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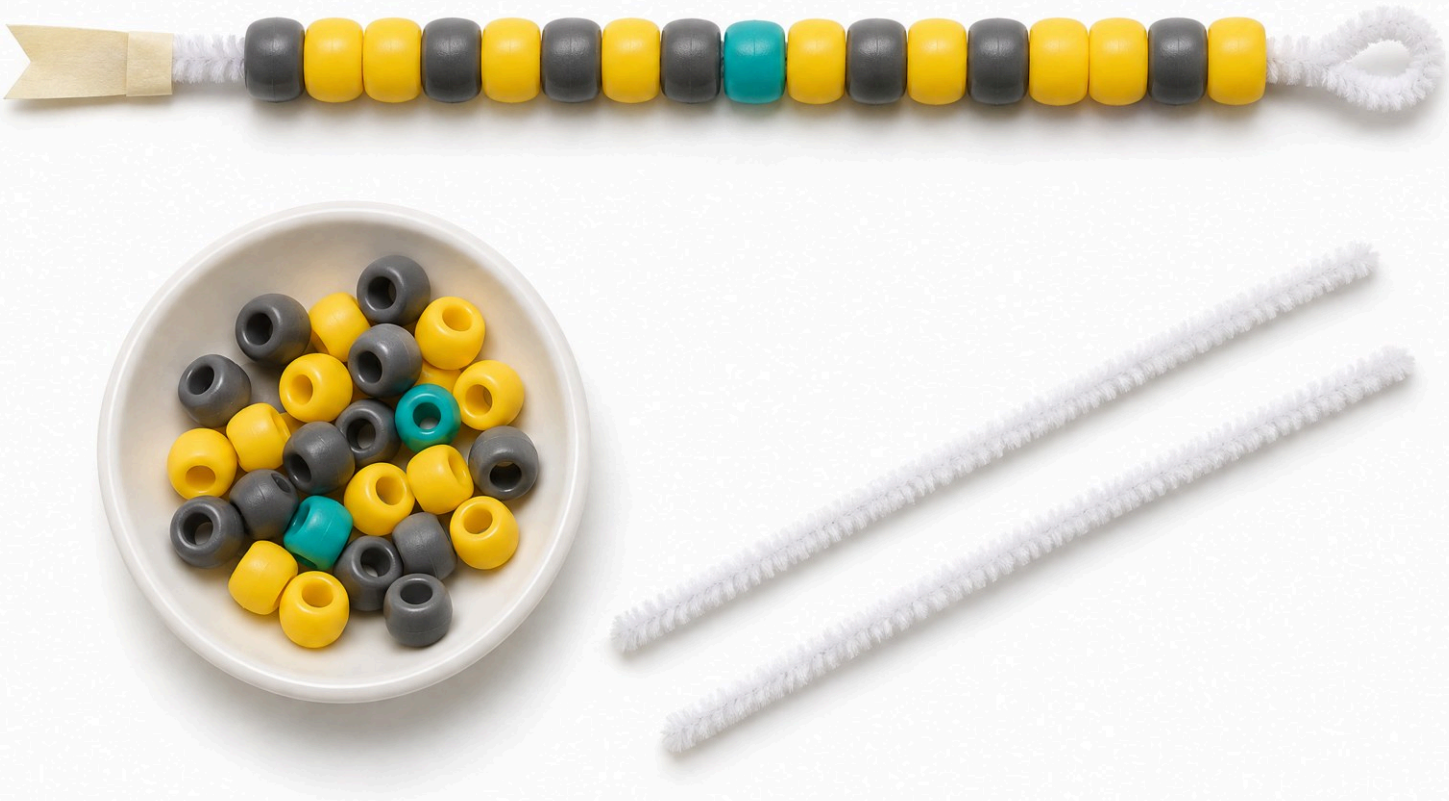

GIVE SPARK · HANDS-ON COMPUTING LAB

Binary Beads

Can you write initials in beads so that someone else can read them?

Teacher Guide

Grades 3–5 · Computer science · 60 minutes

FREE LAB

OVERVIEW

The lab at a glance

One lesson, one driving question and a strand of beads that has to work for a reader.

THE DRIVING QUESTION

Can you write initials in beads so that someone else can read them?

The test is a classmate reading the strand with no help from its maker.

What children do

Children choose one or two initials, their own or those of someone they want to make a gift for. They look up each letter in an alphabet key, copy its eight-digit code and thread eight beads in two colors to match. A classmate who has not seen the plan then tries to read the strand using only the beads, the tag and the key.

What children learn

Information can be represented with only two symbols. The order of the symbols matters, so one changed bead changes the letter. A message can only be read when the writer and the reader share the same rules.

Success looks like

1. I use my two bead colors the same way all along the strand.
2. I thread eight beads for each letter, in the order shown in the key.
3. A classmate can read my initials from the beads, the tag and the key, without hints from me.

What each child makes

One straight strand on a pipe cleaner. A tape flag marks the start. Eight beads stand for the first letter. One bead in a third color marks the gap, and eight more beads stand for the second letter. A paper tag with the color key travels with the strand. Children can twist the finished strand into a bracelet or clip it to a bag.

AT A GLANCE

Time: 60 minutes.

Grouping: each child makes a strand. Partners check each other's plans.

Standards link: supports NGSS 4-PS4-3, using patterns to transfer information.

SESSION PLAN

STAGE	MIN
Mystery strand	5
Decode together	10
Plan the code	10
Thread and check	15
Reader test	10
Fix and reflect	7
Clear away	3
Total	**60**

THE STUDENT RESOURCE

A separate three-page PDF: My Code Plan, the Alphabet Key with a cut-out tag, and Can Someone Read My Beads?

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PREPARATION

Get ready

Pipe cleaners, beads in three colors and one sample strand.

Materials

For each child

- 1 pipe cleaner, 12 inches (30 cm) long
- Up to 16 pony beads in two colors, plus 1 bead in a third color
- A 2-inch (5 cm) piece of masking tape
- The three student pages, a pencil and coloring pencils that match the beads

For each table

- A tray with the three bead colors in separate piles
- Scissors for cutting out the tag

For you

- A sample strand for the letter M, made with the steps below. Leave off the tag.

How to build a strand

1. Fold the tape around one end of the pipe cleaner to make a flag. Write START on it. This is where reading begins.
2. Thread the eight beads for the first letter, one at a time. Push each bead up against the flag.
3. Thread one bead in the third color. It marks the gap between letters and is not part of the code.
4. Thread the eight beads for the second letter.
5. Bend the bare end back on itself and twist it into a small loop, so no bead can slide off.

Pony beads grip a pipe cleaner, so the order holds while children check and swap. A child who chooses one initial stops after step 2 and makes the loop.

The color key

This guide uses charcoal for **0** and yellow for **1**, with teal as the gap bead. Any three colors work if every child at a table uses the same two code colors.



Your sample strand for M. Read from the START flag.



Each bead is pushed up to the tape flag, so the first bead threaded is the first bead read.

COUNTING BEADS

For 25 children, set out about 250 beads in each code color and 30 gap beads. Children count what their own plan needs before they collect, because the two colors are rarely needed in equal numbers.

SAFETY

Pipe cleaner ends are sharp wire. The tape flag covers one end and the loop tucks in the other. Keep small beads away from younger children at home.

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TEACHING SEQUENCE

Run the lesson

A mystery strand, a shared key, a plan a partner checks and a reader who has never seen it.

Mystery strand 5 MINUTES

DO Hold up your M strand with no color key and no alphabet key. Ask, “These eight beads stand for one letter. What would you need to know to read it?” Collect ideas until the class has named what each color means, where to start and which pattern stands for which letter.

Decode together 10 MINUTES

DO Give out the alphabet key. Tell the class that charcoal means **0** and yellow means **1**. Children write the eight digits your strand shows, then find the matching letter in the key. Then draw these two rows on the board.

A START ▶ 0 1 0 0 0 0 0 1

C START ▶ 0 1 0 0 0 0 1 1

ASK “Only one bead is different. Is it still the same letter?”

SAY *“Computers store letters as patterns of* **0***s and* **1***s. Anyone who has the same key can turn our beads back into letters.”*

Plan the code 10 MINUTES

DO On page 1, children write their one or two initials. For each letter they copy all eight digits from the key, including the first **0**, and color the eight circles to match. Then partners swap pages and check every digit against the key before anyone collects beads.

Thread and check 15 MINUTES

DO Build a strand in front of the class, following the five steps on student page 1. Children count out their beads and build their own. After each letter they lay the strand under the row on their plan and check it bead for bead. They cut out the tag on page 2 and color in its key.

Reader test 10 MINUTES

DO Each child gives a strand, its tag and page 3 to a classmate from another table. The maker keeps page 1 face down. The reader writes the digits for each group of eight and finds each letter in the key. Only then does the maker turn over the plan.

Fix and reflect 7 MINUTES

DO If the reading did not match, the maker checks three things in order on page 3: the tag, the plan against the key, and the beads against the plan. They fix the one thing that was wrong.

ASK “Could we swap both colors and keep the same message? What would the reader need to know?”

LOOK FOR

Children who say the message stays the same when the colors change, as long as the reader gets the new color key. The colors are a choice. The order is the code.

IF THE READING DOES NOT MATCH

Every digit is the opposite. The reader swapped the colors. Check the tag.

The letters come out backwards or as nonsense. The reader started from the loop end. Point to the START flag.

One letter is wrong. Lay the strand under the plan and find the first bead that differs.

The plan itself is wrong. A digit was miscopied from the key, most often the first **0**.

A reader guesses the initials. Ask for the digits first. A guess is not a reading.

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The computing and the learning

What the beads show, how to see what children understood and how to adjust the task.

The computing behind it

Binary uses two digits, **0** and **1**. One binary digit is called a bit, and each bead here is one bit. Eight bits make a byte. The alphabet key uses the standard computer codes for capital letters, known as ASCII, written with eight digits. In that code every capital letter begins with **0 1 0**, which is why the first three beads of every letter look the same.

The beads make three ideas visible. Two symbols are enough to write any letter. Changing the order changes the meaning. A message can be read by anyone who shares the rules, so this is a code and not a secret.

What to look for

LOOK FOR	EVIDENCE IN THE TASK	A USEFUL QUESTION
A consistent code	The same color means the same digit all along the strand	“Which color is your **0**? Show me on the tag.”
Attention to order	The beads match the plan, bead for bead from the flag	“What happens if I read it from the other end?”
Shared rules	The reader needs only the strand, the tag and the key	“What would a new reader need from you?”

A correctly threaded strand does not show understanding by itself. Ask each child to decode one letter from someone else’s strand, or to explain why A and C differ by one bead.

Support and challenge

Support. One initial is a complete message. A child can also color the circles on the plan and have a partner thread while they direct and check.

Challenge. Ask how many different patterns eight beads in two colors can make. Children can start with two beads and three beads and look for the pattern.

Ideas children often bring

A CHILD MIGHT SAY	YOU COULD RESPOND
“Yellow always means 1.”	It does on our key. Another class could choose the opposite, and their reader would need their key.
“It is a secret code.”	Anyone with the key can read it. Codes like this are for sharing information.

WHY THE GAP BEAD MATTERS

Without a gap, a reader has to count to eight perfectly to find where one letter ends. The third color shows the break at a glance, and it gives you a quick way to check a strand from across the table.

MAKE IT A GIFT

Twist the two ends together for a bracelet, or hook the loop onto a bag or key ring. The tape flag still marks the start. Send the tag and the alphabet key home with it.

LONGER LESSON

With 90 minutes, children write a three- or four-letter word across two pipe cleaners and add a short note that explains why they chose it.

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My code plan

Can you write initials in beads so that someone else can read them?

Name _____ **Date** _____

1 My message

Choose one or two capital letters. They can be your initials or the initials of someone you are making this for.

My letters ☐ ☐ They are the initials of _____

2 My color key

Color the three circles to match your beads.

◯ means **0** ◯ means **1** ◯ is my gap bead

3 My code plan

Find each letter in the alphabet key. Copy all eight digits into the squares, including the first **0**. Then color each circle to match its digit.

LETTER 1 ☐ START ▶ ☐☐☐☐☐☐☐☐ digits on top beads below

LETTER 2 ☐ START ▶ ☐☐☐☐☐☐☐☐ digits on top beads below

4 Partner check

Swap pages. Your partner checks every digit against the alphabet key.

☐ Letter 1 matches the key. ☐ Letter 2 matches the key. Checked by _____

5 Count my beads

I need _____ beads for **0**, _____ beads for **1** and _____ gap bead.

6 Build my strand

1. Fold the tape around one end of the pipe cleaner. Write START on it.
2. Thread the eight beads for letter 1. Push each one up to the flag. Check them against your plan.
3. Thread your gap bead.
4. Thread the eight beads for letter 2. Check them against your plan.
5. Bend the bare end into a small loop so no bead can slide off.

Chose one letter? Skip the gap bead and the second letter. Make your loop after your eighth bead.

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Alphabet key

Capital letters in our eight-bead code.

How to read it. In this key, charcoal means **0** and yellow means **1**. Read all eight beads from left to right. Every capital letter begins with **0 1 0**.

A	0	1	0	0	0	0	0	1	**N**	0	1	0	0	1	1	1	0
B	0	1	0	0	0	0	1	0	**O**	0	1	0	0	1	1	1	1
C	0	1	0	0	0	0	1	1	**P**	0	1	0	1	0	0	0	0
D	0	1	0	0	0	1	0	0	**Q**	0	1	0	1	0	0	0	1
E	0	1	0	0	0	1	0	1	**R**	0	1	0	1	0	0	1	0
F	0	1	0	0	0	1	1	0	**S**	0	1	0	1	0	0	1	1
G	0	1	0	0	0	1	1	1	**T**	0	1	0	1	0	1	0	0
H	0	1	0	0	1	0	0	0	**U**	0	1	0	1	0	1	0	1
I	0	1	0	0	1	0	0	1	**V**	0	1	0	1	0	1	1	0
J	0	1	0	0	1	0	1	0	**W**	0	1	0	1	0	1	1	1
K	0	1	0	0	1	0	1	1	**X**	0	1	0	1	1	0	0	0
L	0	1	0	0	1	1	0	0	**Y**	0	1	0	1	1	0	0	1
M	0	1	0	0	1	1	0	1	**Z**	0	1	0	1	1	0	1	0

Cut out this tag. Color its three circles to match your beads. Keep it with your strand.

How to read my beads

◯ means **0** ◯ means **1** ◯ is a gap

Start at the tape flag. Read eight beads for each letter. Find each group of eight in the alphabet key.

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Can someone read my beads?

The test is whether a classmate can read your strand without your help.

Name _____ **Date** _____

Give this page to your reader with your strand and your tag. Keep your plan face down.

1 My reader decodes

Reader: start at the tape flag. Write one digit for each bead. Skip the gap bead. Then find each letter in the alphabet key.

Letter 1 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ = ☐

Letter 2 ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ = ☐

Reader's name _____

2 Did it match my plan?

Yes Not yet

3 If it did not match

Check these in order. Tick the one that was wrong, then fix it.

- ☐ The tag: my color key and the START flag
- ☐ My plan against the alphabet key
- ☐ My beads against my plan

I fixed it by

_____

4 My thinking

To read my beads, someone needs to know

_____

_____

If I changed one bead in a letter,

_____

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