Byte-sized Learning, Big Impact!

Hands on CS in STEM

2025

Authored by Melinda Renteria

Agenda

- Introductions
- Play-Based Learning
- Byte Beads Design
- Computational Thinking Principles
- Game Set Up/Instructions
- Play Session
- Reflection

Think Pair
Share

Think about an activity you taught or experienced where you had fun and mastered a complex idea.

In your pair, discuss:
Just-Right Challenge: How did the activity hit the sweet spot of being neither too easy (boredom) nor too hard (overwhelm)

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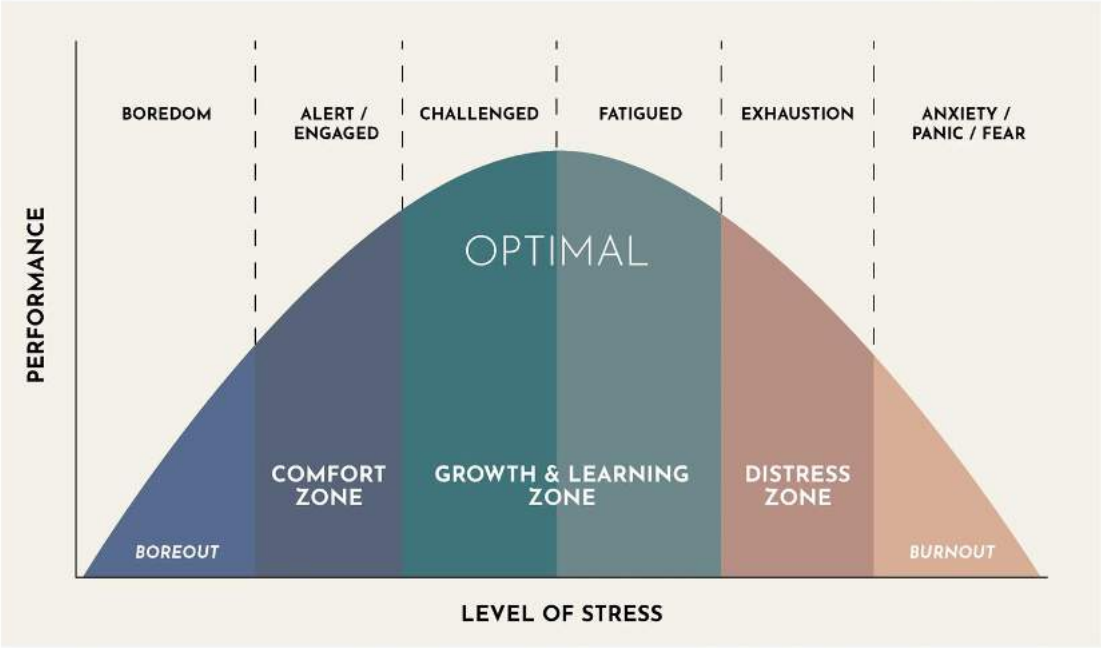
5 minutes to discuss with a partner

The Science of Learning

Yerkes-Dodson Law



More tools, guides and coaching support at thepathfinder.coach.

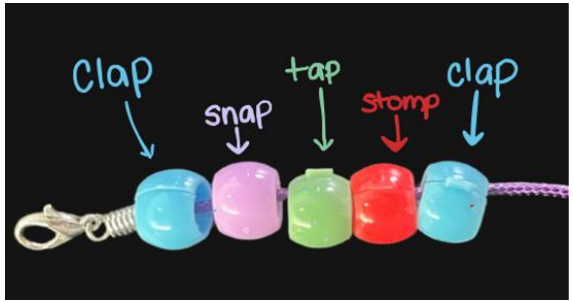
How Byte Beads Came to Be

- Literature review on instructional techniques
- Implementing a low-tech learning scaffold for MFlow
- I had a very introductory understanding of programming and data processing
- Friendship beads and yarn as tools to think with

Thinking Like a Computer

During Byte Beads, your string of beads will tell you what sounds to make.

It’s a lot like if you were a “computer” following a “code.”



Like a computer programmer, you’ll have to think like a computer as you create and change your “code,” which in this case is your sequence of beads!

Computational Thinking Competencies

Decomposing Problems

Breaking the sequences into individual elements to complete

Pattern Recognition

familiarization of sound association through game play and recognition of strategy

Abstracting Models

Using tangible materials to think through abstract of complex concepts

Algorithmic Thinking

Breaking down a problem, identifying a solution and applying this structure to future problems

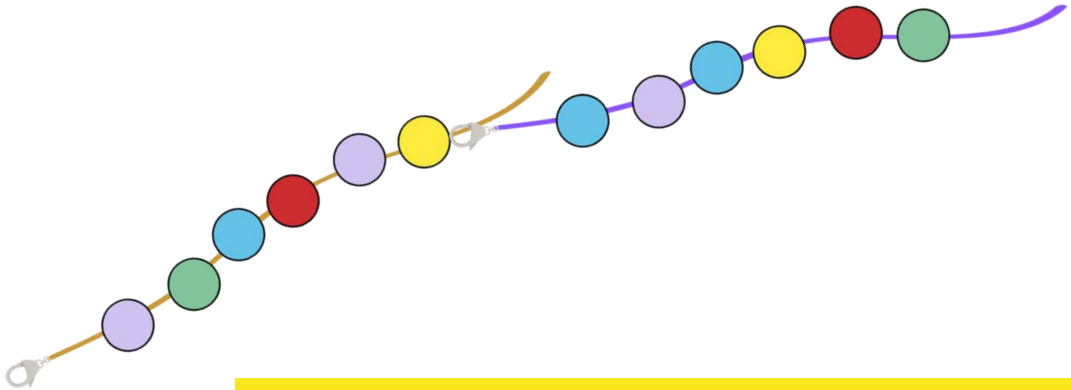
Ref: ISTE Computational Thinking Competencies complementing the CSTA K-12 CS Standards for Students

Game Introduction

The objective of Byte Beads is to introduce computational thinking and promote executive functions of students while maintaining engagement and creating a joyful experience.

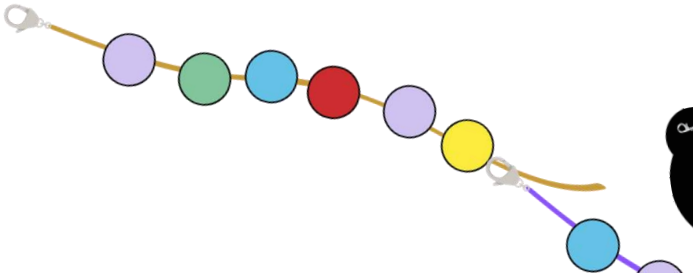
The elementary computational thinking skills incorporated into the game can help form a foundation for **higher order thinking skills** in computational domains.

Byte Beads also aims to help students practice and improve various **executive functions** including *selective attention, working memory, inhibitory control, and cognitive flexibility*. The game also aims to foster social emotional learning through its interactive and collaborative nature. These skills have been shown to be relevant to academic abilities and overall academic performance.



How to Play Byte Beads

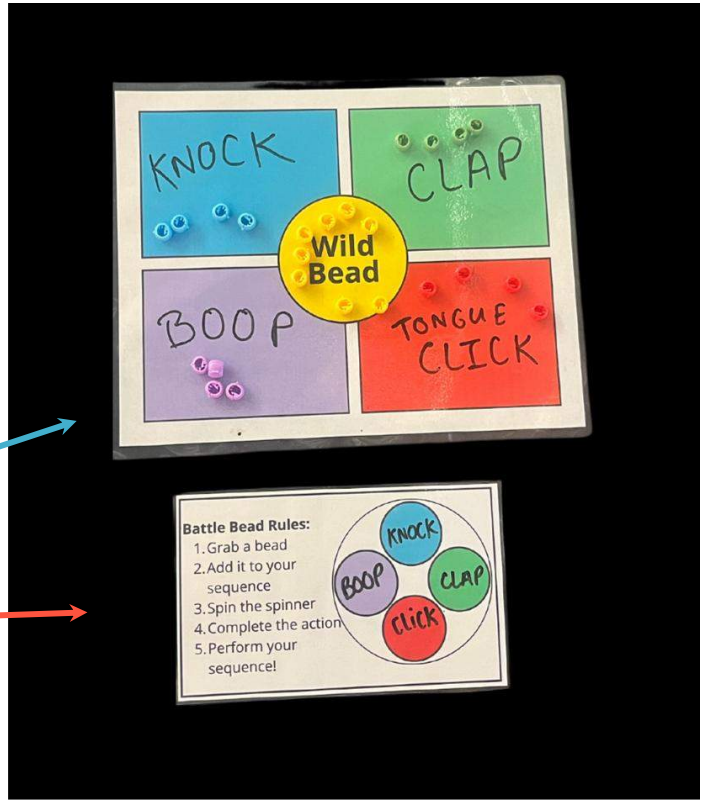
1. Game Setup
2. Warm-Up Play
3. Game



Game Setup – Assigning Colors

With your gamemates, decide what color will match up to what sound for your game.

Write the sounds on the big **Table Card** and the smaller **Player Cards** using the dry erase marker.



For Example:

Blue = Snap

Red = Clap

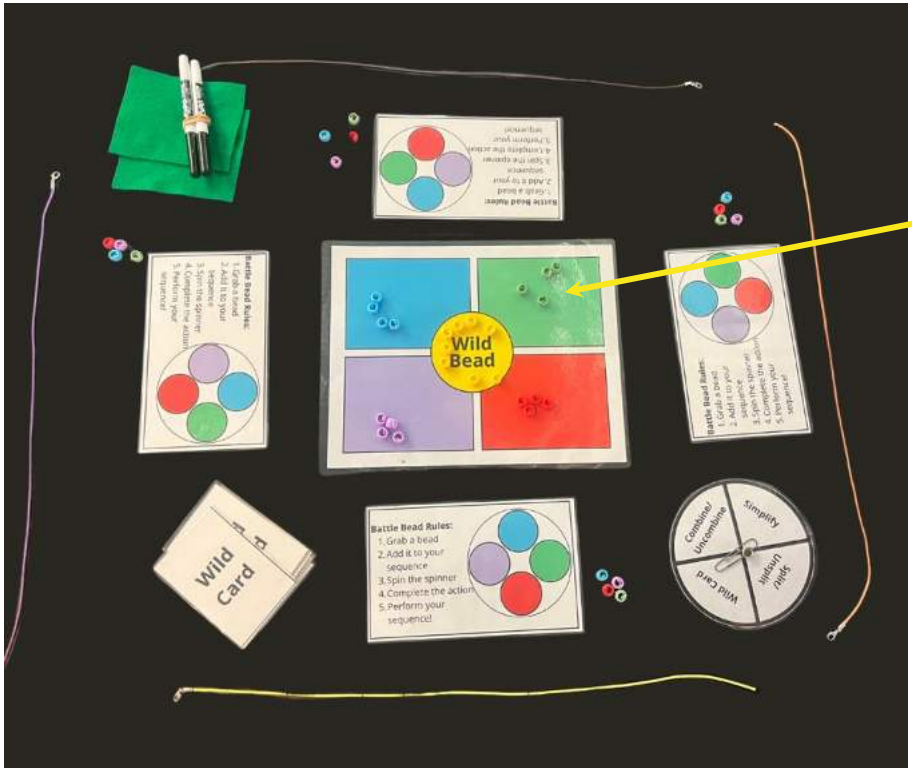
Purple = Stomp

Green = Tap (on the table)

You can also use vocal sounds, like “boom” or “boop” or “meow” etc.

Game Setup – The Game Table

Each player takes a string, a Player Card, and one bead of each of the four colors EXCEPT for yellow so that everyone has four beads.



The remaining beads go on the Table Card on top of their corresponding colors.

The spinner and the Wild Cards should be placed on the table.

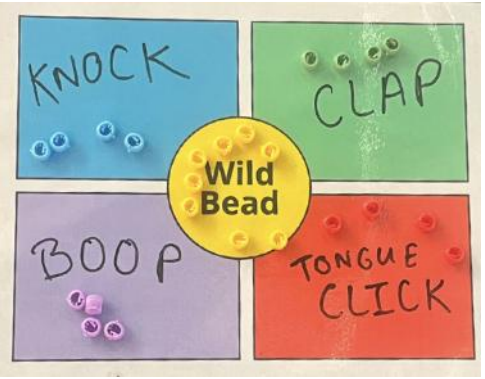
Warm-Up Round

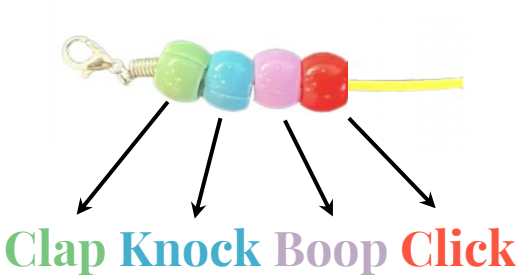
1. Put your beads on your string in any order

1. Select 1 person to start

1. Perform your sequence in the order of your beads **3 times**

1. Move onto the next person





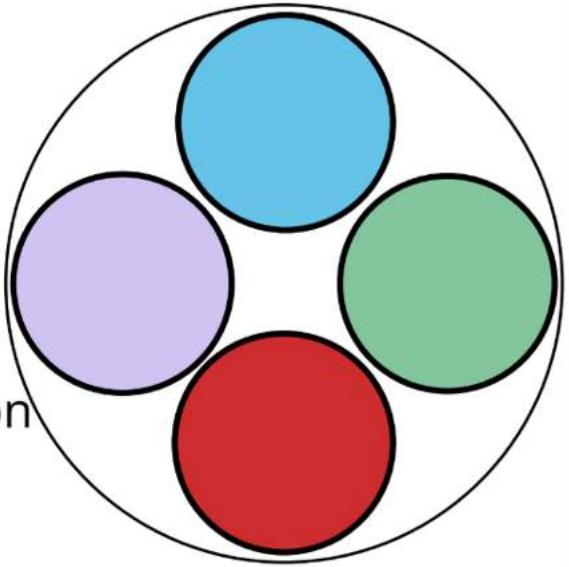
When you perform a sequence, the color of each bead shows you what sound to perform.

Look at the table card, or your player card, as you go to know what sound to make for each bead.

Game Play

Byte Beads Rules:

1. Grab a bead
2. Add it to your sequence
3. Spin the spinner
4. Complete the action
5. Perform your sequence!



The game ends when you run out of beads or your teacher tells you time is up!

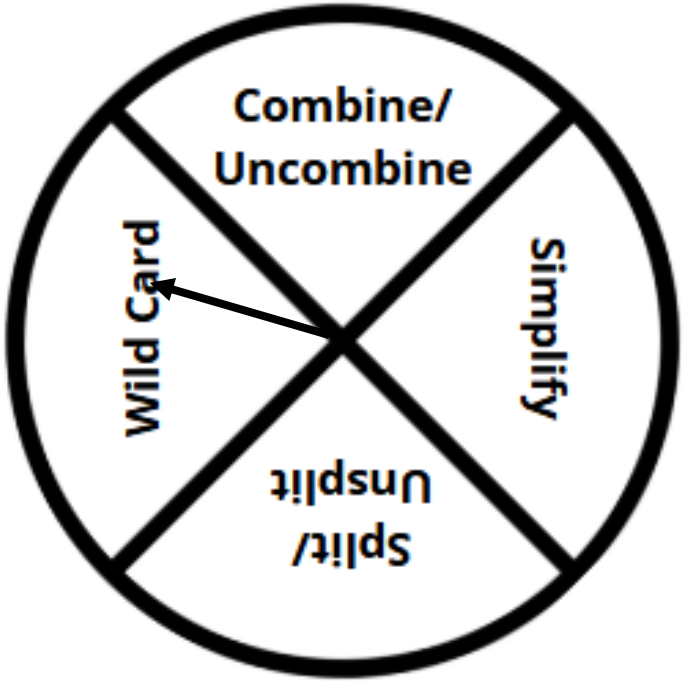
Wild Beads

If you or your teammates notice a mistake during your performance, you must add a yellow Wild Bead to the end of your string. **You can only get a Wild Bead when it's your turn, not when it's someone else's turn.**

The other players get to pick a sound for that yellow bead that you're not already using in your game. That yellow bead will make that sound for the rest of the game.

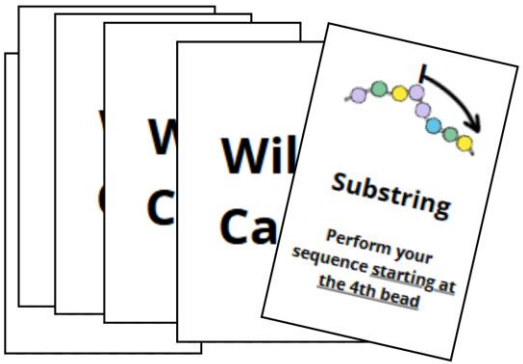
At the end of the game, the players with the fewest number of Wild Beads are the winners!

Spinner Actions



Spinner Actions

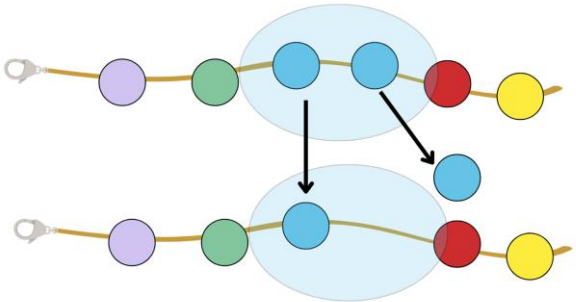
Wild Cards



Draw a Wild Card.

The challenge on the card applies **only to the player who drew it** and **only for that round**.

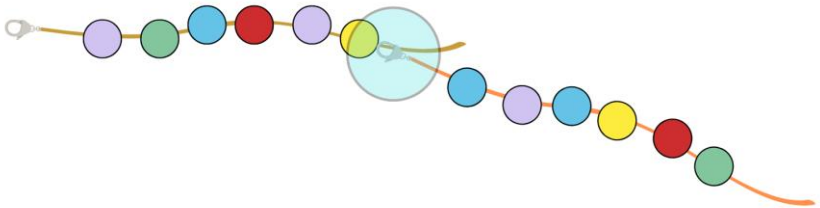
Simplify

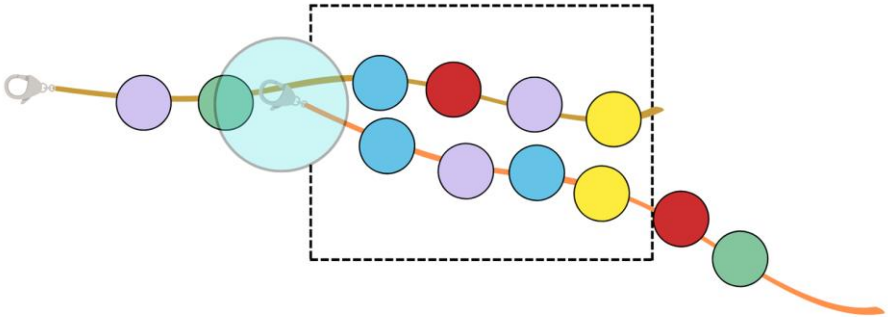


If there are two beads side-by-side of the same color, one can be removed.

If there are not, nothing happens.

Spinner Actions





Combine: Pick another player and attach that player's sequence **to the end of your sequence** using the clasp.

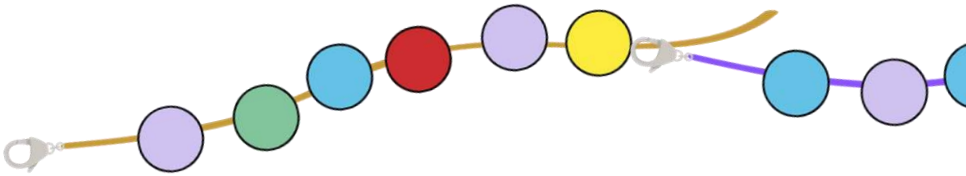
When it's time for either player to perform, you perform your sequence and then the other player performs their sequence (see diagram).

Uncombine: If your sequence is already combined with someone else's, separate your sequences.

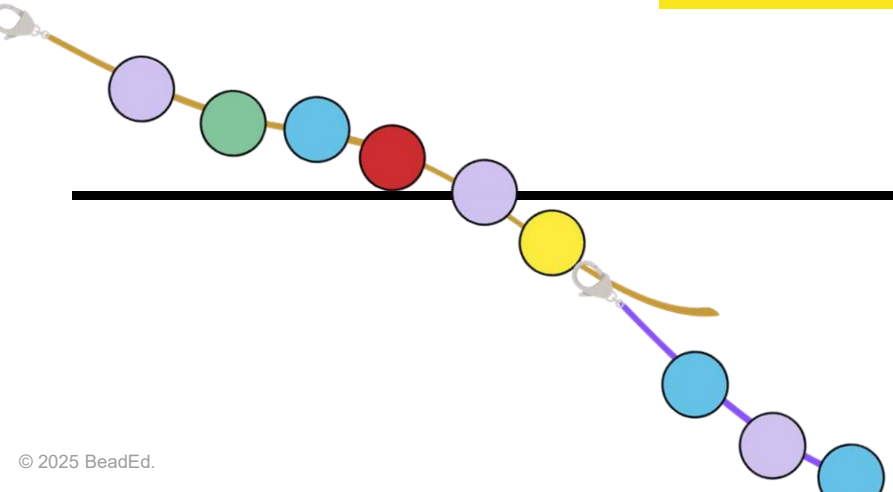
Split: Pick another player and attach that player's sequence to yours using the clasp **anywhere except at the end of your sequence.**

When it's time for either player to perform, each player performs the beads on their string with the second player starting when the branches split (see diagram).

Unsplit: If your sequence is already split with another person's sequence, separate your sequences.



Let's Play!

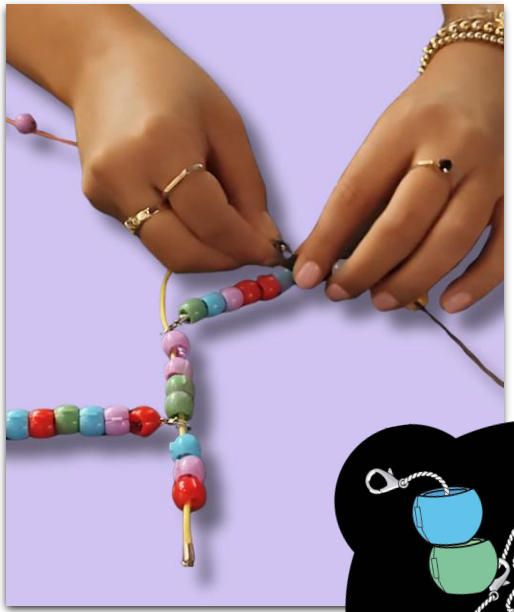


Reflection

- How many of you found this entertaining/challenging?
- How many of you realized you were learning some programming skills?
- What CS concepts did you notice?
- Did anything surprise you?
- What was the most challenging element of the game?

Part 2

- Game Review
- Learning Targets
- Introductory lesson with arrays
- Computational Concepts and Executive Function Mapping



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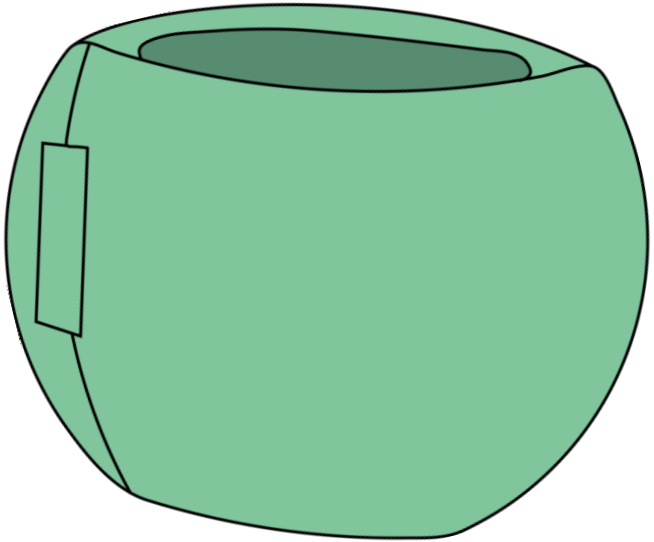
- Game Review Video
- Learning Targets
- Sample Lesson on Arrays
- Curricular Reflection
- Additional Concept Mapping
- Review

Learning Targets

- **Describe** what an array is and how it is used to store data
- **Understand** that arrays group similar information together
- **Explore** the ways a sequence of functions can be performed and manipulated
- **Identify** the location of an element
- **Explain** arrays using words like “index”, “element”, “sequence”

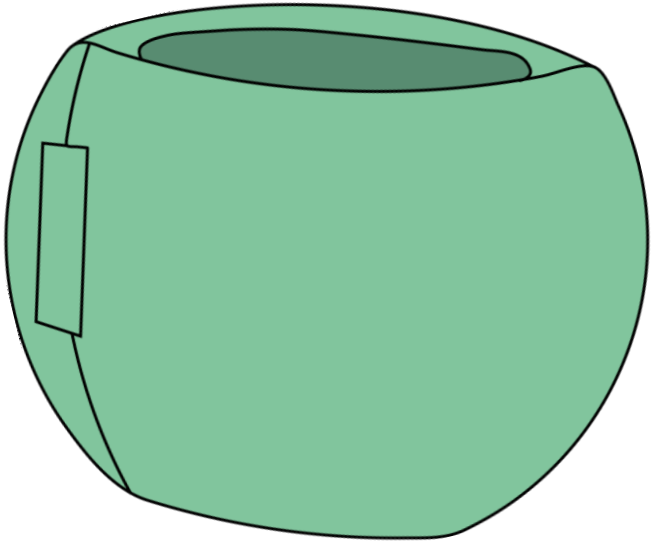
Sample Lesson on Arrays

Why is the game called Byte Beads?



What is a byte?

Why is the game called Byte Beads?

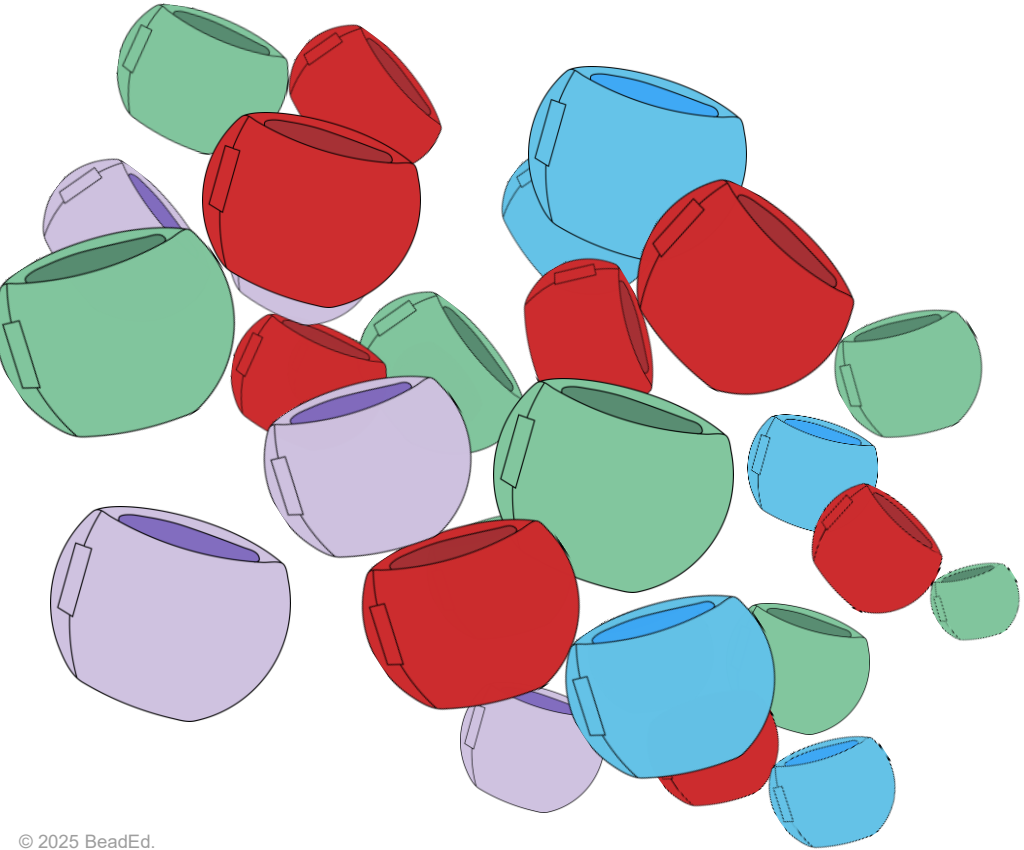


What is a byte?

Byte: a unit of data/information in computers

Each bead is a piece of information or data!

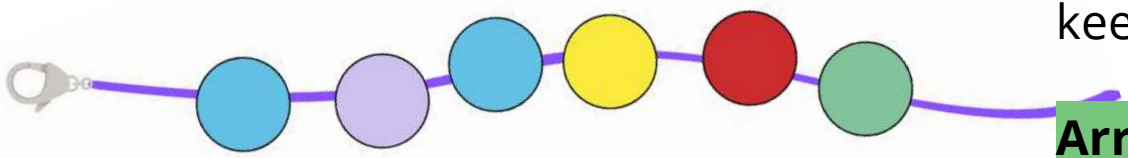
Our minds love staying organized!



We get overwhelmed if there is too much information and no organization!

Our brains always try to group information together to make it easier to understand.

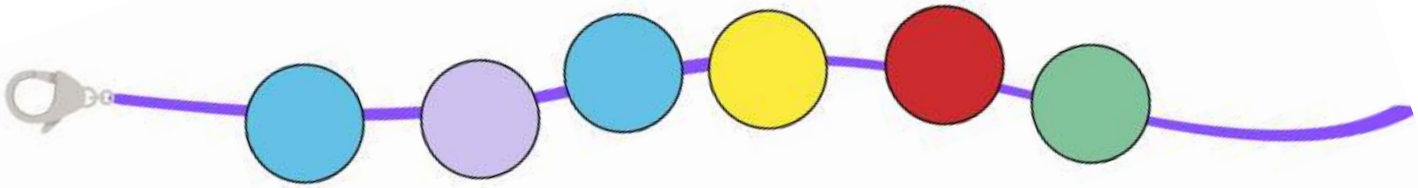
Our minds love staying organized!



We can string the information together to organize it and keep it all in one place.

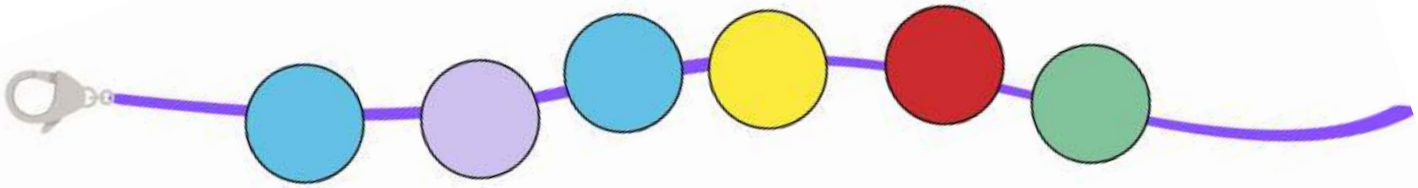
Array: a structure created when we organize information together (sequence of beads!)

Arrays like to have only 1 type of data



All the pieces on the string are beads and they all represent sounds.

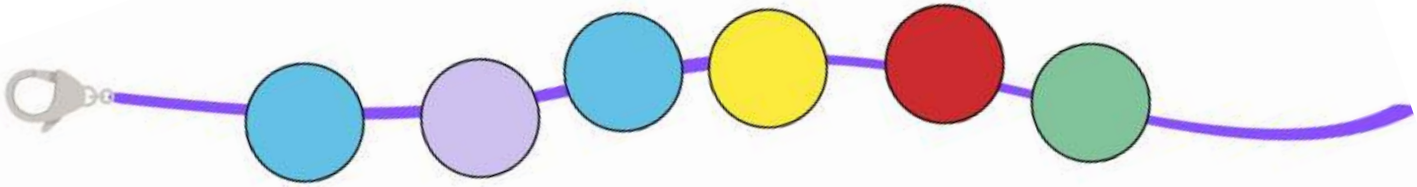
Arrays like to have only 1 type of data



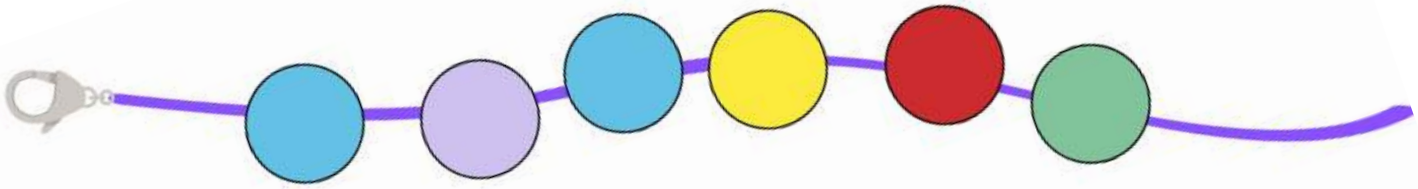
All the pieces on the string are beads and they all represent sounds.

The color, specific sound, size can be different, but they are all still beads!

How many elements are in this array?



How many elements are in this array?

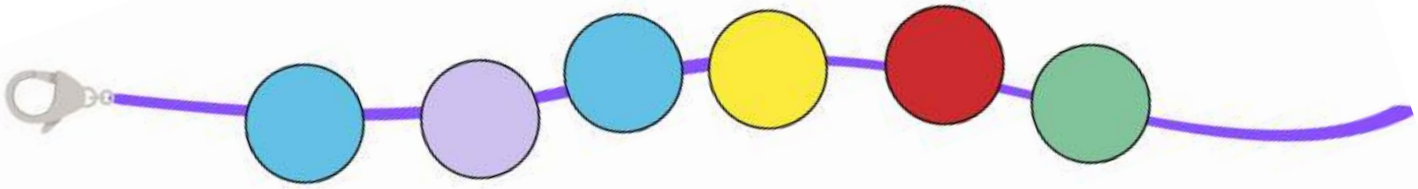


purple_sequence					
0	1	2	3	4	5

The first element in an array is actually counted as 0.

What is the position of the yellow bead in my purple sequence?

How many elements are in this array?



purple_sequence					
0	1	2	3	4	5

The first element in an array is actually counted as 0.

What is the position of the yellow bead in my purple sequence?

purple_sequence[3] = yellow

Curricular Reflection

Glow & Grow

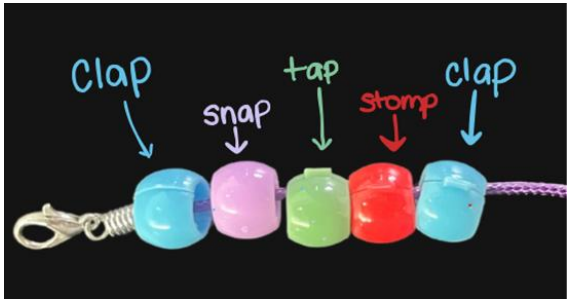
Let’s chart it out! Divide the page into 3 sections and brainstorm with a partner.

Glow	Grow	Additional Teachable Topics
Good things about the lesson/game	Constructive feedback, revisions, things you might do differently	Other subjects/disciplines that can be taught using BB

Consider which computational concepts were taught/practiced (arrays, algorithms, loops, etc.), how can the game be adapted to teach different subjects, possible assessment measures

Conceptual Mapping

Computational Thinking Concepts



Decomposition- breaking down the sequence to one bead at a time

Pattern Recognition - familiarization of sound association through game play and recognition of strategy

Model Abstraction - beads represent programming

Algorithmic Thinking - recognize a problem (performing the sequence) and evaluate the steps required to solve the problem (break down the sequence into steps, first clap, then snap)

Programming concepts teachable using the game:

- Arrays - sequences of beads representing the data structure for arrays
- Indexing - referring to a particular bead in the sequence
- Data types - colors of the beads are representative of the kind of information associated with them, ie the sound and action pairs
- Value stored - associated sound-action pairs

This offers further exploration into functions as a systematic group of actions to be performed as demonstrated by the spinner wheel actions in the next slide.

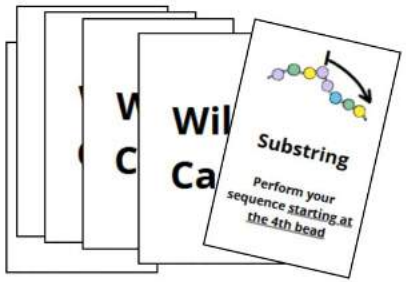
Programming Concepts in Spinner Actions

Wild Cards

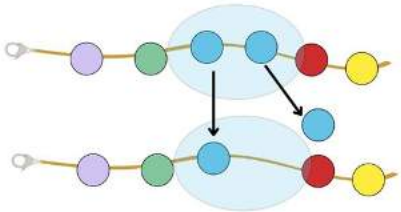
Loops

Substrings

Reverse Traversal



Simplify



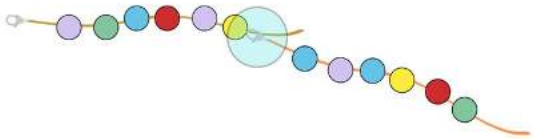
Data Compression

Code Optimization

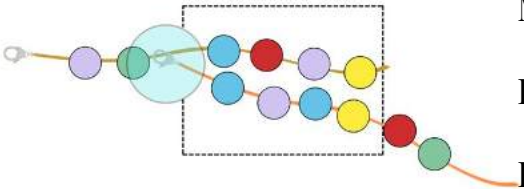
Combine

Concatenation

Appending



Split



Parallel Processing

Multi-threading

Branching

Forking

Linked List Example

Sound Sequence (Linked List)

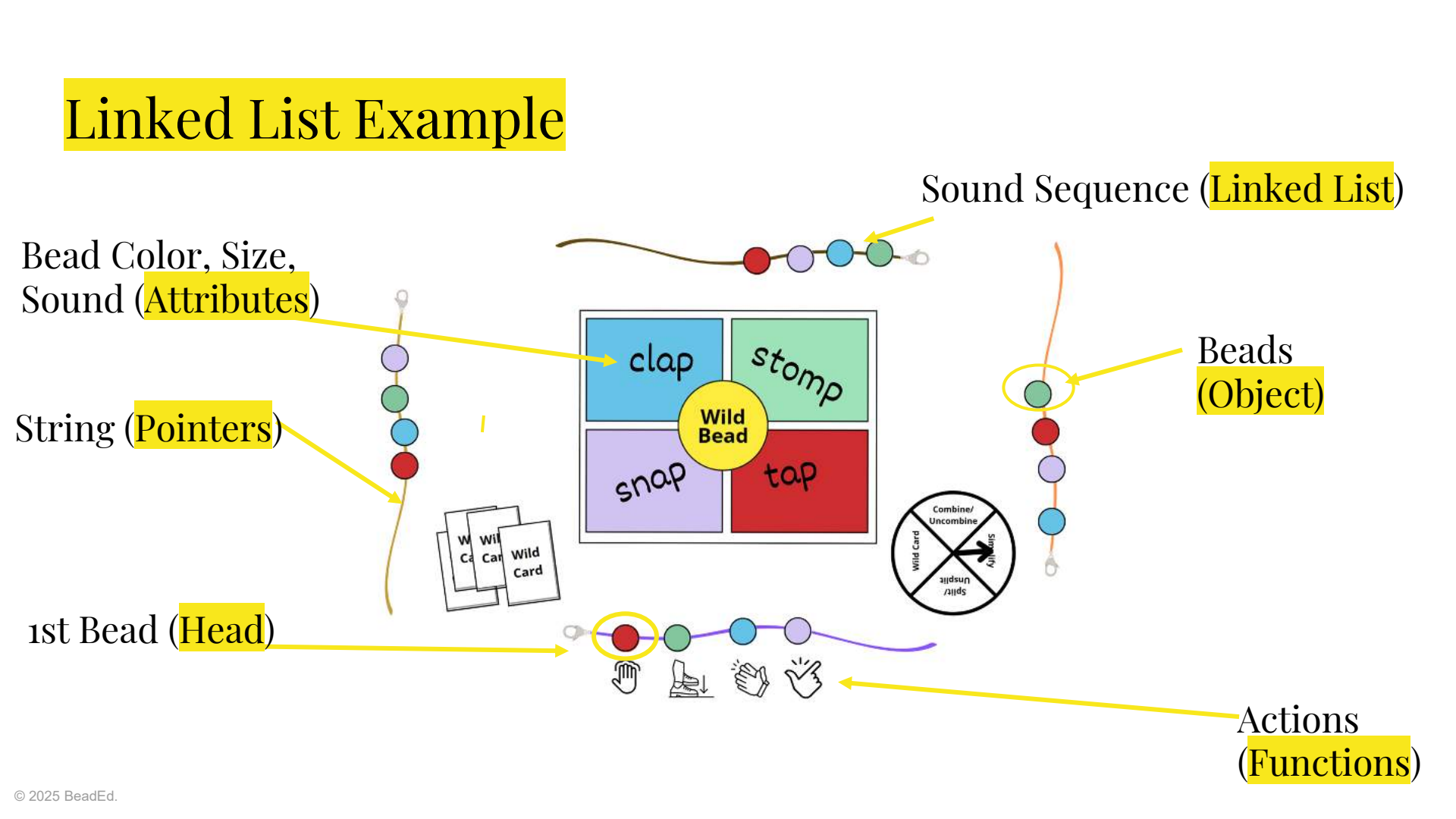
Bead Color, Size, Sound (Attributes)

String (Pointers)

Beads (Object)

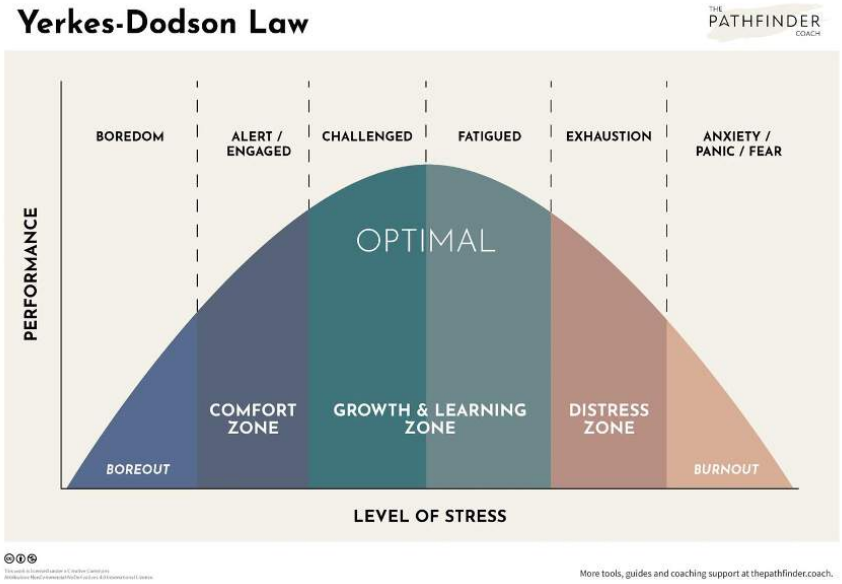
1st Bead (Head)

Actions (Functions)



Executive Functions Make Strong Learners

- Transferable skills that help with any subject or discipline
- Improves concentration and resilience
- Aid in achieving goals
- Boosts Academic success
- Enhances Social Skills
- Builds independence



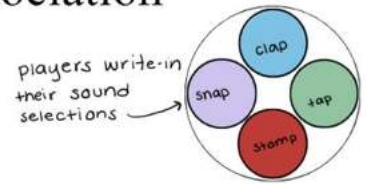
Executive Functions in Byte Beads

Working Memory: Players must keep in mind what sounds are associated with which colors and which Wild Beads while performing. Players also must keep track of how the sequence is changing in terms of Wild Card, splits, and combines.

Inhibitory Control: Players must perform the right sounds at the right time and perform their sequences at the right time in relation to other sequences (e.g. being able to wait for your time to perform). Players must also inhibit the sequence they have become accustomed to once beads have been added or removed or once a wild card has been drawn.

Wild Bead

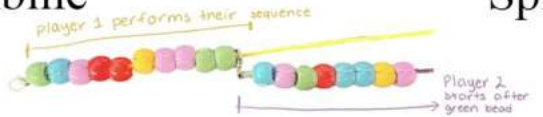
Association



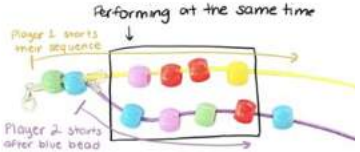
Wild Card

Simplify

Combine



Split



Attention: Players must focus on instructions, rules, and game play. They have to pay close attention to their own performance and the performances of other players.

Cognitive Flexibility: Players must learn how to play the game and then must adapt to changing rules (with the Wild Cards) and changing circumstances (e.g. splits and combines). Byte Beads also allows players to think creatively about strategy when choosing beads or choosing how to split sequences together.

Review

- Play-based learning is an effective tool
- Byte Beads is intended to offer a physical modality for learning computing concepts.
  - Arrays
  - Linked Lists
  - Computational Thinking skills
- CS is for everyone!
  - BB creates an inclusive and accessible learning environment
  - Materials can be printed and replicated or substituted for what is available

“Children learn best by making and experimenting not by memorizing facts” -Logo

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Thank You!

thebeaded.org

melinda@thebeaded.org