11th - 12th Grade Lesson Plan

Introduction to Earning Interest
TEACHER WORKSHEET

- **VOCABULARY**

  Principal: an amount of money owned by an investor and held by a financial institution such as a bank.

  Deposit(s): the act of establishing, or adding to, an existing **principal**.

  Balance: the amount of money in a bank account.

  Interest: the amount of money you earn by leaving **deposits** in a bank or financial institution. **Interest** is a **percentage** of your **principal**.

  Term: the period of time an investment lasts.

  Annual Percentage Rate (APR): the percentage rate at which interest is calculated **annually**.

- **CERTIFICATE OF DEPOSIT (CD)**

An agreement between an investor and a bank (or financial institution) whereby the investor agrees to put a certain amount of money on **deposit**, this is the **principal**, for a certain amount of time without withdrawing it, this is the **term**, and the bank agrees to pay the investor **interest** at an agreed upon **percentage rate**, this is the **annual percentage rate (APR)**.

Example 1

Michael is saving money to buy a car. He takes **$8,000** to the bank and opens an **annual certificate of deposit (CD)** upon which the bank agrees to pay him **2% interest**.

- **Principal = $8,000**
- **Term = 1 year**
- **APR = 2% (.02)**

Beginning Balance	2% Interest	Ending Balance
$8,000	**$160**	**$8,160**

$8,000 x .02 = $160
$8,000 + $160 = $8,160

- **VOCABULARY**

  Compound Interest: interest calculated on **both** the **principal** you have on **deposit** and **interest** that has accumulated in the past.

  Compounding Period: the amount of time that elapses between **interest** payments.

  Annual Compounding: once per year.

Example 2

Now, let's say Michael leaves his money in the bank for four years. The **term** of an **annual CD** is four years, so he will be earning **2% per year** for four years. Since this is an **annual CD**, **interest** will be added to the **principal** at the end of every year. This is called **compounding annually**.

	Beginning Balance	2% Interest	Ending Balance
Year 1	**$8,000**	**$160**	**$8,160**
Year 2	**$8,160**	**$163.20**	**$8,323.20**
Year 3	**$8,323.20**	**$166.46**	**$8,489.66**
Year 4	**$8,489.66**	**$169.79**	**$8,659.45**

- **NOW YOU TRY**

  The students will complete page one of the "Now You Try Student Worksheet."

- **QUARTERLY COMPOUNDING - STATEMENT SAVINGS ACCOUNT**

  Quarterly Compounding: a type of **compounding period** in which **interest compounds** every three months.

  - Jan - March 1st quarter
  - April - June 2nd quarter
  - July - Sept 3rd quarter
  - Oct - Dec 4th quarter

Michael's bank offers other types of investment accounts in addition to **certificates of deposit (CD)**. One type of account is called a **statement savings account**. This type of account is similar to a **certificate of deposit (CD)** because it also pays an **annual percentage rate (APR)** of interest, but there are some differences too.

A statement savings account doesn't require Michael to promise to leave the money in his account for a specific period of time. Michael can go into the bank and withdraw his money any time he wants. Also, instead of paying Michael his **interest** only once per year (**annually**), the bank will pay him the **interest** he has earned so far every **quarter**. **Statement savings accounts often compound quarterly**. Michael will receive an **interest** payment **deposit** into his account at the end of every **quarter**.

When that happens, the **interest** Michael earned in the previous **quarter** is added to his **principal** and the new **balance** becomes Michael's new **principal balance** for the next **quarter**. Now Michael will begin earning **interest** on his **interest**! This is called **compound interest**.

<u>Example 3</u>

Let's say Michael takes his **$8,000** into the bank and opens a **statement savings account** instead of a **certificate of deposit**. The bank is going to pay him the same **2% interest** on this account that it was offering for the **certificate of deposit**. Michael's beginning **principal amount** is again **$8,000** and his **APR** is still **2%**. However, Michael gets **interest compounded quarterly** on this account.

1. First, calculate his annual **interest**:

   $8,000 x .02 = $160

2. Next, calculate what his **1st quarter interest** payment will be:

   $160 / 4 = $40

3. Now add Michael's **1st quarter interest** to his **principal balance:**

   $8,000 + $40 = $8,040

   - At the end of the **1st quarter,** his **principal balance** will be **$8,040.**

4. Now calculate the annual **interest** he will earn on **$8,040.**

   $8,040 x .02 = $160.80

5. Calculate his **2nd quarter interest** payment**:**

   $160.80 / 4 = $40.20

6. Next, calculate Michael's new **principal balance:**

   $8,040 + $40.20 = $8,080.20

   - At the end of the **2nd quarter** his **principal balance** will be **$8,080.20.**

7. Next, calculate the **annual interest** he will earn on **$8,080.20:**

   $8,080.20 x .02 = $161.60

8. Calculate his **3rd quarter interest** payment**:**

   $161.60 / 4 = $40.40

9. Add Michael's **3rd quarter interest** payment to his **balance:**

   $8,080.20 + $40.40 = $8,120.60

   - At the end of the **3rd quarter** his **principal balance** will be**: $8,120.60**

10. Finally, calculate the **annual interest** with a **balance** of **$8,120.60:**

    $8,120.60 x .02 = $162.41

11. Calculate his **4th quarter interest payment:**

    $162.41 / 4 = $40.60

12. Add his **4th quarter interest** payment to his **balance:**

    $8,120.60 + $40.60 = $8,161.20

    - At the end of the **4th quarter** his **principal balance** will be **$8,161.20.**

After four **quarters** have passed, Michael has had his money in the **statement savings account** for one year. His ending **balance** at the end of that year is **$8,161.20**.

Do you remember what his ending balance would have been if he had opened a **certificate of deposit** instead? **($8,160)**

Let's compare these two choices. Which type of account would have earned Michael more **interest**?

How much **more interest** would Michael earn by opening the **statement savings account** instead of the annual **certificate of deposit**? **($1.20)**

Why? Both accounts were paying the same **2% APR,** why were the balances different at the end of the year?

If **2%** of **$8,000** is **$160**, and he earned **$161.20** in the **statement savings account**, then he must have actually earned more than **2%** in the statement savings account.

This is because he **earned interest on his interest** during the year. **His statement savings account** *yielded* more than **2%** for the year.

This extra money he earned, because of **compounding interest**, is called **annual percentage yield (APY)**.

- **VOCABULARY**

ANNUAL PERCENTAGE YIELD (APY): the actual rate your money earns taking compounding into consideration.

To **calculate the APY**, we divide the amount of interest he earned for the year by his original **principal deposit.**

$161.20 / $8,000 = .02015 = 2.015 %.

So, the statement savings account, paying an **APR of 2%** will earn an **APY of 2.015%** because of the effect of **compound interest**.

- **NOW YOU TRY**

The students will complete page two of the "Now You Try Student Worksheet."

- **COMPOUND INTEREST FORMULA**

As you can see, compounding several times per year and holding an investment for multiple years would make for a lot of manual calculations. Luckily, there is a formula called the **compound interest formula** that allows us to calculate the accumulated balance of an investment across multiple years and multiple compounding periods.

The teacher will introduce the compound interest formula below:

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

Where: A = Accumulated Balance
P = Principal
r = APR expressed as a decimal
n = number of compounding periods/year
t = number of years the investment lasts

Use the same example:

Let's say Michael takes his **$8,000** into the bank and opens a **statement savings account** instead of a **certificate of deposit**. The bank is going to pay him the same **2% interest** on this account that it was offering for the **CD**. Michael's beginning **principal amount** is again **$8,000** and his **APR** is still **2%**. However, Michael gets **interest compounded quarterly** on this account.

Principal = $8,000
APR = 2% or .02
n = 4 (quarterly)
t = 1 year

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

$$A = \$8{,}000(1+\frac{.02}{4})^{4(1)}$$

$$A = \$8{,}000(1.005)^{4}$$

$$A = \$8{,}000(1.02015)$$

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

Compare the interest calculated using the formula with the interest calculated when we did the calculation "the long way" by hand. Notice the interest amounts match: $161.20.

Annual Percentage Yield (APY) = $161.20 /$8,000 = .02015 = 2.015%

- **NOW YOU TRY**

  The students will complete page two of the "Now You Try Student Worksheet."

$$A = \$7{,}500(1+\frac{.03}{1})^{1\times 3}$$
$$A = \$7{,}500 \times 1.03^{3}$$
$$A = \$7{,}500 \times 1.092727$$
$$A = \$8{,}195.45$$

$$A = \$7{,}500(1+\frac{.03}{4})^{4\times 3}$$
$$A = \$7{,}500 \times 1.0075^{12}$$
$$A = \$7{,}500 \times 1.093806$$
$$A = \$8{,}203.55$$

- **MONTHLY COMPOUNDING - MONEY MARKET SAVINGS ACCOUNT**

  Compounding Period: the amount of time that elapses between **interest** payments.

  Monthly Compounding: when interest compounds once per month.

Michael's bank offers another type of investment account called a **money market savings account**. This type of account works just like the statement savings account except the **compounding period** is **monthly** instead of **quarterly**.

Most money market savings accounts **compound monthly**. Michael will receive an interest payment deposit into his account at the end of every **month**.

When that happens, the interest Michael earned in the previous month is added to his **principal** and the new balance becomes Michael's new **principal balance** for the next month. Now Michael will begin **earning interest on his interest monthly**!

<u>Example 4</u>

This time, Michael takes his **$8,000** into the bank and opens a **money market savings account** instead of a **statement savings account**. The bank is going to pay him the same **2%** on this account that it was offering for the statement savings account. Michael's beginning **principal amount** is again **$8,000** and his **APR** is still **2%**. However, Michael gets **interest compounded monthly** on this account.

<u>The 1st Quarter Interest Calculations</u>

1. First, calculate his **annual interest**:

   $8,000 x .02 = $160

2. Next, calculate what his **1st month's interest** payment will be:

   $160 / 12 = $13.33

3. Now add the **1st month's interest** to his **principal balance:**

   $13.33 + $8,000 = $8,013.33

   - At the end of the **1st month** Michael's **principal balance** will be **$8,013.33.**

4. Next, calculate the **annual interest** he will earn on **$8,013.33:**

   $8,013.33 x .02 = $160.27

5. Calculate his **2nd month's interest** payment**:**

   $160.27 / 12 = $13.36

6. Now add his **2nd month's interest** to his **principal:**

   $13.36 + $8,013.33 = $8,026.69

   - At the end of the **2nd month** his **principal balance** will be **$8,026.69.**

7. For the **3rd month,** calculate the **annual interest** he will earn on **$8,026.69:**

   $8,026.69 x .02 = $160.53

8. Next, calculate his **3rd month's interest** payment**:**

   $160.53 / 12 = $13.38

9. Add Michael's **3rd month's interest** to his **principal balance:**

   $13.38 + 8,026.69 = $8,040.07

   - At the end of the **3rd month** his **principal balance** will be **$8,040.07.**

10. At the end of three months, we have completed the **1st quarter.**

What would Michael's **balance** have been at the end of the **1st quarter** if he had a **statement savings account compounding quarterly**? **($8,040)**

Calculations for all 12 months of the year:

	Beginning Balance	2% Interest	Ending Balance
1st Month	**$8,000**	**$13.33**	**$8,013.33**
2nd Month	**$8,013.33**	**$13.36**	**$8,026.69**
3rd Month	**$8,026.69**	**$13.38**	**$8,040.07**
4th Month	**$8,040.07**	**$13.40**	**$8,053.47**
5th Month	**$8,053.47**	**$13.42**	**$8,066.89**
6th Month	**$8,066.89**	**$13.44**	**$8,080.33**

7th Month	**$8,080.33**	**$13.47**	**$8,093.80**
8th Month	**$8,093.80**	**$13.49**	**$8,107.29**
9th Month	**$8,107.29**	**$13.51**	**$8,120.80**
10th Month	**$8,120.80**	**$13.53**	**$8,134.33**
11th Month	**$8,134.33**	**$13.56**	**$8,147.89**
12th Month	**$8,147.89**	**$13.58**	**$8,161.47**

Note: We rounded the monthly interest calculation *up* before we added each month's interest to the balance at the beginning of the month. There may be as much as a three cent difference at the end of the year when we calculate the interest using the formula. This three cent difference still yields the same **APY**.

Michael's **$8,000 original principal deposit**, put into a **money market savings account** at **2% APR**, **compounding monthly** would be worth **$8,161.47** at the end of one year.

What **APY** does this account yield? **(.02018 or 2.018% APY)**

Now, let's try using the formula:

Principal = $8,000
APR = 2% or .02
n = 12 (monthly)
t = 1 year

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

$$A = \$8{,}000(1+\frac{.02}{12})^{12(1)}$$

$$A = \$8{,}000(1.001666)^{12}$$

$$A = \$8{,}000(1.02018)$$

$$A = \$8{,}161.44$$

$$APY = \frac{\$161.44}{\$8{,}000} = .02018 = 2.018\,APY$$

- **Compare Annual vs. Quarterly vs. Monthly Compounding APYs**

  Annual 2% Quarterly 2.015% Monthly 2.018%

- **NOW YOU TRY**

  The students will complete page three of the "Now You Try Student Worksheet."

- **Compare APY and APR**

  Discussion:
  1. Why might a bank advertise deposit accounts using **APY** instead of **APR**?

  2. Why might they advertise **APR** instead of **APY** on credit cards?

Assessment/Evaluation

- The teacher will assess the students' knowledge of APR, APY, and compound interest using the **11th - 12th Grade Assessment Worksheet**.