Force Changes Velocity

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Concept: 1) How does force affect the motion of an object?

Description of Activity: We used this towards the end of our force and motion unit, so we assumed they had a good grounding of motion terminology and at least what force was. We introduced them to the laptops, motion sensor and Knex race cars. We did this as a formal lab in their lab journals, so we forced them to predict what would happen to the motion of the car as a force was applied. We developed a set of instructions with them, then let them experiment. They used the laptops extensively, using it to control the motion sensor, collect data, and analyze it. We then had them print graphs off the computer in insert into their notebooks. Concluded with a discussion about what they learned and how they learned it.

Anticipatory Set: We had the COOL equipment out to perk their interest. Then in their lab write up, we got them to think about how force would affect the car.

State Standards:

- PS.6.6.9 Conduct investigations to calculate the change in speed caused by applying forces to an object
- PS.6.6.7 Describe the effects of force: 1) move a stationary object 2) speed up, slow down or change the direction of motion 3) change the shape of objects

Materials:

- K'NEX race cars with spring motors or rubber bands (can purchase from Carolina)
- laptops
- Pascal motion sensors (borrowed from Stephen Skinner, can buy from pasco.com)
- tape
- index cards

Prerequisite Skills: Familiarity with a PC. Fundamental knowledge of force and motion.

Key Questions:

- How does force affect the motion of an object?
- Is the amount of force proportional to the effect?

Management Suggestions: Be sure you are VERY Familiar with the software and motion sensor; beware of little quirks that can throw students data off (short vs. long range settings, non flat index card, etc.) It is often helpful to have an assistant that has some knowledge as well. Be prepared to handle a wide array of finishing times.

Procedure:

Before Class Preparation

- Install software for motion probes on all laptops (www.pasco.com)
- Make sure all students can log onto and use laptops
- Build all K'NEX cars [get kids to come help during lunch for a few days or can build them in class if you have time (15-25 minutes), which gives them hands on in building complex machines.]
- Do test runs to prove principle and have a good set of data in case everything goes wrong.
- Have all equipment grouped and ready to hand to kids.

Class Time

Have them get out their lab notebooks and create a new lab. Give them the question "What will happen the car's motion when a force is applied to it?" Then let them create a hypothesis; this is where they will do their thinking and start the inquiry. Next, give them the material list and lead them in a discussion, where they give you the procedure of how to carry out and find an answer to the question and verify their hypothesis. I think this is a very important part of the inquiry process. Just because you have an idea doesn't mean you can test it. You really develop their scientific minds here. The general idea is for them to hit the main components; I don't focus on the specifics unless they just start hitting them right off the bat. One specific procedure to remember is to have them attach a 4x6 index card to the back of their car so the motion sensor can easily track the car. After the procedure is created, give them instructions on what data is required for them to have to prove their hypothesis. They need a velocity vs. time graph for 3 different forces being applied. Then they need a table consisting of Force, Initial velocity, maximum velocity, change in velocity for 3 trials at 3 different forces. For this lab we used the wind up motor spring cars and measured force in revolutions of the wheel. They then need to create a graph of change in velocity vs. force.
After the requirements are understood, do a short demonstration on how to use the software and motion sensor. Let the students have their materials and go to town. This part can take anywhere from 30 minutes to 1hr 30 minutes depending on how many problems the group encounters and savvy at least one person is with the computer.
Once all the data is collected, graphs made, results written and conclusions justified, gather the students to discuss what they've learned.

Discussion & Follow Up Activities:
After making the change in velocity vs. force graph, hopefully will see the proportionally increasing relationship between the two. Lead the students through a discussion of what they thought. Have them critique their ideas based on data they've gathered.
For homework, a good review sheet with simple conceptual questions would be valuable.

Assessment Plan:

Participation in the discussions is what I go by in the immediate evaluation. It lets me know what they experienced. Later on we do CPA quizzes to see if they've developed the "terminology" to describe what we've learned better. We also look at the grades on the unit test.

Extension & Enrichment:

Ask them if this makes sense and examples of where they have felt this effect. A real car would be a great one. Show them that this is practical in explaining how the real world works.

Reflection:
This is a long lab; we had 1 hr 50 minute periods and it took about 1.5 periods to get all of this done. I really think it is worth it for two primary reasons. First, you're forcing them to inquire about this process, including coming up with an explanation and how to test it. Second, they get a big jump in technology, which I think is important to keep up with how scientists really work today (with computers and advanced automated equipment and graphing on the pc rather than by hand). Third, they really start to deal with equipment and setup issues like real scientists; a lot of students get frustrated because it's not a "I can do this in 10 minutes on th first try" experiment. This challenges a lot of students to work hard to get good results. Management is a little tough because their seemed to be a million questions about little setup quirks.