Comparative Field Investigation And Engineering Solutions

Toad Abodes

Second Grade

PEI PACIFIC EDUCATION INSTITUTE

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Overview

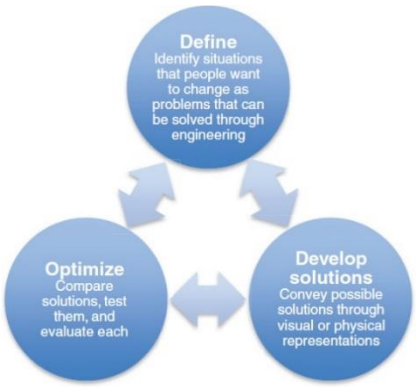
Many second-grade students leap at the opportunity to build play-houses or forts outdoors. The following lessons harness that enthusiasm and engages them with the beloved classic, *Frog and Toad Together* by Arnold Lobel, to build science skills and knowledge. Students start in the first lesson by learning about Toad and his list. Students will explore their own school campus and make a list of materials available on their school campus to build a rain proof toad abode. Next students test these materials to determine which are the hardest and which are the most flexible. Students will then make an origami frog. Students must design, using only the materials they tested, a dwelling large enough to fit their origami frog and keep it dry in the rain. Student's will draft plans, build, test, and optimize their solutions to the question, "how do you build a natural toad abode"?

Background

The following is an excerpt from the Next Generation Science Standards Volume 2 Appendixes – Appendix I

Engineering design in the earliest grades introduces students to "problems" as situations that people want to change. They can use tools and materials to solve simple problems, use different representations to convey solutions, and compare different solutions to a problem and determine which is best. Students in all grade levels are not expected to come up with original solutions, although original solutions are always

welcome. Emphasis is on thinking through the needs or goals that need to be met, and which solutions best meet those needs and goals.



When assessing students' final engineered projects, keep in mind that originality is not a criterion. Assessing if their projects could fit the origami toad and keep it dry are the benchmarks of success. Final assessment should not be conducted only after multiple iterations of the project. Optimization from first attempts is a crucial element of the engineering design standards, and an excellent opportunity to integrate into any growth mindset lessons teachers may do with students.

Students will need to be able to gather and use at least four different materials from the school grounds to build their toad abodes. Examples of these materials can be sand, soil, grass, leaves, twigs, bark, and rocks. Become familiar with your school campus and know where students will have safe access to these types of materials. Students should be able to dig in the ground as well as gather some of this material from the surface. Do not allow students to break branches or pick leaves off plants. In the location where you plan to test the toad abodes resistance to rain, make sure it is okay for students to dig small holes. Part of the learning experience is to make it okay for students to get their hands dirty!

Comparative Field Investigation - Which substances on my school ground are the hardest, and which are the most flexible?

Descriptive Field Investigation - Which substances return to their previous state after being frozen?

Engineering Solutions – How to build a dwelling that will fit an origami toad inside and keep it dry in a rainstorm?

Next Generation Science Standards-3-Dimensions

Dimensions from the Framework	What Students are Doing
Science and Engineering Practices • Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations and designing solutions	Planning and carrying out investigations: *Students will be testing 4 different substances found on the school grounds for their relative hardness and flexibility.* Analyzing and interpreting data*: Students will be looking at the results of both testing the materials for their toad abode and testing if their toad abode meets the design criteria.* Students construct explanations: *Students will articulate the design challenge of building a toad abode. Develop a model of a potential solution and explain why they used a particular material over other materials.*
Disciplinary Core Ideas **PS1.A: Structure and Properties of Matter** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces. **ETS1.C: Optimizing the Design Solution** Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	Students will be investigating and describing different types of materials found on the school grounds and analyze which material is best for building their toad abodes. Students will engineer buildings for their toad abode and compare it to classmates structures.
Cross Cutting Concepts • Patterns • Energy and Matter	• Students will be noting the patterns on what types of materials are more likely to have particular qualities. • Students will test using soil, rocks and plant pieces how the smaller portion of material can be reassembled into a new object.

English Language Proficiency Standard:

ELP.2-3.2 participate in grade appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions.

Objectives

Students:

- Identify materials on the school campus that are natural and plentiful enough to build a toad abode that will fit an origami toad.
- Investigate the physical properties of different materials and assess their usefulness for their engineering design.

Materials: *Frog and Toad Together* by Arnold Lobel, clipboards, paper, pencils, one, lined, 3x5 index card for each student, spray water bottle, watering can, student pages or student notebook.

Learning Experience

Students will listen to the first chapter of *Frog and Toad Together* then they will walk the school grounds looking for natural materials to build a toad abode. For this project students may work as individuals, in pairs or small teams. Each student should document their individual and group thinking throughout the design process, utilizing either the generated student pages or in a science notebook.

Engage

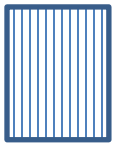
1. Read students the first chapter, "A List," from *Frog and Toad Together*.
2. Ask students if they have ever made a list. Let students share their personal list experiences, such as shopping, chores or gift lists.
3. Explain that in this story Frog and Toad live in homes, or Toad Abodes. Toads, like most living creatures need shelter, a part of their habitat.
4. Hand out student page **Introducing the Challenge.**
5. Let students know they will be building shelters for toads, using only the natural materials a toad would find on the school grounds. Review the difference between natural materials (rocks, dirt, leaves) and human-made materials (plastic, glass, paper, metal).
6. Tell students the class will be going outside to make a list of the materials that are available on the school grounds to build toad abodes. They must find at least four different materials they could possibly use.
7. Review your classroom rules and procedures for being outdoors. Ensure that each student knows the boundaries to explore and your signal to regroup as a class.
8. Lead students outside with clipboards, paper and pencil and direct them to an example of a type of material that is available on the school ground they may consider using.

9. Gather students back together when each child has identified at least four suitable items to be used for building materials. It is appropriate that many of the students have identical lists. Some students may not think materials such as soil, sand, or "dirt" should be considered. Have some prepared probing questions such as, "where have you seen frogs or toads in picture books or on TV?", "do you know where other animals live on the school grounds?" and "what do moles or ants make their homes out of?".

Explore

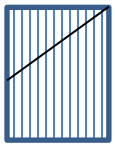
Create your Toad! Give each student a lined 3x5 card (you must use a notecard for these directions to work) to create their toad. The following steps provides a durable jumping origami toad (other patterns could be used as well).

1. Position the 3x5 with the lines facing up with the 3-inch side positioned as the top and bottom and the 5-inch side as the sides.



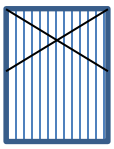
2. Fold the top left corner over to the right edge forming a triangle.

3. Unfold

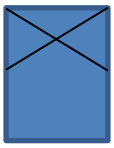


4. Repeat steps 2 & 3 for the top right corner.

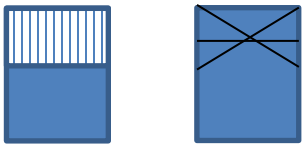
5. You should now have a large “X” on the top of your card.



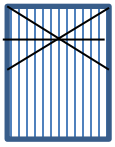
6. Turn the card over to the plain side.



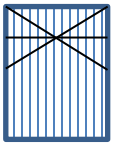
7. Fold the top edge of the “X” to the bottom of the “X” and unfold.



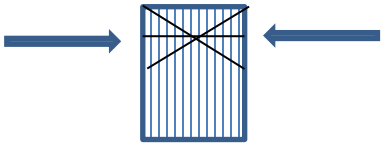
8. Turn the card back over to the lined side



9. With your finger gently poke the center of the “X” making a slight scoop shape.

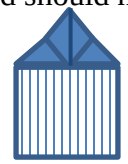


10. With each of your forefingers bring the sides of the scoop together.



11. Flatten down the top into a triangle shape.

12. Working only on the triangular shape fold the bottom corners towards the top forming the toad's arm. The overall shape of the card should now be like a house.



13. Fold the sides of the house in to meet at the center.

14. Fold the bottom of the narrow house all the way to the top.

15. Fold the same edge back down to the new bottom. This forms the back legs of the toad.

16. Looking at the toad from the side arrange the back legs to form a "Z" shape.

17. Place your toad on the table and give its back a gentle quick tap to make it jump.

Design Challenge. Once students have their toads made, they are ready for the design challenge. They must build a toad abode out of the materials found on the school grounds that are big enough for their toad to fit in and keep it dry when it "rains".

1. Hand out student page **First Brainstorm.**
2. Have students **sketch their initial ideas** of how to build a toad abode with the materials they listed. Have students **label their drawings**. The test will be water, sprinkled from a watering can, onto their structure for 30 seconds. If the toad inside gets wet the design has not met the engineering criteria.

3. Students should be able to **articulate the design challenge criteria and constraints**. Use the student pages **Describing Criteria and Constraints** or a science notebook to answer the following questions:
    1. What are the rules (criteria) you must follow to build the toad abode?
    2. What challenges (constraints) might you have as you build the toad abode?
    3. What are some possible solutions to the challenges you might face?

Explain

Test the materials

1. Explain to students that before they can begin building their toad abodes, they must first test their chosen materials on three characteristics; **hardness** and **flexibility.**
2. Hand out the student pages **Hardness test and Flexibility.**
3. Demonstrate to students a sample **hardness** test, where you take two different materials and scratch them against each other. Does one of the materials scratch or dent the other? The material that does not scratch or dent is harder. Model how students can keep track of their results by **recording their tests and their results**. You can use student pages or a journal to do this.
4. Students will **reflect on their results** and determine if their tests make them change any of their initial design ideas. The results may be slightly ambiguous. The goal is to have students understand that materials will have different hardness characteristics.

    Teacher Note: if a student is testing a material like soil, or sand, they must understand that soil is made of many small particles and that if you rubbed a leaf on a pile of sand, the sand itself is not damaged by the leaf. Demonstrate to students how to do a finger smudge test. Have a little moisture on the tip of your index finger, dip your finger into your soil medium and then rub your finger against the other material. If the other material scratches or tears, consider the soil medium harder.

5. Once students complete the hardness test repeat a similar procedure for **flexibility**. Each student should try to bend the material in half. If the material is too small (soil) to bend,

let the student make note that the soil is too small to test. This is okay. Common results will see more flexibility in certain plant material and more rigidity in rock samples.

Elaborate

1. Hand out the student page **Optimizing Scientific Tests.**
2. Have students return to their first design sketches and update them after conducting the three investigations.
3. Ask students to work in small groups and discuss why they think they should update their designs or change some of their first ideas.
4. Students should complete a new sketch that will be used to build their toad abodes.
5. Take students outside to build their toad abodes.
6. Once students have their toad abodes built have them put their origami toads inside. If they cannot fit their toad inside, they have not met the design criteria.
7. If the toad can fit, sprinkle the top of the abode with water from a water can to simulate a rain storm. **Let the water fall for 30 seconds.**
8. Have the students remove the toads, if the paper shows sign of getting wet, they have not met the design criteria.
9. Have students reflect upon their results and record in their student pages or journals using **Testing Built Toad Abodes 1st Trial.**

Evaluate

1. It may be tempting to end the design challenge here, however this does not complete the full process. It is imperative that students have another opportunity to optimize their designs and test a new iteration using the student page **Optimizing after Scientific Test: Third Sketch of Toad Abode.**
2. It is appropriate that students will imitate other classmates' successful designs and should give them credit in their reflections, a technique often used by scientists.
3. Students who may have met the design criteria in the first iteration, should now be required to improve their design by **either** making it larger so the toad can host his friend frog or survive a longer rain storm (more than 30 seconds).
4. Make sure students reflect upon their results and sketch a new updated plan before building their second toad abode to test.
5. Have students record their final test results on student page **Testing Built Toad Abode 2nd Trial.**
6. Hand out reflection and assessment page **I used to think…But now I know page**. This page is desired to be cut into three.
7. Tell students they are going to reflect on their learning from Toad Abode about phases of matter and materials used for engineering.

8. Using the sentence starters have students draw or write about their previous understanding and new learning. If you have never done a reflection like this before, you might want to model it for student or have students work in small groups. Scaffold this activity as needed dependent on student needs and time of year.
9. Hand out the reflection and assessment page **Toad Abode: Claim and Evidence**.
10. Have students complete the CE using their Toad Abode and the tests they completed to provide evidence to support their claim. It is appropriate for students to access their work from previous parts of the investigation.
11. Evaluate students' claim and evidence of the best building materials to engineer Toad Abodes. Make sure it is accurate and with details. Collect this for evidence of progress towards standard K-2- ETS1-3. See the rubric for scoring.

Extensions

- Additional NGSS opportunities – Read the rest of Frog and Toad Together, in the 2nd chapter test why seeds grow just as Toad does.
- Art – Have students paint terracotta pots to take home and put outdoors to encourage frogs and toads to have additional habitats.
- Math – Conduct an origami hopping competition where students must measure, and graph which toads jump the farthest. Create a competition for different origami toad designs using different paper material.
- Career Connections – Invite presentations from field biologist that works on amphibian health monitoring or a zoologists who might work on breeding endangered frog species.
- Social Studies – explore frogs' importance to local Tribal communities. Or compare to how people build homes for themselves, what materials do we use?

Suggested Additional Reading

- *How a House is Built* by Gail Gibbons 1990
- *Frogs* by Gail Gibbons 1993
- *Frog or Toad, how do you know?* by Melissa Stewart 2011
- *The Girl who Never Made Mistakes* by Mark Pett and Gary Rubinstein 2011
- *Those Darn Squirrels* by Adam Rubin and Daniel Salmieri 2012

Toad Abode

Student Pages

Name: _____

Engineering Design Challenge: Toad Abodes

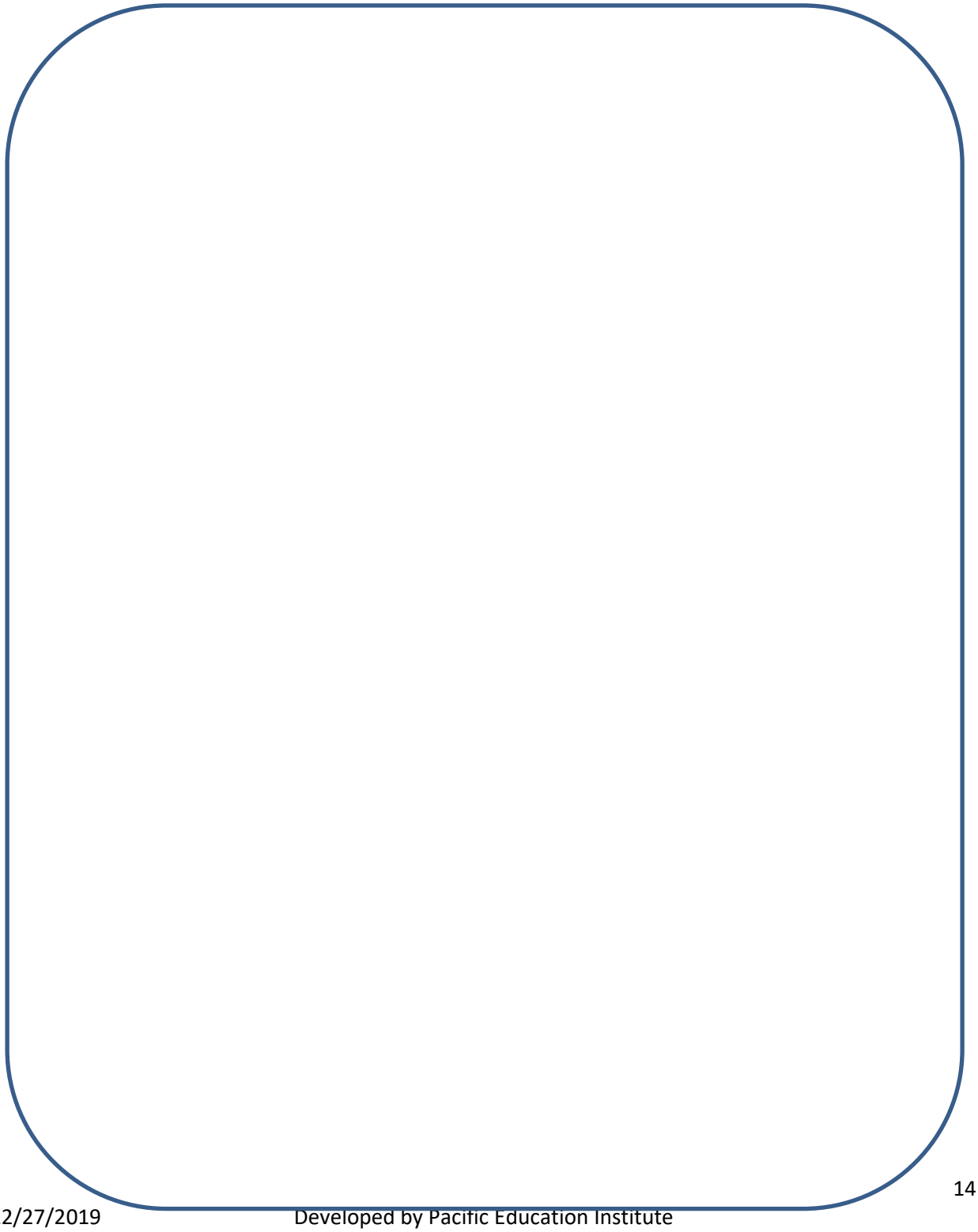
Introducing the Challenge

What different materials can you find on the school grounds.

Name of material	Where did you find it outside?	Is there enough to build a toad abode with?
1.		
2.		
3.		
4.		

First Brainstorms!

You made your toad! Sketch your first draft of a toad abode. Label the materials you are using in your possible solution. Will it be waterproof?



Describing Criteria and Constraints

1. What are the rules that you must follow in building this toad abode?

2. What are the most challenging parts to building this toad abode?

3. Describe the constraints of the challenge and possible solutions to problems.

Conduct Investigation of Hardness, Flexibility, and Wetness Tolerance

HARDNESS TEST

1. Write your material 1 in each line next to Material 1, the name of your material 2 next to material 2, and 3 next to 3 and 4 next to 4.
2. For each test scratch the material against each other. The material that gets scratched by the other is less hard. Circle the material that is the hardest in that test.

Example:

a. Material 1: Straw vs Material 2: Woodchips

Test 1

Material 1: _____ vs Material 2: _____

Test 2

Material 1: _____ vs Material 3: _____

Test 3

Material 1: _____ vs Material 4: _____

Test 4

Material 2: _____ vs Material 3: _____

Test 5

Material 2: _____ vs Material 4: _____

Test 6

Material 3: _____ vs Material 4: _____

Which material that you tested has the most circles?

_____

Which material has the least circles?

_____

List your materials from hardest to softest?

How do you know which are the hardest and which are the softest?

How will you use your hardest material when building your toad abode? Why?

How will you use your softest material when building your toad abode? Why?

How will you use your other material? Why?

FLEXIBILITY TEST

1. Write your material 1 in each line next to Material 1, the name of your material 2 next to material 2, and 3 next to 3 and 4 next to 4.
2. For each test bend your material until it snaps or breaks. The material that bends farther or longer is more flexible, the material that bends less is more rigid. Circle the material that is most flexible in that test.
   Example:

Straw Woodchips

Material 1: _____ vs Material 2: _____

Test 1:

Material 1: _____ vs Material 2: _____

Test 2:

Material 1: _____ vs Material 3: _____

Test 3

Material 1: _____ vs Material 4: _____

Test 4

Material 2: _____ vs Material 3: _____

Test 5

Material 2: _____ vs Material 4: _____

Test 6

Material 3: _____ vs Material 4: _____

Which material has the most circles?

_____

Which material has the least circles?

_____

List your materials from most flexible to most rigid.

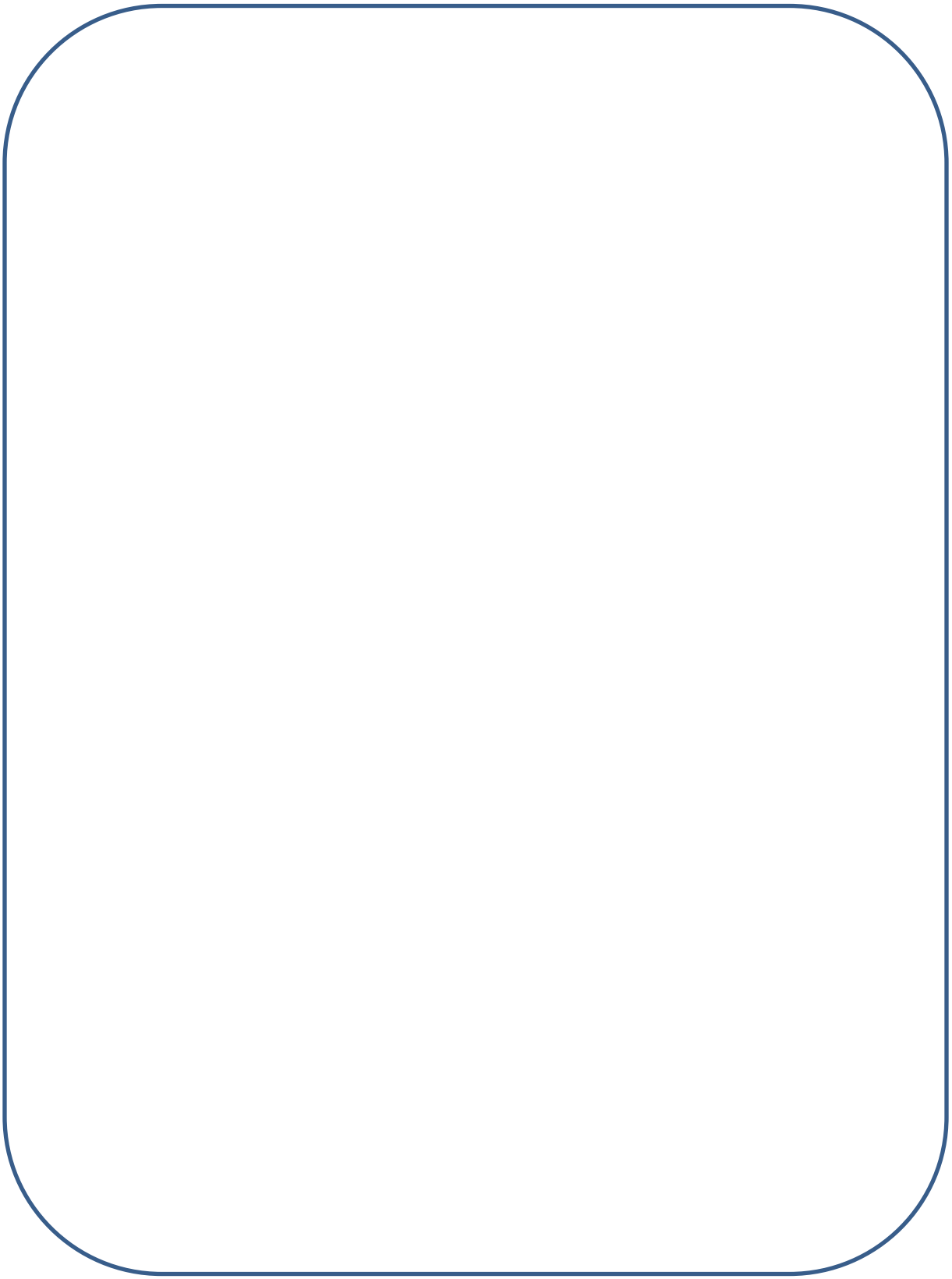
How do you know which is the most flexible and which are the most rigid?

How will you use your most flexible material when building your toad abode? Why?

How will you use your most rigid material when building your toad abode? Why?

How will you use your other material? Why?

Optimizing after Scientific Tests: Second sketch of toad abodes



Testing Built Toad Abodes 1st Trial

1. Did my toad fit into the toad abode?

2. Did my toad get wet?

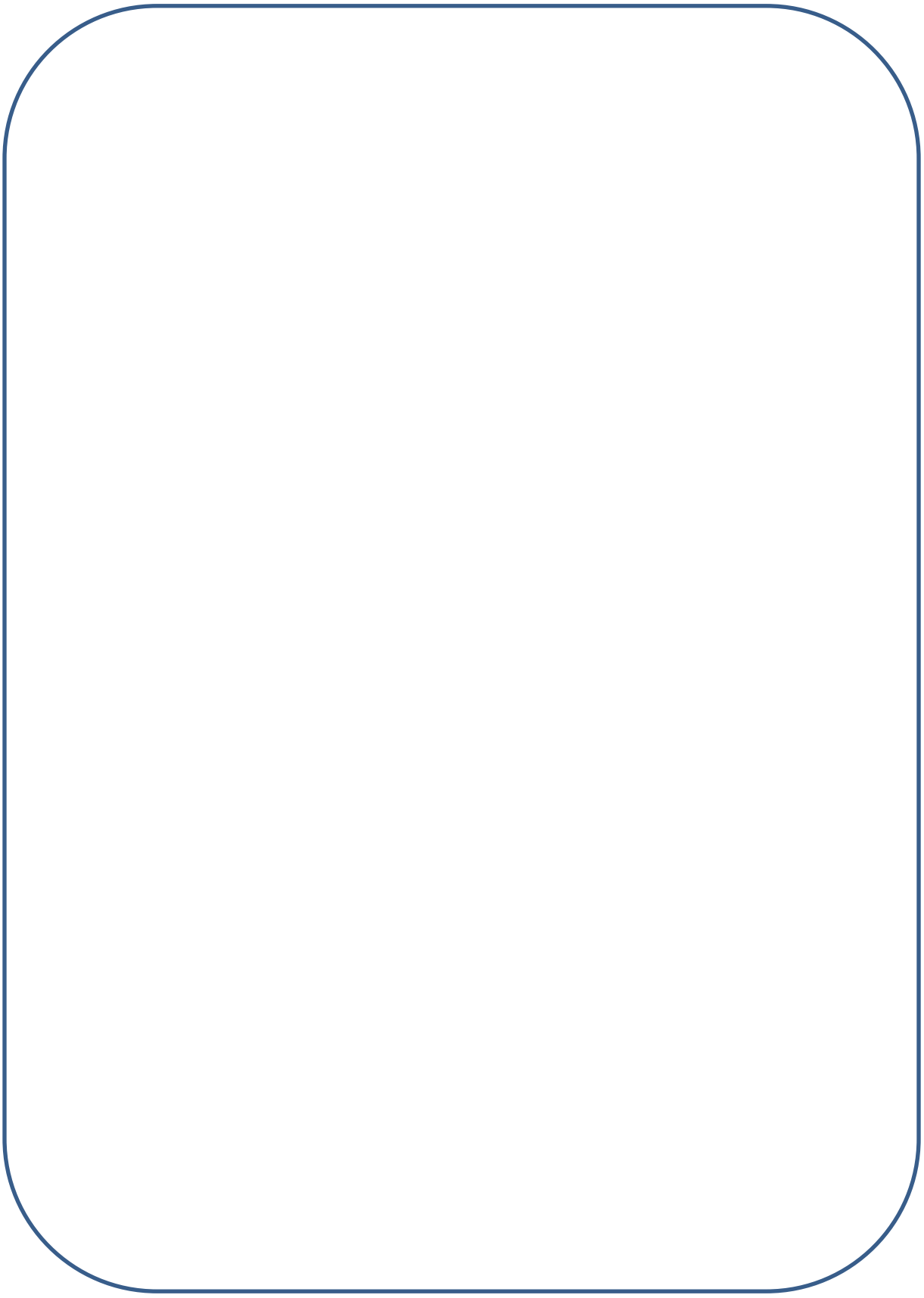
3. Which of my materials worked best?

4. How can I improve my toad abode?

5. Could I make it bigger to fit a friend in with my toad?

6. Could I make it more waterproof to keep my toad dry if it rained longer and harder?

Optimizing after Scientific Tests: Third sketch of toad abodes



Testing Built Toad Abodes 2nd Trial

1. Did my toad fit into the toad abode?

2. Did my toad get wet?

3. Which of my materials worked best?

4. How can I improve my toad abode?

5. Could I make it bigger to fit a friend in with my toad?

6. Could I make it more waterproof to keep my toad dry if it rained longer and harder?

Reflection and Assessment

I used to think:

But now I know:

I used to think:

But now I know:

I used to think:

But now I know:

Name: _____

What is the best material to build a Toad Abode from? Use evidence from your Toad Abode tests.

Write the claim to answer the question:

_____

_____

_____

Evidence: Write or draw evidence to support your claim.

Rubric for Claim and Evidence for Toad Abode

Standard: K-2-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

***This assessment is showing student progress towards achieving the full standard.**

Score of 4	Score of 3	Score of 2	Score of 1
Student was able to write a claim and show evidence using a model and words.	Student was able to write a claim and show evidence using a model but **some** details are missing.	Student was able to write a claim or show evidence using a model but **not both**.	Student was **not** able to briefly write a claim or create a model to provide evidence of the claim.