Physics:
A Weighty Issue for the Masses

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INTRODUCTION

Physics has been defined in many ways, but basically it is the study of the way the physical world works. We may not know the rules, but we understand and respect their existence. Much of what we know and continue to study is based on the works of Galileo, Sir Isaac Newton, and many other scientists. Children very often accept things that they cannot explain. They are very comfortable with not being able to explain circumstances.

I have been teaching for twenty years. Currently I am in a first-second grade looping cycle. I am teaching first grade this year, and will follow those students to second grade next year. I have done this for several years now, and find it to be very rewarding. As a bilingual teacher I am able to see considerable growth in all areas by the end of the second grade. I have seen phenomenal growth in not only the subject areas, but also other areas which I believe essential to overall success. One such area is organization. I understand that for some this may be innate, but for many others it must be taught. By developing students' organizational skills, they will formulate questions and present answers in a more organized way. Physics is a wonderful subject in which even very young students can apply their knowledge and utilize their skills in the most organized way. Physics absolutely demands it.

As a first-second grade-looping teacher, I teach all subject areas. Edna Moreno Carrillo Elementary School is located on the east side of Houston in the Houston Independent School District. The Houston Independent School District is the seventh largest district in the nation. Carrillo has an enrollment of 710 students in a school-wide Title I program. Ninety-eight percent of the student population is Hispanic. Ninety-one percent of the students are on free/reduced lunch. Sixty-two percent are Limited English (LEP). Fifty-seven percent of the students are in Bilingual programs. Twenty percent are in Gifted/Talented programs.

OBJECTIVES

SCI.1.4A – Collect information using tools including cups, hand lenses, clocks, computers, thermometers, and balances.

SCI.1.5A – Sort and classify objects and events based on their properties and patterns such as rocks by and weather changes by season.

SCI.1.4C – Measure organisms and objects and parts of organisms and objects, using non-standard units such as paper clips, hands, and pencils.

SCI.1.7A – Observe, measure and record changes in size, mass, color, position, quantity, sound and movement.

SCI.2.D – Construct reasonable explanations and draw conclusions.

SCI.3A – Make decisions using information.

RATIONALE

The seminar will provide me with an overview of what some may believe to be very basic principles of physics. However basic, they will be challenging to me, as I, like many, have come to accept the world as it is without fully understanding it.

I believe that once you pose the questions, children will become interested in their answers. Since answering physics questions often requires hands-on experience, I believe the overall learning expedition will be exciting for them. Developing a deep understanding is a daunting challenge. Learning through discovery is some of the most meaningful learning that can occur. Children construct knowledge based on experience. They maintain those beliefs until they are given reason to believe otherwise. Often that "reason" is the result of experience. In the event of a question, students either change what they believe to be true or simply accept the new set of circumstances. Admittedly, this unit has been quite an undertaking for me, the main reason being that physics was not my field of study in college. As with most courses of study at the university level, my initial course of study was somewhat broad, but my focus became narrow and very specific quite quickly. I enjoyed learning and revisiting some of these physics concepts. Although Newton's laws were not new to me, preparing ways to present them to first graders was.

UNIT BACKGROUND

There are many principles and a multitude of avenues of study to pursue. I initially considered Newton's three laws. I thought about developing a unit around the exploration of those, which I believed to be the basic laws of physics. However, the more time that I spent in class, the more I saw that to truly understand, the students would need a very clear presentation of the principles. This suspicion was validated by a comment that Dr. Gemunu Gunaratne, our seminar leader, made one evening. As a physics professor, he stated that he noticed how students come to college with extensive knowledge of all the formulas, but without a truly deep understanding of the concepts. I want to provide a foundation upon which students can continue to build.

I want to focus on some basic concepts of physics. This unit contains activities that address a variety of concepts. Students will participate in a variety of activities across the curriculum. Although it is important to learn the concepts through discovery, it is just as important to be able to communicate that knowledge. This communication may take place via writing, oral presentation, or project preparation.

They may gain the knowledge in a science work station and be able to share the results through graphs and charts compiled in a math work station. Students will also report and reflect on their experiences orally and in writing in literacy stations. Children have different styles of learning. Many gifted students are not reached because they may not necessarily be able to showcase their talents in traditional modes. Susan Winebrenner directly addresses this when she states, "Every pedagogical method we've used with gifted kids over the years is now considered state-of-the art for all kids" (4). Literacy Stations, Work Stations, and Learning Centers are some of the terms used to describe active learning situations. Students move about from activity to activity with a specific goal and purpose in mind. Work Stations provide students the opportunity for discovery learning. Teachers are not merely responsible for presenting the material. More importantly, they must engage children in learning – so much so that they become responsible for their continued interest and learning. By working in groups, there is a multitude of opportunities for rich conversations among children. What may look like play is actually meaningful learning where deep understanding begins. During this time students are engaged. All students are present in the moment of learning. Although they may not be posing actual questions, they are there for the dialogue. It is from these experiences that they can explain to others who do not understand or present their findings to a larger group.

Learning Centers can be approached in two different ways. Some find it beneficial to have a series of five different activities. Students spend about fifteen minutes at each activity, or Work Station, and then move on to the next. However, if you choose this approach you will have to have enough time to do five rotations or extend the time to more than one day. For example, if you allot forty-five minutes for the lesson, you will only have enough time for three rotations. You will have to continue the activity on a second day to allow for another two rotations so that all students would have done all activities. The other option is to have five stations of the same activity. This just so happens to be my personal favorite. I find that it works well with younger children who have limited experience with rotating to different stations. It also works well for me as a teacher. I find it easier to take anecdotal notes of the groups' progress and discussions if they are all doing the same activity. I also find the whole-group discussions more productive as well. A final thought on this option is that by duplicating the same activity, you are able to complete it in one day. It is also easier to grade any documentation that you put in the Work Station. Any teacher knows that it is easier to grade twenty-two of the same thing as opposed to five of this, five of that, etc. I do believe that the more experience that students have with Work Stations, the more able they are to rotate among them. It is equally important for students to understand that although these activities are fun and interesting, they are still responsible for documenting their learning. For this reason, I always have some sort of paperwork requirement in every Work Station. I also always like to have each group member write their names on everyone's paper in the group. I do this because if someone fails to complete the written portion of the assignment, I can ask someone else in the group. I always explain to the group that they are responsible for each other's learning. They are instructed to check to make sure everyone has his or her documentation.

I have heard time and time again that if a student can explain how he or she arrived at a correct answer or teach someone else how to arrive at the correct answer, that student truly *knows* the subject matter. Some prefer to have one small group do a particular activity during a given day. As the week progresses, more groups participate. Ultimately, by week's end, all students have had a small group learning opportunity. Another option is to have several activities for several simultaneous groups. Personally, I find these most exciting. They do, however, take the most preparation time on the teacher's part, and self-discipline on the students'. Fear not! Students can learn to go through these activities independently. I suggest starting in pairs. Establish basic rules, and I swear by paper documentation. Students must understand that the activity is fun, but there is important work to do. Debbie Diller has excellent resources on not only setting up the centers, but managing them as well. Although she addresses activities in Literacy Stations, we must understand that "literacy" is not limited to language arts. Students must be literate in all subject areas, especially the sciences. My students must submit some sort of documentation. That documentation may not necessarily reflect what they did, but it will reflect that they did the work. I also believe it important to have a place for all members of the group to sign. The name of the person who did the work would be first, and all others would follow. I find this particularly helpful for reviewing the documentation from the day's activities. Admittedly, a teacher cannot see every activity of every group. However, as she monitors the overall group, circulating amongst the small groups, she can consult an individual's paper.

Friction

I believe that this particular principle has great possibilities when it comes to experiments and daily activities. Friction is the result of surface irregularities. Movement of rough surfaces makes molecules move faster and create heat, consequently raising the temperature of the surface. Temperatures increase because molecules are moving faster. How will children understand such abstract concepts? They will use the demonstrations as springboards for dialogue. Although they will not have the vocabulary, they will have some idea of what is happening. These ideas will be the basis for rich guided discussions. Since becoming a teacher, I have discovered that I know many things, but I may not have fully understood them. An example of this occurred when I became a presenter of math inservice modules for teachers. Of course, I was trained as a presenter for these inservices. I remember the topic of square numbers. I remember wondering how I would teach such a concept. According to my experience, you were given a series of numbers referred to as squares and square roots. You just remembered what they were; there was never an explanation of why they were referred to as squares or roots. In the training I was shown how square numbers actually form a square when using base ten blocks on centimeter graph paper. I had no idea! Things are much the same with my discovery of physics. This unit will focus on friction; however, other concepts may be introduced. The introduction of these principles can serve as a basis of study.

Safety

I believe it imperative to teach safety initially as an isolated unit of study. Students must understand that there are precautions that must be taken. One cannot assume that the mere appearance of a substance provides us with all the necessary information. Students must understand that they are not to touch or taste anything unless instructed to do so. There are several resources available to teachers about this subject: United Streaming™ and BrainPop™ are two of the more popular and most recent. Part of the unit must address what to do in case of emergency. Students should be familiar with emergency protocol. For example, if you conduct most of your experiments or presentations in the classroom, you should instruct them as to how emergencies or accidents are handled. This protocol may be somewhat different from an actual laboratory situation. I conduct some experiments in my room. I am most fortunate in that I have a sink in my room. However, if I didn't, and I felt that I needed a water source, I would let students know where that was. The protocol is different when we go to the actual science lab at my school. The lab has something that looks like a sink, but in actuality is an eyewash station. A student attempting to use the eyewash station would be in for wet surprise, as the faucet is designed to flood the eyes with water in the unfortunate incidence of contamination.

After the overall safety unit is taught any applicable rule or precaution should be revisited prior to any demonstration or experiment. There are also universal precautions to consider. These are good rules to live by and students should know how to properly wash their hands, not just wash the soap down the sink. They should also know not to touch bodily fluids. Nosebleeds and loose teeth are common in first grade. As teachers we are provided with rubber gloves in observance of universal precautions. I take them out and show them to the students and explain that I follow the same rules, as do all of the teachers and the school nurse.

Acceleration versus Velocity

According to Newton's First Law, the velocity of a free object is constant. However, because of friction, air resistance, etc., it is difficult to find free objects. On the other hand, if all the forces on an object balance, its velocity is constant. For example, while riding in a car at a fixed speed and direction, you hear the steady hum of the engine. The force provided by the engine is balanced by friction, air resistance, etc… If you cover your eyes and ears during such motion, it is impossible to know that you are moving. However, as the gas pedal is pressed further, the pitch of the hum changes and a passenger would feel that they are pushed against the seat. This is indicative of acceleration. The transmission adjusts, and the hum returns, as the constant velocity is reestablished.

Linear and Angular Momentum

Momentum (mass x velocity) of a system remains unchanged unless it is acted on by outside forces. For example, it is conserved during a collision of two particles. Consider, for example, the collision between two cars. How they move after the collision (for example, which car will be pushed back) depends on their momentum; thus, a rapidly moving car can push back a very slowly moving truck. Picture a figure skater. I remember Dorothy Hamill slowly gliding along the ice. She then would go into one of those breathtaking revolutions. She began slowly, with her arms outward, and one leg seemingly floating along the side. As she pulled her arms and leg in close she spun, faster and faster. However, her angular momentum remains the same. She slowed as she returned her arms and legs to their original positions.

Buoyancy

Archimedes' Principle

Bloomfield describes this as "the observation that an object partially or wholly immersed in a fluid is acted on by an upward buoyant force equal to the weight of the fluid it's displacing" (145). The principle is named after Archimedes. He was noted for many accomplishments during the first century BC; however, his "war machine" inventions won him great prominence and popularity. Hiero II, the king of Syracuse, had requested that a gold crown be made. Unfortunately, Hiero II suspected that his crown would not be fashioned with pure gold, as per his request. Archimedes figured out how to test if the crown was actually made of pure gold by using buoyancy.

Children have some idea about buoyancy; they just do not have the scientific vocabulary to describe these ideas. You can begin discussion about this principle by referencing their last visit to the pool. The discussion will eventually touch on how much easier it is to pick someone up while they are in the water. Now students are ready for the vocabulary to describe that knowledge. They are also now ready for a demonstration of the principle. Weigh an item on a spring scale. Record that amount. Place the item on the scale below water and weigh again. It will be lighter the second time because of buoyancy.

Conversion of Energy

Energy has many forms, including kinetic (energy of motion), sound, heat, etc. Unless work is done, the total energy of a system remains constant. However, energy can be converted from one type to another. For example, when you apply sandpaper in a back and forth motion across a piece of wood, the wood becomes hotter. The heat is the energy that is converted from (kinetic) energy from the movement across the wood. Children can easily see and feel this process. For this reason this activity is particularly meaningful. It is a complex concept for the age level, but it now becomes more easily understood. Students can repeat this experiment using different surfaces, noting the similarities and differences. Again, once students begin the process of making predictions and trying them out, they will become more comfortable with the idea and better at the process. Energy can also be viewed as the grand total of a bank account. There is a total for the savings account and a total in the checking account. While amounts from one can be transferred to the other, the grand total remains the same.

Another illustration of this concept would be the use of a spring. When the spring is pulled back, force is applied and energy is stored in the spring as potential energy. When released the energy is converted to kinetic energy and a mass at the end of the spring moves. The more that the spring is pulled, the faster the mass will move when released. Students can repeat this experiment using different sized springs.

Conductors

Through movement, charges in electrons can form currents. Most teachers of young children are familiar with the song about the bears in the bed. One gets in and says, "Roll over, roll over," so they all roll over and one falls out. This is pretty much the case among conductors. The electrons begin to move about and one is cast off. The castoff electron takes the charge with it. This all happens quite quickly. Think about how quickly the handle of a pan can become too hot to hold once the pan is heated.

This is a great time to remind students about science safety. It would be good to ask students if you can look at something and determine if it is too hot to touch. Unfortunately, we do not always get a visual indicator when something can harm us. A cold handle of a pan looks just like a hot one. You don't know the difference until you touch it, and if it is too hot, well, it's too late. You are already burned.

I recall an event that occurred years ago. I can laugh now, but at the time it practically frightened me to death. My childhood home had a covered patio with ceiling fans rated for outdoor use. Part of the second story of my home extended over the patio as well. One day we noticed the ceiling fans spinning at the highest speed…without being turned on. My mother frantically turned the switch off and on. She followed that with turning off individual breakers and ultimately she shut off all electrical power to the house. No use, those fans just spun and spun. I never saw my mother so worried. She called friends and neighbors and they came, looked, scratched their heads, and moved on. She ultimately got in contact with the contractor who supervised the construction of the second story. She insisted that she bring the electrician, because she feared that the fans would overheat and the "whole house [was] going to burn down." The contractor and electrician came, and they too were amazed with the automatic spinning fans. They went upstairs and discovered a leak in the toilet. The water had traveled to the fan and shorted it. The water from the leaking toilet served as a conductor for the electricity, hence the mysterious spinning fan. I really wished that I had a bit more knowledge regarding this subject. Experience was my teacher and education does cost. Whether it be service calls or tuition, education costs.

So why do you get shocked when you get out of your car? We sometimes mistakenly believe that our "electric personalities" are the culprits. Such is not the case. It is actually the car that generates the charge as it passes through the air. This is more evident on less humid days. In places where the humidity is high, the water molecules will take most of the charges from the car as they pass through the air. Needless to say, Houstonians don't have a big problem with this.

Transfer of Energy

When cooking in a pan with a metal handle, you must always remember to keep a potholder handy. This is essential, as you will not be able to comfortably grab the handle to maneuver the pan or its contents. Why does the handle become so hot? Do we traditionally apply heat directly to the handle itself? On the contrary, the heat is applied below the pan, and the handle is connected to the pan. As the pan becomes heated, the atoms begin to move and continue to move as the heat increases. The "hot" atoms do not move from the pan to the handle; they move against each other, transferring the energy throughout the pan and its handle.

Thermodynamics

There are four laws regarding thermodynamics: The Zeroth Law and the First through Third Laws of Dynamics. These are all very interesting, and you are sure to amaze friends and family at your next dinner party should you choose to start spouting their coordinating formula. However, that is not the purpose of this unit. The purpose is to develop an understanding of some basic principles. The First Law of Thermodynamics states that "The change in a stationary object's internal energy is equal to the heat transferred into that object minus the work that object does on its surroundings" (Bloomfield 241). This is easily demonstrated in the following activity: It requires only cold water and the use of blender. After pouring the water into the blender, turn it on. After some time, stop the blender. You can be *very* scientific and use a thermometer, but nevertheless, the water will be warmer, so much so that its rise in temperature can be determined by touch. This is the First Law of Thermodynamics in its purest sense. The blender blades did work on the water and produced heat. This is an excellent activity for young children. They can see the blades turning, the water spinning, and hear the “screaming” of the blender. It is obvious that “work” is being done. I especially like this activity because it appeals to many senses. Visual learners’ interests will be peaked by the spinning water, while the auditory learners might enjoy the “blender screams.” We know that students learn in different ways. Some are auditory, some are kinesthetic, and some are visual learners. By designing lessons that incorporate a variety of physical responses, you cover all the bases; and more importantly, you widen your margin for success with the students. This activity involves the senses of sight, hearing, and touch. There are many times in scientific experiment situations when it is only appropriate to observe.

LESSON PLANS

Lesson One: Magnetic Fields (Adapted for 1st/2nd grade students from Van Cleave 52)

Objectives

• SCI.1.7A – Observe, measure and record changes in size, mass, color, position, quantity, sound and movement.
•SCI.2.D – Construct reasonable explanations and draw conclusions.
• SCI.3A – Make decisions using information.

Introduction

Construct a K-W-L Chart about magnets.

Concept Development

Provide students with a variety of magnets for visual inspection.

Student Practice

Students will rotate in Learning Stations. Each station will have a magnet and a variety of items with which to test their attractiveness to the magnet. Students will test each item and note the results on the documentation sheet.

Assessment

Students will be provided with a sheet which will have all of the items tested. At the conclusion of the activity, the sheet will be used to assess their acquired knowledge during the rotations. They will be able to note each item’s attractiveness to the magnet.

Closure

Students will return to the K-W-L Chart and make any additions and corrections. Students will also categorize items as those attracted to magnets and those that are not.

Resources

• A variety of magnets (at least four) • coins (penny, nickel, dime, quarter)
• iron nail • paper clip • aluminum foil • wax paper • plastic top

Lesson Two: Electricity (Adapted for 1st and 2nd grade students from Van Cleave 12)

Objectives

•SCI.2.D – Construct reasonable explanations and draw conclusions.
• SCI.3A – Make decisions using information.

Introduction

Ask students what they know about heat. Record the responses on butcher paper. Ask students about ways to make something hot, and record the responses.

Concept Development

Have students rub their hands together quickly for a few seconds. Have students then touch their hands, noting the increase in heat. Ask students to explain how their hands became warmer.

Student Practice

Students will work in groups. The number of students in the groups will depend on the teacher's access to materials and the experience of the students. Students can work in pairs, triads, or quartets. Groups larger than four may require more materials. However, the teacher will model the activity, and do it simultaneously with the class. While in groups, students will use the aluminum foil to fashion a 6 inch x 1 inch wire. The wire will be passed around the group, allowing the students to note the temperature of the wire by touch. The wire will be held to each pole of a AA battery for twenty seconds. The wire will then be passed around the group so that each member can touch it, noting the change in temperature.

Assessment

Students will be provided with a sheet of paper that is blank at the top and lined at the bottom. Students will create illustrations of the activity and write about the results of the activity.

Closure

Students will debrief after the activity. The teacher will explain that the battery is an energy source. Students will provide examples of things that use battery power. The teacher will then explain that the energy in the battery was converted to heat energy.

Resources

• AA battery • aluminum foil • scissors • ruler • aluminum foil

These are materials for one group.

Lesson Three: Friction (Adapted from an experiment suggested by Dr. Gunaratne)

Objective

•SCI.2.D – Construct reasonable explanations and draw conclusions.
• SCI.3A – Make decisions using information.

Introduction

Ask students what they know about sliding. Record their responses on butcher paper. Ask students about what makes it easier or more difficult to slide.

Concept Development

The teacher describes the differences in the sliding speeds of their examples as friction. In situations where things slide more quickly or easily there is less friction. In situations where it is more difficult for things to slide or they slide more slowly there is more friction.

Student Practice

Students will work in groups. The number of students in the groups will depend on the teacher's access to materials and the experience of the students. Students can work in pairs, triads, or quartets. Groups larger than four may require more materials. This activity works best in a rotating Work Station format. Each station would have a surface (white board, cardboard, wood, blackboard, cutting board, etc…) and items which to slide on them (white board erasers, black board erasers, wooden blocks). The students can test each item on the provided surface. Older students can measure the angles at which the item begins to slide as the surface is raised. The teacher should in fact model each of these activities at some point. It can be done before the students do it as an instructional activity, or you may choose to do it after the students have done it as a follow-up activity, at which time the teacher can take the measurements and record them for all to see.

Assessment

Students will be provided with a sheet of paper that is blank at the top and lined at the bottom. Students will create illustrations of the activity and write about the results of the activity.

Closure

Students will debrief after the activity. The teacher will explain that friction is what caused some items to slide less easily than others. The teacher will then review the items and the surfaces and ask the students to indicate if there was more or less friction and why. I have included lab notes from this experiment when I conducted it with my first grade students. They are located in the appendix.

Resources

- 9 x 12 whiteboard
- 9 x 12 blackboard
- 9 x 12 cardboard
- wood (manageable size)
- blackboard eraser
- whiteboard eraser
- wooden block
- plastic top

Lesson Four: Mechanical and Heat Energy (Adapted for 1st and 2nd grade students from Van Cleave 204)

Objective

- SCI.2.D – Construct reasonable explanations and draw conclusions.
- SCI.3A – Make decisions using information.

Introduction

Ask students what they know about heat. Record their responses on butcher paper. If students have done other experiments, and have more experiences, this portion of the lesson may be somewhat lengthy. However, it is important that students recall prior knowledge.

Concept Development

The teacher reviews the recorded responses on the butcher paper. The teacher uses the responses to demonstrate evidence of heat energy.

Student Practice

Students will work in pairs, but with their own materials. First students are to place a rubber band on their forehead and note the temperature. Then they are to put the rubber band around their one finger on each hand and pull the rubber band as far as you can without breaking the band. Immediately afterwards, place the rubber band back onto the forehead. The rubber band will be warmer.

Assessment

Have students discuss the results of their findings in groups of four. Have the groups report to the class. One member explains the results as the other explains. The other two members are responsible for turning in a written report for the group. They would have scribed the group's discussion.

Closure

The teacher will explain that they used mechanical energy to pull the band. The energy was not lost; it just changed form to heat energy.

Resources

• rubber bands

APPENDIX

The following is a series of lab notes taken during an experiment that I conducted based on friction. I used a felt eraser measuring 2” x 1” and several surfaces. The surfaces used were a dry erase board, glass cutting board, cardboard, and a piece of wood. The eraser was placed at the top of each surface. The surface was raised and at the point that the eraser began to slide, the angle was measured.

Dry Erase Board	35º
Glass Cutting Board	42º
Wood	71º
Cardboard	67º

I learned that the degree at which the eraser began to slide on both the glass and dry erase board were very close. These surfaces are similar in that amount of friction generated on them is very similar since there was only a 7º difference in the two. The same holds true for the wood and cardboard, since they only had a difference of 4º. I would like to conduct the experiment again using a dry erase board eraser. I will use the same surfaces and compare those differences. This experiment is ideal for primary students. They can very easily make predictions and actually execute the experiment. They would not however, be able to accurately measure angles, but could understand their measurements after participating in the activity. This measurement experience is essential. It is based on the premise that the more you measure, the more you know about measurement.

This purpose of this experiment was to teach my students about friction. The concept can be illustrated more clearly by obtaining photographs of the surfaces taken by cameras with lenses that highly magnify the surfaces. By doing this, students can see that surface that look about the same, or feel about the same, are actually very different. It is these differences that account for the difference in degrees in measurements of the angles at which the eraser began to slide.

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