

Title

The Nature of Science: What are the characteristics of life?

Lesson Summary

In this guided-inquiry lesson students will use the scientific method to construct a definition of life, which includes the characteristics of living things.

General Goal

The purpose of this lesson is for students to begin to develop an understanding of the nature of science by observing many different living organisms and non-living things to determine characteristics common to all living and once-living organisms. The students will experience that nature is conserved and that all living things can be described using the same general characteristics of life.

Duration

This lesson should take five 90-minute periods.

Specific Learning Objectives

Content Objectives:

The student should be able to:

1. Provide a definition of life based upon observations and data collected.
 - a. Life can be defined by the characteristics that make up living organisms.
 - b. The characteristics that define living organisms are:
 - i. Living things are made of cells
 - ii. Living things grow and develop
 - iii. Living things obtain and use energy
 - iv. Living things respond to their environment
 - v. Living things are able to reproduce
2. Provide a basic framework within which he/she works (the steps of the scientific method).
3. List and define the parts of a microscope.

From the construction of the definition of life, the student should be able to identify that:

4. Nature is conserved and that all living things can be described by the same characteristics.

Process Objectives:

The student should be able to:

5. Define a purpose for the scientific method. (Process – scientific thinking).
6. Apply data collection and analysis tools to novel situations.
 - a. Attention to detail
 - b. Drawing
 - c. Organization
 - d. Tables
 - e. Venn diagrams

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7. Use a microscope correctly.
8. Use data to support that an unknown object is living or non-living.

Standards:

An overview of the Indiana Academic Standards 2000 for Biology I that this lesson addresses are:

1. The student must model the process of scientific investigation through inquiries, fieldwork, lab work, etc.
2. The student will practice designing investigations and experiments, making observations, and formulating theories based on evidence.
3. The student will be given opportunities to engage in long-term and on-going laboratory and fieldwork.

Specific standards addressed by number are:

1. Standard I: Principles of Biology
 - a. Understand the living environment
 - b. Living organisms are made of cells (B1.1)

Prerequisite Knowledge/Skills for Students

Students should be able to generate a list of qualities common to living organisms, once-living organisms and non-living things. Students may state the following characteristics:

1. Living things grow (and develop).
2. Living things require food (energy).
3. Living things use food (energy).
4. Living things respond to stimuli (environment).
5. Living things reproduce.
6. Living things breathe.
7. Living things move.
8. Living things have blood.
9. Living things have souls.
10. Living things have feelings.

Because many students equate living organisms with animals (as compared to plants, fungi, bacteria, and protists) it is important to have students list organisms they believe are living and non-living. This step will trigger students to expand their view of life (introduce them to biodiversity) and to start them thinking in a larger framework of organization.

Students may also have basic skills in microscopy. If not, they will develop them through this lesson.

Background Information

The state of Indiana assumes that students enrolled in Biology 1 (or life science) should be able to perform the following acts:

1. Model the process of scientific investigation through inquiry, fieldwork, lab work, etc.
2. Practice designing investigations and experiments.
3. Make observations.
4. Formulate theories based upon evidence.

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5. Develop good communication skills.
6. Develop logical thinking skills.

In my classroom, there are numerous examples of living and once-living organisms from the five kingdoms. There are also numerous examples of non-living things. The students will use samples from the classroom collection to construct a definition of life.

What do we mean when we say biology is the study of life? The students will observe each of the samples to construct lists of things that are alive and not alive. From these observations the students will identify characteristics of living and non-living things. From these observations, students will construct hypotheses based upon their lists to answer the question, "What are the characteristics of life?" They will demonstrate (experiment and collect data) that all living things have certain characteristics in common (the conclusion).

This lesson will be question oriented from the teacher to the lab groups and vice versus. To demonstrate the historical perspective of the nature of science, the students will need to regroup as a class often to exchange ideas so that each group can expand or narrow their perspectives of the inquiry lesson.

This lesson will be the second one the students experience in my classroom at the beginning of the school year. They will begin this lesson on day four. Textbooks will be distributed, but no reading assignment will be giving to ensure that the students construct their own definition and knowledge of the characteristics of life.

This lesson will be student lead and teacher guided. Technology will provided as students develop a need for it. For example, hand lenses will be made available readily, but microscopes will not be available until a lab group develops a logical line of reasoning to explore closer characteristics that distinguish living from non-living things. Once a student argues for the need for a microscope, then the class will have an activity about the parts of the microscope and its proper use. Without the use of the microscope, the students will not be able to construct that living things are made of compartments (cells) and non-living things are not.

A dilemma can be posed to students to help them sort through their data. The flame/candle test is a good example. Present them with a lit candle and ask them questions based upon the characteristics they have derived (use their lab sheets/posters) to determine if the candle flame is alive. Another good example is the growing of a crystal medium. Use Epsom salt for quick crystal growth and formation.

This lesson could be very overwhelming for students. Therefore, after students have developed their initial lists and characteristics of life, each group will be given five samples. Their task is to use the process of the scientific method to determine which samples are living and non-living.

Students will develop proper lab technique by careful observation by the teacher. The students will construct the need for drawings that attend to detail, tables that compile and organize data, and Venn diagrams that reveal data in a different manner.

This lesson is one of many in a series for students to develop an understanding of the biodiversity of the area in which they live. Other lessons that follow this initial one will be:

1. The cell.
2. Energetics.
3. Genetics.
4. Evolution.
5. Taxonomy.
6. Ecology.

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Preparation for Lesson

Materials

1. Read chapters 11, 12, and 13 in Moore's book. The purpose of this reading is for the teacher to develop an understanding of the inquiry, hypotheses and experimental methods of the scientists that made discoveries leading to the characteristics of life, the cell, reproduction, etc.
2. Variety of living and non-living things. In my room, I will have the following living and once-living organisms available:

iguanas	hissing cockroaches	rats	Giant millipede
snails	rabbit	guinea pigs	gerbils/hampsters
finches	boa constrictor	fish	stemmed fungi
stalked fungi	isopods	algae	different plants and seeds
pond water	mold	yeast	bacteria

I will have the following non-living organisms available:

desks	chairs	paper	magnets
honeycombs	rocks	shells	wasp nests
pencils	nails	carpets	books
crystals	seeds	pens	tile

Other equipment that will be needed:

chalk	overhead	overhead film and pens	hand lenses
dissecting microscopes	TV	flexible camera	slides
probes	cover slips	distilled water	droppers
food for living organisms	flip chart and pens	compound microscopes	stain
mixed bean seeds	candles and matches	matches	containers
label tape	permanent markers	Epsom salt crystals to grow	newsprint
markers	3x5 cards	VCR	black paper

Preparation

Do not feed the animals in the morning so that they will be hungry. Arrange the animals and their cages so that they are easily accessible to the students. Remove the iguanas from their cage and shut the door so that they cannot go back inside during the lesson.

Have samples of the "microscopic" organisms in containers clearly labeled. Have other living organisms labeled, such as algae, pond water, fungi, etc.

Maintenance of Organisms

Make sure the organisms are not stressed and not provoked by the students. At the end of each day, feed the animals and place them back in their original cages. Check them each day for accidental mishandling.

Instructional Strategy

Engagement

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Day One:

The students will be engaged in inquiry once they step into my classroom each day. I will capture the moment of their inquisitiveness of the things in the room by writing on the board the question, "What is life?" Have each student write the answer to this question on a 3x5 card and collect it. This card will act as a pre-test to measure the goal of defining life at the end of the lesson.

I will have one of the students be the recorder of the ideas so that I can circulate around the room asking questions and responding to answers. The students should record responses on large newsprint paper that can be saved and referred to later.

To help students develop an answer to the question, I will ask, "Can you list some things that you consider to be living?" Title the newsprint with the date and "Living things."

I will then ask them the question, "Can you list some things that you consider to be non-living?" Title the newsprint with the date and "Non-living things."

Now that the students have an idea of things that are living and non-living (so they think), I will ask the question, "Can you make a list of things in this room that are living and non-living?" (Answer yes.) Give each group of students a set of markers and newsprint paper. So get to work. You have 15 minutes to make a list of living and non-living things. This activity should mimic the class activity. Students should organize their data by living and non-living things. Circulate around the room to make sure they are collecting and organizing their data.

After students generate their lists of living and non-living things found in the room, we will record their observations on newsprint for a class list of living and non-living things. Reconvene students and have one student act as recorder. Make two new lists on newsprint and title them accordingly. Post this list on the bulletin board for future reference. Have students put their names on their personal lists and collect them. This activity will lead into the next segment of the lesson, exploration.

Before ending class, show students a prepared a crystal medium. Do not tell the students that it is crystal medium, but that you received this stuff and wanted to see if it did anything.

Exploration/Discussion/Explanation

Day Two:

Review the chart of living and non-living things. Have a student play recorder and generate a list of characteristics the students believe make the things on the chart living or non-living. Title the chart accordingly. Post this chart on the bulletin board. Have the students write the list on their own paper to be referred to at their lab benches.

Divide the class into six lab groups (one group per lab area). Give each group a total of five things (living and non-living). Give the students sheets of blank paper to collect their data on. Using the information provided on the charts constructed, have students complete the following sentence for each thing: "_____ things are alive." (These statements are their hypotheses.)

Regroup as a class and discuss the data collected. Are there any inconsistencies in the data among the different charts and group data sheets? Are there any consistencies? Are the students being misled?

After much discussion about the characteristics, pose the following dilemma demonstration.

Place a candle on the demonstration table. Light the wick. Ask the class the

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following question, “What do you observe?” Write the responses on newsprint. Compare the flame responses to the characteristics the students have listed. Can the flame be considered a living thing according to their data? Can it be considered a non-living thing according to their data? The students “know” that the candle and flame are non-living but do they know why?

Day Three:

Have another teacher come to the room and ask you to look at something they found. The other teacher wants to know what it is. It just happens to be too small to be seen with the unaided eye so you will need to use a microscope. Hook the microscope up to the TV monitor so that the class can see the process that you are going through. Tell the other teacher that you think it is alive but you will need to look at it further to decide exactly what it is. The other teacher should ask, “How do you know that?” Ask the class to answer that question for you.

The flame test should have left some doubt in the students’ minds as to the data supporting their hypotheses. They should have in their minds the microscope. Ask the students, “Is there something missing in your observations?” One of the students may propose that living things are made of cells. “How do you know of cells?” “What is a cell?” “Where should I look for cells?” “What biology tool should I use to see such things?”

Generate a list of characteristics of a cell. The students should respond with small, many, round, square, flat, etc. Have the students go back to their lab stations to refine their work on their data collection and observations. Remind them that they should be documenting all of their findings and non-findings.

Regroup. Review the characteristics generated the prior days and ask, “Does any group want to add or subtract to the lists from yesterday’s data collection?” Take an object and using the characteristics that the students have generated, such as the crystal medium, determine as a class if the object is living or non-living (A bean seed is another good example, but more difficult. They should determine that the bean seed should have cells).

Day Four

On this day, students will learn about the microscope and its proper use. Have prepared handouts of the microscope that can be labeled. Also, have a lab ready that introduces them to the microscope and that allows them to see different things. Use algae, moss, hair, iguana or snake skin, spores, pollen, crystals, plant tissue, etc. Have the students look and draw enough of the items that should give them a sense of the cell idea. Collect the labs at the end of the lesson.

As a group, construct a list of similarities and differences among the items viewed. Have the students group the items based upon their observations. Can they determine which items are living and non-living?

Day Five

Hook the microscope back up to the TV. Show a nematode that responds to light. You can do this by covering part of the condenser light with a dark piece of paper that would cover it or by watching it and moving the slide around. The students should quickly observe that the nematode doesn’t like the light. Demonstrate response to environment at the microscopic level. Do not tell them that this is occurring. Ask them, “What is happening?” “Why is the nematode acting so strangely?”

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Review the characteristics generated the prior days and ask, “Does any group want to add or subtract to the class data collection?” Take an object and using the characteristics that the students have generated, determine as a class if the object is living or non-living (use an isopod).

Ask the class if their groups need to do any further data collection. As a class, generate a refined list of the characteristics of life (the conclusion part of the scientific method). From the generated final list, have the students answer the question, “What is life?” on a 3x5 card. Collect the responses and compare to their previous response on day one of the lesson. This card is the post-test.

Ask the students, “What processes did you go through to be able to answer the question, What is life?” Have a student play recorder and title the newsprint, “How We Got There.” They should be deriving the scientific method. As a class, refine the list to develop the class’s scientific method process that they can post and use during the semester.

Have the students go around the classroom again to certain objects and have them list the things that are living and non-living. Collect the data sheets.

Assessment

The assessment methods of this lesson include:

1. Pre-test.
2. Post-test.
3. Construction of hypotheses.
4. Revision of hypotheses.
5. First data list of living v. non-living things.
6. Last data list of living v. non-living things.
7. Daily 3x5 card quizzes that reviews the prior day’s information.
8. Examination that addresses the following:
 - a. The processes of scientific method/thinking.
 - b. What is the purpose of the scientific method and why would it be used?
 - c. Why is it so hard to define life?
 - d. Define life by addressing the characteristics of living things.

Students will take a pre-test, which is the question, “What is life?” This definition will be compared to the definition of the same question on the post-test. Examine the initial hypotheses (_____ things are alive.) Are the hypotheses stated in a testable manner? Compare these hypotheses to the revised hypotheses as data is collected. Are the hypotheses revised so that they can be tested?

Review the first list of living and non-living things to determine the organizational nature of the student. Did the student make two categories? Any category? How did the student organize the data? Compare the first list to the final list. Is there any organization in the second list?

Throughout the lesson, give mini-quizzes on 3x5 cards to assess understanding over the previous day’s information. Have the students list characteristics of life, define life, procedures they are following, parts of the microscope, etc. Use these cards to assess understanding to determine if you need to modify or direct inquiry in a different direction or to regroup and clarify information.

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Give the students an examination that asks them to address the four questions above.

Comments

Science is not only a framework of asking questions, but asking questions that are useful. This lesson is very question based. The teacher will need to monitor and question lab groups so that they develop proper inquiry skills.

The students are essentially going through some of the same inquiry as that of the early scientists. An overall goal of science is to understand the nature of it. The students should be able to construct an understanding of its nature by the inquiry experienced in this lesson. They should understand that all living things are conserved. All living things can be discerned from non-living by the same simple tests of characteristics. The problem arises in science when something is discovered that does not obey the criteria given, such as a virus.

References

Moore, John A. (1993). *Science as a Way of Knowing*. Harvard University Press: Cambridge, MA.