Physics, Sports and Visual Literacy
or
Teaching Forces and Motion the Fun Way!

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Introduction

Reid Park Elementary School serves students Pre-K-8th grade. The school is located in Charlotte, North Carolina in the urban school district of the Charlotte/Mecklenburg School System (CMS), which is the twenty-second largest in the nation. The school serves 550 students with ninety-nine percent of the population being African American. We have 27 English as Second Language students. Our school also serves some students with special needs including physical, mental and behavioral. Ninety-eight percent of our students receive free or reduced lunch making us a Title I school. Many of our students live in several government housing complexes that are located near our school. Due to our previous low test scores, Reid Park was designated a strategic school two years ago. Many changes have occurred since that time. A new principal and several hand selected teachers were brought to the school. The current principal was given freedom by the school district to try new strategies to raise test scores. One of these strategies was to hire a full time Science Facilitator, and that's how I began my new challenge in October of 2009.

As the full time Science Facilitator at our school, I have created/established a Science Lab from a classroom. The Lab has five tables for group experiments and cooperative working groups as well as a Media Viewing Space (rugged area where a computer, smart board, ladybug document camera, and digital microscope are located). The Science Lab experience is considered a "Special" on the same level as Media Center and Computer classes. Every student in the school comes to the Lab during the school year for a forty minute lesson one time a week. Most of our students have had very little exposure to science, science concepts or science vocabulary.

I currently teach Science using the North Carolina Standard Course of Study (NCSCoS) and appropriate teaching methods, resources and strategies related to designing effective science learning experiences for my students. Next school year (2012-2013) our state will change from NCSCoS to new State Essential Standards and Common Core Standards.

For most lessons I use the Five E's (*Explore, Engage, Explain, Elaborate, and Evaluate)* in planning interactive lessons. I have discovered many excellent interactive science web sites where students can perform virtual experiments. Viewing these web sites as a group has had a real impact on student learning. Many of my students are lacking in life experiences and the use of the computer gives them background knowledge to be able to perform their own discovery experiments.

Rationale

The state of North Carolina has elevated the fifth grade Science test as a "gate-way" test. The Science end of grade (EOG) test has been placed on the same level as Reading and Math EOG's. Schools are often judged by the public, parents, teachers and others on how the students score on the EOG's. These facts have had a great impact on the teaching of Science at the elementary level. Testing our students in science is stretching our teaching of science in awesome ways and with wonderful results!

During the third quarter of fifth grade I am assigned to teach Forces and Motion. The NCSCoS competency goal is: The learner will conduct investigations and use appropriate technologies to build an understanding of forces and motion in technological designs. The Essential Standard Clarifying Objective is: Understand force, motion and the relationship between them. Of the four topics in fifth grade we are asked to teach, Forces and Motion proves most challenging for me and my students. Often I do not connect the vocabulary with clear ideas in my head or with daily activities. Through this curriculum unit I will gain a deeper understanding of physics, how to apply the vocabulary to every day circumstances and then be able to transfer the knowledge in a way that will help my students have a deeper understanding of the world around them.

For the last few years of teaching this subject I have taught Forces and Motion by the use of videos from Discovery Education, hands on activities, and a few experiments. This has been marginally successful. As a reflective teacher I was searching for a way to study this goal in a highly motivational way using sports as the hook. Dr. Patrick Moyer, associate professor of Physics at University of North Carolina at Charlotte, and I discussed looking at the topic through the lens of table sports using visual representations to demonstrate the science concepts and synthesize ideas and vocabulary.

I want my students to first be enthusiastic about understanding the basics of forces and motion and the accompanied vocabulary by the use of the table sports. This unit will focus on 5 "table sports" including modified versions of basketball, baseball, air hockey, bowling and football. These sports will all be able to be played in the science lab.

As I studied the EOG released test questions and the formative test given by our district I noticed that not only are our students expected to know the content and vocabulary of some of the basic physics ideas, but they must also possess the skill of being visual literate to be successful as a student and at passing the EOG test. Many of the test questions include reading of diagrams, charts, illustrations, maps, etc. Some of the visual literacy skills are interpreting scientific photographs, figures, labels, and graphic symbols. As I prepare my students to become 21st Century learners I will incorporate into this unit ways to develop the student's visual literacy.

My objectives for this unit include helping students understand that an unbalanced force is needed to move an object or change its direction. I also want my students to understand force, motion and the relationship between them. My students will also be able to explain the factors that affect motion including: force, friction, inertia, gravity and momentum using the table sports introduced in this unit and visual literacy as the focus for learning this information.

Instructional Content Background

The teaching of vocabulary is the job of all teachers. The understanding of content vocabulary is, after all, an excellent predictor of success in the subject area (1). While inquiry skills, concept development, and understanding are the main goals, students knowing and using key vocabulary are important outcomes of science education**.**

Science texts contain many new words that students are expected to learn from reading. These words represent important ideas and concepts that are central to science understanding. However, learning new words encountered in text can be a difficult task for young students. It is therefore our duty to provide successful instruction with on conceptually important words that are essential for understanding broad ideas in the unit of forces and motion.

Dr. Moyer helped our seminar in the selection of vocabulary words that educators should master, integrate and be able to conceptualize before they begin teaching this unit. I have used "kid friendly" language in defining the words so that it can be used as a quick reference as this curriculum unit is taught.

The **position** of an object is the location of an object. If the position of the object changes you will know it has moved by the objects relationship to its surroundings. An example of position would be my chair was at my computer, now it is located at the table near the door. The position of the chair has changed.

Distance is the length of the path traveled between two places. **Displacement** is the vector between the two places (length) between two places. When an object moves it goes from starting position to an ending position. Measuring the length (path taken) between the starting and ending positions gives you distance. Measuring the straight length between the starting and ending positions gives you the displacement. I measured the distance from the computer to the table near the door and it was five feet. My chair was displaced five feet. I measured the distance (path- around tables 2 and 3 so that it could rest at table 1) and the distance my chair moved was 10 feet.

Motion is a change in position. Many of my students stay in motion! When my chair changed position it was in motion**.**

Speed is how fast an object moves over a certain distance. To measure speed you need to measure time and distance. The distance an object travels in a period of time tells you its speed. An equation to use is speed equals distance divided by time. We use units such as mile per hour or meters per second to measure speed.

Velocity is the rate of motion (speed) in a specific direction. **Acceleration** is the rate of change in velocity. You speed up if the acceleration and velocity point in the same direction. You slow down (also referred to as **decelerating**) if the acceleration and velocity point in opposite directions. When you accelerate or decelerate, you change your velocity by a specific amount over a specific amount of time.

Gravity is a force which tries to pull two objects toward each other. Anything which has mass also has a gravitational pull. The more massive an object is, the stronger its gravitational pull is. The closer you are to an object, the stronger its gravitational pull is. Often when we think of gravity we think of the gravitational pull of the Earth on us and everything around us.

Weight is how much pull gravity has on an object. Gravity is what gives you weight. I would weigh much less on the moon! This is due to the fact that the moon has much less gravitational pull. Weight is equal to the force of gravity.

Mass is defined as the measure of the amount of "stuff" in something. The more mass something has, the harder it is to move or, the more sluggish it is. If we were on the moon our mass would be the same, but our weight will have changed.

Forces are all around us and can change an object's motion. A force is a push or a pull. When forces are equal, or balanced there is no change in motion. Unequal forces cause a change in motion. Change in motion occurs when an object starts moving or stops moving, speeds up, slows down or changes direction.

Friction is the force that occurs when one objects rubs against another. Different materials produce different amounts of friction. Ice produces very little friction while sandpaper creates much friction. Friction slows things down or prevents it from moving in the first place. Friction always opposes velocity.

Momentum can be defined as "mass in motion." All objects have mass; so if an object is moving, then it has momentum. The amount of momentum that an object has is dependent upon two variables: how much stuff is moving and how fast the stuff is moving. In terms of an equation, the momentum of an object is equal to the mass of the object times the velocity of the object. A ten pound bowling ball moving at 1 mile an hour has as much momentum, or striking force, as a five pound bowling ball moving at 2 miles an hour.

Inertia is the ability of an object that is not moving to remain in place, or the ability of an object that is moving to keep moving unless a push, a pull, or some other kind of force acts on it.

Newton's Laws

Now that we have explored some of the vocabulary of forces and motion I turn to Sir Isaac Newton, a physicist, mathematician, astronomer and philosopher who lived over 300 years ago.

Newton gave us three laws to explain the proprieties of motion. Although we are not asked by NCSCoS to teach the laws, as teachers we must understand the laws and apply them to our teaching.

The first law states that an object at rest tends to stay at rest, and an object in motion tends to stay in motion, with the same direction and speed. Motion (or lack of motion) cannot change without an unbalanced force acting upon it.

The second law says that the acceleration of an object produced by a net (total) applied force is directly related to the magnitude of the force, the same direction as the force, and inversely related to the mass of the object. The second law shows that if you exert the same force on two objects of different mass, you will get different accelerations. The effect (acceleration) on the smaller mass will be greater. The greater the force on an object, the greater the acceleration is of an object that the force was applied to. An example of this is when, in baseball, if I hit a ball as hard as I can, the ball accelerates more than if I was trying to bunt the ball. Also the greater the mass of an object, the smaller the acceleration. An example would be again if I were playing

baseball, if I hit a 5—pound ball and a 1—pound ball with the same force, the 5 pound ball would accelerate less than the 1 pound ball because it has a greater mass.

The third law says that for every action (force) there is an equal and opposite reaction (force). Forces are found in pairs. Two objects are always involved in reaction. One body can never exert a force upon another one without the second reacting against the first.

Importance of Visual Literacy

Visual Literacy is the ability to read and interpret visual images and is now considered a critical part of students' needed competencies. A visual image not only gives meaning to words and offers an alternative to words as a means of communication it gives the student a valuable tool for information retention. When words and visual elements are related they help students comprehend and synthesize new information.

Teachers of today must accept the challenge of emphasizing what students can do with knowledge rather than on just what units of knowledge they have. This shift is reflected in the revised version of Bloom's taxonomy. The revision included creating at the top of the pyramid replacing evaluation. To achieve this high level of cognition the abilities to process, organize, and assimilate new knowledge in needs. Visual literacy, which calls on the student to interpret, demonstrate, and apply learning to new situations, is an example of the highest level of creating.

The process of becoming visually literate involves the student's ability to interpret and create visual information, to understand images of all kinds, to use images to communicate more effectively, and to apply visual representations as a means for mastery and long-term retention of knowledge (2)

Strategies

The first strategy is to bring my students to a basic understanding of forces and motion as it pertains to the selected table sports that will be used in this unit. I will start with my students' own questions and personal curiosity about the modified table sports of baseball, basketball, air hockey, bowling and football. We will discuss the skills needed to play these table games, and how/why we are using these games to teach science. The questions they formulate as they contemplate the forces and motion of the sport will be used to guide the unit.

The second strategy is to help my students to understand what visual literacy is and how visual literacy will be developed as we study forces and motion. They will then reflect on what they already know about being visually literate and how they can retain

knowledge by creating their own works of visual literacy. Building upon their experiences of how sports are played and upon pictures of the various sports we will name and label the forces and motions.

Another strategy that I believe will help my students will be to include a vocabulary list at the beginning of their Science Journals where they reference the words they will need to accurately describe the forces and motion they encounter while playing each of the table top games. After each of the vocabulary words they will leave five blank lines. Throughout the unit students will place the name of the sport, and a brief description of how that word pertained to the sport. In this way the students will connect the words of physics to everyday activities.

I will use projects, laboratories, cooperative learning, hands-on instruction, inquiry based science throughout the unit. I will use computers and the smart board as well as my ladybug (docushare) technology.

Classroom Activities

Lesson 1 – Table Top Baseball

Materials needed for this activity include styrofoam balls, straws, timer and a mini-baseball diamond drawn on a table, floor or desk. In my lab I will use a 5 foot tables and have students to draw a diamond on the top of the table with a marker. Students will also need their Science Journals along with a student made chart and the smart board.

To begin the lesson students will engage in a conversation on how baseball is played and how to score points in a ball game. The students who have firsthand knowledge of how the game is played will explain to others how to play and score in the game.

Working in cooperative working groups students will work in groups of 4 or 5. Number the students so that each student has a turn to be the observer, timer, score keeper and player. Explain to students that today we are going to play baseball in a new way. Our baseball is a styrofoam ball and we are playing table top baseball. The students are going to use air blown through a straw to move the ball around the bases. One student will use the stop watch to record how much time it takes for one team member to get a "home run". Another team member will observe and record how many times the first player has to move in order to get the ball around the bases to the home base. The students will keep track on a chart, recording each time and number of physical movements (change of position) it takes to score a home run. The second time two players will each take straws and move the ball around the bases for a home run.

Again a student will record the time and the number of different positions it takes to make a second home run. Hopefully students will figure out that they need to strategically place themselves in order to have the quickest time with the least position changes. The third time 3 players with straws will work together to move the ball for a home run. Records will continue to be kept for each trial. The final time, 4 players will have straws. The teacher will walk around the tables checking to see if students are playing table top baseball according to instructions, working cooperatively and recording their findings on the chart.

When the game is finished have the students analyze the chart they have made. Which homerun took the longest time, which one took the least amount of time? Which homerun took the most changes in position? Why do you feel this happened? What information do you gather from the chart?

Using the smart board demonstrate how to make a graph showing each tables time and position changes. Each of the table groups can use a different color on the graph. Discuss as a whole group reasons why each tables had different data. Was the time shortened if the group worked as a team? When (if) they strategically placed people, where they able to create less position changes, therefore decreasing their time? How can we relate that to the real game of baseball?

Students will make an entry into their journals showing the data they gathered, the graph that was created, and they will diagram the activity. Using the diagram they will label the forces that were used in playing the table top version of baseball. After measuring the distance around the diamond and using the data from the chart the students will measure the speed the ball traveled.

In their cooperative learning groups I will encourage each group to create their own experiment by changing one variable of their choosing. Students can change size, shape, or mass of the ball (use ping pong ball or squash Styrofoam ball) or change surface of ball diamond (add cloth or sandpaper). Students may also change how the ball is moved from one base to the other. After students have created, played and charted their "new" game have each group explain to the class what variable they changed and how it the new game compared to the original data.

As assessment for this activity I will ask myself the following questions. Did the students work cooperatively together and keep accurate records? Where they able to determine the motion of an object by following and measuring its position over time? Did each student begin to build an understanding of forces and motion? Students will also be assessed on their Science Journals.

Lesson 2 Table Top Football

The materials you need for this sport is a sheet of paper to make the football, a table with a miniature football field marked out, three pencils, tape and clay to make the goal posts. Safety glasses will also be worn while playing the game. No shoulder pads required. Provide a Table Top Football Rules Sheet for each team (just in case students are not familiar with rules) Students will need to keep records or "stats" of the game on a chart using a ruler as the measuring tool. The data gathered will be used at a later time while writing in their Science Journals.

First students will create their playing field, goal posts and football. Each team of 2 will have one half of a five foot table to play on. The person who reaches 35 points first will be the winner of the game.

The person to go first is selected through rock, paper, and scissors game. The "winner" becomes the flicker and flicks the football with his finger toward his opponents end. The receiving player then has four flicks, or downs to slide the ball so that part of it, even a fraction, overhangs the table edge. If this happens the person has made a touchdown and receives 6 points. The scoring player gets to try for the extra point by "kicking" the ball from his end zone through his opponent's goalposts. If the football falls off the table, the defending player takes possession.

If the football stops short of the end zone on the 4^{th} flick, the defense takes over where the ball came to rest. If the football falls off the table, the defending player takes possession. If a player flicks the ball off the table three times, the defending player can attempt a 3-point field goal the same way as an extra point by "kicking" the ball through the goalposts.

While the game is being played, the players will keep data on how far the football moved and how many inches each flick or "kick" went. When time permits students will write in their journals how they used the data to help them plan their strategy on how much force to apply to the football. Was keeping data useful to playing the game? The students will diagram the playing field. They will select their favorite play to show on the diagram. They will label the diagram with the forces and motion that were used to "make the play". How did Newton's laws apply to themselves in their favorite play? What part did friction play? How does the understanding of forces and motion come into the sport of Table top football and make you a better player?

Lesson 3 Table top Basketball

The materials needed are a block of wood, 2 push pens, rubber band, and plastic spoon to make the launching device. Each team will need a Styrofoam or ping pong balls and

a basketball hoop and backboard made from paper and tape. Students will also need their Science journals.

First students will make their basketball hoops and backboard by following the step by step procedures found on the website Instructables.com (see web page in bibliography) Students will then make a catapult using the block of wood, push pens, rubber band and plastic spoon by following the directions found on eHow.com. This web address is found in the bibliography under how to construct a catapult.

When students are ready to play table top basketball they will play a version of "horse" called "M-O-V-E". Player one will place the catapult on the table and try to make a basket. If he/she is makes the basket player 2 will shoot from the same place and try to make the basket. If player 2 makes the basket then player 1 will select a different place (move the catapult) on the table to make a shot. If player 2 misses the basket they will earn the letter M and player 1 selects another place to try to make a basket. When player 1 misses the basket then player 2 takes over the lead position. You can only earn a letter when you are trying to make a basket that has already been made by your opponent. The first person to spell MOVE will congratulate his partner and be declared the winner.

After the first game students will begin writing in their Science Journals. They will first list the materials for this game then diagram the game. They will label the forces that applied to their game and how Newton's laws were evident during the game. As a group, we will discuss kinetic and potential energy as it relates to the catapult and the students will include this in their diagram.

Lesson 4 -Table Top Air Hockey

Materials needed for this lesson are lid to water or soda bottle with whole punched in the middle, large balloons, CD-Rom or DVD disk, marking pen to create air hockey field on table top, clay, and long strips of tag board to outline field, a homemade fan and the student's Science Journals.

Students will first assemble their hovercraft by watching a 3 minute video on teachersdomain.org then following instructions on how to build their air hockey game piece. Each student will make a game piece and take turns putting them into play. Students will then use half of a 5 foot table to mark the playing field. Each playing field will have a center line (a player must stay on his half of the field) and two goal sections, three inches from the ends of the table. The students will use tag board strips to outline the field. The strips will be held upright with small bits of clay and should be able to withstand the air hockey game piece hitting it. The tag board strips will also

deter the air hockey game piece from going off the edge. Finally students will create their own fans for use in moving the game piece down field towards their goal.

The students are now ready to begin the game! The object of the game is to be the first player to score 7 points. Points are scored when any part of an air hockey game piece is inside of your opponent's goal section. No part of a players body can cross over into the opponent's half of field. Players will take turns putting the hockey game piece into play (making sure they only blow up their own hovercraft). When the air hockey game piece runs out of air the new piece will be placed in the same location with the player who is on that side of the field able to make the first move.

After the first game has been played, students will work in their science journals to explain their procedures and diagram the game. What forces were at work to win a point? Have students try to move the hockey game piece without the balloon. They will note the difference in their journals. What force is less when the hockey game piece "floats" on air? Ask the students to think about the possibility of cars made like a hovercraft. Have students list at least three advantages and three disadvantages of cars that glided on an air cushion.

While the teacher checks the journals and speaks with individual students about any misconceptions they may hold, have the students change one thing (variable) about the game, then play a second game. If time permits, students will share how they changed the game and if the change made the game more enjoyable.

Lesson 5- Table Top Bowling

Materials for this sport include double sided tape, marbles or gum balls, and long tables. On one end of the table, close to the edge of the table, place double sided tape the entire width of the table. At around the four feet mark of the table place three 2 inches strips of tape perpendicular to the first strip of tape. Place the number 8 on the small strips (they are worth 8 points) and the number 6 on the large strip. Draw a line 2 inches from the bottom of the table the whole width of the table.

Now the game is ready to be played. Each player has 10 game pieces to try to score as many points as they can for their team of two. The first player will roll the balls down the lane with the object of having the ball stick to the tape. If the ball rolls off the table at any point that ball is worth 0. For every ball that lands on the tape and sticks they will earn 6 or 8 points. If a player knocks off his own game piece that game piece then scores a 0, unless the player knocks it from the small tape (8 points) to the long tape which the ball would score 6 points. After the first player is finished rolling his 10 pieces he/she will add up the points and place the number on the score sheet, and remove the game pieces. Team two, player one will then get a chance to score as many

points as possible. Team one, player two will then take a turn and add their points to team one player one. Team two, player two will then play.

The object of this game is to stick your game pieces to the small strips of tape or the larger strip of tape at the end. In order to score the most amount of points the player most control how hard the ball is accelerated. If the ball is pushed too hard it will roll off the table resulting in 0 points. If the ball is not pushed hard enough it will not reach the tape. Students will need to be keenly aware of the forces and motion in order to be successful at this game.

After students have played the game, they will write in their Science Journals including a diagram of how the game was set up. In their journals they will include how the game was played using as many physics words as they can.

Culminating Activity

The culminating activity will be for students to participate in a project that is of high interest to them. Students will be able to select from a list of suggestions or create their own. Some ideas would include make a brochure, draw a poster, create a book to educate younger students about forces and motion (which is part of the first grade curriculum), or other visual. Students will also create a post test using questions they have produced while learning about forces and motion.

Works Cited and Reading List for this Unit

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