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| (ES) IV.3.2: Explain how forces (pushes and pulls) are needed to speed up, slow down, stop, or change direction of a moving object. | **TASK 1: Force and Motion investigation with writing prompt as assessment:** Students conducted a hands-on investigation exploring the ways air from a straw can push various balls (of different masses) from different angles to study changes in direction. This investigation introduced students to concepts including force, motion, stop/start of motion, changes in direction, push, force strength, and force needed to push different massed objects. The writing prompt was given prior to investigation and discussion as the assessment. (worksheet #2 attached). FEATURES in task:  
  - Students were to use the scientific vocabulary to explain the investigation results (vocabulary included push, force, motion, mass, and change in direction.)  
  - 3 questions were prompted and the following ideas were looked for in each question:  
    - #1: force starts and stop the motion of an object  
    - #2: the change of direction of the object was because of the air pushing the ball from different places/angles/ways.  
    - #3: each ball had a different mass so the force needed to put the ball in motion was higher and lower depending on the ball type. | 23/27 85% |
| (ES) IV.3.2: Explain how forces (pushes and pulls) are needed to speed up, slow down, stop, or change direction of a moving object. | **TASK 2: Ramps and Cars investigation with explanation writing prompt as assessment:** Students conducted a hands-on investigation exploring different ramp sizes and the effects of the ramp size on a moving toy car. Students also added pennies to the toy car to explore the effects of added weight on the toy car down the ramp. This investigation introduced the concepts of gravity and weight. The writing prompt was the formal assessment (worksheet #4 attached) FEATURES in task:  
  - Students were to define “gravity” and “weight” in scientific wording prior to hands-on experience with concept, discussion, and direct instruction.  
    - Gravity: pull from the Earth; pull between 2 objects.  
    - Weight: measure of the pull of gravity  
  - Students were to explain investigation results using the new vocabulary “gravity” and “weight.”  
    - Conclusion #1: As the ramp was higher, the pull from gravity was more direct.  
    - Conclusion #2: pennies were added, the toy car had more weight, so more pull from the gravity.  
    - Conclusion #3: weight of the car increased because the pull from Earth increased; felt heavier with more mass on toy car. | 21/27 78% |
### TASK 3: Rough Roads investigation and explanation writing prompt as assessment:

Students conducted a hands-on investigation exploring how far the toy car moved on different road surfaces including: sandpaper, wax paper, aluminum foil, felt fabric, and bubble wrap when it is pushed (measure the distances and compare roads qualities). The writing prompt was broken up into individual questions so students could focus on 1 idea (worksheet 6 attached).

**FEATURES in task:**
- Students were to complete statements about investigation for clarification including which road the toy car went the longest/shortest distance (A and B).
- Students were to explain what friction had to do with the investigation (C)
  - Friction was the force that slowed down the car; friction was the force between the car (wheels) and the road surface.
- Students had to state which roads had the least/most friction during the motion:
  - (D): sandpaper; bubble wrap
  - (E): wax paper, aluminum foil
  - This is showing if students are connecting the ideas of what friction does (slow down objects in motion) to the roads tested (high friction means car did not move far; low friction means car moved longer distance).
- (F) Students had to apply their knowledge of what friction was to come up with 3 real-world examples of where to find friction
  - Shows if students know what friction is (force between 2 objects rubbing) and that friction SLOWS objects down: looking for 2 objects rubbing and a situation where an object would slow down because of that rubbing.

### TASK 4: Apply Your Forces investigation as assessment:

Students will apply their knowledge of force strength (push), friction (road surface), gravity (ramp height), and weight (addition of pennies) to create 2 scenarios using the same materials as in the previous 3 investigations. Students must come up with the scenario where the toy car will move the fastest and farthest as well as the slowest and shortest distance using the materials given.

**FEATURES in task:**
- For the fastest and farthest toy car, students will use the highest ramp (gravity’s pull), smoothest road surface (low friction), harder push (force strength), and addition of pennies on toy car (added weight for gravitational pull strength).
- For the slowest and shortest car, students will use the lowest ramp (gravity’s pull), roughest road (high friction), lighter push (force strength), and no addition of pennies (no added weight for gravitational pull strength).
- The assessment is hands-on and involves the student “SHOWING” their knowledge and demonstrating force/motion while explaining the concepts, or the “why.”

| (ES) IV.3.2: Explain how forces (pushes and pulls) are needed to speed up, slow down, stop, or change direction of a moving object. | 20/27 74% | 22/27 81% |
Carly Zenk: Maybury Elementary: 3rd grade

Assessments: Analysis and Reflection

I. Which features were most problematic? (Listed below and explained in II and III)

**TASK 2:** Students were to define what “weight” was in their own words.
**TASK 2:** Students had to answer “Conclusion #3” which asked why weight increased as pennies were added to the toy car.
**TASK 3:** Students were to distinguish between what roads and the most and least friction during the rough roads investigation (show the connection between friction and an object slowing down).
**TASK 3:** Students were to give real world examples of where they find or have seen friction slowing down an object to show their knowledge of how friction is the force of 2 objects rubbing and slowing motion.

II. Which goal features were most often not present?

**TASK 2:** Students did not define weight as a measure of the pull from gravity. Weight was not expressed as a part of a force or connected with gravity’s pull. The students were finding it difficult to replace their previous notion of what “weight” means with the new scientific concept of “weight” focusing on forces and gravity as a force. In the investigation, more pennies were added, so the toy car had more weight to move down the ramp. Students did not connect the idea that weight effects motion.
**TASK 2:** Students did not see the pennies as added weight, or the measure of the pull increasing on the toy car to make the toy car move faster down the ramp. Students did not see weight as a measure concept.
**TASK 3:** Students did not connect that the higher the friction force, the slower and less distance the car would move or the lower the friction force, the faster and more distance the car would move. Students did not connect the word “friction” with a force that slows objects down or is the rubbing between 2 objects.
**TASK 3:** Students did not come up with real world friction examples accurately. They did not write 2 different objects rubbing together, or show any objects slowing down due to the frictional force. They seemed to only see friction as connected to the roads in the investigation.

III. Which naïve features were most present?

**TASK 2:** The students described weight as “how much you weigh” or “how many pounds something is” or “how heavy or light something feels.” This shows that the student is not connecting the term “weight” with how it pertains to gravity’s pull. Students did not see weight as a MEASURE of the pull but instead kept with their comfortable definition of weight being how heavy something is (did not revise prior knowledge).
**TASK 2:** Students only saw the pennies as mass and not added weight, or added pull from gravity. Students knew it the toy car was heavier, but remained in the mindset of added mass instead of connecting the “heavier” car as added weight to move the car moved faster down the ramp.
**TASK 3:** Students connected the higher friction with the longer distance/speed and the lower friction with the slowest/shorter distance. This is because those connections might have been instinctual to put the “high with the high” and “low with the low.” The terminology was in the way of the actual concept of friction being a force. So students saw the wax paper having a lot of friction because the car went the farthest and the bubble wrap having low friction because the toy car went the shortest distance. Students are viewing friction as a “push” force instead of a force acting AGAINST the starting force.
**TASK 3:** Students gave real world examples with one-word answers such as “slide” or “floor” or “carpet.” These may be on their way to examples, but these students didn’t show that friction needs 2 objects rubbing together (slide and legs, floor and skateboard, carpet and feet.) Students were having trouble seeing friction outside of the investigation: the friction was on the roads only, not between the car and the roads.
IV. How well did your assessment work in providing evidence of and insights into student learning?

Overall, the assessment tasks were accurate and served well as insight to a student’s learning. The main reason is because all of the assessments were prior to investigation experiences with the concepts, discussion about concepts, and direct instruction connecting scientific vocabulary to the concepts. The written format of the assessments allowed students time to think about the concepts at hand and allows them to express their understanding clearly. The format of the “Explanation” sheets also allowed students to build up the discussion the “why” of the investigations. Looking at the “Rough Roads Explanation” assessment sheet, students were asked individual questions building up to connecting the road type to the concept of friction.

Also, any discussions prior to assessment allowed students to compare their ideas, and “talk out” what they have experienced. Once the teacher gives direct instruction, any misconceptions students have about the concepts or experiences can be discussed as a group.

TASK #4 assessment is a positive way to check for student understanding of the force concepts because it allows students to take charge of the concepts and to own those concepts. Students are leading their expression of what force, motion, gravity, friction, and weight are by demonstrating their knowledge with a hands-on application. The students are able to SHOW what they know with a demonstration instead of writing out their experiences again.

What changes or additions of tasks might be useful to improve evaluation of student learning?

After completing the science unit and assessments, I see changes that would benefit my evaluations. First, I would implement drawings of forces in action so students can have another method of expressing their thoughts. Sometimes students do not have the words to describe their thoughts, but are better suited to drawing what they understand. Also, I would add more demonstrations of understandings to my assessment tasks so students can SHOW me the concepts of force while explaining to me what is happening and why at the same time (immediate connection between DOING and KNOWING). This could be done informally while walking around during investigations or in an interview situation.

Another possible assessment, on the same idea of doing demonstrations, would be to take a field trip or extend the investigations outside to the real world. Students could act out the various forces while explaining them to me, so they can easily connect real world situations to the concepts because they would have experienced them. Overall, I would want more of a variety of assessment types besides written formal assessments, informal note taking, and questioning during discussions. I would lean more on the demonstration side of assessment (hands-on, doing).

What other changes might you make in your analysis, if any?

Another change I would make in my analysis would be to make expectations on the written assessments either clearer or more open to student thinking. I think that some of the written assessments limited student expression but at the same time didn’t set clear expectations of what I was looking for. Next time, I would either set structured expectations (use this word to explain....) or give a student a open-ended prompt to allow students to express more of what they are thinking individually while trying to implement the scientific vocabulary later on when the concepts are more solidified.

Due to time constraints, science is only done a few times each week, not allowing students to revisit concepts as much as needed. This makes science feel like it is one concept after another. If I had the ideal situation, I would revisit each concept several times before implementing the vocabulary. I believe if the student has grasped the concept strongly enough, adding a label (vocabulary term) to that concept wouldn’t catch students off guard as much as it does when the concepts are continuously being added to the unit.
Assignment #5:
Assessment/Analyzing Student Learning from Your Unit
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