GREAT LAKES LEARNING

LESSONS & ACTIVITIES BASED ON THE MONTHLY GREAT LAKES NOW PROGRAM

EPISODE 2209 | FINDERS, KEEPERS

FASCINATING FRESHWATER FISH

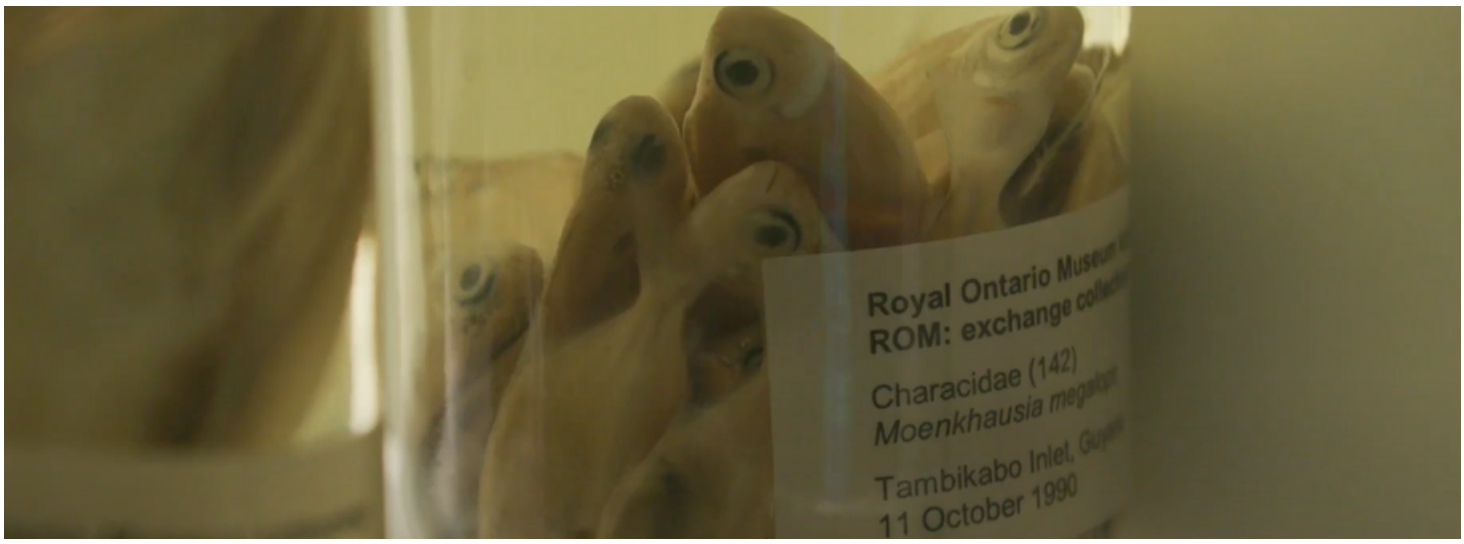

Image Credit: Great Lakes Now

OVERVIEW

This lesson will explore the phenomenon of **biodiversity in the Great Lakes** and the efforts one museum in Ontario, Canada has taken to catalog it. Students will learn about the history of fish indexing in the Great Lakes, the type collection at the Royal Ontario Museum, and discover why this kind of organism library is helpful to preserving the Great Lakes ecosystem.

LESSON OBJECTIVES

- **Know** the history of the Royal Ontario Museum (ROM) fish type collection
- **Understand** how organisms are classified and named
- **Be able to** model and calculate the biodiversity index for a sample area

WHAT YOU'LL NEED

- Computer or mobile device with Internet access to view video and online resources
- Notebooks and pencils
- Chart paper
- Sticky notes
- Markers
- Lab supplies (see individual activities for a full list)
- Copies of the Student Handouts

INTRODUCTION

Keeping track of all the types of organisms in an ecosystem can be a challenge, but it's important work, because knowing what species are present helps scientists make comparisons over time to see how the ecosystem is changing. That's what keeping a "**type collection**" record can do—like the fish inventory at the Royal Ontario Museum (ROM). This gives scientists a sense of the level of biodiversity and helps unknown organisms to be identified or classified by comparison. And if you are ever in the area of the ROM, not only can you see the collection, but you can even take a **fish identification workshop** yourself.

This lesson includes multiple activities, including lab activities, that can span the course of several sessions or be adapted to fit the needs of your group's meeting format.

Some prior knowledge* with which students should be familiar includes:

- phylogenetic classification
- taxonomic hierarchy (e.g., kingdom, phylum, etc.)
- binomial nomenclature (e.g., "genus species" naming) for organisms
- pre-algebra concepts like the distributive property, order of operations and probability

Follow this QR Code or hyperlink to the Episode Landing Page!

Check out our full collection of lessons for more activities related to topics like these.

****The sequence of these activities is flexible, and can be rearranged to fit your teaching needs.***

NGSS CONNECTIONS

Phenomenon: Biodiversity

- HS-LS2-7
- 3-LS4-4
- 2-LS4-1
- MS-LS2-5
- MS-LS2-1
- SEP-2
- SEP-4
- SEP-5

During the course of the lesson, students will progress through the following sequence** of activities:

- Class discussion to elicit or activate prior knowledge
- Close reading of a **photo**
- Teacher notes on taxonomy
- Watch a segment from *Great Lakes Now*
- Class discussion to debrief the video
- Read about a library of fish
- Model biodiversity of an ecosystem and calculate its diversity index
- Master new vocabulary through a structured process known as CODE

The lesson progresses through three major sections: **launch, activities, and closure.** After the launch of the lesson, you are ready to begin the lesson activities. Once finished with the activities, students will synthesize their learning in the closure. You can select the activities that are best suited for your learners and teaching goals, and then sequence them in a way that makes sense within your learning progression and the scaffolds of the lesson.

If you use this lesson or any of its activities with your learners, we'd love to hear about it!

Contact us with any feedback or questions at:
GreatLakesNow@DPTV.org

TEACHER BACKGROUND INFORMATION

by Great Lakes Now Contributor, Gary G. Abud, Jr.

**This information can be presented by the teacher as notes to students at the teacher's discretion.*

How many types of fish species do you think there are in the Great Lakes? Take a guess and then have your students do the same. You could even have them vote via a show of hands: do you think the number is in the dozens? Hundreds? Thousands? Ten thousands? Hundred thousands? Millions?

Over the years, scientists, government agencies, fishers, and private citizens have been observing the vast number of species in the Great Lakes. And they've not only been taking notes, they've been taking samples. That information along with the specimens themselves have allowed the cataloging of all the known fish species in the Great Lakes. And the library of this freshwater collection is organized in the Royal Ontario Museum where scientists can study the Great Lakes ecosystem by referencing and indexing new measurements of biodiversity in the waters and helping to identify unknown fish species.

Every set of information needs a system for organizing it and referencing it. Organisms are no different. That's why in the 18th century Swedish botanist Carolus Linnaeus devised a system based on Latin words known as **binomial nomenclature** to generate a **scientific name** for organisms. His system is still used today in scientific communities around the world, but outside of those settings, most people use what's known as a **common name** to refer to an organism. That's why we say our favorite flower is a daisy and not a *Bellis perennis*.

In this system, an organism's name is developed based on its most prominent features and the Latin words for those features. Similar to people, it has a first name and a last name. The first name is the **genus** name. It is always capitalized. The last name, however, is the **species** name and is not capitalized. The entire name is written in italics in the order *Genus species*.

The classification of organisms follows the relationships they have on the basis of different characteristics for categories like genus and species, but also several other higher-level traits.

Image Credit: Great Lakes Now

When organisms are classified based on their relationships among different levels in the scientific naming system it is called **phylogenetic classification** and the study of classifying organisms is known as **taxonomy**. The current taxonomic system has eight levels in its hierarchy. Each level denotes a broader or more specific trait, depending on the sequence in which you are viewing the hierarchy. From highest level (broadest category) to lowest level (most specific), the taxonomic levels are: **domain, kingdom, phylum, class, order, family, genus,** and **species.**

The name an organism is given at each level in the taxonomic hierarchy is called a **taxon**. Dogs, for example, are members of the *Carnivora* order, because they are carnivores—they eat meat primarily—and so *Carnivora* is the taxon at the order level; *Canidae* is its taxon at the family level, etc. **This video on Life's Filing System** from PBS LearningMedia does a thorough job of explaining the entire taxonomic methodology. The Royal Ontario Museum uses such taxonomy to file its collection of fish so that each species is near its relatives and can be easily located.

Once organisms are classified, we can better identify them in nature, and that allows us to measure how many of different species there are in an ecosystem. This is known as a **diversity index.** It tells you how likely any two randomly-selected individuals in an area are to be different species from one another. The value is not very useful by itself, but holds great value when scientists compare the diversity index values for different locations. It can help them to know which areas are more diverse and create maps to reveal patterns in species diversity within a given ecosystem. For example, the diversity of your backyard is probably far less than the diversity of the state park closest to your home where no people are allowed to build homes or live.

LESSON LAUNCH

A. Warm Up

The warm up is intended to be structured as teacher-facilitated, whole-group student discussion activities. It helps students to begin thinking about the topic at the center of the lesson.

1. Ask students to list out on a piece of paper five things that come to mind when thinking of **biodiversity**.
2. Have students pair up with a partner to share their five ideas with each other. If any ideas appear on both lists, have students circle those.
3. Then, engage students in a whole-group discussion to ask them to share any ideas that were circled.
4. Generate a list of the circled ideas.
5. Ask for volunteers to share any ideas that were not circled that they think are really important to include in this topic.
6. Generate a separate list of those ideas.
7. At the end of making the two lists, have students copy down one single list of all the circled ideas and important ideas in their notebooks or on their paper.
8. Ask students individually to rank the ideas in the list from most to least relevant.
9. Ask for some students to share which term should be most relevant and why they think that is. Engage the whole group in discussion to arrive at consensus about the most relevant idea related to **biodiversity** that they already know about or that came to mind during this exercise.

Image Credit: Great Lakes Now

B. Close Reading a Photo

Show or distribute a copy of **this photo** students and have students discuss with a partner:

- what is going on in this picture?

Then have two sets of partners form a small group and make connections between their partner conversations about the photo and the ideas that came up during the warm up activity about things that came to mind about **biodiversity**.

C. Bridge to Learning

After the warm-up activity has concluded, help students prepare for the learning that is about to come by distributing the address of the White House to students:

1600 Pennsylvania Avenue NW, Washington, DC 20500

- Ask them to list all the parts of the address separately and label each
- Invite them to consider if there are other parts of the White House address that are missing (hint: country, continent) and why they think those are left out
- Have them rewrite the address with those omitted fields and then update their list of fields with the added information. Inform them that this address is a **taxonomy** that categories different levels of specificity on where a building is located from country to the building number on a street
- Finally, ask them to complete an address taxonomy for their home address to explain to a partner

D. Background Information Notes

Explain that we are going to build on these ideas and learn more about how fish are classified and cataloged in this lesson. Then proceed to give the notes from the **Teacher Background Information**.

ACTIVITY 1: WATCH A GREAT LAKES NOW SEGMENT

This activity is a video discussion of a *Great Lakes Now* episode segment.

First, inform students that they will be watching a *Great Lakes Now* segment discussing the use of SONAR to map the bottoms of the Great Lakes. During the video they need to jot down four things they took away from the video using the **4 Notes Summary Protocol**.

Then, if students are not already familiar, introduce them to the 4 Notes Summary Protocol, which they will use after they finish watching the video, where they write down one of each of the following notes:

- **Oooh!** (something that was interesting)
- **Aaah!** (something that was an ah-ha moment)
- **Hmmm…** (something that left them wanting to know more)
- **Huh?** (a question they have afterward)

Next, have students watch the segment from episode 2209 of *Great Lakes Now* called **Jar Trek**.

Last, have students complete their individual 4 Notes Summary and then discuss those in groups of 3-4 students.

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

Post-Video Discussion

After the groups have had time to go over their 4 Notes Summaries, invite a handful of students to share out some of their notes, eliciting at least 1-2 of each of the 4 Notes and listing those somewhere for the whole group to see.

Ask students to turn back and talk with their groups to make connections between the *Great Lakes Now* video and what they remember from the warm-up activities.

How is what we saw in the video the related to what we discussed earlier in this lesson during the warm up?

After giving the groups some time to talk, bring the whole group back together for a shareout and discussion of ideas.

In this culminating discussion, the goal is to help students make connections between the video segment and what they discussed during the warm up activities earlier in the lesson about what they knew about **biodiversity**

Once the discussion finishes, have each student write a "**Sum It Up**" statement in their notebooks. This is a single sentence that captures the big idea of what was just learned.

Have 2-3 students share out their **Sum It Up** statements before concluding this activity.

ACTIVITY 2: READ ABOUT THE LIBRARY OF LIFE

Libraries are places where you can pull a book off the shelf and read it. But what if there were a place where you could pull an organism off the shelf to study it like a book? That's what a **type collection** does.

In this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article **A Fish's Shelf Life** by Kathy Johnson from *Great Lakes Now*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

Image Credit: Great Lakes Now

Last, have each group craft a summary statement of the most important point from their discussion and ask for a volunteer in each group to share that key point with the whole group.

As student groups share their most important point, record their ideas on the board and have students copy the list of student ideas down into their notebooks.

Once the shareout is complete, ask students to return to their groups and discuss one last question based on the article:

Based on the article, how well does this system for tracking biodiversity helps us to protect the biodiversity of an ecosystem like the Great Lakes?

After giving the groups some time to discuss this question, invite conversation from the whole group to see what consensus can be reached.

Be sure to encourage students to support their claims with evidence and reasoning as they discuss in the whole group.

ACTIVITY 3: INDEXING BIODIVERSITY

In this activity, students will conduct an experiment to estimate the diversity of organisms in a given sample for a certain ecosystem area.

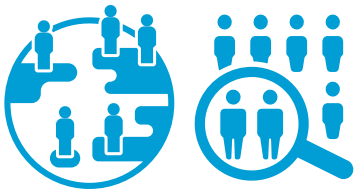

Image Credit: Gary Abud, Jr.

Simpson's Diversity Index is used to calculate how diverse an area is with organisms. This could be with animals, plants, or even humans. The index calculation compares the total number of all the different organisms to the number of each type of organism. It tells the probability when randomly selecting two organisms in an area that each individual will be a different species. Index values closer to 0 indicate low diversity (e.g., low percentage chance of two random individuals being different) and 1 indicates high diversity.

In the study of ecosystems, this index can help you understand the diversity of species as well as the diversity among a particular type of organism. Understanding how populations are distributed and the relative diversity of different areas within an ecosystem using an index like this gives scientists important information on ecosystems, their health, and how they change over time.

For example, say you went into the woods and overturned some logs to reveal what's beneath. You might find a lot of ants. On closer inspection, you notice that not only are there ants but there are several different species of ant in that part of the woods—red ants, black ants, etc. Based on how many of each kind of red ant and black ant that you counted, you could determine an index for the ant diversity in that part of the woods.

Having this kind of an index is helpful to compare other parts of the woods to see if the diversity is the same or different. Let's say that one mile away you overturn another log expecting to see a similar diversity of ants only to find that there are far fewer red ants and many more black ants. One mile farther even away, you notice there are no red ants and only black ants. The diversity index at each spot can help you map an ecosystem.

- **Materials:**
- Glue sticks
- Construction paper or paper plates
- Rainbow sprinkles and single-color sprinkles

First, show the video **Tropical Rainforest Diversity** from PBS LearningMedia to students. Follow the discussion prompts in the video and pause at each point in the video to have students turn and talk with a partner about what the narrator asks and is talking about. After the video, engage the class in a discussion about the key question of the video—**how does the biodiversity within an ecosystem influence the stability of that ecosystem?**

Next, inform students that they will model an ecosystem and calculate its diversity index. Distribute the supplies, and then have groups of students cover their paper with a layer of glue and shake a single color of sprinkles plus the rainbow sprinkles on it. Have them move the plate to evenly coat the sprinkles on its surface.

Then, have students tally up how many colors of sprinkles are represented and how many sprinkles of each color there are on the plate. They should organize and display their data information into a table for easy reference. The colors of sprinkles represent different species and the number of each color represent how many individuals of each species are present.

Last, have students calculate the diversity index for their paper plate ecosystem. It will be helpful for you to demonstrate this step and go through a sample calculation together (but not using sprinkles; use something else like coins, beans, candy, or something digital like emojis.) Have students label their paper with the diversity index on it and then put all the plates adjacent to one another and discuss with the whole class how the differences in index values compare to the distribution of sprinkles.

Simpson's Diversity Index

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

- D is the diversity index
- N total number of organisms
- n is number of one species

**Σ means sum of all the calculations for individuals of each species*

ACTIVITY 4: VOCABULARY'S CODE

In this activity, students will develop their vocabulary with respect to the topic of this lesson using the CODE approach.

Vocabulary's CODE is a strategic approach to direct vocabulary instruction that helps students master crucial concepts and retain new vocabulary terms. Students work their way from initial exposure to in-depth understanding through a series of progressive learning activities that help students "crack" Vocabulary's CODE, which entails connecting, organizing, deep processing, and exercising with the vocabulary terms they are learning.

When teaching vocabulary through the CODE approach, the teacher will engage students in several protocols—one under each of the four stages of the CODE approach—to help students when they are in the process of:

- **Connecting** with new words
- **Organizing** new words into meaningful categories
- **Deep-processing** the most important concepts and terms
- **Exercising** understanding of new words through strategic review and practice

For this activity, a protocol for each aspect of CODE is provided that you can do with students, though you may have other ways that you'd like to achieve each stage of CODE and you can certainly do those just the same.

Before beginning, introduce the vocabulary list of words to students that they are going to be working with. This list will include the terms: **taxon, taxonomy, domain, kingdom, phylum, class, order, family, genus, species, index, biodiversity, ichthyology, category, classification, binomial, phylogenetic, and nomenclature.** Have students write the entire list once in their notebooks, leaving space to fill in a definition for each term as they learn them.

Teaching Tip: demonstrate an example of each of the four protocols for CODE before having students try them independently with their partners or group.

VOCABULARY'S CODE

C onnecting
O rganizing
D eep processing
E xercising

Have students look up a definition (or come up with one) for each of the vocabulary terms. Have a different student share their definition for each term and invite the class to add on or suggest edits to the definition until the class agrees on a working definition of each term.

First, engage students in a **connecting** protocol like **Associations**. In this protocol, students generate words, pictures, feelings, or physical reactions, or whatever else comes to mind when they hear the new vocabulary term. Have a few students share their associations.

Next, engage students in an **organizing** protocol like **Group and Label**. In this protocol, partners examine a list of vocabulary words and place them into groups based on common characteristics. For each group, students devise a label that describes what all the grouped words have in common or how they are related to one another. Have a few students share their groupings and labels.

Then, engage students in a **deep-processing** protocol like **Metaphors and Similes**. In this protocol students use words deeply by exploring their relationships to other words and concepts. The teacher can generate the metaphors and similes and ask students to explain them or task small groups or partners with coming up with their own.

Last, engage students in an **exercising** protocol like **Use It Or Lose It**. In this protocol, students write a short story that correctly uses as many of the vocabulary terms as possible. A rubric for this writing assignment could be that the percentage of the words used from the list translates to their grade on this short story.

ACTIVITY 5: EXPLORE FISH SCIENTIST CAREERS

One of the most-often asked questions of students is: "What do you want to be when you grow up?" Consider this example: what can you do with knowledge of biology, an interest in fish, and a scuba diving passion? Write a column for *Great Lakes Now*!

In this activity, students will use a **Think Pair Square Protocol** for discussing what they will read about this very topic.

First, have students partner up and distribute the article **Fish Scientists** by Kathy Johnson from *Great Lakes Now*. Allow time for students to individually read the article, and have them jot down three things they took away from the article using the **Rose Thorn Bud Protocol**—in their notebook or using the handout.

Then, give students time after reading to discuss the article that they read with their partner. Have students share their rose, thorn, and bud with each other, including how those points connect to each other. The pair should come up with a statement to summarize all of their article takeaways.

Next, have two student pairs join up, standing near each other to form the four corners of a square, to discuss the article and what they talked about in their pairs. Encourage them to come to a consensus about which point they found most important or interesting in the article.

Teaching Tip:
If the reading level of the article is going to be tough for some students to read individually, have partners or small groups read the article together aloud while each follows along.

Image Credit: Great Lakes Now

Last, have each group craft a summary statement of the most important point from their discussion and have them share which personal career story in the article was most inspiring to them. Why?

Have the members of each group to envision possible career pathways that they themselves might take that are creative ways to blend their passions, interests, and favorite subjects? Ask them to make connections to the individuals featured in the article and how their stories might compare and connect with one another.

After giving the groups some time to discuss this question, invite conversation from the whole group to see what career ideas came up in the groups. Be sure to encourage students to support their claims with evidence and reasoning as they discuss in the whole group.

Culminate this activity by having students research the necessary education and experience necessary to pursue their career pathway and create a map of the steps to reach their goals with the **Career Map** in the Student Handouts.

LESSON CLOSURE

After the conclusion of all the activities, help students to make connections* between everything they did in the lesson and what they learned overall.

A. Free Recall

Group students in pairs or triads (e.g., in groups of 2-3 partners) and distribute the **Free Recall Protocol handout**, Alternatively, you can have students do this in their notebooks. Set a 3-min timer and have students generate a list of everything they can remember learning about in this lesson related to the central topic of the lesson. This doesn't have to be in depth, just whatever each group can call to mind. Have them draw lines between any terms that relate to one another. After the timer finishes, give groups a chance to volunteer to share aloud 2-3 things from their free recall lists and any of the connections that they made with those. Jot down any ideas that come up multiple times during the shareout for the whole group to see.

B. Lesson Synthesis

Give students individual thinking and writing time in their notebooks to synthesize their learning, by jotting down their own reflections using the **Word, Phrase, Sentence Protocol.**

In the Word-Phrase-Sentence Protocol, students write:

- A **word** that they thought was most important from the lesson
- A **phrase** that they would like to remember
- A **sentence** that sums up what they learned in the lesson

Image Credit: Great Lakes Now

C. Cool Down

After the individual synthesis is complete, students should share their synthesis with a partner.

After sharing their syntheses, have students complete a **3, 2, 1 Review** for the lesson with their partner, recording in their notebooks or, optionally, on exit ticket slips to submit, each of the following:

- **3 things** that they liked or learned
- **2 ideas** that make more sense now
- **1 question** that they were left with

Invite several students to share aloud what they wrote in either the synthesis or 3, 2, 1 Review.

Lastly, ask one student volunteer to summarize what has been heard from the students as a final summary of student learning.

**Optionally here, the teacher can revisit the learning objectives and make connections more explicit for students.*

Teaching Tip: Use the Student Handouts to help students organize their thinking in writing around each of the lesson protocols.

NAME: _____

A Word, Phrase, Sentence Protocol

What is a **word** that you thought was most important from this lesson?

What is a **phrase** that you would like to remember from this lesson?

What is a **sentence** that sums up what you learned in this lesson?

3, 2, 1 Review Protocol

What are **3 things that you liked or learned** from this lesson's activities?

-
-
-

What are **2 ideas that make more sense** now to you?

-
-

What is **1 question that you were left with** after this lesson?

-

NAME: _____

Free Recall Protocol

With 1-2 partners, generate a list of everything you can remember learning about in this lesson related to the central topic of the lesson. Draw lines between any terms that relate to one another.

NAME: _____

4 Notes Summary Protocol

OOOH!

Something that was interesting to you

AAAH!

Something that became clearer; an "ah-ha" moment

HMMM...

Something that left you wanting to learn more

HUH?

Something you questioned or wondered

Sum It Up Statement:

Summarize your group discussion about your 4 Notes Summaries below:

NAME: _____

Think Pair Square Protocol

THINK

Write down your own individual ideas

PAIR

Summarize what you and your partner discussed

SQUARE

Summarize what your group discussed

NAME: _____

Rose, Thorn, Bud Protocol

ROSE

Something that "blossomed" for you in your learning

THORN

Something that challenged your thinking or was difficult to understand

BUD

Something that's new and growing in your mind — a "budding" idea

NAME: _____

Career Map

IDEAL CAREER:

Research, discuss with a partner, and complete the following prompts to build your career plan.

- **5 Year Goal:** In 5 years, in order to be closer to my ideal career, I need to reach this goal...
- **3 Year Milestone:** In order to move toward my 5 year goal, in 3 years I need to...
- **1 Year Milestone:** In order to move toward my 3 year milestone, in 1 year I need to...
- **6 Month Milestone:** In order to move toward my 1 year milestone, in 6 months I need to...
- **3 Month Milestone:** In order to move toward my 6 month milestone, in 3 months I need to...
- **1 Month Milestone:** In order to move toward my 3 month milestone, in 1 month I need to...
- **1 Week Milestone:** In order to move toward my 1 month milestone, in 1 week I need to...
- **Today:** In order to move toward my 1 week milestone, today I need to...