Designing Experimental Investigations

1.5 hours

Lesson Rationale/Overview: brief description of the lesson topic, activity, assessment (This is part of the knowledge package).

The students will learn the methodology of designing an experimental investigation and practice with an inquiry yeast lab.

Objectives (students will…):

Students will use concepts of experimental design to design and implement a scientific experiment.

Standards (TEKS or national standards addressed):
Bio TEKS:
B.2.A. know the definition of science and understand that it has limitations, as specified in chapter 112.34, subsection (b)(2) of 19 TAC;

B.2.B. know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;

B.2.C. know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;

B.2.D. distinguish between scientific hypotheses and scientific theories;

B.2.E. plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;

Knowledge Package: Add cheat sheet of content overview for your own reference, include misconceptions students may have and how you will address these.
See attached answer sheets

Assessment of Prior Knowledge: Add quick pre-assessment activity here (can be done as hook, or on day prior to lesson) 4 corners/KWL/think/pair/share / exit slip question…

Warm up question – List the steps of the scientific method

Materials / resources / equipment needed:

Teacher:

Experimental design notes

Demonstration – Yeast solution, sugar solution, water, two test tubes, two pipets, two balloons, string, ruler

Student:

Skill sheets, ipads, inquiry yeast lab handout

Daily Agenda: YOU WILL WRITE THIS ON THE TEACHERS BOARD (or have it as the first ppt slide)

(What I will write on the board so that the students' know what is going to happen during this lesson plan).

1. Objective and standard met:
2. What they should be able to do to show their understanding by the end of the lesson:
3. Major activities for lesson
4. Homework or next time…

Activities:

Warm up
Transition – Experimental design notes
Demonstration – yeast lab
Activity – Design your own experiment based on the given parameters

Activity	Time needed	What are you saying / doing / asking	What written directions are you handing out/ writing on the board?	What are the students saying / doing/asking?
Hook/Invitation	**5-8 min**	**I am asking the students to turn in their homework from the last class. Once students are completed, we go over as a class the steps to the scientific method.** **1. "Please turn in your graphing assignment to the tray at the front table."** **2. "Right now you should be writing down the objective and the warm up. You also need to silently and independently answer the warm up question."** **3. Logistics – "There is something we need to go over that is not on our calendar. Today we will be getting our project handouts. Projects are always on purple paper and do not need to go in your unit logs because they are a six weeks project and not a unit project. These handouts are very detailed, you should use them as a checklist to make sure you have everything you need in your biome travel project."** **Make sure to put the document on the doc camera** **4. Go over daily agenda** **5. Go over warm up**	**Objective – see attached powerpoint slide** **Warm up – List the steps of the scientific method**	**Students are working quietly on the warm up after turning in their homework from the previous class. The students will then independently work on the warm-up, share with their group, and then share the steps of the scientific method with the class when prompted.**

Going over unit project	**10 minutes**	***Hand out project sheets and go over important aspects of the project. Take a few questions if they have any. I am summarizing the directions for the biome project handout and explaining my expectations. I make sure to model some of the directions with past projects. *Stress that this is a major grade**	**The due dates for the upcoming exam and unit project are on the board.**	**Students are listening to the instructions.**
Transition/ Experimental design notes	**15 – 20 min**	***Pass out experimental design notes* *Direct the students to the ipads – make sure they are all on the "join me"**	**Notes – Experimental design**	**Students are taking notes in their notes handouts**
Yeast Lab demonstration	**10 min**	**First, I tell the students which materials I am using. Next, I add 5 pipet fulls of water to one test tube. Then I add 5 pipet fulls of yeast solution to the first test tube and quickly cap it with a balloon, making sure all of the air is out of the balloon. Then, I measure the circumference of the balloon with the string and correlate the measurement to the ruler. Next, I add 5 pipets full of sugar solution to the other test tube, followed by 5 pipets full of yeast solution. Then I quickly cap the test tube with a balloon, making sure all of the air is out of the balloon. I then measure the initial circumference of the balloon. Finally, I show the students an example of the yeast solutions after thirty minutes have passed and measure the final circumferences of each balloon.**	**1. Write down everything I am going to say in the top portion of your inquiry yeast lab handout.**	**Students will record as many observations as they can during the demonstration .**
Transition – Experimental design skill sheets	**10 – 15 min**	**I am explaining the different sections of the skill sheet to the students and relating it to the notes we just took over experimental design and the observations of my demonstration.**		**Students are following along with the skill sheet**
Activity – Design the experiment	**Rest of class period**	**I am explaining the directions of the experimental design. "What are some of the things we can change with the experiment?" "Now you are going to design your own experiment keeping most of these constant and manipulating one of these variables. You will work with your table as a group and need to agree on which variable you want to change. Around the room we have set up a list of the materials you will need if you choose to manipulate that certain variable. On a separate sheet**	**The three manipulated variables are on the board: Temperature Size of Container Food Source**	**Students are writing the design to their experiment while consulting with their group members.**

		of paper, go through and design the experiment based on the steps in your skill sheet."		
Homework: **Finish designing experiment**				
Special populations: **Students will be able to work in groups and consult with each other for explanation and discussion.**				

Scientific method in correctly ordered steps. ** Students usually believe that the hypothesis is the first step – make sure they are corrected and redirected to observation**

1. Observation

2. Question to test or Purpose of experiment

3. Hypothesis – *this is an educated guess in a statement form, there is no "I think" or "I believe." Also, a hypothesis is different than a prediction*

4. Gather materials and write your procedure

5. Collect Data – put into a graph

6. Analyze the data

7. Conclusion - *this section needs to include what went wrong in the experiment and what could be improved if you were to do this experiment again.*

Experimental Design notes

1. CONTROL – **you don't necessarily need a control group if you are measuring something like the absorbency rates of a paper towel since most paper towels are absorbant. However, you will need to establish a control with variables such as the different light sources available to a plant.**

2. REPEATED TRIALS – **Why do we do this?** - Accuracy, take an average, sustain validity, in case there was an error. **What is the standard number of trials for any experiment?** – 3-5 trials

3. DURING PLANT EXAMPLE TELL THE STUDENTS TO PUT THEIR PENCILS DOWN

4. CORRECTION – GO over the IVCDV chart extensively, talk about each variable and why we are putting it in a separate section of the chart. Have the students practice with the IVCDV chart.

5. SPONGE BOB EXAMPLE – **Complete this independently and quietly, I will give you time to discuss this with your table, but now is not the time. Discuss the constants with your group.** Go around the room and have students share one constant per table until the list is complete

List of constants:

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1. Type of bubbles, type of solution

2. wand size

3. location of bubble blowing

4. Same person must blow all bubbles

5. same container size

6. force of blowing

V CHART – STUDENTS DO NOT WRITE FIRST EXAMPLE – STUDENTS DO WRITE THE FORMATTING

Form a hypothesis based on the spongebob example. Make sure you include how each of the variables are affecting one another. Do this independently at first and we will share out soon.

Experiment:

Pass out experimental design skill sheet, students may not understand the purpose of the sheet until after the demonstration. Reassure them that it will all come together soon.

Look through this sheet and make the following corrections – SEE ATTACHED SKILL SHEET

Today, as a group, you will be coming up with an experiment based on the demonstration I will perform in a moment. Keep in mind that you will need to get through Steps 1-5 and the data table on your skill sheet.

Pass out Inuiring into Yeast Lab

On the top, lined portion of this paper, you will record everything I am about to do and say. However, only record what is relevant to the experiment, do not comment on the color of my sweater or length of the cart. Only write down the observations pertaining to the experiment. Today you will be designing an experiment of your own based on this demonstration. It is therefore very important that you write down EVERYTHING I say and EVERYTHING that I do. I should be the only one talking during this demonstration, if you are talking, you are disrupting the observations of others.

Put demonstration on the document camera so everyone can see

I have one test tube rack with two large test tubes. In the first test tube, I will add five pipets full of water. In the second test tube I will add five pipets full of sugar water. I will then add five pipets full of yeast solution to the first test tube and then immediately cap the tube with a balloon. I then take my string, wrap it around the balloon so that it is completely touching it and then lay the string next to a ruler to measure the circumference of the balloon. MAKE SURE THERE IS NO AIR IN THE BALLOON BEFORE YOU MEASURE IT. Next I will add five five pipets full of yeast solution to the second test tube and then immediately cap the tube with a balloon. I then take my string, wrap it around the balloon so that it is completely touching it and then lay the string next to a ruler to

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measure the circumference of the balloon. MAKE SURE THERE IS NO AIR IN THE BALLOON BEFORE YOU MEASURE IT. Notice I already have my data table set up on the board so we can put in the values as I measure them and not just write a bunch of numbers down with no distinction. Let the solution sit for thirty minutes and then measure the balloons again with the same string technique. *Do the lab in the morning before the class starts so you have an example of what the final circumference will look like.* **These values will go in the "final circumference" section of the table.**

PLEASE PUT YOUR PENCILS DOWN

A little bit of background on yeast – it is a fungus that is dormant in its packaged state but can be revitalized with water and food.

What does this yeast use for energy? Sugar

What is the yeast releasing into the balloon as it consumes the sugar? Carbon Dioxide

Further probing questions "What do we eat to obtain energy?" "What is being released into the balloon? Water vapor? Maybe a gas?" "When we eat and then respire, what gas do we release?"

WORK ON THIS QUESTION – **What is the balloon measuring then?** The AMOUNT of Carbon Dioxide

Why did the circumference of the balloon with just the yeast and water not change from initial to final? There was no sugar source for the yeast to use for respiration

Write this next question on the second lined section of the inquiry yeast lab handout. How can we change the amount of CO2 produced? *Let the students answer – a lot of the students will reply 'put more yeast, or put more sugar.' Emphasize that all ratios and amounts will stay the same. Students will also think that maybe the balloon needs to be changed, remind them that those types of variables will not change the amount of CO2 produced.*

Write on board underneath the question as the students answer
1. Change the type of food source
2. Change the water temperature
3. Change the size of the container

These are your options for designing your experiment. Make sure your entire group agrees on which variable to change. How many of these variables are we changing from the initial demonstration? ONE, and only ONE

Turn over your inquiring into yeast paper and get out at least one extra sheet of paper. Also have your skill sheet out to help you. WAIT FOR THEM TO GET IT OUT. **You will need to complete all of the steps on this paper. If you are confused, consult your skill sheet. Each person needs to write their own experimental design but agree on a common variable to change within your group** – MAYBE CLARIFY

There are three stations in the lab section of the room with the proper materials you will need for the given variable you are changing. We have only provided the list of materials

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for each experiment – temperature, food source and container size. It is up to you how you use the materials and make sure you include those materials in your procedure.