





Seaworthy STEM[™] in a Box Series







Part I: Let's Research!

Exploring Primary Sources & Research Techniques

Journal Entry:

"Think about...":

Artifact 1:



Fish. Japan, None. [Between 1800 and 1870] [Photograph] Retrieved from the Library of Congress, https://www.loc.gov/item/2009630313/.

1. Check out the image above, what do you notice, wonder, or predict about its biology?

2. What about this fish gives it a unique purpose?

3. What **STRUCTURES** on the fish are used for specific **FUNCTIONS**? Explain and label a diagram with at least three ideas.



4. What could you add to this fish that would change its function? Specify the function your trying to achieve?

Artifact 2:



Detroit Publishing Co, P. Cow Trunk Fish, Orange Sea Raven, Common Trunk Fish Front View., None. [Between 1895 and 1915] [Photograph] Retrieved from the Library of Congress, https://www.loc.gov/item/2016811478/.

1. Check out the image above, what do you notice, wonder, or predict about its biology?

2. What about this fish gives it a unique purpose?

3. What **STRUCTURES** on the fish are used for specific **FUNCTIONS**? Explain and label a diagram with at least three ideas.



4. What could you add to this fish that would change its function? Specify the function your trying to achieve?

Artifact 3:



Fish. [No Date Recorded on Shelflist Card] [Photograph] Retrieved from the Library of Congress, https://www.loc.gov/item/2003654029/

1. Check out the image above, what do you notice, wonder, or predict about its biology?

2. What about this fish gives it a unique purpose?

3. What **STRUCTURES** on the fish are used for specific **FUNCTIONS**? Explain and label a diagram with at least three ideas.



4. What could you add to this fish that would change its function? Specify the function your trying to achieve?

Part 2: Let's Explore Fish Mouth Structure!

Many scientists believe that fish have been on the Earth for over 450 million years. That means fish were likely roaming the oceans over 200 million years prior to the dinosaurs stomping around on the land and roughly 400 million years before the existence of primates (a group of mammals which includes humans)! Over that large expanse of time, fish have evolved in a number of ways to help their species survive in a wide array of environments.

Throughout the unit, we are going to focus on both the form and function of various types of fish mouths. Studying this specific part of a fish will allow us to make inferences about its diet, how they feed, and maybe even learn about other cool functions which help them survive.

There are three primary types of fish mouths:

- Fish that have a superior mouth have a bottom jaw that is longer than the top part of their mouth. This allows them to easily feed on organisms that are above them, especially near the surface.
- Terminal mouths are fairly even and face towards the front. Some fish with this type of mouth also have a protrusible mouth which allows them to thrust the jaw forward when grabbing food. While these fish primarily eat things directly in front of them, many also have the ability to angle their body, so they can eat off of the surface or at the bottom of a body of water.





• Fish that possess a downward facing mouth are categorized as inferior (also called sub-terminal). This type of mouth, often found in bottom dwelling fish, allows them to easily eat things lower in the water column. Many fish with inferior mouths also possess barbels (slender, whisker-like organs) that help them find food near the darker bottom.









Activity:

Research at least five of the fish listed below.

Suggested fish:

- Hatchetfish
- Cichlid
- Archer Fish
- Common Halfbeak
- Sea Robin
- Smallmouth Yellowfish
- Orange River Mudfish
- Atlantic Mahi Mahi
- Bluefish
- Gray Triggerfish
- Monkfish
- Haddock,
- Northern Anchovy

Complete the charts in the following pages for each species.

Be sure to include at least one example for each of the three types of fish mouths:

- Superior
- Terminal
- Inferior

(Suggested fish: Hatchetfish, Cichlid, Archer Fish, Common Halfbeak, Sea Robin, Smallmouth Yellowfish, Orange River Mudfish, Atlantic Mahi Mahi, Bluefish, Gray Triggerfish, Monkfish, Haddock, Northern Anchovy)

Species:

Mouth Type (Superior, Terminal, Inferior):

Mouth Shape (Insert Drawing or Photo):



```
Teeth Size Compared to the Mouth
(Likert Scale -Circle a choice)
```

(Largest) 5 4 3 2 1 (Smallest)

Primary Diet & Other Unique Mouth and/or Teeth Features:

(Suggested fish: Hatchetfish, Cichlid, Archer Fish, Common Halfbeak, Sea Robin, Smallmouth Yellowfish, Orange River Mudfish, Atlantic Mahi Mahi, Bluefish, Gray Triggerfish, Monkfish, Haddock, Northern Anchovy)

Species:

Mouth Type (Superior, Terminal, Inferior):

Mouth Shape (Insert Drawing or Photo):



```
Teeth Size Compared to the Mouth
(Likert Scale -Circle a choice)
```

(Largest) 5 4 3 2 1 (Smallest)

Primary Diet & Other Unique Mouth and/or Teeth Features:

(Suggested fish: Hatchetfish, Cichlid, Archer Fish, Common Halfbeak, Sea Robin, Smallmouth Yellowfish, Orange River Mudfish, Atlantic Mahi Mahi, Bluefish, Gray Triggerfish, Monkfish, Haddock, Northern Anchovy)

Species:

Mouth Type (Superior, Terminal, Inferior):

Mouth Shape (Insert Drawing or Photo):



```
Teeth Size Compared to the Mouth
(Likert Scale -Circle a choice)
```

(Largest) 5 4 3 2 1 (Smallest)

Primary Diet & Other Unique Mouth and/or Teeth Features:

(Suggested fish: Hatchetfish, Cichlid, Archer Fish, Common Halfbeak, Sea Robin, Smallmouth Yellowfish, Orange River Mudfish, Atlantic Mahi Mahi, Bluefish, Gray Triggerfish, Monkfish, Haddock, Northern Anchovy)

Species:

Mouth Type (Superior, Terminal, Inferior):

Mouth Shape (Insert Drawing or Photo):



```
Teeth Size Compared to the Mouth
(Likert Scale -Circle a choice)
```

(Largest) 5 4 3 2 1 (Smallest)

Primary Diet & Other Unique Mouth and/or Teeth Features:

(Suggested fish: Hatchetfish, Cichlid, Archer Fish, Common Halfbeak, Sea Robin, Smallmouth Yellowfish, Orange River Mudfish, Atlantic Mahi Mahi, Bluefish, Gray Triggerfish, Monkfish, Haddock, Northern Anchovy)

Species:

Mouth Type (Superior, Terminal, Inferior):

Mouth Shape (Insert Drawing or Photo):



```
Teeth Size Compared to the Mouth
(Likert Scale -Circle a choice)
```

(Largest) 5 4 3 2 1 (Smallest)

Primary Diet & Other Unique Mouth and/or Teeth Features:

Part 3: Design Engineering Challenge

Over the course of this next section, you are going to utilize the engineering design process (EDP). The EDP is utilized by people everyday when they are attempting to find a solution to a problem. The goal of the cycle is not to develop a perfect product, but rather it is to develop prototypes (systems or machines) that can improve the current way of doing things.

 Your teacher will identify the problem for you to solve (the engineering design challenge) and will also assign you to a design team of 2-4 students. At this point you will work together to complete the "Team Code of Cooperation" which will lay the foundation for how your team will function. Once complete, please sign then have your teacher initial at the bottom of the page.



- 2. Fortunately, you have already completed much of the necessary research when you completed the "Fish Research Sheets." Explore the fish species from the list contained within the challenge description and find one that seems able to accomplish the challenge provided by your teacher. Now your team will complete "Preparing Goals for an Engineering Design Challenge." The sheet will help your team note the constraints (Time limitations, types/quantities of materials, etc) of the project that are provided by your teacher. With those constraints in mind, your team will then discuss and then list design objectives for the prototype that your team will develop.
- 3. Individual Design: Now that you have developed a list of common design objectives with your team, it is your turn to independently create a blueprint of your prototype. You will draw your idea as well as note the exact materials that you are using in your design. Do not forget to include things like measurements, how the individual components are connected as well as any other comments that you would like to share with your team.
- 4. Team Design: Once all of your team members have completed their individual designs, it is now time to share with the rest of the group. Each person should follow the agreed upon rules in the "Team Code of Conduct" as you work together to develop your team design. Once your prototype is drawn below, please have your teacher initialize the provided space.
- 5. Now it is time to build your prototype!
- 6. Test your prototype (redesign and retest your prototype if necessary and time permits).
- 7. Work as a team to complete the "Prototype Analysis and Reflection" sheet. Then share your solution (or attempted solution) with the class. Be sure to include both your successes as well as your failures so that the various teams can learn from each other's designs.
- 8. Complete the "Peer Evaluation of Teamwork," so your teacher can have a better idea of how the people in your team functioned as a group.
- 9. Submit all of the papers to your teacher.

Team Dynamics

List anticipated goals. All team members agree to:

Α.			
В.			
C.			
D.			
E.			

When a team member lets their team down by ignoring the anticipated goals listed above, the following actions will be taken based on number of offenses:

Step 1:

Step 2:

Step 3:

✓ Teacher Approved:_____

(Teacher's initials)

By signing this document on one of the lines below, you are stating that you agree to meet the anticipated goals and understand the consequences if you fail to do so. **Team Signatures:**

Procedure

What is the Problem?

What is the challenge you are trying to solve? Brainstorm and write out the problem you are trying to solve in question format:

2 What are the <u>Criteria</u> and <u>Constraints</u>?

What is the challenge you are trying to solve? Brainstorm and write out the problem you are trying to solve in question format:

Criteria Brainstorm	Constraints Brainstorm

List final criteria and constraints below:



Budget Allocations:

Item	Quality Needed	Cost per Item	Total
		Total Cost:	

As a team, develop at least five design objectives (attributes that your team would like your prototype to have, based on your background research):

Α.	
B.	
С	
о. П	
D.	
E.	

✓ Teacher Approved:_____

(Teacher's initials)

3 How can we Brainstorm and construct the Prototype?

Design 1						
Does it meet the criteria?						
Does it meet the constraints?						
Is it within the allocated budget?						
lustification:						

Design 2						
	+ + + + +		_			
+ + + + + + + + + + + + + + + + + + + +			_			
		-+ + + + +	_			
* * * * * * * * * * *	• • • • •	+ + + + +	-+ + + +			
		-++-+-+				
	* * * * *	+ + + + +				
* * * * * * * * * *		-+ + + + +				
		+ + + +				
	+ + + + +	+++++				
	* * * * *	+ + + + +				
		+ + + + +				
		+ + + + +				
Does it meet the criteria?						
Does it meet the constraints?						
Is it within the allocated budget?						
Justification:						

Design 3					
* * * * * * * * * * * * * * * * * * * *					
* * * * * * * * * * * * * * * * * * * *	+ + +				
* * * * * * * * * * * * * * * * * * * *					
* * * * * * * * * * * * * * * * * * * *	-				
	+ + +				
	+ + +				
Does it meet the criteria?					
Does it meet the constraints?					
Is it within the allocated budget?					
Justification:					

Trial	Variable 1	Variable 2	Variable 3	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
Variable Averages				
Total Averages				



5 What are our Findings? Data Analysis and Reflection (20 minutes):

Your team will create a quick visual representation of findings. The teacher will indicate the appropriate methods of data visualization. Complete the following:

- A. Discuss and reflect with your team on the following: what worked and what did not in their design.
 - What worked overall? Explain.
 - What did not work overall? Explain.
 - Does my prototype meet the requirements of the design challenge?
 - Can I improve the design from its original specifications?
 - How can I reduce the cost of my final prototype without sacrificing quality?

B. Include the following information in your data visualization:

- Data Chart
- Graph of information
- Answers to all the reflection questions from part A

6 Let's Improve it! Class Discussion, Team <u>Redesign</u> Conclusion

Team Redesign:

Based on the results of your testing, identify two areas of success in your team's prototype design. Why were these areas successful? Explain.

A.

Β.

Based on the results of your testing, identify two areas of failure in your prototype design. What caused the failure? Explain.

Α.

Β.

As a group, determine at least four suggestions for further meeting or exceeding the constraints in the future.

А. В. С. D.

Individual Reflection:

Discuss the most successful designs and strategies:

Α.			
В.			
C.			
D.			

Relate the activity to real-world applications in naval engineering or beyond:

A.
B.
C.
D.

Peer Evaluation of Teamwork

Evaluator's Name:

This form will help you evaluate your team and team members. Please list all of your team members in the space provided below. Then on a scale of 1-5 (1 being the lowest; 5 being the highest), rank your peers (and yourself) on how well you think that each did in a particular area. *Do not forget to include yourself on the list.

Here is the scale:

- 1= Did not perform in this manner at all
- 2= Low performance in this area
- 3= Did okay in this area, but could have contributed more to the group
- 4= Contributed enough to be considered an active part of the group
- 5= Performed as an integral, vital part of the group in this area

Team Member Name	Cooperation	Dependability	Participation	Quality of Work	Motivation	Overall Contribution

I would also like to get an overall idea of how members of your group performed. In the space below, divide the 100% total points amongst the members of your group. For example, if you think each member of the group (including yourself) contributed equally, then assign each member the same number of points. If you think that you had "slackers" or "high achievers" in your group, then assign them less or more points. Again, please include yourself in the scoring. Don't forget that the total should add up to 100 points.

Team Member Name	Number of Points Assigned
Total	100









What's for Dinner Engineering Notebook



Seaworthy STEM[™] in a Box Series





