria can use the rubric to guide their instruction as seemed to be the case in the validation of the STIR.

The content of the STIR was validated using the Delphi technique (North & Pyke, 1969). The Delphi technique is a "set of procedures for eliciting the opinion of a group of people, usually experts, in such a way as to reduce the undesirable aspects of group interaction" (p. 75). In this process, three science educators with expertise in teaching and learning with inquiry reviewed and evaluated the rubric for accuracy, importance and validity of the content. They provided feedback and suggestions and these were incorporated into the instrument. All three unanimously agreed on the content, providing content validity to the instrument.

Methodology

The STIR was piloted with a purposive sample of 5 elementary-certified middle school teachers and 5 secondary science-certified senior high school teachers in a suburban school district. Two observers rated each teacher during their inquiry instruction. The purpose of selecting this type of sample was to ensure variability on this construct.

The researcher randomly selected 5 middle school and 5 high school teachers. The teachers were contacted via email to solicit their participation in the observation of an inquiry lesson.

The researcher and the district's K-12 Supervisor of Staff Development served as the raters for the observations. It is important to note that both the researcher and the Supervisor of Staff Development have considerable experience in the observation of teachers. The researcher has close to 5 years experience in the supervision of teachers while the Supervisor of Staff Development has approximately 25 years. Both observers have spent their careers as elementary teachers and principals. However, neither observer has had any specialized training in inquiry-based science instruction.

After the participants agreed to the observation, one rater contacted each teacher to determine a mutual observation time. The teachers were asked to plan their usual science lesson. However, in order to allay any anxiety regarding the observation, the STIR was shared with each teacher via e-mail. The teachers were not asked to deliver an inquiry-based lesson, but it is important to note they were aware that the focus of the observations would be characteristics of inquiry-based instruction. The observers entered each classroom with no prior knowledge on the content of the science lessons. The raters observed each lesson and rated it according to each essential feature of inquiry on the instrument. The teacher did the same at the conclusion of the lesson. After all 10 observations were completed, a comparison of teacher self-assessments to the rater scores was conducted to establish the reliability of the instruments as a self-assessment tool.

Results

During the first two lessons, the observers discussed the instructional qualities of each lesson as they watched. Subsequently, they completed the rubric as they talked through each category and indicator. These two sessions, in essence, provided the observers with a training session, enabling them to recognize, discuss and solidify their understanding of the language of the STIR in relation to the instruction occurring in the classroom.

The remainder of the observations commenced with a brief dialogue between the two observers focused on the teacher's instructional behaviors. The STIR analysis was completed independently and then shared between the two observers. They matched their placements with 100% agreement on each row.

In addition to the observers' rating, the classroom teacher used the STIR to self-assess his/her instruction at the close of the lesson, returning the rubric to the observers later during the day. It should be noted that some lessons did not contain each essential feature of inquiry.

An analysis was conducted by matching observer 1's rating on each row of the rubric to observer 2's rating on each row thereby establishing a correlational relationship of the observation to the rubric. The resulting correlation of observer to observer for each row placement on the STIR was strong (r=1), establishing the instrument as a validated observation tool for inquiry-based science instruction. The opportunity to discuss the instruction of a few lessons, specifically the first two, provided a vehicle for the observers to establish firmly their understanding of the descriptors in each cell as they related to the instruction that was occurring in the classroom. In addition, the observers' experiences in the area of teacher observation probably contributed to the strong reliability findings between the two observers.

A second correlational analysis was conducted of the classroom teacher's rating and the observers' ratings on each row of the STIR. This analysis was intended to establish the STIR as a self-assessment instrument for teachers implementing inquiry in their science classrooms. The correlation(r) of the matches (N=60) between the observers and teachers was .58. This seems to indicate that the STIR may not constitute a reliable self-assessment tool for teachers wishing to reflect on their inquiry-instruction.

Table 1 displays the percentage of matches and adjacent matches between observers and teachers on the STIR for each essential feature of inquiry. As the table shows, the placement match of teachers and observers in the first three instruction descriptors on the STIR indicates a strong correlation. The percentages of the adjacent placement matches combined with the exact matches between observers and teachers were 80%, 90% and 100%, respectively. However, the last three instruction descriptors did not correlate as strongly as the first three. While the combined matches and adjacent matches of the observers and teachers in descriptor #4 and #6 were 90% and 80%, respectively, the data certainly does not demonstrate the strength in reliability as the first three descriptors.

INSERT TABLE 1 ABOUT HERE

There was a significant lack of correlation of the combined matches in descriptor #5, raising interesting discussion regarding this essential feature of inquiry. Not only was there a low correlation of matches between the raters and the observers, most of the matches occurred in the “not observable” category on the STIR. Additionally, this feature on the STIR seemed to display the most “scatter,” that is, the teacher and observers’ description of the inquiry instruction was, in many cases, placed in non-adjacent cells. This suggests that this feature of inquiry is not as widely understood or perhaps, as widely implemented as the others.

Conclusion

“The meaning of the term inquiry-based instruction when applied to classroom practice often becomes muddled, and the integrity of the inquiry-based instruction can be lost" (Crawford, 2000). Teachers need tools that help them to explore, design and reflect on their science instruction practices, particularly as they relate to student-centered, inquiry-based teaching.

The validation and reliability of the STIR clearly demonstrates its use and effectiveness as a teacher observation tool for supervisors, principals or other change agents who wish to assess teachers' use of inquiry-based instruction in the classroom. Unfortunately, the STIR is not reliable enough to use as a self-assessment instrument by elementary school teachers teaching science. This finding is not surprising. While Koziol and Burns (1986) noted that focused teacher self-reports can gather reliable data on instructional practices, Newfield (1980) reported that, only under certain conditions, can teachers accurately report their own behavior. This raises the question how widely understood and implemented is inquiry-based science instruction?

As the data from the science classroom observations suggests, there is evidence of inquiry-based instruction occurring in sampled classrooms, both teacher-directed and student-centered. In many cases, teachers were able to effectively assess where their instruction was placed on the continuum. We believe that the STIR has much potential to be used as a tool for teachers to assist them in gauging their inquiry-based classroom instructional strategies.

Table 1.
Percentage of Matches and Adjacent Matches for Each STIR Feature

Essential Features of Inquiry-based Instruction Descriptors	Percent Match Between Observers and Teacher	Percent of Adjacent Matches Between the Observers and Teacher
#1 Teacher provides an opportunity for learners to engage with a scientifically oriented question.	70%	10%
#2 Teacher engages learners in planning investigations to gather evidence in response to questions.	70%	20%
#3 Teacher helps learners give priority to evidence that allows them to draw conclusions and/or develop and evaluate explanations that address scientifically oriented questions	80%	20%
#4 Learners formulate conclusions and/or explanations from evidence to address scientifically oriented questions.	50%	40%
#5 Learners evaluate their conclusions and/or explanations in light of alternative conclusions/explanations, particularly those reflecting scientific understanding.	40%	10%
#6 Learners communicate and justify their proposed conclusions and/or explanations.	40%	40%

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Figure 1. Science Teacher Inquiry Rubric (STIR)

Directions: Reflect on the science lesson that you taught today. In your reflection, consider each of the following categories and the six statements on the left, written in bold. After looking at each bold statement, assess today's science instruction based on the categories delineated for statement. Place one "X' in the corresponding cell for each bold-faced statement. If there is no evidence of one of the statements in today's lesson, place a slash through the bold-faced statement. When you are finished, you should have 6 total responses.

Learner Centered ⟷ Teacher Centered

Learners are engaged by scientifically oriented questions.					
Teacher provides an opportunity for learners to engage with a scientifically oriented question.	Learner is prompted to formulate own questions or hypothesis to be tested. ☐	Teacher suggests topic areas or provides samples to help learners formulate own questions or hypothesis. ☐	Teacher offers learners lists of questions or hypotheses from which to select. ☐	Teacher provides learners with specific stated (or implied) questions or hypotheses to be investigated. ☐	No evidence observed. ☐
Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.					
Teacher engages learners in planning investigations to gather evidence in response to questions.	Learners develop procedures and protocols to independently plan and conduct a full investigation. ☐	Teacher encourages learners to plan and conduct a full investigation, providing support and scaffolding with making decisions. ☐	Teacher provides guidelines for learners to plan and conduct part of an investigation. Some choices are made by the learners. ☐	Teacher provides the procedures and protocols for the students to conduct the investigation. ☐	No evidence observed. ☐
Teacher helps learners give priority to evidence which allows them to draw conclusions and/or develop and evaluate explanations that address scientifically oriented questions.	Learners determine what constitutes evidence and develop procedures and protocols for gathering and analyzing relevant data (as appropriate). ☐	Teacher directs learners to collect certain data, or only provides portion of needed data. Often provides protocols for data collection. ☐	Teacher provides data and asks learners to analyze. ☐	Teacher provides data and gives specific direction on how data is to be analyzed. ☐	No evidence observed. ☐
Learners formulate explanations and conclusions from evidence to address scientifically oriented questions.					
Learners formulate conclusions and/or explanations from evidence to address scientifically oriented questions.	Learner is prompted to analyze evidence (often in the form of data) and formulate own conclusions/ explanations. ☐	Teacher prompts learners to think about how analyzed evidence leads to conclusions/explanations, but does not cite specific evidence. ☐	Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to draw conclusions and/or formulate explanations. ☐	Teacher directs learners' attention (often through questions) to specific pieces of analyzed evidence (often in the form of data) to lead learners to predetermined correct conclusion/explanation (verification). ☐	No evidence observed. ☐

Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.					
Learners evaluate their conclusions and/or explanations in light of alternative conclusions/ explanations, particularly those reflecting scientific understanding.	Learner is prompted to examine other resources and make connections and/or explanations independently. ☐	Teacher provides resources to relevant scientific knowledge that may help identify alternative conclusions and/or explanations. Teacher may or may not direct learners to examine these resources, however. ☐	Teacher does not provide resources to relevant scientific knowledge to help learners formulate alternative conclusions and/or explanations. Instead, the teacher identifies related scientific knowledge that could lead to such alternatives, or suggests possible connections to such alternatives. ☐	Teacher explicitly states specific connections to alternative conclusions and/or explanations, but does not provide resources. ☐	No evidence observed. ☐
Learners communicate and justify their proposed explanations.					
Learners communicate and justify their proposed conclusions and/or explanations.	Learners specify content and layout to be used to communicate and justify their conclusions and explanations. ☐	Teacher talks about how to improve communication, but does not suggest content or layout. ☐	Teacher provides possible content to include and/or layout that might be used. ☐	Teacher specifies content and/or layout to be used. ☐	No evidence observed. ☐