Money Math for Teens

Opportunity Costs

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Lesson Plan

OBJECTIVE

Introduce the concept of opportunity costs. Show students there is always a price paid when choices are made.

Students will be able to:

► Recognize and identify the opportunity costs of choices

► Evaluate the subjective value of the choices they make

► Evaluate the quantitative values of choices they make

► Calculate the future value of time deposit investments

► Calculate the minimum monthly payment required on a credit balance.

TEACHING MATERIALS

► Lesson plan

► Opportunity Costs student handout

► Opportunity Cost Exercises worksheet with solutions

LESSON ACTIVITY

1. **Introduce the idea that there are opportunity costs for every choice made.**

   - Ask students to make a list of what they could do with $20.

   - Write their responses on the board as a bulleted list.

   - Ask them to individually decide on their top two choices.

   - Ask for volunteers to share their choices.

     - Lead a discussion of the pros and cons of each of their top choices.

     - Ask how they determined their top choice was superior to their second choice.

     - Explain that the opportunity cost of their first choice is the value of their second choice.

2. **Introduce and present the student handout.**
   - Ask students how they make financial decisions.
   - Read and discuss the $100 choices example (concert, dinner or theme park ticket).
   - Introduce the $5G: Walk or Ride example.
     - Ask students to make a preliminary decision on what they would do if they unexpectedly received $5,000: buy a car, or invest the money.
       - What would the future value of that investment likely be?
     - Next, ask: What would a $5,000 investment at a 3.5% APR be worth in a month?
       - What would the investment be worth in the second month?
     - Introduce the compound interest formula.
       - Use the formula to determine the value of Taylor's $5,000 windfall after five years if she invests it in an annual CD.
     - Repoll the group to see if their initial choice has changed.
     - Ask if it would be possible for Taylor to invest the $5,000 *and* get the car. How?
     - Introduce the monthly payment formula.
       - Use the formula to determine Taylor's monthly payment if she buys the car.
     - Taylor's brother Tyler has a different perspective on saving and spending.
       - Discuss how Tyler got himself into debt.
       - Work through the numbers for each of Tyler's options: investing in a CD, buying a car or paying off his debt.
       - Discuss why the smartest move Tyler can make is to use his $5,000 windfall to pay off the debt he's accumulated.

3. **Introduce and present the Opportunity Cost Exercises worksheet.**
   - Ask students to complete page 10 to illustrate the idea of opportunity costs.
   - Review the compound interest formula example (page 10).
   - Ask students to answer the compound interest questions on page 11. This can be considered part 1 of the assessment for the lesson.
   - Review the monthly payment formula example (page 11).
   - Ask students to answer the monthly payment and compound interest questions on pages 12–13. This can be considered part 2 of the assessment for the lesson.

Student Handout: Opportunity Costs

Have you ever said to yourself, "If I had only done this instead of that," or heard the saying, "Hindsight is 20/20"? Wouldn't making choices be a whole lot easier if you knew the outcome of choices *before* you made them?

There are times when making a choice to do one thing means giving up the opportunity to do another. Sometimes that decision works out well and you are very happy with the result. At other times, the choice works out badly and you end up saying to yourself, "I wish I had made a better decision!"

Consider this scenario: You are driving along a little-used highway in an area you've never been before, and you see a sign:

Gas, Food and Rest Area—11 Miles Straight Ahead

You are thankful for the break you'll get just 11 miles ahead; the drive has been monotonous and dull so far.

Shortly after, another sign announces a split in the road.

Express Highway—Keep Left
Scenic Route—Keep Right

Do you take the left or the right side of the road? If you choose to stay on the long, boring highway, you'll arrive at the rest area in the shortest possible time. However, a scenic route may be filled with interesting sights and possibly places to stop that offer more than just a well-deserved break from driving.

You know what rest areas offer and what to expect. If you choose the scenic route, you are giving up the opportunity to stop sooner. If you choose to stay on the highway, you are giving up the chance to check out the wonders that may be on the scenic route.

Every choice has some cost associated with it. The value of the choice *not chosen* is called the **opportunity cost** of the choice you made. Let's say you have $10. You could buy lunch with the money, or you could use it to go to the movies. If you choose the lunch, the opportunity cost of that lunch is the movie you miss. If you choose the movie, the opportunity cost of that movie is your hunger.

Opportunity cost is the price we pay when we give up something in order to get something else. There may be several things we could have done and several others we gave up, but the *most desirable* of the choices we did not make is the opportunity cost of our choice. Not *everything* we gave up counts as opportunity cost.

For example, let's say you have $100. You have three choices. You could buy:

1. A ticket to a cool concert
2. Dinner for two at a fancy restaurant
3. A ticket to Disney World with lunch included.

Each choice costs $100. At first, it seems that if you choose the concert, then the opportunity cost of the concert is the dinner for two and the Disney park pass with lunch. However, you can't have both choices anyway—you can have only one of the three. Which would you choose instead of the concert? That choice is the opportunity cost of the concert.

Making a choice always involves a cost. Making sound, wise decisions isn't always easy, especially when we take the opportunity costs of our decisions into consideration.

$5G: Walk or Ride?

Let's consider a responsible young lady; we'll call her Taylor. Taylor comes into an unexpected $5,000.

Taylor is always thinking and analyzing her best move. She'll consider the opportunity cost of her choices when deciding how she can benefit most from her windfall of money.

She considers a list of items she wants and narrows her choices down to two. What should she do with her $5G?

- ► Buy a sweet used car.
- ► Invest the $5,000 and make it grow.

Each choice becomes the opportunity cost of the other:

- ► If she buys the car, then the $5,000 is gone.
- ► If she invests the $5,000, then she's walking.

To decide which choice is better for Taylor, we'll first need to put some value on each decision. If she chooses to buy the car, then the future value of a $5,000 investment is gone.

What would the future value of that investment likely be?

There are many ways to invest $5,000—stocks, bonds and mutual funds, to name a few. Let's take a conservative, safe investment: a bank certificate of deposit (CD).

What would be the future value of a bank certificate of deposit with a beginning balance of **$5,000**, an annual interest rate of **3.5%** that compounds monthly and that is held for the next **five years?**

We can start with $5,000 and calculate one month's interest at a 3.5% annual rate. Adding that to the $5,000, then repeating those steps for the next 60 months, could take some time! Fortunately, there is a formula we can use to do this calculation. It's called the **compound interest formula.** It is used to calculate the future, accumulated balance of an investment across multiple compounding periods. The formula looks like this:

Where: A = Accumulated balance

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

P = Principal

r = APR expressed as a decimal

n = Number of compounding periods per year

t = Number of years the investment lasts

So, Taylor does the math:

P = **5000**

r = **3.5% = 0.035**

n = **12 (monthly compounding)**

t = **5 years (the investment would last five years)**

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

$$A = 5000\left(1+\frac{0.035}{12}\right)^{12\times5}$$

$$A = 5000(1 + 0.0029)^{60}$$

$$A = 5000(1.0029)^{60}$$

$$A = 5000(1.189756)$$

$$A = \textbf{\$5,948.78}$$

Investing the $5,000 in a bank CD would leave Taylor with a balance of **$5,948.78** in five years.

The opportunity cost of buying the car is giving up $5,948.78 in five years if she invests in a bank certificate of deposit. What other costs come with the purchase of a car? What will the car be worth five years from now? What are the costs of gas, insurance and maintenance over five years?

Choosing to invest the $5,000 in a bank CD means the opportunity cost of the CD is the car. Without a car, she may not be able to drive to work. Without transportation to work, she may not be able to sustain an income. So what are the true costs of not having the car?

Taylor estimates the car will be worth about **$2,000** in five years. So, if she uses the $5,000 to pay cash for the car, her asset will be worth $2,000 in five years. If she decides to invest the $5,000, her asset will be worth $5,948.78 in five years. Paying cash for the car results in an opportunity cost of **$3,948.78.**

The opportunity cost of investing the money, however, is foregoing the car. Can she find a way to have both? Can she invest the $5,000, see her investment grow to $5,948.78 in five years *and* have the car?

Well, she can't buy the car and invest the money unless she finances the car and invests the money. Only one use of that $5,000 is possible. So what would it cost to finance the car?

Opportunity Costs

There is a formula to calculate the monthly payment necessary to pay off a balance at a certain interest rate in a certain amount of time. The formula to calculate the monthly payment on an original principal loan amount (P) at an annual interest rate (I) that will be necessary to pay the entire loan off in N months is:

$$\text{Monthly Payment} = \frac{(P \times (I \div 12))}{(1 - (1 + (I \div 12))^{-N})}$$

Where:

P = Principal amount of the loan

I = Interest rate of the loan

N = Number of months to pay off the loan

Let's say the interest rate at Taylor's bank on a used car loan is **7.5%.** The monthly payment if she finances the car over five years is:

P = 5000

I = 7.5% = 0.075

N = 5 years = 60 months

$$\text{Monthly Payment} = \frac{(5000 \times (0.075 \div 12))}{(1 - (1 + (0.075 \div 12))^{-60})} = \frac{5000 \times 0.00625}{(1 - (1 + 0.00625)^{-60})}$$

$$\frac{31.25}{(1 - (1.00625)^{-60})} = \frac{31.25}{(1 - 0.68809)} = \frac{31.25}{0.31191} = \textbf{\$100.19}$$

Taylor can invest her $5,000 in the CD and buy the car if she is willing to take on a monthly car payment of **$100.19.**

Over 60 months, she will pay **$6,011.40** in car payments. The difference between what she would pay ($6,011.40) and what her CD is worth ($5,948.78) is only $62.62. Taylor likes the idea of having that $5,000 CD around for five years, and she can afford $100.19 per month for a car payment.

Also, she calculates that her assets five years from now would be $5,948.78 (in the CD) plus the $2,000 that she estimates the car will be worth, or **$7,948.78.** If she initially bought the car for cash, her assets would be only $2,000; if she initially invested the money and didn't buy the car, they would be $5,948.78. The opportunity cost of $100.19 per month is whatever she could do with that money besides buying the car.

What would _you_ do?

Taylor has a brother named Tyler. Tyler is quite a bit different from Taylor. Tyler enjoys immediate gratification and living for the moment.

Tyler sees his sister with her fat bank account and shiny new ride. He'd like those opportunities, too. But if Tyler gets a $5,000 windfall, he will manage his money differently, because he doesn't consider his options like Taylor does.

Tyler can't resist concerts, dinners and adding to his wardrobe. He likes to go places and do fun things and buy things all along the way. As a result, Tyler has accumulated a **$5,000** debt on his credit card. Currently, he is making the minimum monthly payment of **2%** of the balance on his credit card from the wages he earns at his part-time job. Tyler's credit card carries a hefty **17%** interest rate along with the balance.

> 0.17 x 5000 = $850/year in interest
>
> or
>
> 850/12 = $70.83 per month

Tyler's first month's balance, then, is **$5,070.83.**

The minimum monthly payment Tyler is required to make to his credit card company is 2% of the outstanding balance: 0.02 x 5070.83 = **$101.42.**

From that payment, the credit card company will take $70.83 in interest. The rest of the payment will reduce his balance to:

> 101.42 − 70.83= 30.59
>
> 5000 − 30.59 = **$4,969.41**—Tyler's balance at the beginning of the next month

During the next month, interest continues to accrue on Tyler's balance. Because his balance is a little smaller than it was last month, though, his minimum monthly payment will be slightly lower.

> 4969.41 x 0.17 = 844.80
>
> 844.80/12 = 70.40
>
> 4969.41 + 70.40 = 5039.81
>
> 0.02 x 5039.81 = **$100.80**, Tyler's payment for the 2nd month

From that payment, the credit card company will take $70.40 in interest. The rest of the payment will reduce his balance to:

$$100.80 - 70.40 = 30.40$$

$$4969.41 - 30.40 = \textbf{\$4,939.01}$$

As you can see, Tyler's balance is being reduced very slowly. In fact, because he is paying only the 2% minimum required each month, in 60 months Tyler will still have an outstanding balance of **$3,519.83.**

While Taylor had the luxury of investing her $5,000 windfall and financing her car, Tyler does not enjoy the same choices. Taylor decided the opportunity cost of allocating about $100/month toward a monthly payment on the car was worth it. The car was her first choice. However, Tyler does not have the same options. He has already allocated $100/month toward his credit card balance. The decision regarding what to do with that $100/month has already been made.

So what are Tyler's choices? He has a $5,000 windfall just like his sister, but his options are different.

Tyler's choices are:

> ► Invest the $5,000.

> ► Buy a car.

> ► Use the $5,000 to pay off the debt he has foolishly accumulated.

We've seen that it's possible for $5,000 to become $5,948.78 in five years (60 months) if it's invested in an annual CD. If Tyler does this, his debt will still be **$3,519.83** at the end of the 60 months, but he'll have some savings. In five years, his assets would be:

$$5948.78 - 3519.83 = \textbf{\$2,428.95}$$

Or he can buy a car and pay up to $5,000 for it in cash. Then he'd have a car and still have the $100/month free to make payments on his credit card debt. But remember, the estimated value of the car in five years is $2,000. In 60 months, his assets would be:

$$2000.00 - 3519.83 = \textbf{-\$1,519.83}$$

Clearly, the value his assets would have after five years makes this decision easy. Investing the money instead of buying the car would leave him with some value five years from now. Buying the car would leave him $1,519.83 in the red.

Between these two choices, investing the money is the wiser move. But what about investing the money versus using it to pay off his debt?

Above, we calculated the first two months of Tyler's payments on his $5,000 debt at 17% interest. If we carried on doing each calculation every month for 60 months, we could come up with an exact figure for the amount of interest Tyler will have paid in five years.

However, doing this calculation isn't necessary. We see that the interest on his first two payments is around $70 per month. The amount of interest will decline as his balance decreases. In 60 months, he won't have paid off even half of this debt, so his interest payments will not be cut in half, either. That means his interest each month for the first 60 months will be between $70 and $35 per month.

Let's estimate the interest by going halfway between—that is, averaging—$70 and $35. Tyler will pay an average of **$52.50** in interest per month over the 60 months.

In 60 months, Tyler has paid:

$$5000.00 - 3519.83 = \textbf{\$1,480.17 of his loan back}$$

$$52.50 \times 60 = \textbf{\$3,150 in interest}$$

If Tyler invests the $5,000 instead of using it to pay off his debt, at the end of five years he will have paid around $3,150 in interest and $1,480.17 of the original $5,000 he borrowed—or **$4,630.17**—but he will still owe **$3,519.83.** So even though his CD will be worth $5,948.78, he's already spent $4,630.17 paying back his debt and still owes $3,519.83. His assets, then, are essentially negative:

$$5948.78 - 4630.17 - 3519.83 = \textbf{\$2,201.22}$$

Tyler's final option is to use the entire $5,000 windfall right now to pay off this $5,000 debt. The opportunity cost of this decision is not having a car and not having the investment, either. Tyler would end up with no debt, but nothing else either, right?

Not quite. Remember, Tyler has accumulated a debt of $5,000, which is financed at 17% interest. We calculated that if Tyler paid the minimum monthly payment for five years and then was able to pay the remaining balance off at that point, he'd end up paying **$8,150** in total on this debt. That's $3,150 more than he borrowed and far more than the $948.78 he'd earn in interest on the five-year investment. It appears Tyler has no choice but to pay off the loan with his windfall and begin again.

Once we are aware of opportunity costs, we begin to stop and take a moment to think before we make any quick decisions. We begin to realize there are opportunity costs attached to each and every decision we make and, we hope, start making better decisions.

In the cases of Taylor and Tyler, we can see that not only do opportunity costs affect the decisions we make, but the decisions we make affect the opportunities that come our way.

Student Handout: Opportunity Cost Exercises

When we choose between two things, the thing we give up, or the thing we don't choose, is our opportunity cost.

Below are some choices you might face when making everyday decisions.

Circle your two favorite choices. Then put an X through the choice you would give up between your two favorites. The item you cross out is your opportunity cost.

Candy Bar	Movie	TV Show	Music Genre	Restaurant Food
Peanut butter cups	*Avatar*	Local news	Rock	Italian
Milky Way	*Inception*	*The Biggest Loser*	Jazz	Mexican
Snickers	*The Roommate*	*The Simpsons*	Rap	French
Hershey bar	*The Blind Side*	*The Office*	Hip hop	Chinese
PayDay	*The Dilemma*	Sports	Country	American

The formula for determining the future value of an investment (*A*), given an initial principal amount (*P*), an interest rate (*r*), a term in years (*t*) and the number of times the investment compounds per year (*n*) is:

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

Example >>>

How much will an $8,000 investment be worth in one year if I invest it in a 2% certificate of deposit (CD) that compounds quarterly?

$P = 8000$

$r = 2\% = 0.02$

$n = 4$ (quarterly)

$t = 1$ year

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

$A = 8000\left(1+\dfrac{0.02}{4}\right)^{4 \times 1}$

$A = 8000(1 + 0.005)^4$

$A = 8000(1.005)^4$

$A = 8000(1.02015)$

$A = \mathbf{\$8,161.20}$

Answer

This $8,000 investment will be worth **$8,161.20** in one year.

Your Turn

How much will a $5,000 investment be worth in four years if I invest it in a 3.5% certificate of deposit that compounds monthly?

How much will a $3,500 investment be worth in three years if I invest it in a 4% certificate of deposit that compounds monthly?

How much will a $6,000 investment be worth in 60 months if I invest it in a 7% certificate of deposit that compounds quarterly?

How much interest will a $5,000 investment accumulate in six years if I invest it in a 5.25% certificate of deposit that compounds monthly?

One vital piece of information you'll need when deciding if you can afford something that you are going to finance is what your monthly payment will be. This will tell you if you can indeed afford the purchase.

The formula to calculate the monthly payment on an original principal loan amount *(P)* at an annual interest rate *(I)* that will be necessary to pay the entire loan off in *N* months is:

$$\text{Monthly Payment} = \frac{(P \times (I \div 12))}{(1 - (1 + (I \div 12))^{-N})}$$

P = Principal amount of the loan

I = Interest rate of the loan

N = Number of months to pay off the loan

Let's try it out:

A buyer wants to purchase a $25,000 automobile at 6% interest and pay the loan off entirely in three years.

$P = 25000$

$I = 6\% = 0.06$

$N = 3$ years or 36 months

Now use the formula:

$$\text{Monthly Payment} = \frac{(25000 \times (0.06 \div 12))}{(1 - (1 + (0.06 \div 12))^{-36})} = \frac{25000 \times 0.005}{(1 - (1 + 0.005)^{-36})} =$$

$$\frac{125}{(1 - (1.005)^{-36})} = \frac{125}{(1 - 0.83564)} = \frac{125}{0.16436} = \mathbf{\$760.53}$$

Your Turn

How much will the monthly payment be on a $5,000 loan with an 11.9% interest rate for 60 months?

How much will the monthly payment be on a $3,500 loan with a 13.9% interest rate for 72 months?

How much will the monthly payment be on a $7,500 loan with a 9.9% interest rate for 48 months?

How much will the monthly payment be on a $1,750 loan with a 19.9% interest rate for one year?

Let's try some analysis:

How much will the monthly payment be on a $4,000 loan with a 12% interest rate for 48 months?

Name the top two things you can think of that would be worth that much per month to you.

Given a choice, which of these would you choose?

What will the monthly payments total after 48 months?

If, instead of paying this loan, you saved this monthly payment for 48 months, the amount of money you will have accumulated is the same as the answer to the previous question.

If you had saved that amount instead of paying off the loan, and the interest rate on a typical certificate of deposit four years from now were 7.1% compounded monthly, what would that amount of money be worth if invested in a CD for:

▶ One year?

▶ Three years?

▶ Five years?

When we choose between two things, the thing we give up, or the thing we don't choose, is our opportunity cost.

Solutions: Opportunity Cost Exercises

Below are some choices you might face when making everyday decisions.

Circle your two favorite choices. Then put an X through the choice you would give up between your two favorites. The item you cross out is your opportunity cost.

There are no right answers. Choices students make are subjective.

Candy Bar	Movie	TV Show	Music Genre	Restaurant Food
Peanut butter cups	*Avatar*	Local news	Rock	Italian
Milky Way	*Inception*	*The Biggest Loser*	Jazz	Mexican
Snickers	*The Roommate*	*The Simpsons*	Rap	French
Hershey bar	*The Blind Side*	*The Office*	Hip hop	Chinese
PayDay	*The Dilemma*	Sports	Country	American

The formula for determining the future value of an investment (*A*), given an initial principal amount (*P*), an interest rate (*r*), a term in years (*t*) and the number of times the investment compounds per year (*n*) is:

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

Example

How much will an $8,000 investment be worth in one year if I invest it in a 2% certificate of deposit (CD) that compounds quarterly?

P = 8000

r = 2% = 0.02

n = 4 (quarterly)

t = 1 year

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

$A = 8000\left(1 + \dfrac{0.02}{4}\right)^{4 \times 1}$

$A = 8000(1 + 0.005)^4$

$A = 8000(1.005)^4$

$A = 8000(1.02015)$

$A =$ **$8,161.20**

Answer

This $8,000 investment will be worth **$8,161.20** in one year.

Your Turn

How much will a $5,000 investment be worth in four years if I invest it in a 3.5% certificate of deposit that compounds monthly? **$5,750.19**

How much will a $3,500 investment be worth in three years if I invest it in a 4% certificate of deposit that compounds monthly? **$3,945.45**

How much will a $6,000 investment be worth in 60 months if I invest it in a 7% certificate of deposit that compounds quarterly? **$8,488.67**

How much interest will a $5,000 investment accumulate in six years if I invest it in a 5.25% certificate of deposit that compounds monthly? **$6,846.59 − $5,000 = $1,846.59**

One vital piece of information you'll need when deciding if you can afford something that you are going to finance is what your monthly payment will be. This will tell you if you can indeed afford the purchase.

The formula to calculate the monthly payment on an original principal loan amount (P) at an annual interest rate (I) that will be necessary to pay the entire loan off in N months is:

$$\text{Monthly Payment} = \frac{(P \times (I \div 12))}{(1 - (1 + (I \div 12))^{-N})}$$

P = Principal amount of the loan

I = Interest rate of the loan

N = Number of months to pay off the loan

Let's try it out:

A buyer wants to purchase a $25,000 automobile at 6% interest and pay the loan off entirely in three years.

P = 25000

I = 6% = 0.06

N = 3 years or 36 months

Now use the formula:

$$\text{Monthly Payment} \ = \ \frac{(25000 \times (0.06 \div 12))}{(1 - (1 + (0.06 \div 12))^{-36})} \ = \ \frac{25000 \times 0.005}{(1 - (1 + 0.005)^{-36})} \ =$$

$$\frac{125}{(1 - (1.005)^{-36})} \ = \ \frac{125}{(1 - 0.83564)} \ = \ \frac{125}{0.16436} = \mathbf{\$760.53}$$

Your Turn

How much will the monthly payment be on a $5,000 loan with an 11.9% interest rate for 60 months? **$110.97**

How much will the monthly payment be on a $3,500 loan with a 13.9% interest rate for 72 months? **$71.93**

How much will the monthly payment be on a $7,500 loan with a 9.9% interest rate for 48 months? **$189.86**

How much will the monthly payment be on a $1,750 loan with a 19.9% interest rate for one year? **$162.03**

Let's try some analysis:

How much will the monthly payment be on a $4,000 loan with a 12% interest rate for 48 months? **$105.34**

Name the top two things you can think of that would be worth that much per month to you.

Given a choice, which of these would you choose?

What will the monthly payments total after 48 months? **$5,056.32**

If, instead of paying this loan, you saved this monthly payment for 48 months, the amount of money you will have accumulated is the same as the answer to the previous question.

If you had saved that amount instead of paying off the loan, and the interest rate on a typical certificate of deposit four years from now were 7.1% compounded monthly, what would that amount of money be worth if invested in a CD for:

▶ One year? **$5,427.23**

▶ Three years? **$6,252.69**

▶ Five years? **$7,203.69**