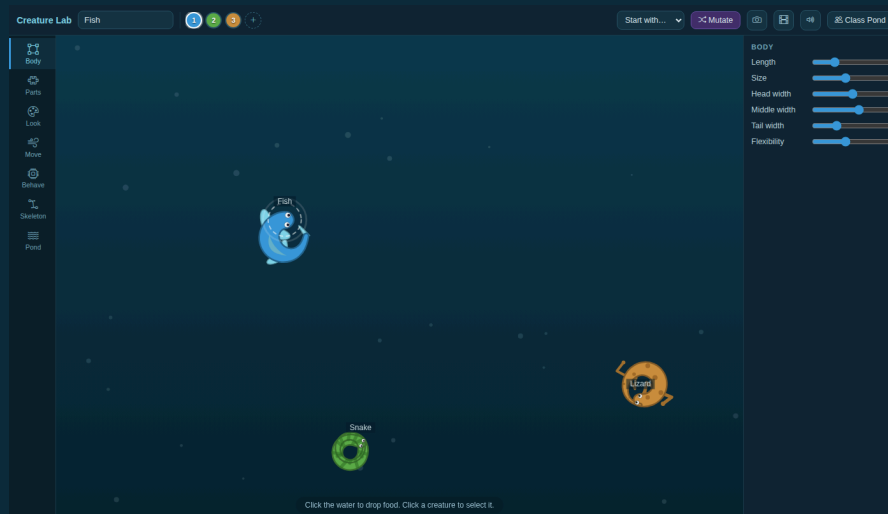


mytekDev

Creature Lab: How Far Can a Body Bend?

Grades 4-8 · 45 minutes

Math · Computer science



Slides, rubric and answer key

Print and go

No student accounts

Angles that move

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A ten-minute walkthrough to rehearse before class, and background in plain words for the teacher
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in grades 2-3 and 9-12
- Standards: Common Core math, CSTA 2017 and NGSS

Creature Lab: How Far Can a Body Bend?

Grades 4-8 · 45 minutes · Math, Computer science

Three creatures circle in a pond: a snake coils into a ring, a lizard just closes one, and a fish only makes a C. Students look under the skin and find that each body is a chain of joints, every joint following the one ahead and bending only so far. They add up the angles, predict which bodies can curl all the way around, and then find how flexible the fish must be to close its ring.

At a glance

ESSENTIAL QUESTION

How can one small rule make a whole body move?

OBJECTIVES

Students will be able to:

- describe a creature's body as a chain of joints that each follow the joint ahead
- add the bend at each joint to find how far the whole body can bend
- predict whether a body can curl into a full circle (360 degrees), then test the prediction
- change a creature's flexibility or length so that it can curl all the way around

VOCABULARY

joint, chain, rule, angle, bend, flexibility

STANDARDS

4.MD.C.7, 1B-DA-07, 4.NBT.B.5, 3-5-ETS1-3

TIME AND MATERIALS

45 minutes, grades 4-8.

- One computer or Chromebook per student or pair
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the worksheet

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/creaturelab?lesson=how-far-can-a-body-bend&ref=tpt-creaturelab-1 once on a student computer to see the three circling creatures and to check that your school's filter allows it. No account is needed.

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the completed worksheet and the student's changed fish, scored with the rubric out of 12.

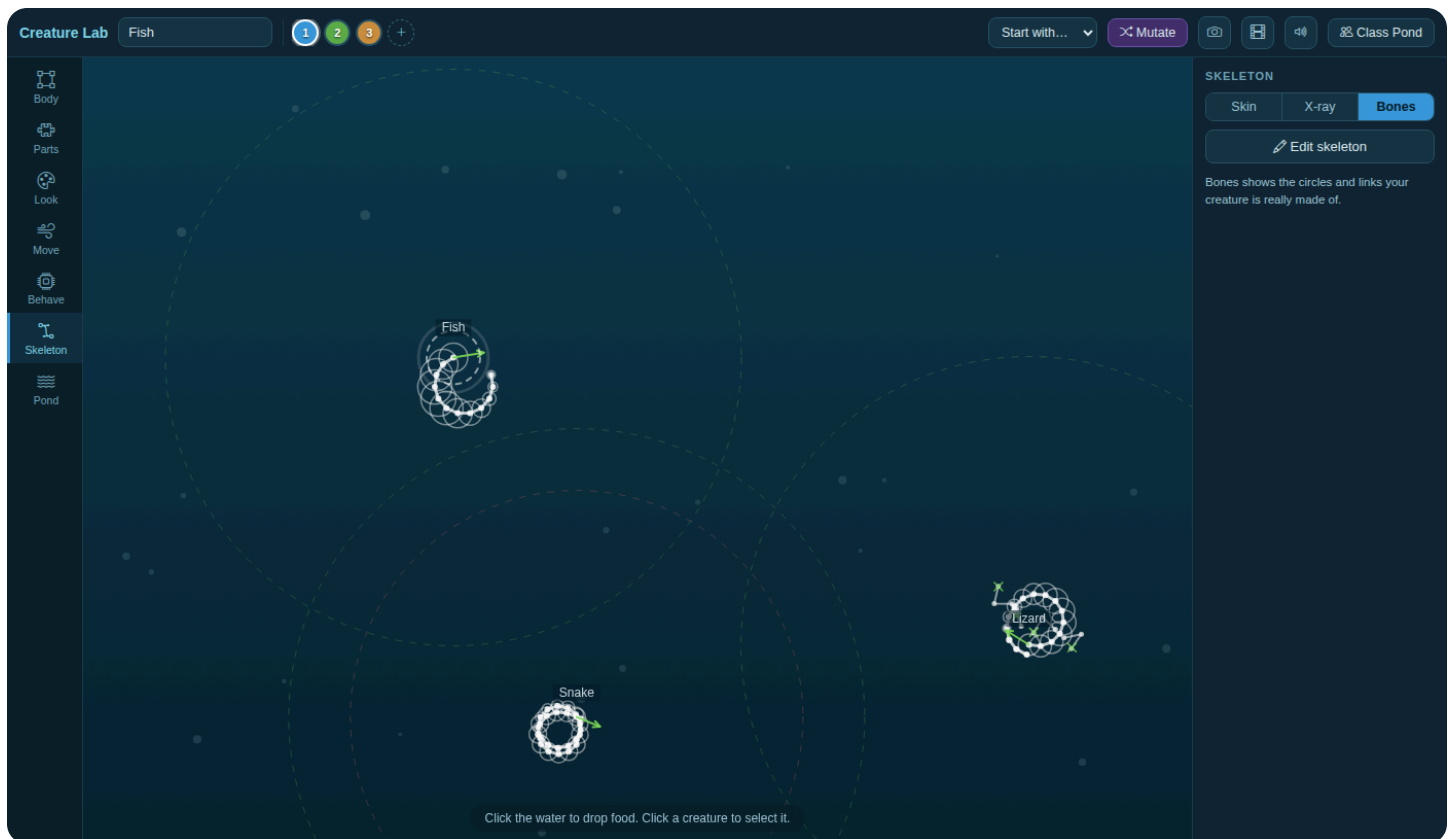
TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they make is stored on our server unless they choose to save it to an account. If your school blocks new sites, ask IT to allow mytekdev.com.

Before you teach: do it once yourself

Close the fish's ring yourself once before class, about ten minutes.

1. **Open the lesson.** Go to mytekdev.com/try/creaturelab?lesson=how-far-can-a-body-bend&ref=tpt-creaturelab-1. A fish, a snake and a lizard swim in tight circles. The selected creature's name is in the box at the top left, next to the numbers 1, 2 and 3; the fish is 1.
2. **Look under the skin.** Open **Skeleton** in the rail on the left and pick **Bones**. The snake's chain coils inside itself, the lizard's just closes, and the fish's stays a C.
3. **Make it floppier.** With the fish selected, open **Body** and drag **Flexibility** to about seven tenths of the way along. The view stays on Bones, and the fish's chain now closes into a ring.
4. **Try length instead.** Drag **Flexibility** back to two fifths of the way along, where it started. Then drag **Length** right a little at a time, counting the dots, until there are 16. The ring closes again.



Bones view with the starter: only the fish cannot close its ring.

If you see something else: if **Length** and the width sliders are missing from **Body**, **Edit skeleton** was pressed, which swaps the sliders for a hand-built skeleton; press **Reset to sliders**. **Body** changes only the selected creature, so check the name box says **Fish**. Clicking the water drops food; clicking a creature selects it.

Background in plain words

Each creature's body is a chain of joints. The head goes where the brain steers it, and every joint behind it follows one simple rule: stay the same distance behind the joint ahead. Nobody animates the tail; it falls into place because the rule repeats down the whole chain. Game and animation programmers use this same follow-the-leader trick for snakes, tentacles and ropes.

Each joint can also bend only so far from the line of the joint ahead, and the Flexibility slider sets that limit, from about 13 to about 42 degrees. Bends between joints add up, so the whole body can curl at most the number of bends times the limit. A full circle is 360 degrees. A body with too little total bend makes a C however hard it turns. A long body can close a ring even when each joint is stiff, because many small bends add up: that is how a real snake, with more than 200 vertebrae, coils.

STUDENTS ASK	A GOOD ANSWER
Why not just tell the fish to turn harder?	Its brain already turns as hard as the app allows. What stops the ring is the body: how far each joint can bend, times how many bends there are.
Why 11 bends and not 12?	A bend is the gap between two joints. Twelve dots have eleven gaps.
Why does the snake overlap itself?	Its bends add up to about two full circles, more than one ring needs, so it wraps around on itself.
Is the worksheet's total exact?	Close, not exact. The degrees on the worksheet are rounded, and the app measures the fish at 269 degrees, against 264 on paper.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 7	Warm-up Hook	Show the title, essential question and Today I can slides (about 1 minute). Then have students open the link or scan the QR code on the worksheet. Three creatures, a fish, a snake and a lizard, swim in tight circles: each one's brain says drift slowly and keep curving right, as hard as it can. A short guide runs along the bottom; tell students to do its first step only, then wait. Ask: "All three swim in a tight circle. Why can't the fish make a ring?"	Watch the three creatures and answer the question.

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
7 to 15	Direct instruction (I do) Model it	Show the vocabulary slide. Then, on the projector, open Skeleton in the rail on the left and pick Bones: each creature is a chain of dots. Say the rule: every dot follows the dot ahead and stays the same distance behind it, and that one rule, repeated down the chain, is the whole animation. Then show that each joint can bend only so far: open Body and point to Flexibility, which runs from about 13 degrees per joint at the left to about 42 at the right. Work the fish on the board: 12 joints make 11 bends; at its flexibility each bends about 24 degrees; $11 \times 24 = 264$ degrees, less than the 360 of a full circle, so the fish cannot close a ring however hard it turns. Watch for: Students multiply by the joints: $12 \times 24 = 288$. The bends are the gaps between the dots, so there is one fewer bend than joints.	Watch, and copy the fish's sum into the worksheet table.
15 to 23	Guided practice (We do) Predict, then look	Together, students work out the snake (26 joints, so 25 bends, at about 29 degrees: $25 \times 29 = 725$ degrees, two whole circles) and the lizard (16 joints, so 15 bends, at about 26 degrees: $15 \times 26 = 390$ degrees, just over one circle). They write yes or no for a full ring before looking. Then everyone looks in Bones: the snake's bend adds up to about two circles, so it wraps around on itself; the lizard just closes its ring; the fish makes a C. Before moving on, check that every table has all three rows.	Work out each total, predict, and check in Bones.
23 to 37	Independent practice (You do) Close the fish's ring	Walk the room and ask the questions under What to look for. Students select the fish (click it, or its number at the top), open Body and change one slider at a time: Flexibility (to the right) or Length (more joints). After each change they count the joints (the dots in Bones), read the degrees per joint from the slider table on the worksheet, work out the new total, and check it in Bones. A fish curls all the way around once its total passes 360: at its length, Flexibility about seven tenths of the way along, where each joint bends about 33 degrees ($11 \times 33 = 363$); or at its flexibility, about 16 joints ($15 \times 24 = 360$). Students who finish make the stiffest fish that still closes its ring. Watch for: Length has disappeared from Body: the student pressed Edit skeleton, which hides the simple sliders. Reset to sliders brings them back. Watch for: The slider changed the snake or the lizard. Body changes only the selected creature: click 1 at the top and check the name box says Fish.	Change one slider at a time, work out the total, and check in Bones until the fish closes its ring.
37 to 45	Closure One rule, and exit ticket	Ask the essential question again: one rule, follow the joint ahead and bend no more than so far, repeated for every joint, makes swimming, slithering and coiling. Then hand out the exit ticket.	Answer the essential question out loud, then the exit ticket on their own.

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- What is the one rule every joint follows?
- Why does a fish with 12 joints have only 11 bends?
- How far can the whole fish bend? Is that a full circle?
- Which slider did you change, and what total did you work out?
- Without trying it: would a stiff snake still make a ring? Why?

The last one is the real test. A student who works out that a long body can make a ring even when each joint is stiff, because many small bends add up, understands that the angles are additive and that the rule is repeated down the chain.

Cross-curricular extensions

- Science: real snakes have more than 200 vertebrae. Why can they coil so tightly? (Many small bends add up, just like the chain.)
- Math: a fish has 11 bends. What is the smallest bend per joint that makes a full circle? ($360 / 11 =$ about 33 degrees.)
- Art: draw a creature as a chain of circles of different sizes, as the X-ray view in Skeleton shows them.
- Computer science: Lesson 2 programs the creature's brain with rules: sense, decide, act.

Vocabulary

joint	One of the dots in a creature's skeleton. Each joint follows the one in front of it.
chain	Joints joined one after another, like the links of a necklace.
rule	An instruction a computer follows every time. Here: stay the same distance behind the joint ahead.
angle	How much something turns, measured in degrees. A full turn is 360 degrees.
bend	The angle between two links of the chain. Each joint can bend only so far.
flexibility	How far each joint can bend. Low is stiff, like a fish; high is floppy, like a snake.

Differentiation

ENGLISH LEARNERS

- Post the vocabulary with a picture for each word: the dots in Bones, an angle with its degrees, a full circle marked 360.

STUDENTS WITH IEPs OR 504 PLANS

- Where the IEP allows a modified assignment, give the multiplication answers and ask only for the yes or no prediction and the check in Bones.
- Allow a calculator for the totals.

- Point at each joint on the projector as you count the bends.
- Let students answer the prediction column with yes and no only.
- Pair students: one changes the slider, the other works out the total.
- Read the exit ticket aloud.

STUDENTS WHO NEED MORE SUPPORT

- Write the three sums on the board as a model:
bends x degrees = total.
- Remind students that 12 joints make 11 bends: count the gaps between the dots, not the dots.
- Check in at minute 28: has the student changed only one slider?

STUDENTS READY FOR MORE

- Find the shortest snake that still coils into a ring at its flexibility.
- Give the fish legs in Parts and look in Bones: what keeps each foot planted while the body moves?
- Open Program the brain in Behave and switch to Code. Change turn(20) to turn(5), then to turn(60). turn(5) makes a wider circle, but turn(60) circles exactly like turn(20). Why? (A creature can turn at most 6 degrees each moment, so anything bigger is the same as 6: a body has limits, whatever the brain asks for.)

Adapting for other grades

Younger students: For grades 2 and 3, do the sums together on the board and keep to the prediction and the check in Bones. Score the second and third rubric rows only (out of 8; 6 or more meets the objectives).

Older students: For grades 9 to 12, have students derive the flexibility needed for a ring as a formula, degrees per joint = $360 / (\text{joints} - 1)$, compare it with the slider, and read the app's chain code (a for loop over the joints) for the rule itself.

Student worksheet

Name: _____ Date: _____



Open the app: scan the QR code, or go to mytekdev.com/try/creaturelab?lesson=how-far-can-a-body-bend

Essential question: How can one small rule make a whole body move?

Bends = joints - 1. Total bend = bends x degrees per joint. A full circle is 360 degrees. Count the joints as the dots in Bones.

Flexibility slider: all the way left = 13 degrees per joint, a quarter = 20, halfway = 27, three quarters = 35, all the way right = 42.

CREATURE	JOINTS	BENDS	DEGREES PER JOINT	TOTAL BEND	FULL RING? (PREDICT)	BONES SAYS
Fish	12		24			
Snake	26		29			
Lizard	16		26			
My fish 1:						
My fish 2:						

1. **Look under the skin.** Open **Skeleton** in the rail on the left and pick **Bones**.
2. **Change one thing.** Pick the fish, open **Body**, change **Flexibility** or **Length**, then work out the new total.

1. What is the one rule every joint follows?

Exit ticket

Name: _____

1. A creature has 10 joints. How many bends does it have? (A) 10, (B) 9, (C) 11.
2. A creature has 20 bends, and each can bend 20 degrees. Can it curl into a full circle? (A) yes: 400 degrees is more than 360, (B) no: 40 degrees is too little, (C) no: 20 is less than 360.
3. A fish cannot close its ring. Name two different changes that could help, and say why each one works.

Exit ticket

Name: _____

1. A creature has 10 joints. How many bends does it have? (A) 10, (B) 9, (C) 11.
2. A creature has 20 bends, and each can bend 20 degrees. Can it curl into a full circle? (A) yes: 400 degrees is more than 360, (B) no: 40 degrees is too little, (C) no: 20 is less than 360.
3. A fish cannot close its ring. Name two different changes that could help, and say why each one works.

Answer key: worksheet and exit ticket

Measured in the app with the starter's three creatures circling as tightly as they can: the fish curls 269 degrees, the lizard 372, the snake 712. The worksheet's rounded degrees give 264, 390 and 725: close, because the slider's degrees are rounded to whole numbers.

CREATURE	BENDS	TOTAL BEND	FULL RING?
Fish	11	$11 \times 24 = 264$	No
Snake	25	$25 \times 29 = 725$	Yes, and it wraps around on itself
Lizard	15	$15 \times 26 = 390$	Yes, just

Closing the fish's ring: Flexibility about seven tenths of the way along (about 33 degrees per joint: $11 \times 33 = 363$), or Length up to about 16 joints at the same flexibility ($15 \times 24 = 360$), or a mix of both.

EXIT TICKET	ANSWER	WHY
1	B	The bends are the gaps between joints, so there is one fewer bend than joints.
2	A	$20 \times 20 = 400$ degrees, more than 360, so the body can curl all the way around.
3	Any two of: more flexibility (each bend is bigger); more length or joints (more bends to add up)	Full credit for two changes with a reason about the total bend.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Adds the bends	Every total is right, with bends counted as joints minus one, and the student explains why it is one less.	Every total is right, with bends counted as joints minus one.	Totals are worked, but some count joints instead of bends.	Totals are missing.
Predicts, then checks	Every prediction was written before looking, matches Bones, and any surprise is explained.	Every prediction was written before looking and checked in Bones.	Some predictions are checked, or written after looking.	No predictions are written.
Closes the fish's ring	The fish curls all the way around, with one slider changed at a time, and the student can say the smallest change that works.	The fish curls all the way around, with one slider changed at a time.	The fish curls further than before but not all the way around.	The fish is unchanged.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The math standard is the center of this lesson: students add the angle at every joint to find the whole body's bend. The CSTA 2017 standard covers predicting from data.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
Common Core Math	4.MD.C.7	4	Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.	Students add the bend at each joint to find the whole body's bend, and compare it with the 360 degrees of a full circle.
CSTA 2017	1B-DA-07	3-5	Use data to highlight or propose cause-and-effect relationships, predict outcomes, or communicate an idea.	Students use joints and degrees per joint to predict which creatures can curl into a ring, then check in the Bones view.
Common Core Math	4.NBT.B.5	4	Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	Students multiply bends by degrees per joint, such as 25 x 29 for the snake and 15 x 26 for the lizard, to find each body's total bend.
NGSS	3-5-ETS1-3	3-5	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Students change one setting at a time, Flexibility or Length, test each change in Bones, and use the fish's C shape as the failure point that shows what to improve until it closes its ring.

Checked October 2026 against: Common Core State Standards, Grade 4 Measurement and Data, CSTA 2017 progression chart, Common Core State Standards, Grade 4 Number and Operations in Base Ten, NGSS 3-5 engineering design.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up. Work stays in the browser tab until it is closed.

To keep students' work, and see every student's creatures in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/creature-lab/lessons/how-far-can-a-body-bend/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time. A student who started at the worksheet link and then signs up keeps what they made.

Creature Lab's chain and animal rigging are ported from animal-proc-anim by argonautcode, open source under the MIT License.

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