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TE 861B: Inquiry Lesson Sequence

I. Initial Plans

Clarifying Your Goals

Performance expectations:

NGSS: PS1A Structure and Properties of Matter
Scientific Practices: obtaining, evaluating, and communicating information, defining problems, engaging in argument from evidence
Crosscutting Concepts: Structure and Function
SWBAT: Explain why density is a characteristic property
SWBAT: Calculate density of various substances
SWBAT: identify substances based off of their density
SWBAT: explain why substances sink, float, or suspend in a given liquid

Initial Plan

Describe a plan for all phases of your lesson sequence:
my students will participate in a week long unit covering density.
Before pHet Lab either day one or after the test discussion day before starting unit:
Give students the prompt 'Why is it that a large boat floats but a small pebble sinks?'
Have students write; share out with their partners; and then share out as a class.
Day one- They will start with a pHet lab where they can virtually explore density. Students will be asked a series of follow up questions as they through the lab and test different scenarios.

Day two - teacher will discuss the pHet lab with students, asking them to work in small groups in order to discuss their results, partnering them up with someone that they did not work with on the day of the lab in class. After discussing the changes they will report out with the teacher, teacher will then discuss and lead class to a definition of density
Day three- students will go through a Flinn designed investigation where they will each be given a different graduated cylinder with a mystery amount of clay attached on the bottom students will graph the mass and volume of various amounts of the same liquid; using the graph they will predict the mass of the graduated cylinder.

Day four- teacher will give some direct instruction on density, talking students through what they should have done in the previous lab and guiding them to create a procedure on how to find the density of a variety of regular, and irregular objects as well as liquids. Students will complete a full pre-lab for this activity. (Title, purpose, hypothesis, materials, procedure, and data table)
Day five students will find the density of various liquids, irregular, and regular shaped objects.
Day six students will be given a scenario where their friend will claim that they have a piece of gold they want to sell them for a low price; they will create an experiment in which they can test to see if the piece of gold is really gold.

Phase 1: Engaging with a problem/Questions
The starting prompt will be 'Why does a large boat float while a small pebble sinks?'

Can two different sized objects have the same density?

Phase 2: Data or observations / Evidence.

Day one pHet lab over density; see attached write up
day two - students will analyze data from previous day

Students will enter the room and be asked to compare their findings from the pHet lab of the previous days. I will ask them to discuss in small randomized groups differences and similarities in their data. They will then be given the chance to write on large white boards as a group the generalizations they can make about density after doing the lab. I will list on the board a series of suggestions on where to look at in their data; such as 'what happens if only mass changes? What happens if only volume changes? If you have two objects of the same material what stays the same and what can change?'
Day three Flinn inquiry investigation- students will have recorded data and will graph the mass and volume
day four students will analyze previous day's evidence/data as well as report out within their small groups
Day five density of regular, and irregularly shaped objects and liquids- students will create their own data tables, and record data points and calculated the density

Day six density scenario- students will use the previous knowledge to write up an experiment, no data will be taken on this day

Phase 3: Finding and explaining patterns / Explanation.
pHet - Students will be asked analysis questions looking for trends in the data they are collecting throughout the lab students will also report out with small groups the following day and talk to the teacher about their data and any issues they had with their data

flinn - students will have created a graph of the volume and mass of the liquids and will use this graph not only to determine the liquid's density but also in order to determine the mass of their graduated cylinder. Students are expected to be able to figure out that the spot where the best fit line intersects with the y axis is the mass of the graduated cylinder. Students will speak in small groups in order to understand how their data shows them the mass of their graduated cylinder.

scenario- students will be asked to use the preceding days information in order to create a lab that they could theoretically do to prove if their friend's piece of gold for sale is actually gold or just a painted rock.

various objects- students now have a good understanding of what density is so they will be able to find the density of their objects and will be able to create their own procedures and data tables. They will be asked to explain their findings and whether their predictions were correct.

Phase 4: Alternate Explanations. How will your students evaluate the quality of their data or resolve conflicting explanations between groups?

In each day of the mini unit students will be asked to talk to at least two different groups in order to compare their data, they will be asked to share their data and then reflect on any differences that may occur. I will be asking students to defend their data and if any discrepancies occur they should try and resolve them together in their groups. I will also lead them in discussions in order to help facilitate class—wide explanations for their data.

As students work in their small groups they will try and resolve any differences in their data. I will circulate and intervene when I see data points that are far off, if I see outlining data I will combine groups so students have the ability to look at even more data, I will encourage them to look at their different pieces of data and try and identify the outliers. If they identify the outlying piece of data I will then have them analyze in a group why their data was an outlier.

I think I will have the largest variety of answers in my gold writing summative assessment. If I have students that tell me that they could end up being tricked with a density the same as gold if it is a mixture I will encourage them to do some research into other characteristic properties in order find another way of proving that it is really gold. My plan would be to have students research other characteristic properties for homework that night, then discuss their findings at the start of class before having them write their explanations. In their explanation prompt I will ask students to find a way of justifying that it is gold in a secondary manner.

Phase 5: Communicate and Justify: How will your students illustrate their understanding through written or oral communication?

Students will be showing their understanding over the topic of density and how it is a characteristic property by engaging in the argument scenario. Students will write an essay explaining how they will prove that their friend is just trying to trick them by trying to sell them a gold painted rock.

Throughout the unit students will be discussing within their groups and reporting out to the class their findings. They will also be asked a ticket out formative assessment for each day where there is not a lab assignment. Lab assignments will serve as the written communication and assessment for the days in which a lab is required.

II. Revised Plans

1. What have you learned from interviews with your students or discussions with your colleagues that lead you to change your plans?

After discussing the lesson plans with several of the other teachers that will be teaching density in the coming days at my school I have decided to make a few changes to my plans. I think that I will need to spend a bit more time reaping activities. My classes are large and my students are of varying abilities, unfortunately they are very much still ninth graders and I think a bit more hand holding, for lack of a better term will be necessary than how I originally planned the lessons to go. I need to spend a few days recapping after each activity and giving them more back ground on density. Section one has been changed using the track changes feature in order to reflect these changes. After interviewing my students it seems that they do not have a good grasp of what density is going into the topic. My students gave me a lot of responses dealing with the mass of an object is what causes it to sink or float, I think that I need to demo objects with the same mass that have differing volumes in order to show them that it is not mass alone that dictates whether the object will sink or float.

2. What assessments (both embedded/formative and summative) will you use to assess students' understandings?

I am admittedly a bit confused about the assessment tasks. I plan on having assessment tasks throughout each day of the lesson. I formatively assess my students whenever I am lecturing, they are doing activities, or anything in-between. The pHet lab, the Flinn lab as well as the lab of regular/irregular objects and liquids will all be handed in and will include research questions as well as conclusions. On the day where students are given the scenario to write about this is an assessment task in which students are going to be making connections. I am asking my students several ticket out questions throughout the lesson sequence in order to ensure they are understanding as we go along. My ticket outs will follow the learning as a progression model. Because those questions will build on each other. The first will be fairly basic and then each subsequent one will demonstrate a deeper understanding of density culminating in the scenario writing that I will have the students do at the close of the mini unit.

3. Use Track Changes on Section 1 above to show how your plans have changed.

III. Final Report

Your Students' Learning

In 1-2 pages, respond to: How well did your students understand performance expectation(s) that you taught? Describe at least one way in which they were successful and one way in which they were not completely successful. Provide evidence from student work to back up your claims.

I have taught the density unit for several years, this year I changed the way I was planning on approaching it due to this assignment. Overall I think it went pretty well. I taught the unit to 76 freshmen in my two sections of Next Generation Science. When I analyzed their responses and performance over the unit I focused especially on those students that I had originally interviewed at the start of the unit. Overall I expected students to grasp density fairly quickly, I watched as my students began to understand the concepts in waves. Each year that I teach density I have changed it a bit but this year I felt as though the flow of the unit went the best. For the most part I followed the plans that I originally outlined. I started the unit asking my students why they think something large like a boat would float however something small like a pebble would sink. This question came from my interview report. I thought that it would be a good springboard for my students to start thinking about the idea of density as a ratio. To start I had a lot of students giving me responses about buoyancy. I had several students who gave me responses that didn't make much sense or didn't have much science backing it up. I have a very small amount of students who talked about density itself. I was pleasantly surprised that I had a decent number of students who talked about how the boat was so large and that compared to its weight had something to do with its ability to float. For our first day or exploring density I had my students look at a pHet lab online. I ended up modifying the worksheet a bit. I wanted to make sure the lesson was very much inquiry based and the students didn't waste their time on the assignment. I had students get used to the application by first having them go through a few options step by step, and then instructed them a little less in order to let them discover things on their own. For the hypotheses at the start of the lab I had my students predict the density for objects that would sink, float, or suspend in water. Close to 50% of my students had at least one incorrect, however I was impressed with their responses to why their hypotheses were incorrect when the lab was complete. Many of my students said that they weren't certain what density really was until they were able to manipulate the variables. I was most impressed with a few of my students who in their conclusions mentioned that this lab helped them solidify why mass and volume were not good properties to use to identify something, because they were able to see how if you changed both at the same rate the density didn't change.

After the density pHet lab I moved my students on to teaching briefly about density, I made sure that students knew the formula and the density 'triangle' so they were able to understand how to find mass, volume, and density when given the other two. We worked in groups on the problems. As I circulated from group to group I made sure each student was working as equally as possible. I gave each group a wide board in order to work on the density problems. At the close of the class we did a ticket out where students simply had to solve a density problem, over 75% of my students got it correct or close to correct.

The third day of our density unit students did a challenge lab in which they were asked to create a graph of mass and volume of various samples of liquids, they were then asked to create a best fit line and estimate the mass of their graduated cylinder. I was very impressed with how well

most of my groups did. The first time they had to check in with me I had some lower scores however by the last time most students had begun to understand the idea and knew what they were doing. After seeing them attempt to graph and not do their best I decided that I needed to go over graphing the following day.
The fourth day we spent talking about graphing, best fit lines, independent and dependent variables before finally talking about the density. By the end of the class I felt as though my students all had a good grasp on the ability to create a best fit line. Day five my students were asked t find the density of several regular and irregular shaped objects and did a great job of it. I had very few students who asked questions throughout. The last day I had my students respond to the gold scenario. I have approximately 1/3 of my class who either added a lot of extra stuff into it or they didn't answer the question properly. This is one of my biggest concerns in my building, I often times feel as though I have taught something fully but then when I ask my students a question in a format I haven't previously asked them I feel as though they crash and burn. My students are so conditioned to simply memorize as opposed to actually learn and apply the knowledge.
Throughout my lesson sequence I was able to have my students work independently and in small groups hands on almost every day. My students were also able to communicate with one another frequently and discuss and debate their results. There is a huge push in my school to increase student engagement in formative assessment. So I know that I made an effort to ensure that I was able to make use of a variety of formative assessments in which I was able to see responses from all my students.

Final Revisions and Reflections

Explain how you would teach this lesson sequence differently or change your goals the next time. Why would you make these changes?
I have already made a few changes to my sequence as noted above after my revised plans were turned in. I made the changes due to suggestions both from a co-worker as well as my instructor. The changes I would make to this lesson sequence in the future would be to start with the gold scenario. I think that starting with this question would give me a much better idea of all the misconceptions my students hold before teaching the unit. I think maybe even in addition to the gold question I would ask a few of my interview questions that I had asked my focus students for the student interview assignment. I found many of the questions I asked those few students to be very helpful in shaping my direct instruction. After preforming the Flinn challenge lab I know that I will in the future need to spend some time perhaps at the beginning of the year where I will review all types of graphing. Throughout the semester I have had to stop lessons to teach histograms, heating curves, and now best fit line. My students not knowing about these concepts was not something I foresaw as I taught this unit differently than in the past.

Continuing to Work with Students

How will you follow up on this lesson sequence, helping students to assess and extend their understanding, and to apply what they have learned in future units?

This topic will be a continuing trend in our class. Since we talked about density we moved on to other characteristic properties. I was able to link density with boiling point and melting point as all being things that would assist us in identifying a substance. I tested my students for a second time on density when i gave them a unit test over characteristic properties. Now we are moving on to solubility however after christmas break I will be requiring my students to preform a week long lab practical in which they will need to separate and identify a series of substances, they will be reviewing density before this process. I will ensure that I continue to mention density throughout the coming weeks in preparation for my students to do the sludge test.

Appendix

PhET Density Lab

Go to my website and click on the PhET Density Lab link.

A. When you see the wooden block, grab it with your mouse and put it in the water. Note that you can manipulate the block by pushing them underwater

Wooden block:

Mass= _____ Volume = _____ Density = _____

Manipulate blocks, use different materials, in the custom setting to find out the following

1. When objects float, they displace an amount of water equal to their: _____
2. When objects sink, they displace an amount of water equal to their: _____
3. What is the density of water? _____
4. How do you think this activity would change if the objects were placed in a denser liquid like Mercury?

Click on the custom block and then choose each of the following materials and manipulate them so that they have the following masses and volumes. Place the object in the water and determine the density.

Material	Mass	Volume	Density	Mass	Volume	Density	Mass	Volume	Density

Styrofoam	1.0 kg			2.0 kg			3.00 kg		
Wood	2.0 kg			5.0 kg			8.0 kg		
Ice	2.0 kg			5.0 kg			8.0 kg		
Brick	2.0 kg			5.0 kg			8.0 kg		
Aluminum	2.0 kg			5.0 kg			8.0 kg		

What happens to the density of the object, as the mass increases? _____

Suppose you have a piece of Zinc that is 5.0 g and a piece of zinc that is 50.0 kg. Which piece has a greater density? _____

Material	Mass	Volume	Density	Mass	Volume	Density	Mass	Volume	Density
Styrofoam		2.0 L			5.0 L			10.0 L	
Wood		2.0 L			5.0 L			10.0 L	
Ice		2.0 L			5.0 L			10.0 L	
Brick		2.0 L			5.0 L			10.0 L	
Aluminum		2.0 L			5.0 L			10.0 L	

What happens to the density of the object as the volume increases? _____

Suppose you have a piece of Zinc that is 5.0 L and a piece of zinc that is 50.0 L. Which piece has a greater density? _____

Now click the button for “Same Mass” fill in the following table:

Color	Mass (kg)	Volume (L)	Density (kg/L)	Does it Float?
Blue				
Yellow				

Green				
Red				

Click on the button for “Same Volume” fill in the table below:

Color	Mass (kg)	Volume (L)	Density (kg/L)	Does it Float?
Blue				
Yellow				
Green				
Red				

Click on the button for “Same Density” fill in the table below:

Color	Mass (kg)	Volume (L)	Density (kg/L)	Does it Float?
Blue				
Yellow				
Green				
Red				

Click on the button for “Mystery Blocks” fill in the table below:

Block	Mass (kg)	Volume (L)	Density (kg/L)	Material?
A				

B				
C				
D				
E				

1. Put the blocks in order from least to most dense:
   _____
2. Which blocks would float? _____
3. Which blocks would sink? _____
4. What can you say about the density of 2 objects that are made of the same material?
   _____