

# **Economic Sustainability: Don't Judge a Book by its Cover**

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## **Overview**

In today's fast paced, Google driven, instant gratification world, most people do not have the time or patience to wait for information. They want to know the answers right now, not stopping to think if the information they are receiving is completely, if at all, accurate. We are constantly influenced and even pressured by family, friends, advertising, and social media to make quick, irrational decisions. This is especially true of teenagers, who are at a critical stage of cognitive development where receiving information and making decisions can greatly affect their lives in both positive and negative ways. Teenagers tend to be impulsive; their brains are not physically capable of the reason skills that we acquire as adults. In many cases, this leads them to make poor choices, some of which can have serious consequences. If students could be better informed about the world around them, then hopefully they will make better choices that will make their lives better in the future when, as adults, they will have to make crucial decisions regarding finances.

According to a 2015 statistic, the average credit card debt is over \$15,000. It concerns me that people do not know how to manage their money. I have owned a credit card since the age of 18, and I am proud to say that I have always paid my credit card bill in full each month. Many people purchase things on credit cards knowing that they can just pay the minimum amount each month. What they do not realize is that credit card companies LOVE when you do this. The less you pay each month, the more interest they will receive. Too many people are in debt for this reason, and it seems to be getting worse over time. If children can be well informed about money, they can avoid going down the same path as their parents. To be well informed, they have to know the sustainability of economics in various situations that they will encounter in their lives.

## **Rationale**

The word sustainability is defined as the following:

noun

1.

the ability to be sustained, supported, upheld, or confirmed.

2.

Environmental Science. the quality of not being harmful to the environment or depleting natural resources, and thereby supporting long-term ecological balance:

Sustainability has become somewhat of a buzzword over the last few years, particularly in the field of Science, as described in definition #2 above. To me, though, sustainability can take on a whole other set of meanings, as described in definition #1 above. My goal of this unit is to get middle school children to understand what is required to sustain or uphold something; we will investigate a wide range of topics from owning a business to competing in a race. Each topic, some vastly different than others, will all focus on one common theme: Sustainability. The activities presented will be used in my Math class as a way to explore graphs, table, equations, and computation of the four operations.

Teenagers need as much accurate information as possible to make informed decisions in their daily lives. Unfortunately, they don't always get this information due to their impatience, or simply because outside influences such as social media are sending them the wrong message. They see products such as cell phones advertised on television with the promise of "no money down!", but is this necessarily they best deal out there? Another concern I have is that students don't have the knowledge or care about wasting products. They will grab 3 tissues just to blow their nose once! They will throw out half of their lunches. I want my students to be able to analyze buying things in bulk quantities. Is buying that 4-gallon jar of mayo really worth it if half of it spoils before I get to use it? My goal is to use Math to help students gather accurate information using critical analysis, rather than making quick, irrational decisions that many of them do on a daily basis. Students also have to learn what sustainability means in physical activity. If I am running a 3-mile race, should I run as fast as I can right away? Can I sustain this speed for 3 miles? Or should I choose a different strategy to run so I can win?

As a Math teacher, I am always looking for ways to relate my curriculum to the real world. I currently teach an 8<sup>th</sup> grade Math class, where part of the curriculum is to explore areas involving rates of change, unit rates, slopes, and intercepts. There are many real-life examples that can be shown to students to demonstrate these topics. I also teach my students the importance of managing money each year. I am hoping this course will allow me to introduce new ways to show them how to do this, especially when it comes to paying bills and comparing costs of different companies to find the best unit price, (i.e. PECO vs. other electrical companies.)

## Objectives

This unit is designed for an 8<sup>th</sup> grade Pre-Algebra class of about 25 students. The objectives of this unit will include the following:

- Students will use slope to find the unit rate on a graph.

- Students will use tables, graphs, and equations to compare different companies to see which is more economical, and at what quantities.
- Students will understand the slope intercept form  $y=mx + b$ , specifically the meaning of the slope and y-intercept as it pertains to a real-world scenario.
- Students will use functions to understand the meaning of linearity, as well as functions that are non-linear.
- Students will analyze graphs where the lines are increasing, decreasing, or constant, and describe the differences between the changes in a line on a graph.
- Students will use systems of equations to compare multiple real-world scenarios.

## Strategies

Unfortunately, many students in urban cities are not motivated in school, particularly students learning math in the middle school environment. Since math involves a lot of formulas, rules, and procedures, students can easily get bored or ask the universal question “why should we learn this?”

In order to motivate students, real-life activities will be used to help them understand the importance of analyzing numerical situations closely to make informed decisions. These activities will include, but not be limited to, the following:

- Whole group
- Small group
- Use of technology including computer programs and graphing calculators
- Physical activity

As mentioned above, many of the activities unit will be used to motivate and engage students, as well as meet the needs of different learning styles. In many of these activities, identifying students’ misconceptions will be discussed at first. Through the use of these activities, misconceptions will eventually be clarified to help students fully understand the facts. This will make them not only better students but better citizens for the future!

## Classroom Activities

### Lesson 1: Let’s Go Running!

Objective: Students will be able to compare running rates over time in order to analyze the results on a graph.

Materials: Clock or Stopwatch

This activity will take place in the school gym. Students will work in groups of four. They will rotate doing the following jobs: Running Laps, Counting number of laps out loud, Recording results, and Monitoring the clock. For each round, a student will run laps for a total of two minutes. Before beginning, students will record their predictions of the number of laps run. Students will likely pick a higher number, as middle school

children tend to feel invincible when it comes to physical activity! Many will not take into account that over time they will not be able to sustain their pace from the beginning.

After students perform the experiment, they will make both a table and a graph. We will discuss as a whole group the pattern in the tables; most likely student will average 2-3 laps per ten seconds, then by about the one-minute mark this will decline significantly. Students will be able to understand that they could not sustain their pace that they had at the beginning, that over time they simply were too tired. I will ask students how they could improve on this. Student will be able to tell me that if they started at a more moderate pace, they would have a better chance of sustaining their running pace over the full two minute time period. When looking at their graphs, student should see that their lines began straight and then gradually start to curve in; we will discuss what both the straight and curve parts of the graph mean. Students will be able to realize that the moment they could not sustain their pace is when the graph begins to curve.

## **Lesson 2: Pay Now or Pay Later??**

Objective: Students will be able to use unit rates and initial costs in order to compare competing companies.

Materials: TI-73 Graphing Calculators, Computers

Introduction: We will review and discuss the running laps activity. This will lead into a discussion into today's lesson how in many situations what occurs at the beginning of a time period isn't necessarily sustained over a longer period of time. We will discuss competing business, specifically a membership to a local gym.

Activity: Students will be presented with two competing gym memberships. One will have no sign-up fee but will cost \$50 per month. The other will have a \$50 sign-up fee, and a \$20 per month membership. Students will vote on which membership they would choose. Most likely, many of them would not want to have to spend any money to join, and won't realize the long-term impact of the lower monthly membership fee. Students will make a graph on paper, and a table using their graphing calculators. They will have to decide when each gym is cheaper than the other. We will also discuss when the graphs cross each other. What does this mean? Would it matter which gym I choose at that point of intersection? Students will then research another product with two competing companies and analyze them in the same way. One company will need to have an up-front fee; the other a higher monthly rate.

Conclusion: Students will realize that although it sounds better to not pay a membership fee, the higher monthly rate cannot sustain the better deal over a long period of time. It's worth it to pay the membership fee!

## **Lesson 3: Is Buying Bigger Better?**

Objective: Students will be able to analyze products of different sizes in order to determine which one has the better unit price.

Materials: Computers, worksheet, calculators

Introduction: Students will be given a worksheet with questions that I created about their views on spending money. Students will share their responses. This will then lead into a discussion of the pros and cons of buying products in small vs. large quantities. If needed, I will guide students to consider the following: price (specifically unit price), convenience, wasting of product, and boredom of the same product. I will present students with the option of buying a 1 oz. bag of chips at CVS vs. an 11 oz. bag. I will mention to students how in many situations buying the larger quantity is a better deal, and their job in this lesson is to just choose which deal is better mathematically. However, I will also explain that ultimately what they buy is their decision. I do not want any of my students to have feel like that must buy something just because it happens to be a better deal. I will ask them what factors may influence someone to buy a smaller quantity? A larger quantity?

Activity: Students will choose products from a teacher created worksheet “Should I Buy Big?” They will decide which products they would buy bigger quantities, and which they would buy small quantities. Students will work in small groups and research on the Internet to compare products of different sizes from a particular store. The product must be the SAME, (i.e. 2 sizes of Kellogg’s Frosted Flakes, not Kellogg’s vs. store brand as this could alter the pricing.) Students will compare unit prices, and will note when buying a larger quantity is better, or when smaller is better. (Most of the time larger will be better) They will make a poster showing the comparison of products and their different sizes. They will explain which is the better buy by displaying each product’s unit price (i.e. cost per oz., bottle, etc.) They will also note which products, although a better buy in larger quantities, may not necessarily make the most sense to buy in bulk.

At-home Project: Students will pick one of the products they found on the computer. It needs to be a product they use at home, as well as a product where the larger size had the better unit rate. They are going to investigate the sustainability of buying a large quantity. I will give them two weeks to track how much of the product they use; at which point their product will “spoil.” They will then see how much of the product is left, and calculate the amount wasted from a smaller quantity vs. the larger quantity. They will then write a one-pager explaining if their product would be better purchases in a small or large size.

Summary: Share the article “The Pros and Cons of Buying in Bulk” with the class. Allow for brief discussion in a whole group.

#### **Lesson 4: Should I Save the Tax?**

Objective: Students will analyze the cost of using gas in a car in order to determine if it is worth it to drive to a place with no sales tax.

Materials: Computers, Product Worksheet

Introduction: The lesson will begin with a brief review of sales tax as well as scale drawing on a map. Students learned about this in the 7<sup>th</sup> grade year. We will discuss the different tax rates in our region, specifically Philadelphia, all other cities in Pennsylvania, New Jersey, and Delaware. Our main focus will be comparing cost of sales tax in Philadelphia vs. Delaware, which is a tax-free state.

Activity: Students will begin by filling out the “Should I Save the Tax?” worksheet. They will circle items which they felt would be worth to drive to Delaware just to save the sales tax. We will discuss which items they have chosen, and why. Students will then choose a city or cities in Delaware where they think they would most likely shop. The most likely choice will be Wilmington for its close proximity to Philadelphia as well as the Christiana Mall. Others may choose Rehoboth Beach since there are discount outlet stores there. Students will use a map to measure the distance between their cities. They will then use the Internet to look up gas prices in our area, as well as how many miles per gallon they can expect to use. We will assume mostly highway driving for this, and they can choose their parent’s car or one on their own. Once they determine the cost of a round trip drive, they will create a list of products they may be interested in buying. They will look up the prices of these items, and calculate the 8% sales tax from Philadelphia. It will then be up to them to decide which products are worth saving the tax on to make the driving economically efficient.

Conclusion: Students should be able to recognize that big-ticket items like computers, televisions, etc. are worth the travel. Items that you would buy at a drugstore, fast food restaurant, etc. are not.

### **Lesson 5: Who’s Going to Win the Race?**

Objective: Students will be able to run a race in order to analyze who would win with different speeds and head starts.

Introduction: Review from prior lessons about the differences between unit rates and start-up or one-time fees. I will then introduce the concept of two people racing, where one has a head start. I will ask students to discuss in small groups how two people race is similar to the competing businesses discussed in a previous lesson.

Activity: The activity will take place in the gym, or a similar large open space. Students will pair up and “race” one another. This will be a simulation of a race. Students will walk on a square tile floor at different constant speeds. Each square tile will represent a second of time. The student who is given the “slower” speed will also have a head start. Students will have to predict who will win, and for how long the student with the head start can sustain his lead. After, we will use graphing calculators to show the table and graph from the racing students using a linear equation. They will then keep track of when the faster student catches up to the slower student and passes him. Students will try this with several different partners.

To extend this activity, I will have two students race at the same speed but with only one getting a head start. My goal is to get students to see that in this scenario, the student who begins at the start line will never be able to catch up. This will demonstrate a system of equations with no solution. In another scenario, two students will begin at the start line but run at the same speed. Students will be able to recognize that neither student can win; no matter where they are along the race they will always be tied; thus demonstrating a system of equations with infinite solutions.

## **Lesson 6: How Can We Make a Profit in Business?**

### **Materials: TI-73 Graphing Calculator**

Activity: Students have a solid understanding at this point of what the unit rate and y-intercept represent in most situations. We will use this information to further extend a discussion of what is required to run a business. To begin my lesson, I will ask my students if they have ever been in charge of running a small business or fundraiser such as a lemonade stand, etc. Once I receive student input, we will discuss what is required to start a business, thus introducing the word expenses. If needed, I will guide students to understand that when running a business there are up-front expenses (supplies, labor, etc.) as well costs to produce each item that they will be selling. This will help students make the connection of unit rate and y-intercept in a real-life situation. I will continue the discussion by explaining that money earned is income, and then finally explain what a profit and loss are and how either can happen.

Students will input two equations into their graphing calculator, one each for income and expenses. In pairs, they will analyze the table function, and look for patterns in the tables. Students should notice that in the beginning of time the expenses would be larger than the income, thus leading to a loss of money; eventually the income will be larger than expenses, thus leading to a profit.

After a whole group discussion, I will pose another question to the class? What happens if the income and expenses are exactly the same? Then I will introduce the term break-even point. Students will realize that when running a business this should be a “worst case scenario”, that although you will not earn any money, you also will not lose any.

Extension Activity: Suppose the cost of supplies increases. Would your current income be sustainable? If not, how much would you have to raise your prices by to make a profit?

## **Lesson 7: Designing a Business Plan**

Materials: TI-73 Calculator, Chart Paper, Markers

Students now have an understanding of what goes into owning a business. In this lesson they will create their own business plan. Students will come up with a product that they wish to sell. It can be a real or invented. They will use the Internet to get an idea of the

expenses of their product, as well as a reasonable price to sell it. (Note: although it would be ideal for students to get exact amounts, this lesson is more about understanding profit and loss and not necessarily the exact amounts required, so estimates are satisfactory.) Students will fill out the “Business Plan” worksheet that I have created for them. Students will design a table on chart paper. They will highlight the amount of items needed to sell to have a loss, break-even point, and profit. They will write the equations of their expenses and income. When finished, they will present their posters to the entire class.

### **Lesson 8: Interpreting Unit Rate as a Slope**

Objective: Students will be able to use unit rates in order to understand what the slope of a line represents.

Materials: teacher’s computer, chart paper

Introduction: Students already have prior knowledge of unit rates. This will be the first time they have heard the word slope. I will introduce the equation  $y = mx + b$ . Though they have never seen this, they are very familiar with what each of those variables represents. I will also show them a video called “Slope Dude”, which shows a skier giving the general idea of the 4 kinds of slope: positive, negative, zero, undefined. Having students understand the structure of these slopes will make future lessons much easier for the students.

Activity: Students will make several graphs of unit prices from the previous lesson. Then as a class we will discuss what they see in their graphs. Students will recognize that every graph is a straight-line beginning at the origin. Students will then work in small groups to create graphs on chart paper with the other 3 types of slope. They will come up with real-world situations that would match up to these slopes. I will observe the groups and assist as needed if students are having trouble coming up with graphs. I will guide students to think about what is happening when a slope is negative? zero? undefined?

### **Lesson 9: Graphs Can Tell Me a Story!**

Objective: Students will be able to read and analyze a graph without numbers in order match it up with a real-life situation.

Materials: Poster paper, teacher worksheet “What’s the Graph Look Like?”, worksheets with graphs and stories

Introduction: Students are quite familiar at this point about all the directional changes on a graph; however they have always looked at graphs with numbers. Today they will analyze graphs without any numbers.

Activity: Students will work in groups and will be given a set of pre-made graphs, stories, and tables. They have to match one of each, there will also be a few that won’t



have to match, and for those students will create their own reasonable story about the scenario.

### **Lesson 10: The “Power” of Powers!**

Objective: Students will be able to analyze a non-linear situation IOT understand the differences of linear vs. non-linear functions.

Materials: graphing calculators

Introduction: Most of the 8<sup>th</sup> grade curriculum deals with linear functions. Today we will wrap up functions by focusing on non-linear functions. I will present a scenario to the students: They may do chores every day for a year. They will get paid \$.01 the first day, and will double each day, but only for 30 days, at which time they will stop getting paid. They also have the option of instead getting paid \$20,000 for the entire year. I will ask the class to choose one option that they would prefer to do.

Activity: Students will use their graphing calculators to double their payments for 30 days, and then add up all the money. They will see the power of doubling, as they would make much more money by getting paid only for 30 days. They will graph both scenarios to see how long it will take for \$.01 scenario to become more profitable.

Wrap-Up: Read students *The King’s Chessboard*. This will summarize the power of doubling a number. We will have a brief discussion where students can express their thoughts on functions that double.

## **Annotated Bibliography/Resources**

### **Teacher Resources**

Hughey, Kim. "Slope Dude" *Gdawg Enterprises*.  
<http://www.teachertube.com/video/slope-dude-125151>

-This video will engage students and give them a mnemonic device to remember the four kinds of slope.

Shcoenfield, Alan. "Interpreting Time-Distance Graphs: A Formative Assessment Lesson" *Mathematics Assessment Resource Service*.  
<http://map.mathshell.org/materials/lessons.php?taskid=208&subpage=concept>

-This activity will allow students to think critically about graphs without numbers

Giang, Vivian. "The Pros and Cons to Buying in Bulk". *Business Insider*. October 2011.  
<http://www.businessinsider.com/are-you-really-getting-a-better-value-when-you-buy-in-bulk-2011-10>

-This article will make students think more carefully before buying products in stores.

Chen, Tim. "American Household Credit Card Debt Statistics: 2015". *Nerd Wallet*. June 2015.  
<https://www.nerdwallet.com/blog/credit-card-data/average-credit-card-debt-household/>

-This article will get students thinking about how their parents are in debt, and how they can change their own spending ways as not to be in debt themselves in the future.

Birch, David. *The King's Chessboard*. New York: Penguin Putnam Books, 1988.

-This book will engage students in story-telling to show them the power of exponential functions.

sustainability. (n.d.). *Dictionary.com Unabridged*. Retrieved June 08, 2015, from Dictionary.com website: <http://dictionary.reference.com/browse/sustainability>

## Appendix

# MY VIEWS ON MONEY

Directions: Answer these questions as honestly as your can. There are no right or wrong answers!

1. Do you consider the price of an item before buying it?
2. Would you buy something in a bigger size even if you didn't need it all right away?
3. Do you buy a smaller size product just because it is easier to hold/weights less?
4. Do you tend to go to stores like CVS and 7-11, or to supermarkets?
5. If you could get a better deal on a larger product, would you buy it even if you ended up throwing some of it out?
6. Do you spend your money differently when someone gives it to you as opposed to money you earned on your own?
7. Are you familiar with stores like Sam's Club and BJ's Wholesale Club? Do you know why they are different than regular supermarkets?

## SHOULD I BUY BIG?

Directions: Circle the products you would buy in large quantities. If you do not circle a product, explain why you would not buy a large quantity.

1. Paper Towels
2. Pasta Sauce
3. Canned Corn
4. Milk
5. Toilet Paper
6. Peanut Butter
7. Frozen Pizza
8. Deli Meat
9. Eggs
10. Napkins
11. Ketchup
12. Mayonnaise

# SHOULD I SAVE THE TAX?

Directions: Circle the products that you feel you would spend gas money to drive to a city in Delaware just to save the sales tax.

1. Television
2. Tablet Computer
3. French Fries from McDonalds
4. Cell Phone
5. Rita's Water Ice
6. Furniture for your house
7. Bottle of Coke
8. PlayStation System
9. Video Game for PlayStation
10. Refrigerator
11. Washer and Dryer
12. Any item from the Dollar Store
13. Any item from Five and Below

# Designing a Business Plan

Directions: Answer the following questions about your business:

1. Describe what your product is and what its function is.
2. What are the up-front expenses for your product?
3. What does it cost to produce each unit of your product?
4. What are you going to charge for your product?
5. Write the equations for both your expenses and income. Explain what the coefficients and y-intercepts are and what they mean in this situation.
6. How many units would you sell where you would still lose money?
7. How many units would you need sell to break-even? If there is not break-even point, find the point where the income and expenses are as close as possible.
8. How many units would you need to sell to make a profit?
9. Based on how long it took you to make a profit, do you think you are charging the right amount for your product? Too little? Too much? Explain.

## Content Standards

The Core Curriculum of the School District of Philadelphia is aligned to the Pennsylvania Core Standards from the Pennsylvania Department of Education in the content area of Math for students in Grade 8. Specifically, connections between graphs, tables, and equations.

CC.2.2.8.B.2 Understand the connections between proportional relationships, lines, and linear equations.

- Graph proportional relationships, interpreting the unit rate as the slope of the graph.
- Compare a graph to an equation of a similar situation (i.e. distance vs. time), to see which has a greater rate of change.
- Compare the equations  $y=mx$  to  $y = mx + b$ , and the meaning of each part of the equations.

CC.2.2.8.B.3 Analyze and solve linear equations and pairs of simultaneous linear equations.

- Write and identify linear equations in one variable with 0, 1, or infinite solutions.

CC.2.2.8.C.1 Define, evaluate, and compare functions.

- Compare two different forms of functions (i.e. table vs. graph)
- Interpret the equation  $y= mx + b$  as a linear function, and compare to non-linear functions.