Interest Activity

Overview
In this activity, students develop and understanding of the difference between simple and compound interest. They learn how to compute the amount owed over different times with different interest rates and different frequencies of compounding.

A virtual instrument, Interest.vi, is used to underline the differences between compound and simple interest graphically and numerically. It is also used for calculations and for students to check their work.

Objectives
Students will be able to:

- Articulate the differences between simple and compound interest.
- Calculate the amount owed over time with simple or compound interest.

Standards (TEKS)
Math Models with Applications 1ABC, 2AD, 5AC, 7A

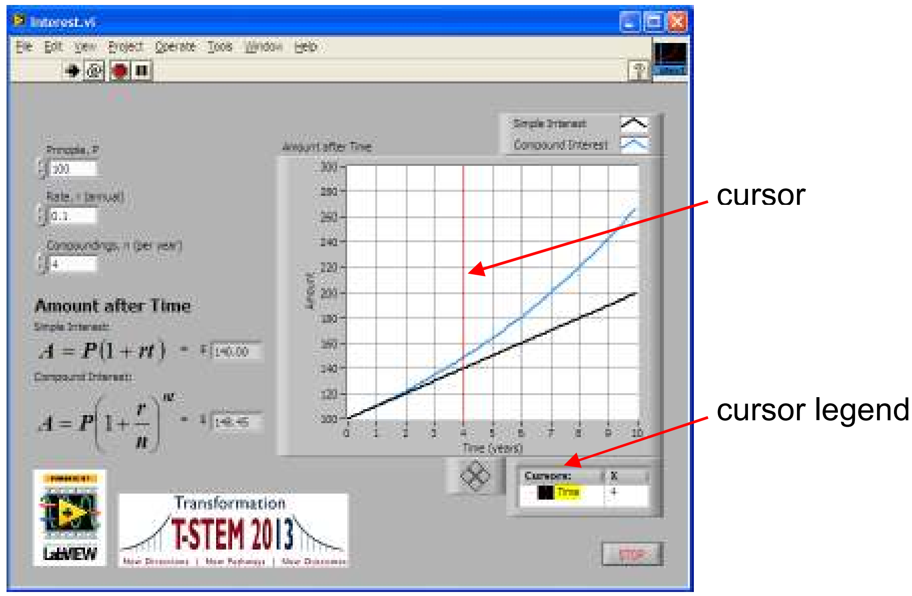
Activity
When money is borrowed, it is common for the borrower to pay interest, like a fee, until the debt is paid. Interest is paid on money borrowed for cars, homes, and for money spent on a credit card. Interest can be earned for putting money into a savings account or investing in the stock market.

Interest is calculated as a percentage. Sometimes the interest is only based on the original amount borrowed, called the **principle**. In these cases, we call it **simple interest**. In other cases, interest is based not only on the principle, but also on any previously accumulated interest. This potentially snowballing scenario is called **compound interest**. It is common for interest to compound annually, quarterly, monthly and, in the case of credit cards, even daily.

Let's take a look at how interest is calculated and get a better sense of the difference between simple and compound interest.

1) Open and run the Interest virtual instrument, VI.

On the Interest VI you will see a control for setting the principle, rate, and number of times per year interest is compounded. A graph shows the amount accumulating over time as interest is added to the principle. In the graph, you will also see a red vertical line, the cursor.



The position of the cursor controls the amount of time used to calculate the amounts displayed to the left of the graph. You can click and drag on the vertical line of the cursor to control the time or you can enter a value into the cursor legend.

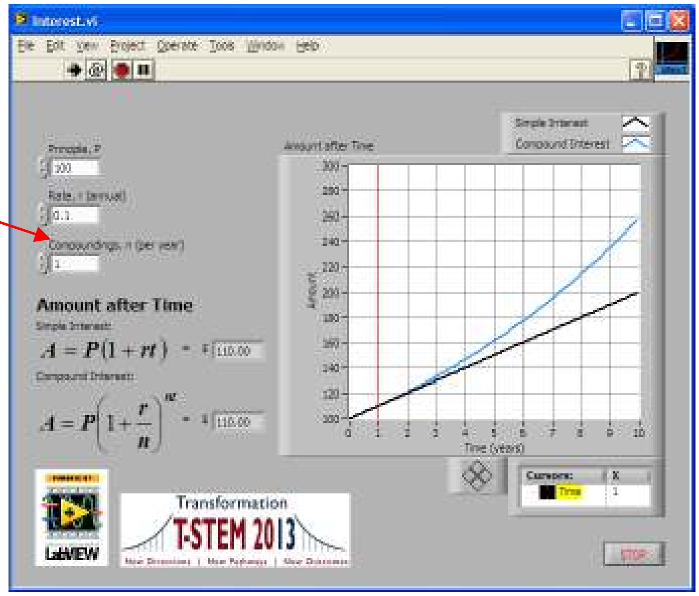
2) If necessary, set the values in the VI to the following:
   a) **Principle**, *P* = $100
   b) **Rate**, *r* = 0.1 (This corresponds to 10%.)
   c) **Compoundings**, *n* = 4

On the graph, the amount of money accumulated over time with simple interest is shown in black. The amount of money accumulated over time with compound interest is shown in blue.

3) How do the two graphs differ from one another? Does this tell you anything the two ways interest can be paid?
4) Set *n*, the number of **Compoundings**, to 1. Use the VI to fill in the following table with how much money is owed in each scenario. (Hint: Use the cursor on the VI to set the time.)

Years	Simple	Compound
1		
5		
10		

Compounds *n* times per year

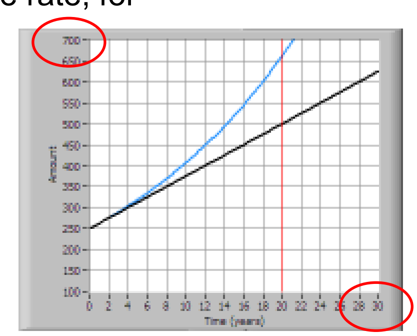


There are formulas for calculating how much money you have or owe when interest is accumulating. With simple interest, the amount after time can be found using

$$A = P(1 + rt),$$

where *P* is the principle, *r* is the rate, and *t* is the elapsed time.

5) Use the formula to calculate the amount owed if \$100 is borrowed with *simple* interest at a rate of 10% per year for 5 years. Does your answer match what you have in the above table?
6) Use the formula to calculate the amount you have in savings if you put in \$250 with *simple* interest with a 5% APR, annual percentage rate, for
   a) 5 years
   b) 10 years
   c) 20 years
7) Check your work using the VI.



You can change the limits on the graph by simply double-clicking and typing in the desired limits.

The formula for calculating the amount after time with compound interest is a bit trickier since interest can be compounded multiple times a year. To find the amount after time with compound interest use the formula

$$A = P\left(1+\frac{r}{n}\right)^{nt},$$

where *n* is used to denote the number of times interest is compounded per year.

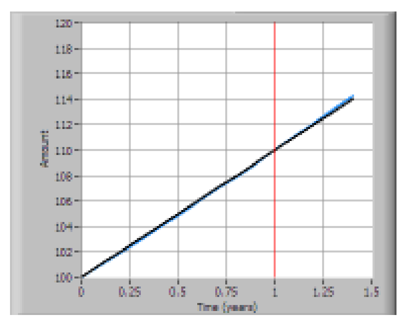
8) Use the formula to calculate the amount owed if $100 is borrowed with *compound* interest at a rate of 10% per year compounded once per year for 5 years. Does your answer match what you have in the above table?

Remember to convert the percentages into decimals when performing calculations or using the VI. For example, 25% is 0.25, 12% is 0.12, and 125% is 1.25.

9) Use the formula to calculate the amount you have in savings if you put in $250 with *compound* interest with a 5% APR compounded monthly for
   a) 5 years
   b) 10 years
   c) 20 years
10) Check your work using the VI.
11) How does the money you save differ when your bank pays you compound versus simple interest?

Next, let's take a look at the impact of compounding with different frequency. That is, let's play with *n* and see what happens.

12) Set the values in the VI to the following:
    a) **Principle**, *P* = $100
    b) **Rate**, *r* = 0.1 (This corresponds to 10%.)
    c) **Compoundings**, *n* = 1
13) Zoom in on the graph by changing the limits of the **Time** and **Amount** axes.
    a) Have 0 to 1.5 years on the **Time** axis.
    b) Have $100 to $120 on the **Amount** axis.
14) Set the cursor so the selected time is 1.
15) Fill in the following table by changing *n*, the number of times per year interest is compounded.



	n	Simple	Compound
Annually	1		
Quarterly	4		
Monthly	12		
Daily	365		

16) Zoom out on the graph by changing limits of the **Time** and **Amount** axes.
    a) Have 0 to 10 years displayed on the **Time** axis.
    b) Have $100 to $300 displayed on the **Amount** axis.

17) Find the amount after 8 years if \$100 is borrowed at 10% compounded at different frequencies.
   a) Use the cursor to set $t = 8$
   b) Note the amount after time for n = 1, 4, 12, 365 in the table

n	1	4	12	365
Amount				

18) Check two of these values by hand. Calculate A if $P = 100$, $r = 0.1$, $t = 8$ for
   a) n = 4
   b) n = 12

19) Do your answers match what you got from the VI?

20) More practice with compound interest:
   a) Calculate A if P = \$1000 with 17.9% APR compounded daily for three years. (This is a common scenario for money on a credit card.)
   b) Calculate A if P = \$250 with 2.9% APR compounded monthly for ten years. (This is a common scenario for money in a savings account.)

You have probably seen storefronts offering to loan you money until you get your next paycheck, known as a “payday loan”. These companies usually charge a one-time fee that is a percentage of what you borrow, also known as interest. The fee is usually in the neighborhood of 20%. That is **not** 20% annually; it is 20% when you repay the loan in a week to a month. Payday loan companies expect to loan money for 7 to 30 days since people usually get paid weekly, twice a month, or monthly.

Let’s say the average payday loan is for 14 days and calculate what the corresponding APR is would be for the 20% fee.

21) Divide 20%, or 0.2 by 14 to find the daily rate.

22) Multiply the daily rate by 365 to get the corresponding APR. (Your answer should be in the neighborhood of 500%)

23) Use the VI to see what will be owed after 14 days if you borrow \$100.
   a) Set P = \$100
   b) Set r to the APR you just found. (Remember: 125% = 1.25 so 500% = 5)
   c) Since time is in years, you have to figure out what to enter for t.
      i. Divide 14/365
      ii. Use the cursor to set t to the value you just calculated.
   d) How much is owed after 14 days?

You are not compounding. There is a one-time payment. The amount owed is the **Amount After Time** with **Simple Interest**.

24) What would be owed if \$500 were borrowed?

25) Stop the VI. You are done.