Inquiry and Investigation Lesson Plan
Lesson Plan
Taken from Eggen P. D., & Kauchak D. P. (2001)

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Core Curriculum standard Fulfilled: Standard II: Students will understand that energy from sunlight is changed to chemical energy in plants, transfers between living organisms, and that changing the environment may alter the amount of energy provided to living organisms.

Core Curriculum Objective Fulfilled:
Objective 2: Generalize the dependent relationships between organisms.
    A. Categorize the relationships between organisms (i.e., producer/consumer/decomposer, predator/prey, mutualism/parasitism) and provide examples of each.

Intended Learning Outcomes (ILO's) Fulfilled:
1. Use Science Process and Thinking Skills
    a. Observe objects and events for patterns and record both qualitative and quantitative information.
    b. Sort and sequence data according to a given criterion.
    c. Develop and use categories to classify subjects studied.
3. Demonstrate Understanding of Science Concepts and Principles
    a. Know and explain science information specified for their grade level.
    b. Distinguish between examples and non-examples of concepts that have been taught.
    c. Compare concepts and principles based upon specific criteria.
    d. Solve problems appropriate to grade level by applying scientific principles and procedures.

Time Needed To Complete Inquiry: Approximately one 45 minute class period

Inquiry: Students will practice forming and testing hypotheses through compare and contrast methods and the analysis of data.

Prior Knowledge Needed: None

Introduction: Since this model is quite different from traditional teaching, the procedure may initially be confusing. It is best to introduce the model using concepts that students are familiar with. Topics such as living things, animals, wooden objects, prime numbers, or even students with red hair are all simple, concrete topics that would help students get used to the procedure.

Materials / Resources Needed for the Investigation: The lesson requires the use of an overhead projector and teacher generated examples and non-examples of the concept being attained.

Procedures of the Investigation:
- The teacher presents positive and negative example(s).

- Students generate hypotheses.
- The teacher presents additional positive and/or negative example(s).
- Students analyze hypotheses and eliminate those not supported by the data (examples).
- Students offer additional hypotheses if the data support them.
- Analyzing hypotheses, eliminating those invalidated by new examples, and offering additional hypotheses continues until one hypothesis is isolated.

Data Collection: Data for the investigation is provided by the teacher. Selecting examples that best illustrate the characteristics of the concept is most important step in the generation of data. Examples are selected so that each contains the combination of essential characteristics held by the concept. None of the non-examples contain the same combination. Having selected the examples and non-examples, the final planning task is to put them in sequence. Practicing hypothesis testing is an important goal when the Concept-Attainment Model is used. The examples should be arranged so the students are given the most practice with analyzing hypotheses. The shortest route to a concept may not give students this opportunity, and it may not result in the deepest student understanding.

Closure: Once students have isolated a hypothesis, the lesson is ready for closure. At that point, the teacher asks the student to identify the critical characteristics of the concept and state a definition.

Assessment: Students classify additional examples as positive or negative and/or generate additional examples of their own.

Eggen P. D., & Kauchak D. P. (2001) The Concept-Attainment Model (Ch. 5, PP.147-168). In *Strategies for teachers: Teaching content and thinking skills.* Needham Heights, MA: Allyn and Bacon.

Example Data for the Concept of Predators:

Apple	No
Robin	Yes
Banana	No
Hawk	Yes
Eagle	Yes
Truck	No
Airplane	No
Black Widow	Yes
Tiger	Yes
Computer	N
Trout	Yes
Rabbit	N
Shark	Yes
Bear	Yes
Deer	No
Cow	No
Bat	Yes
Prey-mantas	Yes
Buffalo	No
Lion	Yes
Coyote	Yes
Rattle Snake	Yes

Concept Attainment Introduction Vignette
Adapted from Eggen P. D., & Kauchak D. P. (2001)

The Concept Attainment Model is a lesson style that students are probably not familiar with. This being the case it is wise to introduce the model using a simple (possibly non-content example). The following vignette will serve as an example as to how the introduction might unfold.

Mrs. Maggio begins her science class by telling students that today they will be doing a different kind of lesson. She states, "Today's lesson is called a concept attainment lesson. The way it works is that I have an idea in my head that you are all going to try and figure out. The object of the lesson is for you to define the concept or idea that I have, and to practice your scientific reasoning skills." Mrs. Maggio has prepared the following list of data (positive and negative examples of her concept) for the lesson. She will only show the class two items at a time.

Apple	Y
Rock	N
Tomato	Y
Carrot	N
Avocado	Y
Celery	N
Peach	Y
Squash	Y
Orange	Y
Lettuce	N
Artichoke	N
Potato	N

Mrs. Maggio turns on the overhead projector and shows the students the first two items on her data list, Apple Y and Rock N. She explains, "Notice on the overhead that apple has a Y next to it and rock has an N next to it. That means that apple is a positive example of my idea and rock is a negative example of my idea. What do think the idea might be. . . ?"
    "We eat apples," Jenny volunteers.

"Good," Mrs. Maggio smiles, "so the idea might be. . . ?"

Jenny does not respond.

". . .Things. . . we. . .?" Mrs. Maggio prompts.

"Eat?" Jenny continues hesitantly.

With that, Mrs. Maggio writes the word Hypotheses on the board, underlines it, and asks, "What do we mean by the term hyptheses? . . . Anyone?"

". . . It's, like . . . kind of a guess," Fina volunteers after a few seconds.

"Excellent," Mrs. Maggio nods to Fina. "Instead of calling it a guess or an educated guess," she continues, "lets refer to hypothesis as a prediction based upon evidence or data. In this lesson our data will be the examples and non-examples shown on the overhead and you as a class will analyze this data and generate hypotheses predicting what my idea is." Mrs. Maggio then writes, *things we eat* under the word *Hypotheses*.

"What else might be a possibility?" Mrs. Maggio goes on. . . . "James?"

"It could also be things that are alive, or . . . were."

"Fine," Mrs. Maggio replies, writing the words *living things* on the board under the list of hypotheses. "Any others? . . . Blake?"

"Well, this is . . . sort of like James's . . . but it's a little different. How . . . about 'things that grow on plants'"?

"Okay . . . . Does everyone see how living things and things that grow on plants are different? . . . No? Karen, can you explain that to the class?"

". . . Like . . . well, there are some living things that don't grow on plants . . . . Like animals."

"Excellent thinking, Karen. Do we have any other ideas?"

After pausing for a few seconds, Mrs. Maggio continues, "Well then, let's look a couple more pieces of data." She shows tomato as an example and carrot as a non-example.

Mrs. Maggio continues, "What does this new information tell us? Let's first look at the hypotheses we have. Are they still acceptable? . . . Serena?"

". . . *It can't be things to eat*," Serena responded.

"Explain why, Serena," Mrs. Maggio encourages.

". . . Well . . . we eat carrots . . . and carrot is not an example."

"Good, Serena," Mrs. Maggio smiled. "Very good, clear explanation. The added information we have requires that we eliminate that hypothesis."

"Now, lets look at the rest of the hypotheses . . . . How about *things that grow on plants*? . . . Sherry?"

". . . Things that grow on plants is out."

"Why? . . . Explain," Mrs. Maggio smiles.

". . . A carrot grows from a plant."

"And?" Mrs. Maggio probes.

"And . . . it's not an example," Sherry adds quickly after Mrs. Maggio's prompt.

"Excellent, Sherry. Good thinking and good explanation."

She turns to the class. "Now, how about *living things*?"

"Also out," Jamie volunteered.

"Go on."

". . . Carrot is living and it's not an example," Jaime explains, beginning to see how the process is intended to work.

"Yes! That's it," Mrs. Maggio waves enthusiastically. "You are really catching on to

this."

"How about things we eat that grow above the ground?" Renita offered.

"Are you suggesting another hypothesis?" Mrs. Maggio asked.

". . . I . . . think so."

"Very good. Perhaps I should have pointed that out in the beginning. We can always add hypotheses as long as the data support them. . . . Now how will we know if the data do indeed support them? . . . Anyone?"

No one responds.

"This is a little tough to describe, so I'll try to help you. A hypothesis is supported if *all* the examples fit the hypothesis, and if none of the non-examples fit the hypothesis."

"For example," she goes on, "do both an apple and a tomato grow above the ground?"

"Yes," the class says in unison.

"Do either a rock or a carrot grow above the ground?"

"Part of the carrot does," Phil notes.

"Good thinking," Mrs. Maggio nods. "What is your reaction to Phil's point, Renita?"

"I meant the part we eat."

"Okay, is that all right with you, Phil?"

Phil shakes his head. ". . . I think we should say, 'plant parts we eat that are above ground.'"

"Excellent. Phil. We can also modify hypotheses so that they better fit our data. This is the kind of thinking that we're after. Very well done!"

"Now . . . is the hypothesis, *plant parts we eat that are above ground*, acceptable? . . . Remember, *all* the examples must fit the hypothesis, and *none* of the non-examples can fit the hypothesis."

Among a chorus of nods, "Yeses," and "Okays," Mrs. Maggio continues with the process. Shawn offers the hypothesis *things we eat with seeds in them*, and Marsha offers *red foods*, to the giggles of the class.

Mrs. Maggio then asks in the form of admonishment, "Are apples and tomatoes both red, and are either the rock or the carrot red?"

"No," the students respond.

"Good. . . . Now, I want us to have fun with this, of course, but remember that the only thing that determines whether or not a hypothesis is acceptable is whether or not the data support it. . . . And do the data support *red foods*?"

The class nods, a bit sheepishly.

"Good. . . . Now, I know you didn't mean any harm, but keep that in mind."

Mrs. Maggio then adds an avocado to the Examples list, a piece of celery to the Non-examples list, and again they analyze the hypotheses as they did before.

Mrs. Maggio continues by adding and analyzing hypotheses with a peach, a squash, and an orange as positive examples and a head of lettuce, artichoke, and a potato as negative examples.

The students continue the process with Mrs. Maggio's guidance, narrowing their hypotheses to *things with seeds in them* and finally modifying the hypothesis to *seeds in the edible part of the plant*.

Now Mrs. Maggio asks, "Does anyone know what we call foods that have seeds in the edible part of the plant, like the examples we have here?"

After hesitating a few seconds and hearing no response, she says, "We call these foods *fruits*." And she writes the word *fruit* on the board.

Mrs. Maggio continues, "Excellent, everyone. Now, we need a good clear definition of fruit. Someone give it a try. . . . Go ahead, Goeff."

"Okay, . . . Fruits are . . . things we eat . . . that have seeds in them."

"Seeds in what part?"

". . . In the part we eat."

"Very good, Goeff. I'll revise this a tiny bit to smooth it out a little, but we essentially have it."

Mrs. Maggio writes on the board, "Fruits are foods we eat with seeds in the edible part."

Now Mrs. Maggio has the class take out a piece of paper and categorize additional examples as either positive or negative examples of the concept *fruit*.

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