Learning Physics and Math: An Aesthetic Approach

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Overview
Rationale
Objectives
Strategies
Classroom activities
Annotated bibliography
Appendices: standards

Overview

Many students who come to our classrooms have other interests far from what is taught, especially in physics and math, which involve manipulation of numbers, symbols, and analyses of concepts. Because of this situation, as a high school math teacher, I have included in this four-week curriculum unit simple pedagogical strategies and hands-on activities related to the teaching of math and physics to 9^{th} and 10^{th} graders. The unit focuses on how to teach students physics and math while incorporating their interests in music, dance, and other artistic pursuits. Hopefully, they will have fun as they learn.

Activities in the unit are designed to reinforce students' abilities to think, explore, discover and create, in order to expel their phobias and stereotypes about science. The students will be empowered to demonstrate how science and math impact daily life but will not have to relinquish their innate aesthetic intelligence: they will do science and still be the artists, rappers, poets, movie stars and dancers they crave to be.

The unit has a threefold focus: math, physics, and the arts. The aspect of math in the unit is intended to strengthen students who have difficulties or fear in dealing with formulas, numbers, and to improve their basic skills. Because math is the foundation of the sciences, it is presented in the unit as a means to an end. The aspect of physics, which is the core, is intended to expose students to the inseparable bond between physics and their immediate surroundings. The aesthetic aspect deals with the introduction and synthesis of intrinsic abilities, entertainment and science. It is intended for students to have fun in the arts while they learn physics and math.

The unit fulfills the requirement of the School District of Philadelphia's Math and Science Core Curriculum for 9th and 10th graders and will utilize concepts of patterns as a basic teaching tool.[1] We will utilize hands on pedagogy, by using music rhythm to discover and appreciate patterns, introducing the prevalence of physics in the daily physical world, and helping students take cognizance of forces acting around them. The National Council for Teachers of Mathematics Standard (NCTM 1998) sets the purpose of patterns, functions and algebra in mathematics education at all grade levels. Mathematics instructional programs should include attention to patterns, functions, symbols, and models so that all students can have various options in problem solving.

Rationale

The primary goal of this unit is to utilize students' interests and abilities to ensure they acquire basic skills in physics and math.

Statistical data indicate that academic performance among public school students on state, college and school district tests, specifically in science and math decreases each year. Students who do not score the required points on public tests are categorized as being below basic, and this serves as one of the yardsticks which lower the status of schools. Schools that remain in a low category for three consecutive years may be assigned special management teams, have enrollment reduced or teachers and administrators replaced. This situation makes it essential for educators to exert much more effort to increase student performance.

Poor academic performance in public schools can be explained from several perspectives, ranging from economic to social. From the economic perspective, public schools are usually crammed with kids from disadvantaged low income neighborhoods where parents have less time to properly monitor their progress because sustenance entails more work hours and less time at home. Without guidance, students do not engage in any form of home based learning activities like homework, reading notes or practicing how to solve science problems.

From the social perspective, the lack of home support results in a variety of social ills such as idleness, teenage pregnancy, gang activities, and low interest in school. To internalize some form of social status or self esteem, students divert their abilities to other activities they conceive as less challenging compared to the classroom scenario. In order to resolve this situation, educators introduce various strategies to create intrinsic and extrinsic motivations in students by teaching in the content area but integrating issues and activities bearing on students' interests.

Background

Students' academic performance and school climate

For two consecutive years, benchmark and Terra Nova scores of my students have declined. During tests, students show no interest in completing the packages and apply less effort to pass. Overbrook High School, where I teach, is located in the Overbrook section of West Philadelphia, between Lancaster Avenue and 59th Street. The school opened in 1924 and currently has an enrollment of approximately 2000 students. Overbrook Community consists primarily of old row homes and a few apartment buildings that house its population of nearly 50,000, according to 2004 statistics. The average household income is approximately $45,000, with a median disposable income of $29,598. Besides a modest sized shopping center, several corner stores have emerged over the years, an indication that low income inhabitants are gradually moving towards self reliance and middle income level.[2]

Overbrook High school is ethnically homogenous: the very large majority of the students are African American and by and large, they come from the same neighborhoods. The lesser percentage comprises Jamaicans and Africans who have assimilated into the culture of the community so much that it is difficult to determine their original identity by speech or lifestyle; nevertheless, there is high diversity among the staff which comprises, besides African Americans, other ethnicities and nationalities, such as Hispanics and Africans.

Classroom Demography

I teach five regular 9th grade intensive math and algebra 1 classes with a total of approximately 150 students. Additionally, I teach two EOP (Educational Option Program) geometry, statistics, and algebra II classes with a total of 42 students. The EOP is a special program for adults and more mature students who are still pursuing high school diplomas. The age range of students in my classes is 14 to 16 years, for regular school and 17 to 42 years for the EOP program.

In spite of the prevailing situation, my personal experience with students at Overbrook High school revealed that they possess tremendous talents in the arts. Whenever the opportunity arises to arrange their own music, imitate renowned musical stars, perform an intricate dance step, or act out a scene, the level of excitement and aroused interest they show is amazing. For example, some students believe they can never pass a science course, because their parents either told them that they too were unsuccessful in science or that they would do better in the arts, as a family inheritance. An excellent entry point in expelling this sort of mindset is to utilize the students' existing skills to teach.

Knowledge presented

The topics that I will teach in this curriculum unit are based on the concepts of patterns in physics and algebra. Its intents are to illustrate the presence of patterns in nature and in day to day life, to demonstrate how extra-curricula interests can be applied in science, to use physics and math theories to analyze aesthetics activities, to demonstrate how waves and motion possess concepts of patterns that impact real life, and to serve as a periscope students can use to explore the integrated world of science and math.

A pattern is *s*omething designed or used as a model for making things. A pattern can be a formula, a routine, or an arrangement of objects. A pattern, whether in nature or art, relies upon three characteristics: a unit, repetition, and a system of organization.

This curriculum unit will use the aesthetic nature of tessellations and symmetry to introduce and help students appreciate the concepts of patterns. A tessellation is created when a shape is repeated over and over again. A tessellation is a repeating pattern composed of interlocking shapes (usually polygons) that can be extended infinitely. The tiling for a regular (or periodic) tessellation is done with one repeated congruent regular polygon covering a plane in a repeating pattern without any openings or overlaps. 'Regular' means the sides of the polygon are all the same length, and 'congruent' means that the polygons fitted together are all the same size and shape. A semi-regular (or non-periodic) tessellation is formed by a regular arrangement of polygons, identically arranged at every vertex point. All the figures fit onto a flat surface exactly together without any gaps or overlaps. All the figures fit onto a flat surface exactly together without any gaps or overlaps. As the students construct tessellations by combining geometric shapes, they will become exposed to the existence of patterns in their surroundings.

The term symmetry means 'constancy', that is, if something retains a certain feature even after we change a way of looking at it, then it is symmetric. Symmetry is a fundamental organizing principle in nature and in culture. The analysis of symmetry allows for understanding the organization of a pattern, and provides a means for determining both invariance and change.

In all spatial patterns there are four basic symmetry operations that may be performed upon a fundamental region, design or motif: translations, reflection, glide reflection, and rotation. Students will be asked to look around the room and list five items or objects that have patterns, tessellations or symmetry.

A section on how to use a physics formula to calculate the time taken for an individual to react to a stimulus is included. Additionally, this section tests the hypothesis that reaction time in catching an object will be slower when music is applied as a prompt, as compared to a situation where there is no prompt. This section is designed to explain the concept and application of the velocity formula in physics.

The curriculum will help students to properly use physics and math formulas. The formulas whose applications that will be taught in this unit include the calculation of transverse wave frequencies, velocities and time of freely falling bodies, and combination of fractions to classify music notes. In all of these demonstrations and expositions, the concept of patterns will be visible, whereby students will produce tables to record patterns generated by repeating the processes. Students will be introduced to the KWL chart and be taught how to use it as a learning tool.

A wave is a distortion in a material or medium, where the individual parts of the material only show periodic motion, but the waveform itself moves through the material. All waves have similar characteristics, and since all forms of wave motion follow the same laws and principles, knowing the fundamentals of wave motion is important in understanding sound, light, and other types of waves. Sound waves occur when a loudspeaker cone moves back-and-forth to create a sound, which is a compression wave.

AC electricity waves occur when electrons move back-and-forth in a wire, sending a wave of electric power through the wire. The back-and-forth motion of the electrons does not result in any net flow of current, unlike DC electric which results in transport of electrons along the wire. Another type of wave is a water wave. When you drop a stone in a pool the waves move outward. The surface of the water looks like it goes up and down, but actually the water molecules move in a circular or oval motion the form the wave. Although light is classified as a transverse wave, the motion of the electrical and magnetic fields may be circular instead. It is hard to tell.

Characteristics of waves

The characteristics of a waveform are wavelength, amplitude, velocity, and frequency. All periodic waveforms have these common characteristics. There are special cases, where only one crest of the wave is seen, like the wave at a ballgame or the sound caused by an impact or explosion. In those cases, neither a wavelength nor a frequency can be defined, since the waveform is not periodic, but one can measure the width of the pulse. The wavelength is defined as the distance from one crest (or maximum of the wave) to the next crest or maximum. The height of the wave (the distance from the peak to the middle of the wave) is called its amplitude. Amplitude relates to loudness in sound and brightness in light.

The velocity of the wave is the measurement of how fast a crest is moving from a fixed point. For example, the velocity of water waves can be measured as their speed in a given direction with respect to the land. The speed of sound is about 1000 feet/second. The speed of light is 186,000 miles/second. The frequency of waves is the rate the crests or peaks pass a given point. Frequency is the velocity divided by the wavelength designated as cycles (or peaks) per second. Cycles per second is also called Hertz.

Objectives

There are several main objectives to this unit. One is to help the students identify and use different types of patterns. Students will utilize will utilize the concepts of patterns to analyze tessellations and understand why shapes used to construct a tessellation must have symmetry or be able to overlap precisely. They will create patterns and observe the extent to which they occur all around us. Another is to identify patterns in data collected from a reaction time activity. Students will apply physics formulas to estimate how fast or slow an individual can react to a stimulus just by common sight, and when music is used as a prompt. They will learn how to manipulate the formula for freely falling bodies in order to calculate velocity and time.

The third objective is for students to help students survey and understand various concepts of wave motion and demonstrate how transverse waves occur. They will produce sound waves by using various shapes and sizes of bottles in order to explain the difference in pitch. They will calculate frequencies and speeds of waves by using formulas; the last objective is for students to identify patterns in musical notes in order to add fractions involving quarters and halves. They will use this knowledge to write short raps about the concepts they have learned in the curriculum unit.

Strategies

The unit borrows some of its pedagogical contents from three learning theories: constructivism, critical cognition, and confluent education. In her book Educational Psychology: The Developing Learners, Ormrod (Pearson Merrill Prentice Hall, NJ, 2006) proposes that constructivism occurs when learners utilize prior knowledge to construct understanding of new information. Critical cognition is an exploratory approach that requires learners to pose questions on the root causes of issues (Ormrod p. 25).[3] Confluent education holistically prepares the learner by incorporating multidisciplinary and multidimensional factors that motivate the learner and enhance learning.

This unit will apply various methods to help students construct and apply knowledge of the topics taught. One of the methods that the teacher will use is expository learning. The teacher will present a short lecture in which the key concepts and fundamentals will be explained to the groups. Instructions and suggestions on expectations and the timetable for completing tasks will be provided. Questions about the tasks will be answered. The purposes of the worksheets, procedures and expectations will be clarified at this point.

After each exposition, the unit will then be 75% student led with teacher involvement as guidance and resources. The three weeks of the unit will be marked by activities and group exercises to ensure motivation remains heightened. After the topic is introduced, students will work in groups most of the time, and do less individual seat work.

Another method is the use of worksheets and transparencies. The worksheets and transparencies will contain formulas, definitions, procedural instructions, and sample problems that will help students to complete tasks. The concept of cooperative groups learning will be introduced to also help students, Groups of three to four students will be assigned roles and specific tasks to perform in the groups. Each group will do role play by assigning every member a specific role. The roles will include group leaders, materials managers, time keepers, and task managers. The teacher will also use KWL charts to help students better understand the concept that of a particular topic being taught. The KWL method is a wonderful strategy that applies constructivism in teaching. Group members will write what they know about the topic, what they want to know or expect to know, and what they learned from the exercise. Each group or think-pair-share will be required to fill out a KWL form at the beginning and end of some of the activities. The forms will be used to assess mastery and implementation of the tasks.

The teacher will give students work to take home. They will be asked to conduct investigations or bring items from home for a particular activity. Homework problems will be adopted from students’ science and math books. In collaboration with the Science department, the teacher will have students engage in learning activities based on the concepts of physics that they will be learning. The science department will serve as resource and reference point.

To assess to what extent the students benefited fro the topic, the teacher will use two pedagogical assessment tools; "RSVP (Reliable, Standardized, Valid, and Practical) and Norm-Referenced Scores" (use of percentile rank and grade equivalent scores)[4]. Data that will be used for student assessment are in-class points, projects, and participation scores. Each group will select one of the topics on patterns and present a brief two-page report.

Classroom Activities

Lesson I: Patterns in aesthetics: Tessellation and Symmetry

Objectives: This lesson will be used to introduce students to the concepts of patterns, tessellations, and symmetry. The teacher will define and show examples of the words "patterns, tessellations, and symmetry", and the students will do activities based on the concepts.

Activity:

The materials we will use are scissors, paper glue, permanent markers, crayons, assorted color construction papers and rulers. The teaching strategy the teacher will use is cooperative group learning. The class will be divided into groups of fours or threes. Each will have a group leader, materials manager, prompt or timekeeper, and presenter.

Each group will be assigned at least one geometric figure, which they will cut out into small units. The small units will be pasted onto the construction paper continuously until a tessellation is created. The units will be colored in various shades to give aesthetic beauty.

Each group that completes its work will write a brief explanation on how the shapes they used for their tessellation can be used in math, science and in the real world. Each group will be allowed 2 minutes to summarize and paste its work on the bulletin.

Lesson II A: Comparing Reaction Time Data

Objectives: We will use this lesson to further explain the concept of patterns and its relationship to the study of physics. This lesson activity will determine the reaction time of selected team members in catching a yardstick. Each group will demonstrate how to assign roles to members and ensure roles are maintained at all times.

The activity will be implemented in two ways: first without music and then with music. The materials we will use are chairs, yard sticks, a CD player/radio, timers or watches, pencils, papers, construction papers, posters sheets, markers and a conversion chart. The chart will have two columns: distance dropped and reaction time. (see appendix)

One person will stand on a chair and hold up a yardstick from the top so that it is up and down with the bottom several feet above the floor. A member from one team will hold his or her thumb and pointer fingers opposite the 18-inch mark without touching the yardstick. The person on top of the chair will drop the yardstick and the person standing on the ground will try to catch it without warning.

In the first round trials, the yard stick will be released without warning and the student standing on the ground will attempt to catch it with his thumb and pointer finger the moment he/she sees it falling. The catcher will depend mostly on his or her eyesight to react. We will determine the catcher's reaction time by first noting what inch mark the fingers were on when he/she caught the yardstick. We will then subtract 18 from this reading to see how many inches the stick fell before it was caught. We will then use the chart to find the corresponding reaction time. Each team will conduct five trials, graph the data and observe the pattern.

The second round trials will involve music. The reason for introducing music in this activity is that the teacher and students want to find out if being focused on listening to the background music can lower their reaction time in catching the yard stick when it is released. If an individual is listening to music and waiting for the music to pause before he attempts to catch the stick, will his reaction will be slower because he was initially focusing o the music? The teacher will do several trials with the students before they draw a conclusion from the exercise.

The way the teacher start this exercise is to play a popular song for the whole class to dance for at most 45 seconds. The person standing on top of the chair and the person expected to catch the stick will not dance but will remain focused. Anytime after 30 seconds, the CD player controller will stop the music without warning and at the same time the person on top of the chair will release the stick, while the catcher will try to catch it with thumb and pointer finger.

We will note what inch mark the fingers are on when the stick is caught. They will subtract this reading from 18 to see how many inches the stick fell before it was caught. The teams will take at least five turns and record the units per distance dropped. At the end of the activities, the charts will be compared to find the winner and answer the following Critical Response Questions: Did the application of music affect the data collected? If yes, to what extend? Who has the quickest reaction time? Why do you think it takes time for your fingers to react when your eyes see the stick start to fall? Can you think of reasons the reaction time might be different among your classmates? What pattern or slope of graphs did you observe? Can it be compared to the chart we used to measure the various Students will utilize the concepts of patterns to analyze tessellations and understand why shapes used to construct a tessellation must have symmetry or be able to overlap precisely. They will create patterns and observe the extent to which they occur all around us.

Lesson II B: Using a physics formula to calculate velocity

Objectives: This lesson will help students interpret physics formulas in order to use one of them to calculate velocity and time elapsed for an object to fall to the ground. The formula that the students will use is velocity equals to half of the gravitational force multiplied by the square of the time elapsed for an object to fall to the ground.

The materials we will use are a yardstick, timer, a tennis ball, and writing materials. The ball will be dropped from different heights multiple times. Each time the ball is dropped, the time it takes to reach the ground will be recorded on a chart. After multiple trials, we will use the formula and the data to calculate the distance. We will also manipulate the formula to find out if the time calculated corresponds to the time recorded from the watch.

The relevance of pattern that the teacher will teach in this lesson is whether the calculations will be the same if different individuals drop the ball from various heights? Can a pattern be identified from the various results? If the results are not the same, how significant/large are the differences?

Lesson III A: Patterns: Wave Motion and Algebra

Objective: Students will use this lesson to explore the concept of wave motion, its various effects and how it relates to physics and math. It will help students use the physics formula to calculate wave movement and will begin with few students and grow into a large circle of students demonstrating the "popular sports stadium wave" (spectators stand, wave both arms in the air, and then sit).[5]

Wave motion is defined as the movement of a distortion of a material or medium, where the individual parts or elements of the material only move back-and-forth, up-and-down, or in a cyclical pattern. It appears as if something is actually moving along the material, but in reality it is just the distortion moving, where one part influences the next.
The teacher will have students answer the following questions in the KWL chart: Exactly, what is wave motion? What are some examples of different types of waves? What common characteristics do all waves have? To help students answer these questions, the teacher will present an exposition or worksheet on example of waves;

Transverse waves are up-and-down motions that create transverse waves. At the ballgame, someone in the stands may start up a "wave" by standing up and then sitting down. The people on one side then stand up and sit down, then the next people, and so one. Everyone is still in their seats, but the wave traveled through the ballpark from one end to the other. Another type of transverse wave is the rope or string shake. You can shake a rope, causing a wave motion. The parts of the rope only move up-and-down, but the wave moves from one end of the rope to the other. A guitar string also has this type of motion.

Activity:

In this activity, the duration of a wave is approximated by a linear function of the number of students participating in the wave. This is a whole-class experiment involving three steps: collecting data, writing an equation, and interpreting the data. The materials we will use include a stopwatch or clock with a second hand, and graph paper, (one sheet per student).

The students will proceed by starting with a group of five students to do the wave. The first student will stand with arms above head, and sit down. The second student will do the same, and the rest will follow. The last student will say "stop" as he/she sits down. The timer will say "start" at the beginning, and record the elapsed time when the last person says "stop". We will repeat the activity by adding the number of participants until everyone has joined the circle.

Assessment:

The tasks each group is expected to perform are as follow:
1) Construct a chart and record the data, and observe the pattern (see appendix II)
2) List the ordered pairs to be graphed. Graph those points on a coordinate plane.
3) State the rule (equation) for the relationship between the number of people (x) and the time taken (y) for the wave in the experiment.
4) Use two points on the graph and find the slope and equation of the function
5) Use the wave formula to calculate the length of the wave by using the various harmonics (see appendix B).
6) Answer the following questions, using your answers in parts 2 and 3.
a) How long would it take for 100 students to do a wave?
b) How many students are necessary for a 30-second wave?
c) Was your answer in b) a whole number? Does a non-whole number make sense?
d) How would your graph be different if every student stood up and turned around twice before sitting down? Explain.
e) How would your graph be different if the first person wasn't paying attention and missed the "start", not beginning the wave for 5 seconds?

Lesson III B: Producing Sounds

Objectives: This lesson will help students discover some of the basic concepts of sound and how it can be produced. They will observe how vibrating objects can produce sounds, observe and confirm that the faster an object vibrates, the higher the sound or pitch, and observe that the slower an objective vibrates, the lower the sound or pitch.

Activities:

The activities will be divided into three parts (ruler, bottle organ, and rubber band guitar). The materials we will need are 2 small mouthed glass bottles of comparable size, 4 metal spoons, a large water pitcher and 4 funnels, wooden and plastic rulers with each student at his or her desk, shoe boxes, 8 small pieces of plywood, 2 large bags of rubber bands and 4 pairs of scissors.

Activity 1: The Ruler Activity

The first demonstration is the use of a ruler to find out the change of pitch due to vibration. The class will be broken up into three groups to do the various demonstrations. Every student in the first group will hold a ruler on a table with half its length over the edge. They will pluck the end of the ruler and listen to the sound. They will then move the ruler so there is only a short length over the edge of the table and pluck it again. Then the same thing will be tried with a longer length of ruler over the edge of the table. As they move the ruler, they will note what happens to the sound. If more of the ruler is over the edge of the table, does the sound become higher or lower? The students will record data from what they observe.

Activity 2: The Bottle Organ Activity

The second demonstration involves the bottle organ concept. We will need six bottles. Each student will identify how the height of an air column affects the pitch of sound. Working as a group, the students will pour different amounts of water in each bottle, labeled A, B, C, D, E, and F respectfully. Next, they will gently tap each bottle with the metal spoon to determine the difference in the pitch of the sound produced. The students will record the data on a chart to show which bottle has the highest pitch.

Finally, the students will fill the bottles up at different levels again. Each student will be allowed to blow across the top of the bottle in order to produce a whistling sound. The class will note the pitch of the sound every time the levels of the water in the bottles are changed.

Activity 3: Rubber Band Guitar Activity

For the third demonstration, students will make their own guitars in order to understand how tension in string instruments affects sound. We will need a number of rubber bands that is six times the number of students, shoe boxes, pieces of wood about half an inch square and as wide as the shoe box. Each group will be issued materials needed to make a rubber band guitar. Students will use scissors and cut a hole in the middle of a shoe box. Next, they will stretch several rubber bands of various lengths and thickness across the top of the box leaving a gap of about half an inch (1cm) between each one. They will then pluck the rubber bands to discover what sounds are vibrating. Finally, they will add the two pieces of wood known as the bridges and pluck the rubber bands again to see if there is a change in the pitch.

Assessment: Teacher will ask the questions:

1. What happens when you pluck the bands without the bridge?
2. Is the pitch of the sound made by the less tight bands higher or lower?

Lesson IV Patterns in Music: Fractions and Musical Notes

Objectives: This lesson will enable students discover how fractions and music create patterns that can be measured. At the end of the lesson they will be able to solve simple fractions and read fundamental musical notes. The students will work in pairs instead of groups. Students will be asked to add musical notes together to produce whole numbers or fractions, and create addition and subtraction problems with musical notes.

Activity: *Clapping the Notes*

The goal of this activity is to have the students identify quarter, half, and whole notes and understand their relations to fractions and the ratios of different fractions. The teacher should assume that some of theses students may have heard a half note being struck but never being told it was a half note. For example, the long or short pauses between notes, constitute quarters, halves and wholes. If these 14 year old 9th grade students do not listen to them, it might be difficult to use the concept to teach. As an interdisciplinary approach, this lesson will be implemented with assistance from the school's music department. The class will pay a visit to the music department, listen to a rendition, and participate in a piano playing demonstration. The students will be encouraged to remember that notes do not represent specific values until they produce a long, short or sustained tone, and that notes are fractions or part of a whole.

The students will listen to the value of each note as the music director claps (in 4/4 quarter notes) for them. The teacher will join the lesson by clapping the value of the whole note, while the music director claps the value of half, quarter, eighth, sixteenth and whole notes. Students will be asked to identify the fraction for each note.

We will then use a keyboard to produce the fractions of the required notes. Each pair will be assigned a set of fractions that they will use to produce notes on the keyboard and note the fractions involved. Next, the class will then be divided into two groups. One side will clap on the whole notes and the other side will clap on the quarter notes (once every beat of the four beat measures). The fractional equivalents of the quarter note, half note, eighth note, and sixteenth note will be clapped.

Students will work in pairs to complete the following worksheets:
Express a specific note as a fraction counting, count the values in a measure as represented by various notes, develop a time signature (numerator/denominator) for a measure with corresponding notes, and write the numerator when given the denominator of a measure. Identify the pattern, addition, and subtraction of these values and simplify the answers.

The teacher will guide students throughout the process. Students will exchange their work with other students, to be checked. As follow up, students will be required to write 5 examples of equivalent fractions and put their answers in reduced terms.

Motivational Activity (optional): The Name Game

The two purposes of this activity are to reinforce the concepts of fractions, and serve as a motivation for the beginning of each lesson. The teacher will need a drum or any material that can substitute a drum. The teacher or leader will have everyone sit in a circle. With hands, the teacher will clap out the beats to his own name and then some other students' names. He will explain to the students that names have beats (or syllables) which we can

clap to. He will have all the students try it one at a time with their own names around the circle or at random if a student doesn't feel comfortable going in order like that.
Once all the students have gone all the way around, the activity will repeat but instead of having the students beat to their names this time, they will beat to someone else's name.

Annotated Teachers' Bibliography

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This volume is composed of strategies and techniques for teaching young children.

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This book provides basic information and illustrations on the acoustical concepts. It begins with simple physics, general information on the laws of physics and its relationship to the acoustics and concludes with a concise lesson on various types of musical instruments. This is an excellent resource for physical science teachers.

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The entire content and especially chapter 2 of this development psychology book explores useful theories of learning (cognition) and provides teachers with necessary pedagogical tools.

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This book is a useful resource and reference on the psychology of learning.

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A complete course in introductory Algebra for 9th and 10th graders. Contains adequate exercises and concepts on algebra and patterns

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A complete course in Physical Science for 9th graders that is ideal for students and teachers.

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This is an interesting book that can help both teachers and students with simple explanations, some hands-on activities and attractive illustrations.

Wood, R., *The McGraw Hill big book on Science Activities: Fun and easy experiments for kids.* McGraw Hill Publish Publishers, New York, 1999.
This book helps children to understand the wonders of nature and advances in science through activities.

Bransfield, Graham J. *Light: Eyewitness science,* Dorling, Kindersley, Ltd., London, 1999.
The book has brief but splendid explanations and illustrations about resources of sound and light.

Schultz, James, Paul A. Kennedy, Wade Ellis Jr., Kathleen A. Hollowell, *Holt Algebgra1*, Holt, Rinehart and Winston: A Harcourt Education Company, TX, 2004,
A complete course in introductory Algebra for 9th and 10th graders that contains adequate exercises and concepts on algebra and patterns

Annotated Electronic Resources for Teachers

Internet–related resources such as Science Web Quests allow teachers and students to both explore the Internet and use Internet to enhance the teaching of Science

<http://graham.main.nc.us/~bhammel/MUSIC/compose.html> accessed March 22, 2007
An essay on patterns in musical composition transformations, mathematical groups, and the nature of musical substance

<http://www.glenbrook.k12.il.us/gbssci/phys/Class/u1111a.html>

This is a series of six lessons on the nature of a sound wave. The site presents teachable details on a wide range of concepts on sound and waves. The information can be use to teach grades 5 through 12.

<http://graham.main.nc.us/~bhammel/MUSIC/8ve.html> accessed March 22, 2007
An excellent site that provides a basic knowledge of musical notes of a piano

<http://www.exhibits.pasci.org//music/MusicPhysics.html> accessed March 25, 2007
This site presents concrete concepts and working definitions of sound as a medium of music, and physics of music as the physics of sound.

<http://www.physicsclassroom.com/Class/waves/U10L1B.html> accessed April 15, 2007
This site contains activities o waves that teachers can use in their classrooms.

<http://www.uk.geocities.com/pikelmas/indexeng.htm accessed March 25, 2007
Presents the concepts of music as an art in which you combine the sounds to produce an aesthetic impression.

<http://www.ccds.charlotte.nc.us/mcgrail/stu9899/math&.htm> accessed March 25, 2007
This site presents a concise lesson on the relationship between math and music. It contains a detailed explanation on the relevance of math and music, formulas used in calculating musical notes, and naming them.

<http://www.teachingtools.com/GoFigure/Activity-SawTune.htm> accessed April 7, 2007
This site provides five hands-on classroom activities on the concepts and process involved in calculating sound waves.

<http://www.emsc.nysed.gov/nysatl/math/Music/html/music2.html> accessed April 12, 2007
A site that with activities that allows students to explore the relationships between musical rhythms and fractions

Annotated Internet Resources for Students

<http://www.learning.org/teacherlab/math/patterns/people/> accessed March 18, 2007
Interactive screen that engages students into critical thinking game on the creation of patterns in real life situations

<http://www.aaamath.com/pat.html> accessed March 18, 2007
Interactive screen that engages students into critical thinking game on the creation of patterns in real life situations

<http://www.aboutscotland.com/harmony/lambda.html> accessed March 18, 2007
Discusses the issue of harmony and proportion, and is an excellent resource for students to understand the scientific works of Pythagoras and Plato regarding tessellations and symmetry.

<http://www.linkslearng.org/kids/1_math/2_Illustrated_Lesson_Symmetry/index.html>
(accessed May 9, 2007)
A website that shows various types of symmetries, tessellations and patterns that is ideal form students' hands on activities.

Appendices/ Standards

NCTM Standard 2 (1998)

Pennsylvania Academic Standards for Mathematics

- 2.8 Equations: Patterns and functions (A)
- 2.8 Algebra and Functions (B)

Sets the purpose of patterns, functions and algebra in mathematics education at all grade levels.
Mathematics instructional programs should include attention to patterns, functions, symbols, and models so that all students understand various types of patterns and functional relationships
Use symbolic forms to represent and analyze mathematical situations and structures;
Use mathematical models and analyze change in both real and abstract contexts

Pennsylvania Academic Standards for Science and Technology
Students will use a variety activities to explore and discover concepts in science especially physics and math

- 3.4.4Physical Science, Chemistry and Physics (C)
- 3.8Science, Technology and Human Endeavors (A, C)

CHARTS

In the chart, it should take 0.10 seconds to catch the yardstick form a height of 2 inches. This chart will be used to compare the data students will collect fro the exercise. The students will verify if catching the yardstick from a height of 2 inches actually takes 0.10 seconds, etc. They will then compare the data in the chart to the data of a new chart they will construct from collecting their own data.

Reaction Time Conversion table

Distance Dropped	Reaction Time
DD=18 – catch reading	Given
2 inches	0.10 seconds
4 inches	0.14 seconds
6 inches	0.18 seconds
8 inches	0.20 seconds
10 inches	0.22 seconds
12 inches	0.24 seconds

The left column of this chart is for the number of people involved in the wave exercise and the right column, the time it takes for the wave movement. As the number of participants increases, the time will be noted.

Wave Activity Data Chart

Data Collected	
Independent (number of people)	Dependent (time taken)

This chart shows the number of loops that constitutes a harmonic. A first harmonic consists of one loop, a second harmonic consists of two loops and so forth.

Wavelength Chart

HARMONIC	# OF LOOPS
1st	One
2nd	Two
3rd	Three
4th	Four
5th	Five
6th	Six

7th	Seven
8th	Eight
9th	Nine
10th	Ten
11th	Eleven

Frequency = Velocity / Wavelength
Another way of writing that is: Velocity = Wavelength x Frequency

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Tip**:** A way to help remember equations is to look at their units of measurement. If Velocity is in meters/second, Wavelength is in meters and Frequency is in cycles/second, then the equation in units would be: meters/second = meters x cycles/second

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The frequency is also the reciprocal of the time between crests passing a point or the period of the vibration. With this measurement:
f= 1 / T

The formulas in this chart below are used to calculate distance, time, and velocity. Students can manipulate the first formula, which is used to calculate the distance an object falls, can be manipulated to calculated time and velocity. The 'd' stands for distance, 'g' for gravitational attraction or force, 't' is for time it takes for the object to reach the ground, and 'v' represents the velocity or speed of the object.

Formula & Calculation Chart

Distance d travelled by an object falling for time t:	$d = \frac{1}{2}gt^2$
Time t taken for an object to fall distance d:	$t = \sqrt{2d/g}$
Instantaneous velocity v_i of a falling object after elapsed time t:	$v_i = gt$
Instantaneous velocity v_i of a falling object that has travelled distance d:	$v_i = \sqrt{2gd}$

Endnotes

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[1] School District of Philadelphia's Math and Science Core Curriculum for 9th and 10th graders
[2] www.pde.state.pa.us/k12 (accessed April 10)

[3]Ormrod, Jeanne Ellis, *Educational Psychology: Developing Learners*, 2006, Pearson Merrill Prentice Hall, NJ, 2006

[4] Ormrod 526-527

[5] http://www.physicsclassroom.com (accessed April 15, 2007)

Unknown
Field Code Changed