Using Assessments to Drive Instruction

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Introduction

This unit is the light unit of physics. For the purposes of this project, I chose to focus on the refraction of light portion of the unit. They will learn why light refracts, how light refracts and how the medium in which an object travels changes the refraction of light. Traditionally, students struggle with the why behind why student's refraction occurs. Throughout the unit, this was true for about 6 of the students in my classes. Students also struggled with the fact that light changed direction in different mediums. In order to counteract these misconceptions, I showed students a laser traveling through a plastic block and a glass block and they calculated the indices of refraction based on the angles measured. The three formative assessments (seen in the Appendix) served to help students really understand the refraction of light. The middle assessment is where students really demonstrated if they had mastered refraction of showed me where there were misconceptions. At this point, I also had them redo the initial assessment in order to see growth of understanding. After learning that my students did not really understand how refraction would change the way fisherman should fish, I went back to the initial lab with the pencil in various mediums and had a class discussion regarding this. My goal was to have 100% of my students understand refraction by the end of the lab.

Analysis of Student Learning

Topic Description

This unit is the light unit of physics. Students will learn about the production, reflection, and refraction of light. They will also learn the geometric options and image formation by lenses and mirrors. Lastly, they will learn about interference, diffraction and polarization of light waves.

Students typically struggle to understand imaginary images and how they are formed. They also struggle to understand why refraction occurs and the components of light that cause refraction.

Targeted Learning Goals

Student will be able to analyze the refraction of light in multiple mediums including water, oil, and gel.

Student will be able to summarize why refraction occurs and how the angle of refraction changes with different mediums.

Students will be able to calculate the indices of refraction for various mediums.

Formative Assessment Task

See attached document.

Formative Assessment Task Rationale

The formative assessment task I have chosen is a performance assessment. Students are required to observe, explain, predict, raise questions, interpret the data, and draw conclusions about the refractive nature of light. According to Shannan McNair (2004), "it takes time to incorporate effective assessments throughout the daily teaching and learning process, but it is worth the effort." McNair goes on to discuss the three types of assessments and what each one looks like. I used her ideas in order to drive my assessment creation throughout this unit (p. 25).

Pre-Assessment: The pre-assessment will allow students to observe the phenomena known as refraction and allow me to gage what they know and don't know. It will also serve as an introduction to refraction as students will hopeful draw a conclusion that summarizes what refraction does, even if they do not have the vocabulary to state exactly what is happen. Most students will likely say that the pencil has changed because the water is distorting it or the water distorts our vision.

During Assessment: The assessment in the middle of the unit serves to see where students are at and where they need to go in order to be successful on the post assessment. Students will think back to the pre-assessment and use their newly learned vocabulary in order to assess where they are at. At this point, they should be able to define the look of the pencil as refraction. They should also be able to state that the index of refraction of the 3 liquids are different and thus the gel has the largest effect on the look of the pencil. Lastly, they should be able to state that it is actually the light changing direction, not a change in the pencil that creates an illusion of the pencil moving. They should then be able to apply this knowledge to other situations such as fishing.

Post-Assessment: The final assessment requires students to create a lab in order to study the index of refraction of 10 different materials. They are required to have a deep understanding at this point of what the indices of refraction are and how different objects would have different indices of refraction. Students will likely choose different household objects and will be required to write a conclusion which summarizes exactly what is happening throughout the lab using the data to support it.

Scoring Guide for Analyzing Students' Responses to the Formative Assessment Task(s)

Pre-Assessment: Throughout the pre-assessment, I focused on two parts: the explanation and the summary. Students that showed mastery at this point of the unit had to say something about the pencil's angle changing based on the substance that it was placed in. They also had to come to the conclusion that the gel appeared to bend the pencil the most and thus thicker substances change the appearance of an object more than thinner substances. After learning that some students were still confused about how when light changes mediums, the light is forced to change directions, I added a lab at this point. I had students do a lab where they measured the

angles of a laser before it entered blocks of different mediums, as it traveled through the block, and as it exited the block. Before the lab, I looked at the students that had shown understanding of the pre-assessment and grouped them strategically with the students that had not yet mastered the topic. I then observed these individuals as they went through the lab and asked clarifying questions and for evidence to back up their thoughts and ideas. Gooding and Metz (2011) suggested these as ideas "to help students identify their own misconceptions" (p. 36).

During Assessment: Throughout the during assessment, I focused on question number 3. In order for students to show mastery at this point of the unit, they should have said something about how due to the refractive index of water, the fish would appear to be at a different location than they actually were. In order for the fisherman to be more successful, he or she should aim just a little bit further than they see the fish in order to have better success with catching the fish. At this point of the unit, there were five individuals that still had not mastered refraction. In order to help these students out, I wrote thought questions on their

After Assessment: In the after assessment, I focused on the student's conclusion. At this point of the unit, students should have easily identified that thicker substances have larger indices of refraction. They also should have tested at least one solid and noted that the solid has a larger index of refraction than any liquid. They last thing that students needed to have was an explanation. In order to show mastery, students must include a sentence about how light is actually causing refraction.

Analysis of Student Work

Pre-Assessment: During the pre-assessment, only 20% of students showed mastery. Of the 20%, 12% of the students had heard of the world refraction before. There were two major misconceptions at this point. The first was that the amount of a medium did not change the

refraction of the pencil. The second was that the pencil appearance of the pencil was not changed at all by the various mediums. In order help with the both misconceptions, the next day, I did a demo showing how the path of light changes based on the medium it travels through. I did it once with a small beaker and water and gel and once with a larger beaker with water and gel. Most students were easily able to see that both of these misconceptions were inaccurate.

During Assessment: At this point during the unit, most students were able to understand what refraction is at that it has something to do with the speed of light in a medium. Students still did not understand how this effected things on a daily basis. The largest misconception during the second assessment was that the fisherman did not need to change anything to catch the fish. This showed that students still did not understand how the amount of a liquid or solid affected the apparent location of an object and that a large lake would make fish appear to be in a completely different place than they actually were. In order to address this misconception, we began looking at how light was refracted in a solid. If students can understand how light is refracted in a solid, than maybe they can better understand how light is refracted in a liquid. Students were able to apply Snell's law to several different media and look at where the light entered and exited blocks of various sizes. At this point, most students understood that the fish would be difficult to find because they would be several inches from where they appear, especially if they were at the bottom of a deep lake, but there were still 4 students that did not understand this. Holzmiller (2008) introduced me to the idea of daily learning logs (p. 65). Although I did not have my students complete a learning log, I used her idea of using the do now or introduction to the next day's lesson to address the misconceptions at this point of the unit. I purposefully called on the 4 students that did not mastery the topics on the during assessment to share out their do now explaining how to fish using what we learned the day before. I then asked clarifying questions

and had other students that had mastered the topic help them out with the answers. At the end of class, I had students re-write their answer to the same question using information we had discussed in class. Of the 4 students that had previously not mastered the material, all of them now showed mastery.

Post Assessment: During the post assessment, it was clear that students knew and understood refraction and the refractive indices of various materials. There were only 2 students out of 25 that were still unable to master the concept of refraction. The first student could not understand how light would change direction when it changed mediums. The second student could not understand that light would change the appearance of any object. Although all students but 2 showed mastery, for the next unit, I want to focus on ensuring that 100% of students show mastery. This can be accomplished by checking in with students individually after the during assessment to see where their thinking is an adjusting instruction accordingly.

Table 1

Student Mastery and Misconceptions by Assessments

Student Number	Assessment 1 Mastery?	Misconceptions	Assessment 2 Mastery?	Misconceptions	Assessment 3 Mastery?	Misconceptions
1	X					
2	X					
3		The pencil was not changed at all by different mediums.		The fisherman does not need to change anything to catch the fish.		Light does not change directions ever. It only travels in straight lines.
4			X			
5			X			
6			X			
7		The pencil was not changed at all		The fisherman does not need to change	X	

		by different mediums.		anything to catch the fish.		
8	X					
9		The amount of a medium had no effect on the amount of refraction.			X	
10				The fisherman does not need to change anything to catch the fish.	X	
11					X	
12	X					
13				The fisherman does not need to change anything to catch the fish.	X	
14			X			
15					X	
16					X	
17		The amount of a medium had no effect on the amount of refraction.	X			
18			X			
19			X			
20	X					
21					X	
22					X	
23					X	
24		The pencil was not changed at all by different mediums.	X			
25		The amount of a medium had no effect		Refraction is not used in the world.		Light does not change the

		on the amount of refraction.				appearance of objects.

Reflections on Teaching

The formative assessments used throughout the unit served to allow students multiple opportunities to demonstrate mastery. There are some things that I would change if I were to re-do this unit. The first is that I when I have students redo the pre-assessment while they are doing the during assessment, I would have them use what they know about refraction to explain their observations. Although most students were able to show mastery over the pre-assessment when they re-did it, I did not think it was as meaningful as I had hoped. In order to make this more meaningful, I would require students to use the definition and what they know about the speed of light in various mediums to describe what happens to the pencil in various mediums. At the very least, I would require them to write a summary after to ensure that all students understand why the pencil appears different in different mediums. This would also allow me to gage where each student is at.

The second change I would make was in the post assessment. Although I think the post assessment served a great purpose, I would spend more time helping students create their lab in order to ensure the results that I would have liked. Most students created a similar lab to the one we had already done where they measured the indices of refraction of various objects that I had in the room. I would have liked to see students bring in objects from home and look at the indices of refraction of these or attempt to figure out what the material is of an object based on the angle of incident and the angle of refraction. In order to ensure more creativity, I would broaden the rubric to fit more different labs and ideas.

Conclusion

Doing a pre, during, and post assessment is something that I will add into my units from now on. I learned a lot about each of my students and where their understanding was at each point of the unit in order to evaluate my day to day lessons and change them based on where my students were at. This is something that would be helpful throughout every unit. I would still like to explore different ways of doing these assessments such as assessing where students are at through class discussions and group work. Overall, I think this unit was more successful and more of my students had a deep understanding of refraction due to the assessments and evaluation of student understanding used throughout the unit.

Appendix

Pre-Assessment

Materials:

- 3 glasses
- Water
- Vegetable oil
- Gel
- 3 pencils

Investigation:

1. **Predict**: Draw what the pencil in the glass of water will look like below:

2. Place the pencil in the glass of water. Record your observation below:

3. **Explain**: Why do you think this happens?

4. **Predict**: What will happen when you place a pencil in a glass of vegetable oil? How will it be the same or different from the water? Draw what it will look like below:

5. Place the pencil in the glass of vegetable oil. Record your observation below:

6. **Explain**: Why do you think this happens?

7. **Predict**: What will happen when you place a pencil in a glass of gel? How will it be the same or different from the water? How will it be the same or different than the vegetable oil? Draw what it will look like below:

8. Place the pencil in the gel. Record your observation below:

9. **Explain**: Why do you think this happens?

10. **Summarize**: What was similar/different about the three different substances that the pencil was placed in?

During Assessment

Think back to the activity where we put the pencil in three different substances in order to answer the following questions.

1. Define refraction.

2. Give an example of two refractive indexes, what makes the indexes the number that they are, and how the two substances causing refraction differ.

3. How can refraction be used by fishermen? Explain where they would need to hold their fishing pole in relation to the fish in order to be more successful at catching fish.

4. Think of one other way that refraction is used on a daily basis. Include why it is important.

Post-Assessment

You have been tasked with creating a lab to find the refractive index of any 10 substances. Write out each part of the lab in detail including a materials list, the procedure, a data table for the results, the calculations necessary, and a conclusion regarding what refraction is, the refractive index is, and how the angle of refraction changes based on the object the light is traveling through. See the rubric below to ensure you have complete the task effectively.

	Rubric			
	4	3	2	1
Introduction	1. Includes the question to be answered by the lab. 2. States hypothesis that is based on research and/or sound reasoning. 3. Title is relevant.	2 of 3 conditions are met.	1 of 3 conditions are met.	None of the conditions are met.
Materials	Materials list is thorough and others could repeat the lab having only the materials listed.	Materials list is thorough but missing some materials necessary to complete the lab.	Materials list is lacking materials necessary to complete the lab.	Materials list is unclear and lacking materials necessary for completing the lab.
Procedure	Description or step-by-step process is included and could be repeated by another scientist.	Description included, but some steps are vague or unclear.	Description gives generalities, just enough for the reader to understand how the experiment was conducted.	Lab would be difficult to repeat as reading must guess at how the data was gathered or experiment conducted.
Data	Results and data are clearly recorded and organized for the reader to see trends. All appropriate labels are included.	Results are clear and labeled, trends are not obvious or there are minor errors in organization.	Results are unclear, missing labels, trends are not obvious, and/or there is not enough data to show the experiment was conducted.	Results are disorganized or poorly recorded, do not make sense or not enough data was taken.
Conclusion	1. Summarizes data used to draw conclusions 2. Conclusions follow data (not wild guesses or leaps of logic) 3. Discusses applications or real world connections. 4. Hypothesis is rejected or accepted based on the data.	3 of the 4 conditions are met.	2 or the 4 conditions are met.	1 of the 4 conditions are met.

References

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