Lesson 4: Why Do Banks Pay YOU to Provide Their Services?

Student Outcomes

- Students compare the rate of change for simple and compound interest and recognize situations in which a quantity grows by a constant percent rate per unit interval.

Classwork

Opening Exercise (5 minutes)

Begin class with a discussion of why banks pay customers interest to provide a service to them. Pose the question first, and have students discuss their ideas, and then give them a bit of history on this topic. This question is revisited at the end of the lesson.

- Have you ever thought it odd that banks pay YOU interest for the honor of looking after your money for you?

Give students time to think about this. Some students may have no concept of this. That is okay. Give them a little history, and they can become familiar with the concept throughout the lesson. They have a chance to answer as we move through the lesson.

- Throughout history, people had to PAY BANKS to look after their money. In the Renaissance, with the rise of world exploration, banks realized that looking after people's money was an incredibly good thing for them. They could make money off of the large amounts of money they were keeping for others. They wanted to encourage more people to give them their money to keep, so they started paying customers.

Have students think about how banks could make this work. If they are paying people to keep their money and making money on this money, what are some things that they could be doing?

Example 1 (10 minutes)

Banks originally computed simple interest, and that is the type of interest studied in this example. Simple interest is calculated at the end of each year on the original amount either borrowed or invested (the principal). Use the basic example below to make sure that students understand the concept of simple interest. It is critical that students have a good grasp of simple interest before moving to the next example.

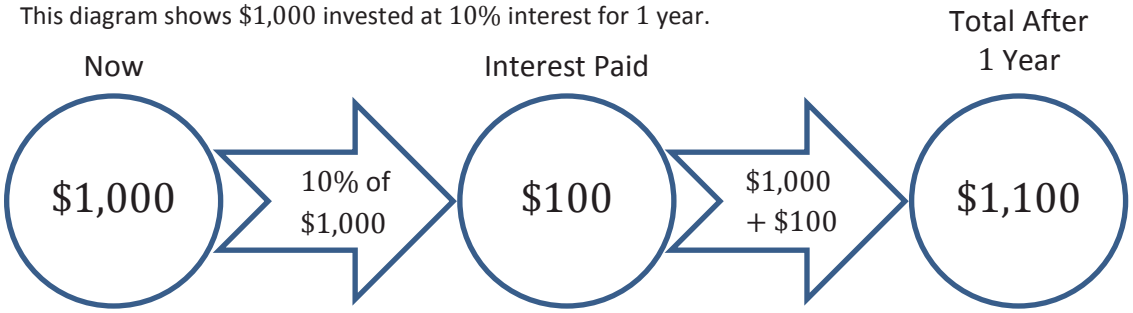
Example 1

Kyra has been babysitting since sixth grade. She has saved $\$1,000$ and wants to open an account at the bank so that she earns interest on her savings. Simple Bank pays simple interest at a rate of 10%. How much money will Kyra have after 1 year? After 2 years, if she does not add money to her account? After 5 years?

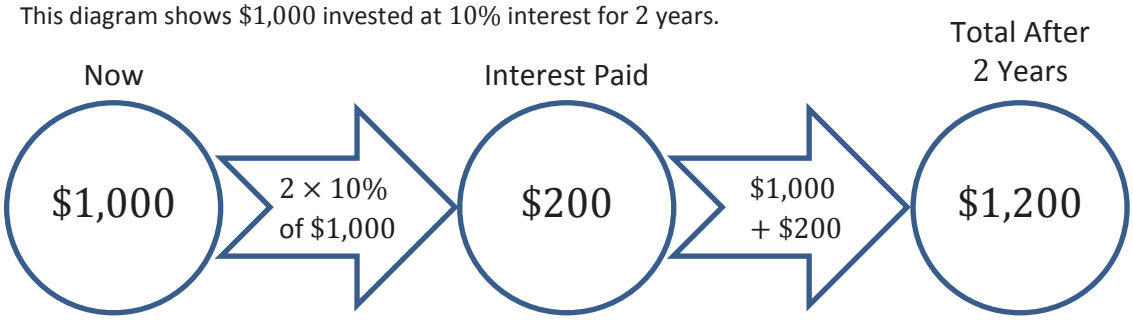
$\$1,100$ after 1 year, $\$1,200$ after 2 years, $\$1,500$ after 5 years

The diagram below helps students see how the interest works.

- This diagram shows $1,000 invested at 10% interest for 1 year.



- This diagram shows $1,000 invested at 10% interest for 2 years.



- Come up with a formula to calculate simple interest.

MP.1 Allow students time to struggle with this formula before suggesting variable symbols or providing them with a formula.

  - *$I(t) = Prt$, where $I(t)$ is the interest earned after t years, P is the principal amount (the amount borrowed or invested), r is the interest rate in decimal form.*

It is important to point out here that this formula calculates only the interest earned, and that to find the total amount of money students must add the interest calculated to the original amount.

Raoul needs $\$200$ to start a snow cone stand for this hot summer. He borrows the money from a bank that charges 4% simple interest per year.

a. How much will he owe if he waits 1 year to pay back the loan? If he waits 2 years? 3 years? 4 years? 5 years?

$\$208,\ \$216,\ \$224,\ \$232,\ \$240$

b. Write a formula for how much he will owe after t years.

$A(t) = 200 + 200(0.04)t$

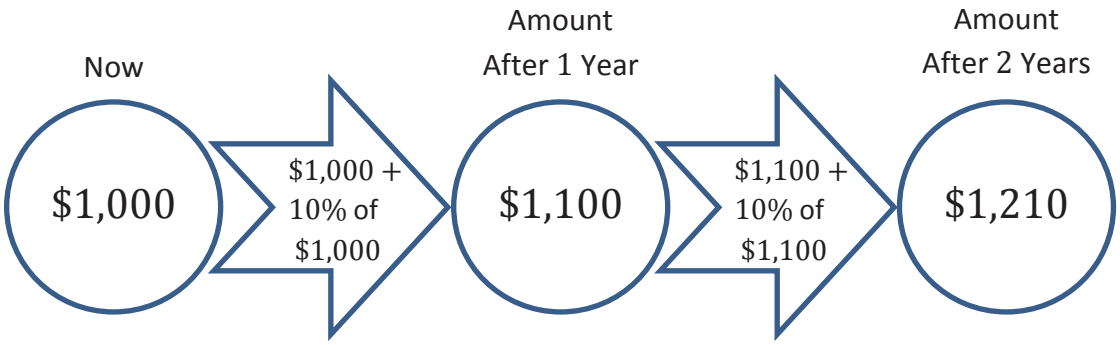
Be sure students understand that you must pay the bank to use their money. You pay banks to use their money, and they pay you to keep your money.

- Can you see a sequence developing from the answer to these questions? What do you notice?
  - *Students should see that the sequence increases at a constant rate (the interest rate) and is linear.*

If students are having trouble seeing the pattern, have them graph the points. Students should see that the data is linear with a constant rate of change per unit (year).

Example 2 (12 minutes)

In the 1600s, banks realized that there was another way to compute interest and make even more money. With compound interest, banks calculate the interest for the first period, add it to the total, and then calculate the interest on the total for the next period, and so on. Show students the diagram below to help them understand.



Ask students to try to write the formula. Let them struggle for a while before modeling this process for them. Help students write this as a formula by writing out what would happen each year for 5 years.

Year 1: $1000 + 0.1(1000) = 1000(1.1) = 1100$

Year 2: $1100 + 0.1(1100) = 1100(1.1) = [1000(1.1)]\,(1.1) = 1210$

Year 3: $1210 + 0.1(1210) = 1210(1.1) = [1000(1.1)(1.1)](1.1) = 1331$

Year 4: $1331 + 0.1(1331) = 1331(1.1) = [1000(1.1)(1.1)(1.1)](1.1) = 1464.10$

Year 5: $1464.10 + 0.1(1464.10) = 1464.10(1.1) = [1000(1.1)(1.1)(1.1)(1.1)](1.1) = 1610.51$

We want them to see this pattern: $FV = PV(1 + r)^n$, where FV = future value, PV = present value, r = interest rate as a decimal, and n = time in years.

Have a class discussion to decide on and choose the variables for this problem. Have students write the defined variables on their papers. It may be necessary to show students how to raise values to an exponent on their calculators.

Ask students if they see a sequence forming, and have them describe it. Have students graph the points $(n, f(n))$ starting with $n = 0$, where n is the number of years that have passed and $f(n)$ is the amount of money after n years.

Example 2

Jack has $\$500$ to invest. The bank offers an interest rate of 6% compounded annually. How much money will Jack have after 1 year? 2 years? 5 years? 10 years?

$\$530, \$561.80, \$669.11, \$895.42$

Scaffolding:

Have students write formulas for these sequences.

This is a perfect time to remind students about rounding to hundredths for money. Why?

Students should say that money is counted in dollars and cents, and cents are $\frac{1}{100}$ of a dollar.

Example 3 (10 minutes)

Allow students to work in groups or pairs to come up with an answer to Example 3, and then discuss. It is important to allow students to work through this process. Do not be tempted to help them too soon. As they are answering the questions, look for students writing formulas, making graphs, making lists, and discussing the patterns.

Example 3

If you have $\$200$ to invest for 10 years, would you rather invest your money in a bank that pays 7% simple interest or in a bank that pays 5% interest compounded annually? Is there anything you could change in the problem that would make you change your answer?

7% for 10 years gives $\$140$ in simple interest, or $\$340$ total.

5% compounded for 10 years gives $\$325.78$.

When students present their work, be sure that they have considered changing interest rates, interest types, time invested, and amount invested. If they have not considered all of these, the problems below can help them to see the changes that would take place. Really take time to look at different cases.

- What would happen if we changed both interest rates to 5%?
  - *The total amount in the account after adding simple interest would be $\$300$.*
- What would happen if we changed the time for each to 20 years?
  - *The total amount in the account after adding simple interest would be $\$480$, and the total amount in the account after adding compound interest would be $\$530.66$.*
- What would happen if we increased the amount invested to $\$1{,}000$ for 10 years?
  - *The total amount in the account after adding simple interest of 7% would be $\$1{,}700$, and the total amount in the account after adding compound interest at 5% would be $\$1{,}628.89$.*

Do more problems like this if necessary. Identify various models, formulae, graphs, tables, or lists in the room that students may have used. Facilitate a discussion about the usefulness of the different models developed by students. Now, revisit our initial question, but ask this:

- If banks pay people to keep their money but still make money, how does that work? (We want students to reason that the banks are making more than they pay, and there are lots of ways that students can explain this.)
  - *Students could say that the banks invest at higher rates than they pay their customers. Students may say that the banks pay simple interest but invest money at compound interest.*

Closing (3 minutes)

- Explain the difference between simple and compound interest.
  - *Simple interest is calculated once per year on the original amount borrowed or invested. Compound interest is calculated once per period (in this lesson per year) on the current amount in the account or owed.*
- Are there times when one type of interest is better than the other for the investor or borrower?
  - *Either type could be better. It depends on the interest rates, the amount of time money is left in the bank or borrowed over, and the amount of money.*

Lesson Summary

SIMPLE INTEREST: Interest is calculated once per year on the original amount borrowed or invested. The interest does not become part of the amount borrowed or owed (the principal).

COMPOUND INTEREST: Interest is calculated once per period on the current amount borrowed or invested. Each period, the interest becomes a part of the principal.

Exit Ticket (5 minutes)

Name _____ Date _____

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Exit Ticket

A youth group has a yard sale to raise money for a charity. The group earns $\$800$ but decides to put its money in the bank for a while. Calculate the amount of money the group will have given the following scenarios:

a. Cool Bank pays simple interest at a rate of 4%, and the youth group leaves the money in for 3 years.

b. Hot Bank pays an interest rate of 3% compounded annually, and the youth group leaves the money in for 5 years.

c. If the youth group needs the money quickly, which is the better choice? Why?

Exit Ticket Sample Solutions

A youth group has a yard sale to raise money for a charity. The group earns $\$800$ but decides to put its money in the bank for a while. Calculate the amount of money the group will have given the following scenarios:

a. Cool Bank pays simple interest at a rate of 4%, and the youth group leaves the money in for 3 years.

$\$800(0.04)(3) = \$96$ *interest earned*

$\$896$ *total*

b. Hot Bank pays an interest rate of 3% compounded annually, and the youth group leaves the money in for 5 years.

$\$800(1.03)^5 = \$927.42$

c. If the youth group needs the money quickly, which is the better choice? Why?

If the youth group needs the money quickly, it should use Cool Bank since that bank pays a higher rate than Hot Bank. The lower rate is better for a longer period of time due to the compounding interest.

Problem Set Sample Solutions

1. $\$250$ is invested at a bank that pays 7% simple interest. Calculate the amount of money in the account after 1 year, 3 years, 7 years, and 20 years.

$\$267.50,\ \$302.50,\ \$372.50,\ \$600.00$

2. $\$325$ is borrowed from a bank that charges 4% interest compounded annually. How much is owed after 1 year, 3 years, 7 years, 20 years?

$\$338.00,\ \$365.58,\ \$427.68,\ \$712.12$

3. Joseph has $\$10,000$ to invest. He can go to Yankee Bank that pays 5% simple interest or Met Bank that pays 4% interest compounded annually. At how many years will Met Bank be the better choice?

#Years	*Yankee Bank*	*Met Bank*
1	$\$10,500$	$\$10,400$
2	$\$11,000$	$\$10,816$
3	$\$11,500$	$\$11,248.64$
4	$\$12,000$	$\$11,698.59$
5	$\$12,500$	$\$12,166.53$
6	$\$13,000$	$\$12,653.19$
7	$\$13,500$	$\$13,159.32$
8	$\$14,000$	$\$13,685.69$
9	$\$14,500$	$\$14,233.12$
10	$\$15,000$	$\$14,802.44$
11	$\$15,500$	$\$15,394.54$
12	$\$16,000$	$\$16,010.32$

At 12 years, Met Bank is a better choice.