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When Will We Ever Use This? Predicting Using Graphs

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Background

High School students are forever asking "When will we ever use this?" To a math teacher the critical importance of math skills appears to be as clear as one's nose on one's face. The students' inexperience makes it difficult for them to envision how they might some day use some of the skills required in the math curriculum. Finding activities that are "fun", and appropriate to the skill levels of the students, is a challenge for a math teacher anywhere.

This unit will be organized linearly where each lesson builds on itself. Graphing may be done by hand, with computer graphing software, or graphing calculators, depending on the availability of technology to the classroom teacher and the technical ability of the students.

Because I teach at a magnet school with a business focus, these lessons will emphasize business decisions. Metropolitan Business Academy is an inter-district magnet high school that provides students with insights into the world of business. The focus is on both entrepreneurship and college preparation. The student's ability to perform data analysis and present the analysis in a format that is clear and understandable is crucial to good business foundations. It is the intent of this unit to provide the mathematical background to enable the student to produce an appropriate graphical display based on the data analysis. However, the materials and topics will be appealing to the teenager, so that any student will be able to connect with the lessons and see their application to some aspect of their current lives or future careers.

The math skills and ideas that are included in this unit are based on learning to read and create scatter plots and line graphs, fit a line to a scatter plot and make simple predictions from data within the scope of the data (interpolation and extrapolation). The skill level is geared to an Algebra I class, but may be adapted to middle school or intensified for Algebra II, where regression analysis of the data by the student may be included.

Group projects will be used in this unit. I have found that when the student has to explain his / her ideas or direct a small group of their classmates, he /she is more likely internalize the concept.

Spending time interpreting graphs, will reinforce skills necessary for the reading for content portion of the

Connecticut Academic Performance Test (CAPT), administered at the end of sophomore year in Connecticut. This is one area with which the students in my school have been struggling. In addition, one of the New Haven Public Schools Algebra I & II curricular power standards is "Collect real data and create meaningful graphical representations of the data". This unit is designed to meet this power standard. The students will develop skills to analyze and model data mathematically. In addition, the students will concentrate on skills to present the data graphically with data mapping. These skills will enhance their ability to logically present and defend business plans.

Overview

Many students taking Algebra I struggle with the concept of the coordinate plane and recognizing the x and y axis and coordinates of a point.

The first activity of this unit will address this skill with an activity based on translations of a triangle in the coordinate plane.

The second activity will examine a scatter plot and a line graph. Understanding the independent variable and the dependent variable will be emphasized. Causality and identifying key words in a word problem will also be investigated. What question is being answered? What do the data mean? Is it truly a relationship between the variables that makes sense or is the relationship forced?

One example of forced data collection is how many steps you take to get to a store from your car and data on how much money you spend in the store. Does it make sense that how much money you spend at a store is dependent on the number of steps you take to a store from your car?

An example of data that makes sense is how much time is spent studying for a test and how many answers are correct. Can the line be extended (extrapolated) and do the data make sense? Do you expect to get more answers correct on a test if you study a longer period of time? The concept of slope of a line and how it correlates to the data is also discussed at this time.

The next activities are extrapolation and line-fitting. The students take existing graphs and predict values of dependent data, based on given independent data. They will extend the line (extrapolate) or create a line on scatter plots. As part of this exercise, the students will look at the data and determine if there is a trend, and whether it is linear. Can a prediction be made based on the data? When considering data from the stock market, it is easy to believe that you can make predictions based on past information. It appears to make sense, but there are many external factors that make predictions anything but foolproof for the stock market.

Lines of best fit will be applied by eye to the data. These lines will be tested against lines of best fit created by regression models on graphing calculators or computer graphing software if it is available.

Because there will likely be a wide range of technology available to both students and teachers, this unit will provide for a wide range of methodologies. However, if teachers are most comfortable with pencil and paper, the bulk of the unit can be undertaken with these tools. Pencil and paper will also be beneficial to the students who have begun to rely on the calculators to do all of the work in creating the graphs and have lost the ability

to create the graphs. In all cases students will be encouraged to interpret the meaning of graphs.

Because it is useful for the students to be able to create graphs on graphing calculators for when they are taking the PSAT, SAT, ACT or CAPT (Connecticut Academic Performance Test) tests, the ability to use the calculators as a graphing tool is also supported here. In addition, calculators and technology may act as a bridge for the students who have special education requirements, where working with paper and pencil may prove so time consuming that the intent of the graph is lost in the arduous process of creation.

History of Graphing

In *The Visual Display of Quantitative Information* , Edward Tufte discusses many of the basic principles of creating good graphs. He credits William Playfair in the mid 1700 to early 1800s to have " developed or improved upon nearly all fundamental graphical designs, seeking to replace conventional tables of numbers with the systematic visual representations of his 'linear arithmetic'." page 10. Many of the graphic techniques that Playfair invented and published are the underpinnings of good graph making today. It is important to note that the graphs that Playfair created were all business graphs. The graph's purpose was to convey a specific idea in a manner clearer than by tablulating data and describing it in words. Graphs helped the reader to get to the gist of the information quicker and draw more informed conclusions.

The basic principles of creating good graphs include data integrity paired with graphical integrity. The size of objects in the graph should be proportional to the data they are depicting. There needs to be a consistency of the physical size of graphical elements relative to the data being represented. Optical illusions should not be used to draw the eye and the brain to make conclusions that are not consistent with what the original data shows. Graphs should not distort data through visual graphics and optical illusions.

Graphs should be designed with the idea of simplicity, using minimal non-duplication of data and data should be presented in context. All of the necessary components should be included, not just a portion that would deceive the reader. Careful setting of horizontal and vertical grid points so as not to distort the data shown is also important. Omitting grid lines or portions of them can eliminate unnecessary ink and clarify the graph.

From the day of Playfair until today, there have been many graphical displays of data, of which many have not adhered to good graph making techniques. In fact with the advent of the computer, many times graphs are hastily prepared and published without the proper editing.

Students today need to be able to create graphs both with paper and computers. Paying attention to the above guidelines will help create graphs that are useful and accurate.

Stock Market Background

In the United States, there are three major Stock Markets, the New York Stock Exchange (NYSE), the American Stock Exchange.(AMEX) and the National Association of Securities Dealers Automated Quotation System (NASDAQ), the largest electronic stock exchange in the US. The purpose of a stock exchange is to facilitate the buying and selling of stocks. A company is listed on only one exchange.

Stocks are traded in shares, where each share of stock signifies a piece of ownership of the company. How big a piece is determined by how many shares of stock the company has issued. Shares are initially offered through an Initial Public Offering or IPO. The money raised through an IPO may be used to pay back investors in addition to funding the company for future expansion or business. A company may compensate certain workers through stock options, thereby giving ownership to workers, but potentially diluting the value of each share of stock.

Even if you do not own any shares of stock, what happens in the stock market does have an impact on your life. Students need to be reminded that a product would not exist without funding for manufacturing and product development. Their favorite sneakers, iPod, or cell phone would most likely not exist if it weren't for the money raised in the stock market. Even those companies that build or manage the malls that are a favorite place for teens to hang out at are on the stock exchange.

After an initial public offering a company may raise more money by selling more stock. Because selling more stock can also make each share of stock worth less, companies that have a good credit rating may issue corporate bonds to raise money.

Companies would not exist for very long if someone did not buy their products or services. When a company sells its products and services and makes a profit, it not only has money to create more products and services, it also has money that it may give back to its investors or stockholders. The company would then issue what is called a dividend. *www.library.thinkquest.org*

The value of the stock may change at any time during the business hours of the stock market. The value is how much someone else is willing to pay for the stock. How much someone is willing to pay is usually based on how well the company is perceived to be valued now and its potential value for the near future. Whether or not a company pays dividends may also be a factor that determines the price of the stock. As the trading has become more computerized and global, the exchanges have begun to offer off hours trading of stock, where trades occur only when there is a direct match of sell and buy requests.

The history of the stock market in the US is as found on *www.library.thinkquest.org* : "If we trace the roots of the New York Stock Exchange to its beginning, we would find that it started out as dirt path in front of Trinity Church in East Manhattan 200 years ago. At that time, there was no paper money changing hands. The idea of stocks was yet to be created. Rather, silver was traded for papers representing shares in cargo, that was coming in on ships every day. The trade flourished."

The American Revolution was expensive and the new Colonial government needed to pay for the war operations. They sold bonds, which are pieces of paper bought for a set price. After a set period of time, the bonds could be redeemed for the amount paid with the addition of interest. Around the same time, the country's first banks started to sell parts or shares of their own companies to people in order to raise money.

This would be one of the first initial public offerings. They sold part of the company to whomever wanted to buy it, thus the beginning the modern day stock market.

"Wall Street was becoming a major center of these transactions, and in 1792 twenty-four men signed an agreement that started the New York Stock Exchange (NYSE). They agreed to sell shares or parts of companies between themselves and charge people commissions, or fees, to buy and sell for them. They found a home at 40 Wall Street in New York City. As they grew they later moved into what is currently the New York Stock Exchange Building." *www.library.thinkquest.org*

As the industrial age came to be with more companies and products, the stock market grew. In the1970's, the first electronic exchange (NASDAQ) came into being. And in 2007 the NYSE merged with Euronext, to become a global electronic market. NASDAQ and AMEX merged, but continue to operate as separate exchanges.

Stock Market Trends

Most stocks are charted at least daily. Data is made available as buys and sells occur. Most data are available at a 20 minute lag unless you pay for more current information. Stock charts can be created on any major brokerage web site (Schwab , Fidelity, Smith Barney, Merrill Lynch), yahoo.com, google.com or any financial magazine site.

Many local stocks are detailed in the local newspaper. In most newspapers end of day stock prices are found, along with the high and low price for the day and the high and low for the past 52 weeks. Other financial indicators are also reported such as PE ratio (stock price to earnings ratio), volume traded, EPS (earnings per share), and dividend yield. Business sections of the newspaper also detail important business events that have an impact on the stock market and individual companies.

In order to find information for a particular stock, the acronym or code, which was assigned to the company when listed on the stock exchange, is used. Examples are: Webster Financial Corporation: WBS, Ford Motors Company: F, McDonalds: MCD. Figure 1 shows an example of the daily time series chart for Webster Financial.

Webster Financial
Figure 1
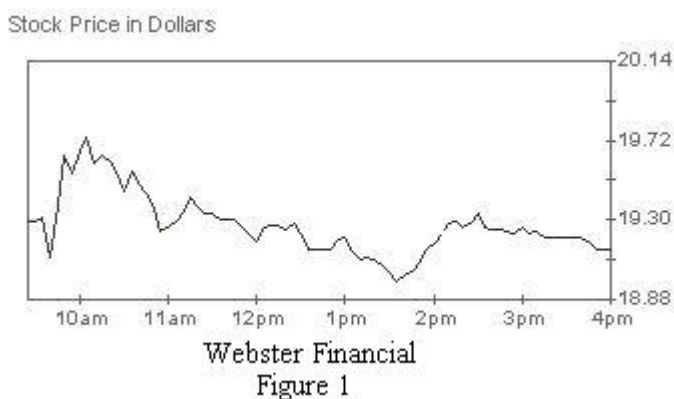
It has been said that overall investing in the stock market produces better returns than most other investments in the long term. However, recent turn of events in the stock market make it difficult to believe that more money is made in stock market investments than any other area. In 2007-2008 skyrocketing oil

prices and sub prime mortgage scandals that have rocked the financial markets. In addition, a worrisome economic picture leaves many investors with very small gains or some very large losses.

In the best of times, investing in the stock market requires research of the company, its management, profits, debt, inventory and current market conditions. Looking at the trend of the stock market price is one piece of vital information that is crucial to making a good decision. Most people are aware of the basic premise to buy low and sell high. Good advice, but being able to interpret whether or not the current time is a good time to buy or sell can only be accomplished by looking at price trends within the bigger picture of the company's health and economic conditions. Graphs of stock prices are key in aiding the decision process.

Before investing in the stock market, it is important to determine what kind of company you wish to invest in. Just as important, is the fact that it can be risky to invest in the stock market. Only invest money that you are willing to lose. To minimize your risk, research becomes the key.

Companies typically fit into what is called a sector. Some of the major sectors are: Financial, Health Care, Energy and Utilities, Entertainment, and Transportation. Are certain sectors currently doing really well? If so then that may be a good starting point. Right now financial stocks are not doing very well as a group, so that would not be a good choice, unless your research shows that you believe they are close to the bottom and you are willing to take the risk. Oil stocks are doing quite well right now, so you may decide that an oil company is the right choice.

Once a decision is made as to what kind of company makes sense, then research to discover the best company for you to invest in, will help you make a better decision. Look at all of the information that is available about the company, annual reports, what analysts are projecting. If income is important, choose a stock that distributes dividends. The higher the yield, the better. If income is not important to you, but investing for the future growth is, then look at a growth stock. Some of the growth stocks are not yet making a profit, so they can be a riskier investment. Compare the stock to how well the Dow Jones average is doing, or one of the other appropriate indices. Consult with a broker, but remember, in the end, it is your own decision.

Historical prices are readily available for individual stocks on the Internet on any of the major brokerage firms or search engines such as Yahoo or Google. The chart of the high and low closing prices of the Dow Jones Industrial Average shows a distinct upward trend from the mid 1980 until 1999, then a distinct downward trend, with a short upswing. The graph of Dow Jones Average is shown below, figure 2.
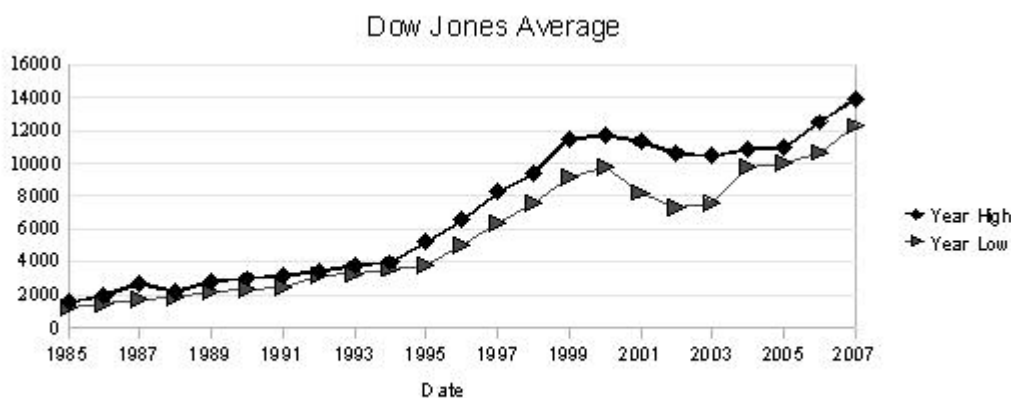

Figure 2

Stock Predictions

There is no crystal ball that shows how stocks will do and everyone is forewarned that past performance is no guarantee of future performance, but there is a plethora of systems that people are employing.

One very famous prediction that went very awry was made by Irving Fisher, an esteemed economics professor at Yale University in 1929. He stated that "Stocks have reached what looks like a permanently high plateau" just a few days before the great crash of 1929 of the stock market on the eve of the great depression. Not only was his personal wealth compromised, but it also impacted his academic reputation.

As late as Wednesday the 23 rd , he stood by his educated opinion that the stock values were not inflated. " For months after the Crash, he continued to assure investors that a recovery was just around the corner. Once the Great Depression was in full force, he did warn that the ongoing drastic deflation was the cause of the disastrous cascading insolvencies then plaguing the American economy because deflation increased the real value of debts fixed in dollar terms." (http://www.econlib.org/library/Enc/bios/Fisher.html)

As one of the greatest mathematical economists, Irving Fisher clearly explained the central principles of and mathematics underpinnings of his theories. Even with his research and great intellect, he had difficulty translating it into personal wealth.

Lesson Plans

X vs Y coordinate

Students in Algebra I still have difficulty understanding the Cartesian coordinate system. When looking at a point (x,y), I remind them to remember what comes first in the alphabet is the first letter. That is x comes before y in the alphabet, so when they see an ordered pair, they should write the letter x above the first coordinate. Y comes after x so it is the second part of the coordinate. Again, writing the letter y above the second coordinate will reinforce this convention. The practice that x is plotted on the horizontal axis and y on the vertical axis is somewhat more difficult to remember. However, I found an exercise that is part of the Algebra Lab curriculum in New Haven District and adapted it to help the students (www.ti.education.com). The exercise also helps in seeing how changing one coordinate may change the position of the point.

Graphing in a coordinate plane - Move a triangle and change its shape

Objective: Students will be able to plot x and y coordinates of points and identify effects of change in x and y values. The exercise may be done with computer software or a graphing calculator or on paper

Instructions for a TI Graphing calculator

Setting up Stat Plot mode:

1. Set your calculator to plot mode. Press 2nd key and Y= key.
a. With cursor pointed to 1: Press Enter key
i. Plot1 is highlighted. Move cursor to ON and press Enter key
ii. Move cursor to type that is connected dots, Press enter key
iii. Move cursor to Xlist and choose name L1 (press 2 nd key then 1 key)
iv. Move Cursor to Ylist and choose name L2 (press 2 nd key then 2 key)
v. Move cursor to Mark and move cursor to the square and press enter key
vi. Press 2 nd mode key to exit out

Entering data:

2. Press Stat key
a. With cursor pointed to Edit press enter

If you don't see L1 at the top, cursor to the top and then to the right until you see L1 or an
b. empty space. If you see L1, press clear and enter to erase its list. If it is an empty spot then
enter L1 by pressing 2 nd and 1 key.
c. Do the same thing for L2.

Enter the x coordinates intoLl1 and the y coordinates into L2 For a triangle in the first
d. quadrant use the following coordinates (1,1), (1,4) , (3,1), (1,1) Entering the first coordinate
again as the last will complete the figure when graphed.

Graphing the data:

3. Press the Graph key and the graph will appear.
If the graph does not appear, check to make sure the window is correct. The standard window
may be created by pressing zoom, then 6 key. Only the first quadrant is shown in the following
chart. Quadrants are numbered counter- clockwise.

Figure 3
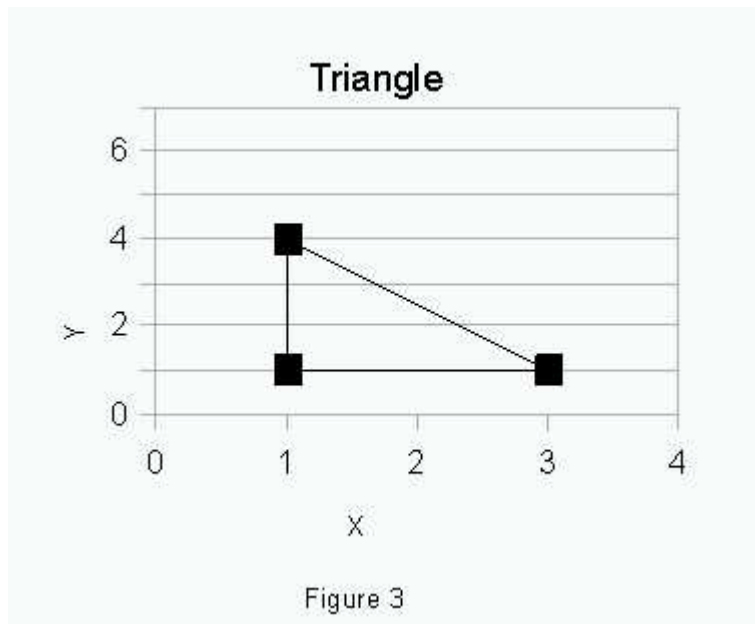
These are the different exercises students :

1. Move the triangle up
2. Move the triangle right
3. Move the triangle to the second quadrant
4. Move the triangle to the third quadrant
5. Move the triangle to the 4 th quadrant.
6. Make the triangle twice as tall
7. Make the triangle twice as wide
8. Make the triangle into a square

The students are encouraged to work in pairs. Through experimentation, the students should figure out what changes to the x or y coordinates make the desired change.

I also use a teacher's calculator connected to view a screen which allows the graph to be display on the white board or a large piece of paper. This allows the students to see where the triangle had been before they began making changes to the coordinates. Multiple lists also may be used to keep several figures graphed on the same coordinate plane.

X -Y dependent vs independent variable

Which variable is the independent and which is the dependent? Students think that the independent variable is always plotted on the x axis, since this it is taught in the science curriculum. However, it is important from a mathematical perspective for them to understand that choosing the x variable is important in the context of how the problem is presented. The question of causality becomes the key factor. This concept seems to be one of the more difficult ones for the Algebra I students to comprehend, especially when the exercise is presented as a word problem. This is a discussion activity.

Examples 1: Juan receives $ 20 from his Grandmother for his birthday. The card says that he will be receiving an additional $ 5 for each month. How much money will Juan have received from his grandmother in two years?

In this case the independent variable x would be the number of months and the dependent variable y would be the amount of money Juan has received.

Example 2: Jane has a steady babysitting job where she makes $ 6.50 an hour. How many hours must she work to make enough money to buy the new iPod she wants?

In this case the independent variable is the amount of money she needs to make and the dependent variable is the number of hours.

Example 3: A vacation trip has been planned and the Smith family would like to get to keep their gas budget reasonable. How much will they spend on gas if gas is $ 4.28 and their car gets 20 miles to the gal?

In this case the number of miles they will travel is the independent variable and the amount of money spent on gas is the dependent variable.

Relations and Predictions

There a linear relationship between pieces of information when knowing one value will allow you to determine the other value. With a linear relationship there is a constant change in the independent variable that is correlated to a constant change in the dependent variable.

Students should be encouraged to consider if the relationship makes sense.Time series data such as time passes, the money that is deposited in a savings bank increases in amount based on the interest rate paid and has a positive correlation. This is a reasonable example of a linear relationship.

Relation Activity

An exercise that would be fun for the students to do is to determine if the size of a persons head or length of their arm or foot is related to how far they can jump. (McDougall Littel, Algebra I).

As part of this exercise, the students should be able to determine that the dependent variable or y is how far they are able to jump. The independent variable is the size of their head, length of their arm or foot. The students will be put their data into a table. Depending on the age and skill level of the students, pre-printed tables could be provided. All students in the class should be included.

The students will then graph their results on paper. They will then draw in a line of best fit, by eye, where the number of points below the line are about the same number as above the line and that the points are the same distance from the line drawn. They will discuss which of the three independent variables was the best predictor of length of jump. The students could be introduced to interpolation by asking how far a student with a head size falling between two values might jump.

Once the graphs are created and the lines are drawn in, the students can determine the equation of the line. The easiest equation is the slope intercept form, $Y = mx + b$, where m is the slope, and b is the y intercept. If they extend the line through the y axis, they will approximate the y value, when x equals zero (the Y intercept). Then they should pick two points that are on the intersection of the grid lines and use the points to

calculate slope (y2-y1/x2-x1). They can then use their equation to predict points beyond the scope of their data. Ask them how far it is reasonable to extrapolate.

This activity may be done where the graphing is done first on paper, then on computer or graphing calculator. The students can discuss if their results are different in either method and why. Also, on the graphing calculator or computer, a regression line may be created by the software. The students will be able to compare their results to this line.

Reading and Interpreting Graphs

The following scenarios of stock prices will help the students explore the fluctuations of stock prices and use the past to make predictions. The following graphs may be used to make predictions. The graphs on the left have been truncated at a particular date. The students are to use the graphs on the left to make predictions as to how the stock price will do in the near future. The graphs on the right show how the stock prices have actually done. Data from Yahoo.finance.com was used to create these graphs. It is simple to download information directly into graphing software to create similar graphs of any company. Choose companies in which your students express an interest.
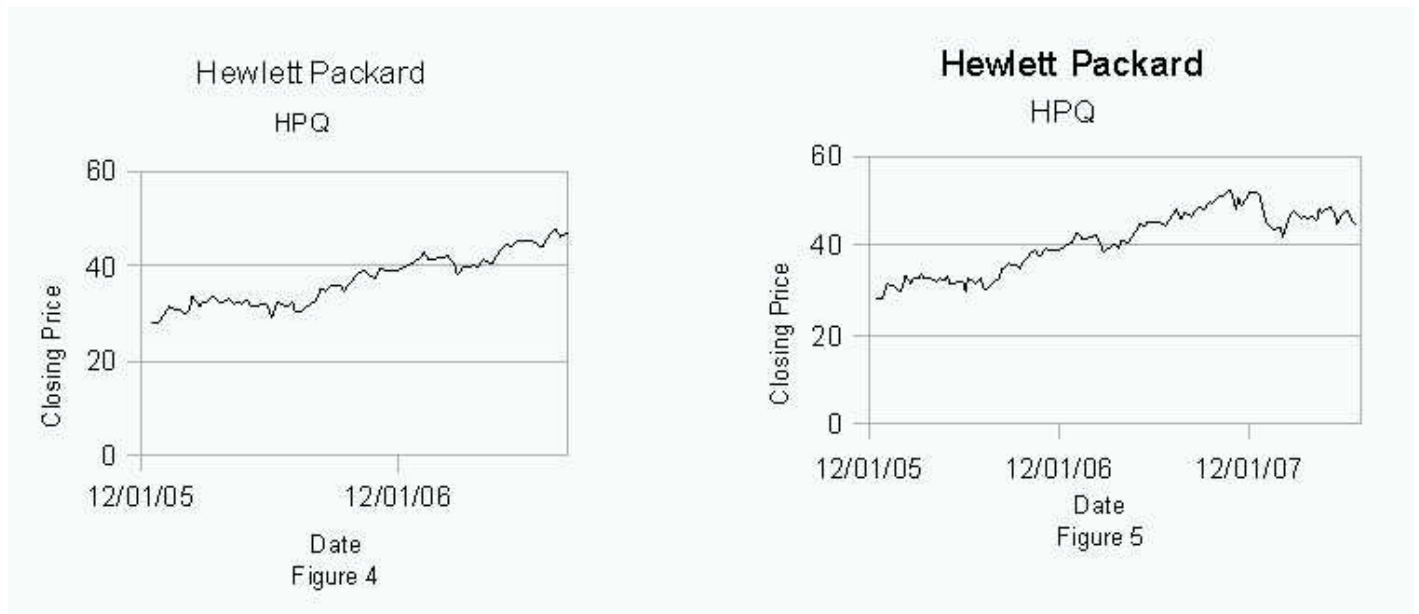
Figure 4

Figure 5

On the graph, figure 4, it appears that Hewlett Packard's stock price will continue to rise. However, the complete graph, figure 5, shows that it goes down and then levels off.
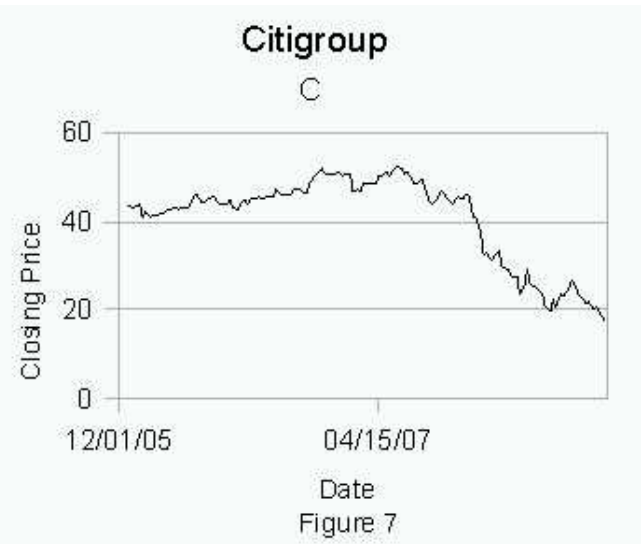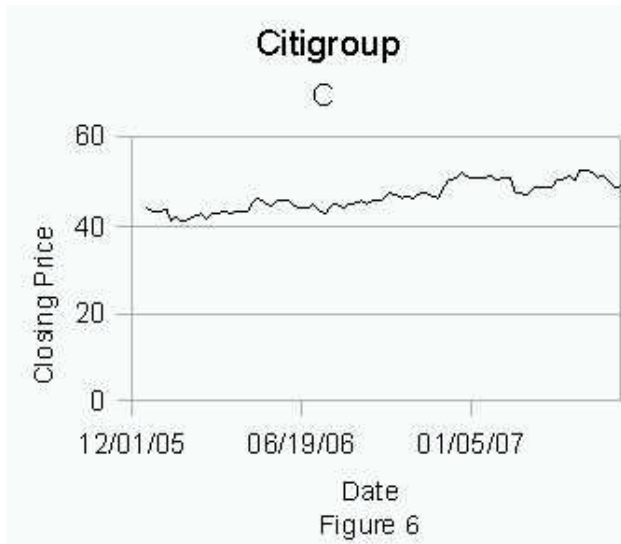
Figure 6

Figure 7

On the graph, figure 6, it appears that Citigroup's stock price is slightly increasing. The complete graph, figure 7, shows that the price in fact went down significantly.
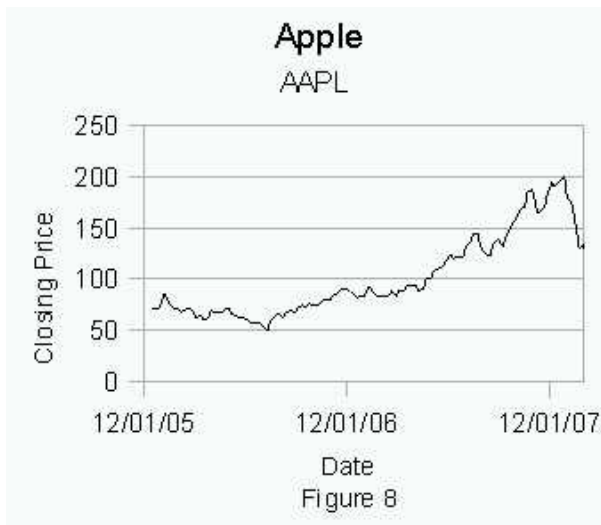
Figure 8

Figure 9

On the graph, figure 8, it appears that Apple's stock price rises nicely then has a downturn. A prediction of that the down turn will continue would be appropriate, but the stock actually recovers and increases in price as shown on figure 9.

SIRIUS
SIRI
Figure 10

SIRIUS
SIRI
Figure 11

Sirius' stock price appears to be trending down in figure 10. An appropriate prediction would be that this trend continues. As the graph in figure 11 shows, Sirius stock price continues to trend downward.
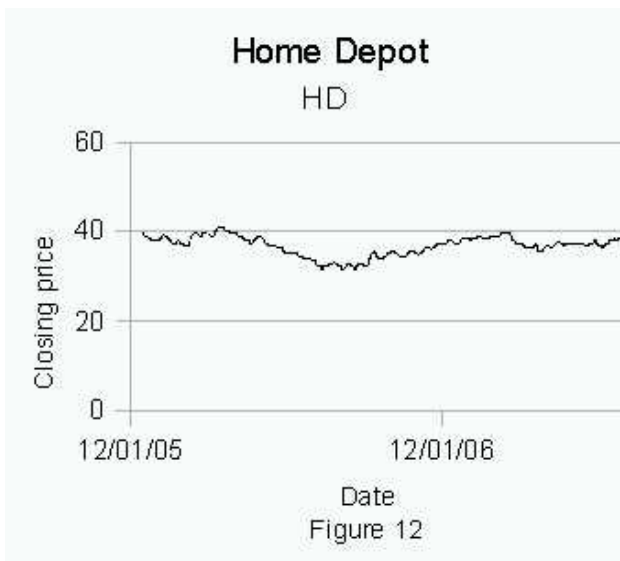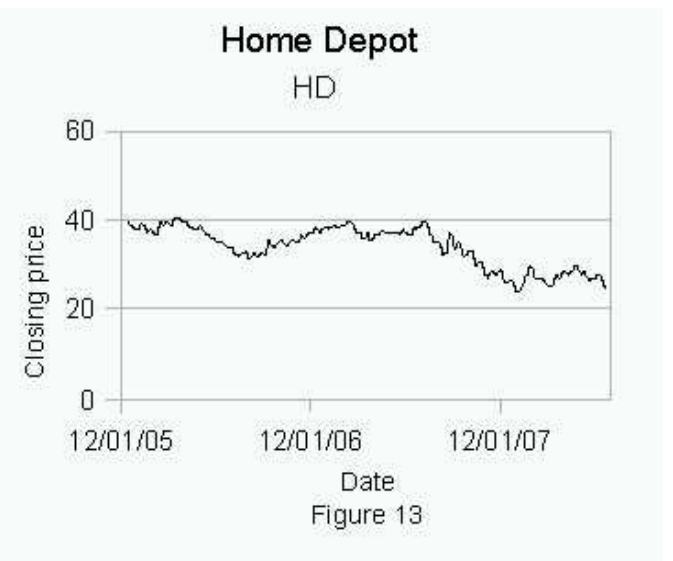

Home Depot
HD
Figure 12

Home Depot
HD
Figure 13

According to the graph , figure 12, it appears that Home Depot stock price is relatively flat and the prediction would be that that would continue. The graph, figure 13 shows that Home Depot stock actually started to trend down.
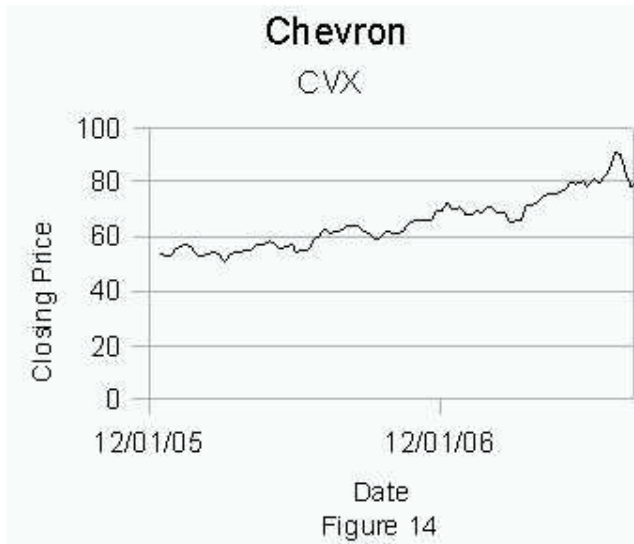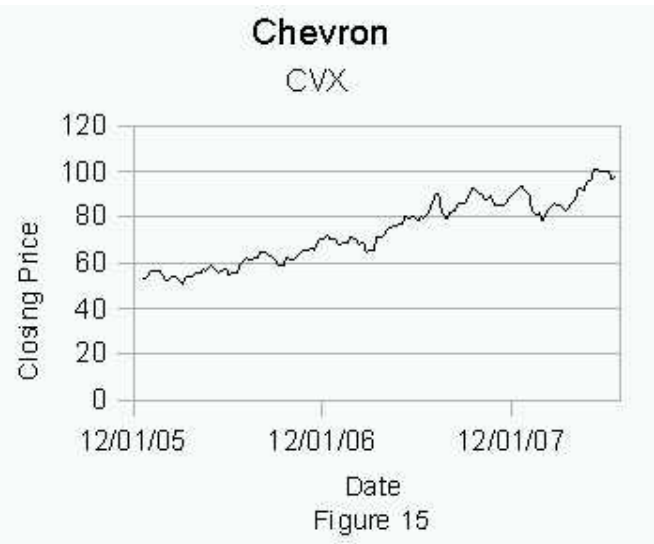
Figure 14

Figure 15

The graph, figure 14, of Chevron's stock price appears to be on an upward trend. The last blip on it may indicate that there is a downward trend beginning. Students may believe that either is correct. As shown an figure 15, the actual trend is that Chevron's stock price continues to increase.

As the students analyze these graphs they will perceive that sometimes the price will go up as they thought it would, but sometimes the price will go down.

The Stock Market Challenge

This exercise will combine research with the excitement of making some money. First the students will pick some companies that interest them. They should determine, based on what they know or which companies had the biggest increase in stock price over the past month. They will be required to write down in a paragraph what their reasons are for believing this. Afterwards, they will record the stock prices, using the end of day prices. Their graph will have days on the x axis and stock price on the y axis. They will then plot the points and create a line of best fit. Using their line of best fit they will predict how their best stock will do in a week. Included should be a graph of the most appropriate major indicator, such as Dow Jones average for comparison.

Continuing on with this theme, the students will then take a the same period of time from the previous year and determine if they see a trend. If there is a trend, the students will again graph their data and make a prediction of where the stock will be at the end of the following week. They are to determine if their prediction is better with more data.

What other factors may have an impact? Is the past a clear predictor for the future price where stocks are concerned? The last relation is whether there is a correlation between the price of the stock and how much money the company is making. Some of the Fortune 100 companies should be compared against smaller companies. What are their results?

In addition, the students should compare their results with what some of the experts have predicted. A quick check as to stock prices before and after any large fall in the stock market such as October 1987 and in 1929 could provide a good historical perspective.

Did they make the best decision, which made them more money? Using a current bank rate, have the

students graph the result of investing their money in a bank account. Would they have more money? Some may determine that putting their money in the bank is the best decision for them.

Even if the students continue to say "when will we ever use this?", they will be a step closer to being able to use math to make better decisions and make more money!

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www.yahoo.fi *nance.com*

www.schwab.com

www.quicken.com

www.fidelity.com

http://www.econlib.org/library/Enc/bios/Fisher.html

www.library.thinkquest.org

www.classzone.com

Teacher and Student Resources

http://nces.ed.gov/nceskids/createagraph/default.aspx

government site -interactive simple graphing

http://www.aier.org/research/cost-of-living-calculator/

cost of living calculator

http://www.incompetech.com/graphpaper/lite/

print your own graph paper

http://www.shodor.org/interactivate/activities/

The site is interactive and has both student and teacher pages.

http://www.shodor.org/interactivate/activities/ScatterPlot/

http://www.mcwdn.org/Graphs/TabGraphMain.html

simple site with quiz format

http://www.statcan.ca/english/edu/power/ch9/using/using.htm

another good looking site from Canada.

http://inflationdata.com/Inflation/images/charts/Oil/Gasoline_inflation_chart.htm

gas price adjusted for inflation

http://www.aier.org/research/cost-of-living-calculator/

cost of living calculator

http://finance.yahoo.com/echarts?s=BSC#symbol=BSC;range=1d

stock market chart - -interactive

http://finance.yahoo.com/lookup

main look-up page

http://www.heritage.org/research/features/BudgetChartBook/index.cfm

private conservative foundation charts federal spending

http://www.publicagenda.org/issues/factfiles.cfm?issue_type=federal_budget

some nice federal budget charts

http://www.ncsu.edu/labwrite/res/res-homepage.htm

collegiate graphing site

http://personal.fidelity.com/toolbox/growth/growth.shtml

investment graphing program

www.gapminder.com

fancy graphics site

http://www.epi.org/content.cfm/datazone_fambud_budget

family budget calculator

www.nyse.com

new york stock exchange site

www.howstuffworks.com

www.nasdaq.com

NASDAQ market site

www.dowjones.com

www.djindex.com *Dow Jone Index Site*

www.yahoo.fi *nance.com*

Can download stock prices directly into worksheet program

www.schwab.com

Brokerage site for investment and company information

www.quicken.com

Financial- personal moneymanagement

www.fidelity.com

Brokerage site for investment and company information

www.education.ti.com

Graphing Calculator site