

A Better STEM Toy

Noble Jones

Fall Thesis 2024



Your Favorite Toys



Who here remembers their favorite toy growing up?



Your Favorite Toys

Who here remembers their favorite toy growing up?



Your Favorite Toys

Who here remembers their favorite toy growing up?

Who here still has that toy?



Your Favorite Toys

Who here remembers their favorite toy growing up?

Who here still has that toy?



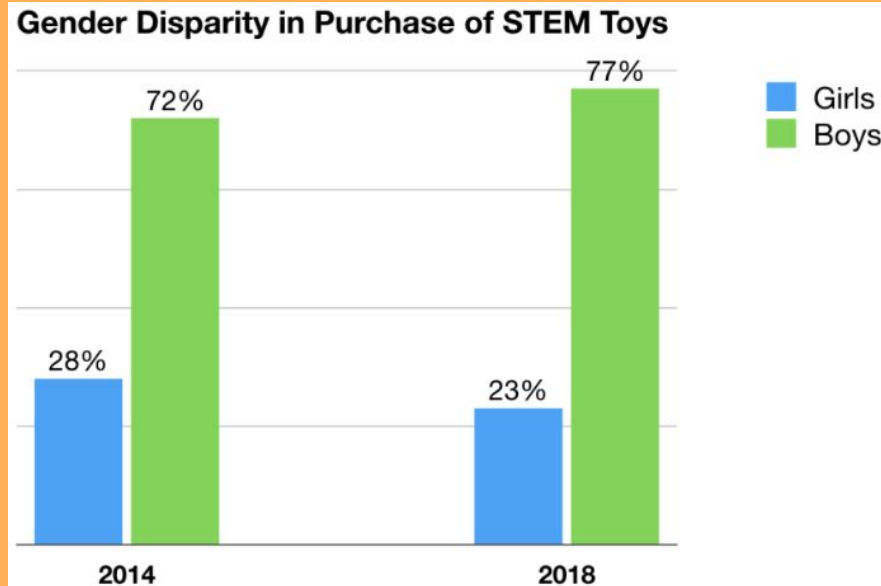
Your Favorite Toys

Who here remembers their favorite toy growing up?

Who here still has that toy?



Because we are here in this program, and in this career field, I can make a general guess that the majority of the toys we thought of tied to creativity and problem solving, but this gender spread is not case with the majority of Americans. In fact...

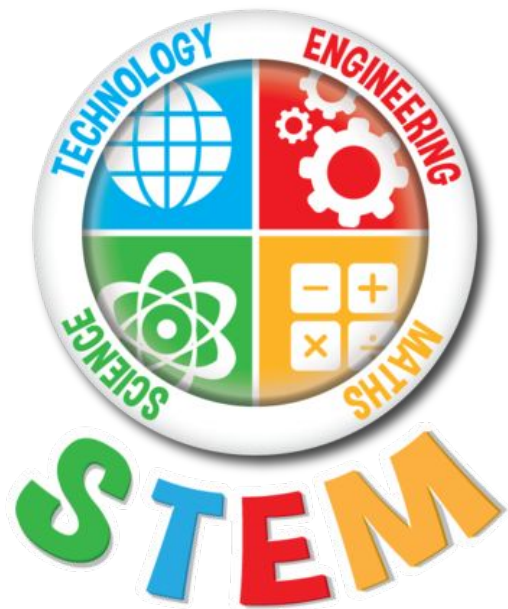


American Society for Engineering Education, 2020

Challenge

For children aged 3-5 years old, there is a large gender gap in which children are getting STEM toys, with boys getting the overwhelming majority of the STEM toys. This is both fueled by and reinforces the current stereotypes and the gender gaps in STEM careers and toys today.

My challenge was to design and create a new STEM toy or line of toys that work towards shrinking this gender gap, and promotes a more equitable future.



Challenge

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My challenge was to design and create a new STEM toy or line of toys that work towards shrinking this gender gap, and promotes a more equitable future.

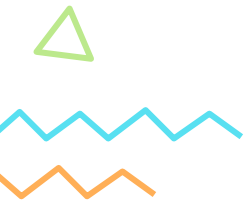




Current Literature



“[Our research] suggests that **exposing students to STEM at a young age goes a long way** in capturing their imagination and keeping them interested in science, technology, engineering, and math jobs in the early stages of their career.” - LittleBits



“While overall, male students performed better than female students on the test, the young women and men who played with construction-based toys and spatially demanding video games performed equally well.

In other words, when researchers controlled for the impact of childhood play patterns, gender differences disappeared. ” - The Swaddle

“Research by the Institution for Engineering and Technology (IET) found that toys with a science, technology, engineering and maths (Stem) focus were **three times as likely to be targeted at boys than girls** . And despite high-profile recent campaigns that have had some success, **toys for girls are still overwhelmingly pink.** ” - The Guardian

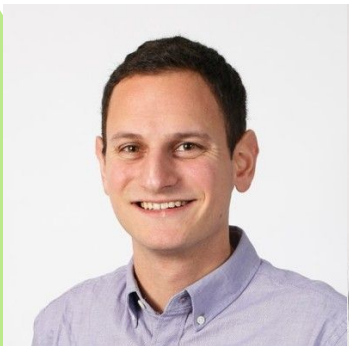
Thank You

Academic Experts

P.H.D.s, Published
Researchers, and
Professors in Early
Childhood Edu.



bennett
day school



Industry Experts

Toy Designers



The background features a large green semi-circle at the bottom. Scattered around it are various colorful geometric shapes: blue and orange zig-zag lines, green and blue triangles, and green circles. The word "Research" is written in orange at the top center.

Research

Here's what I
learned...

Insights → How Might We's

Well-meaning parents often use language like 'it's okay' for girls to play with STEM toys, but this phrasing unintentionally reinforces the stereotype that STEM is a male domain, **requiring girls to seek permission**. Instead, **girls should feel empowered** to explore STEM fields as if they belong in that space, because they do.

"It's okay if she likes to fix things with wires and rubber bands and it's okay if he likes to fix things with a needle and thread... at least we're saying it's okay."


- Frances Judd, Principal of the Bennett Day School

HMW create play experiences that empower girls to see themselves as capable STEM learners without needing external validation?




Insights → How Might We's

Open-ended play and **child-led exploration** foster a deeper understanding of STEM by encouraging children to set their own challenges and **learn from mistakes** . However, while STEM toys for boys often embrace these principles, those for girls frequently do not, potentially **undermining their confidence in problem-solving and exploration** .




HMW design STEM toys that tap into children's natural curiosity and encourage them to embrace trial and error?





Insights → How Might We's

While many buyers desire STEM toys for their daughters, they are often put off by the **heavily gendered STEM toys**, and feel that **overly “girly” toys are inauthentic and inferior**, which they fear will limit their child's opportunities or reinforce harmful stereotypes. Instead, **children and buyers** tend to prefer toys and activities that they feel are **relevant to their interests and meet them where they're at**.



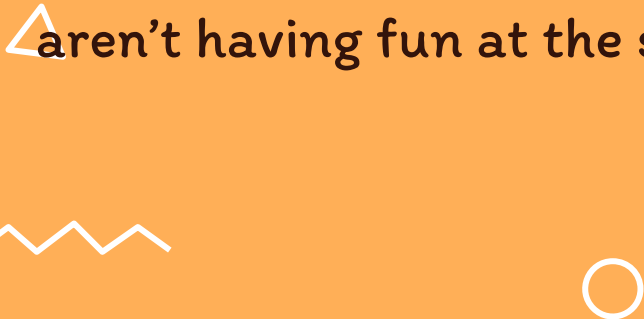
*"Gender-specific marketing and content was seen as **less authentic and inferior**, especially when you start adding the color **pink** for the sake of trying to reach girls." - Khushbu Kshirsagar; S.T.E.M. Toy Designer & Learning Sciences PhD*

HMW design STEM toys that aren't gendered, but is appealing to buyers that are buying for any child, especially girls.



Play = Learning

One thing you will hear often when talking to teachers and parents is that **enjoyment and fun have to be the first priority;** children won't engage and learn if they aren't having fun at the same time.



Play = Learning

Magical



One thing you will hear often when talking to teachers and parents is that **enjoyment and fun have to be the first priority;** children won't engage and learn if they aren't having fun at the same time.



Eye

Catching



Interactive



Foster

Creativity and
Imagination

I Sat Off to Design..

a new and exciting kid's toy that
helps shrink the gender gap in
STEM by encouraging curiosity
and exploration while fostering
confidence and a sense of

General Product Requirements = Brainstorming Prompts

Functional

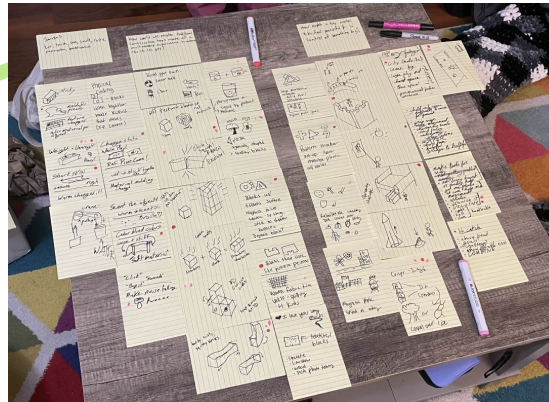
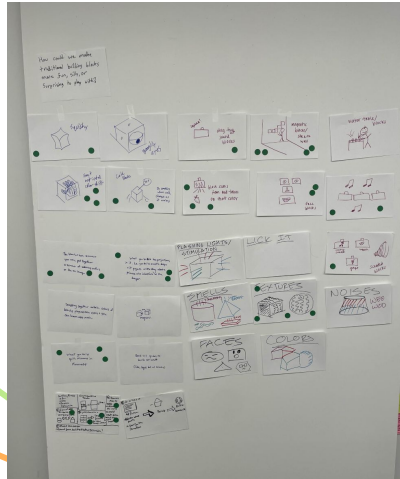
- **Emphasize Open-Ended Play and Child-Led Exploration**
- **Integrate Simple Cause/Effect**
- **Various Forms of Play**
- **Aesthetic Versatility and Neutrality**
- **Durability and Safety**

Emotional

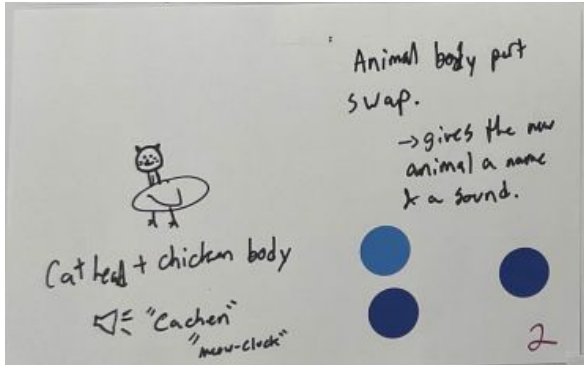
- **Must be FUN and Engaging**
- **Nurture a Sense of Agency and Ownership**
- **Encourage Curiosity and Exploration**
- **Promote Perseverance and Problem-Solving**

Brainstorming

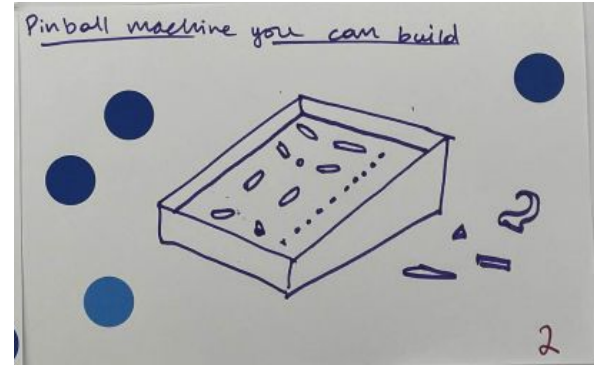
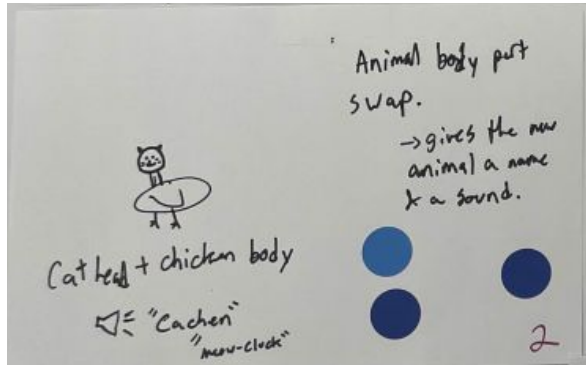
Using my design requirements as prompts, I led multiple group brainstorming sessions and we came up with a whole host of ideas.

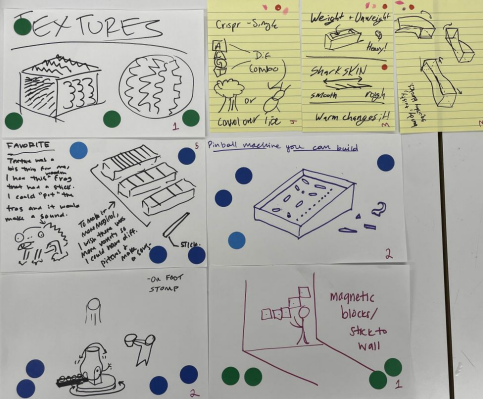
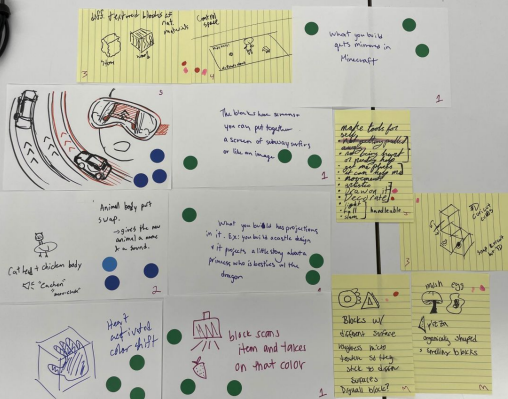
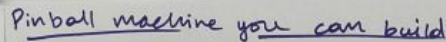
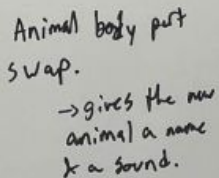


Brainstorming



Brainstorming

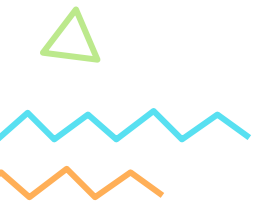




Final Concept



**“A toy that is constructed by the user
that plays sounds and lights based on its
construction.”**




Final Concept - The Why



Open-Ended Play and Child-Led Exploration

Construction-type toys allow for open-ended play, and they promote a lot of foundational STEM skills like Problem Solving and Creativity.



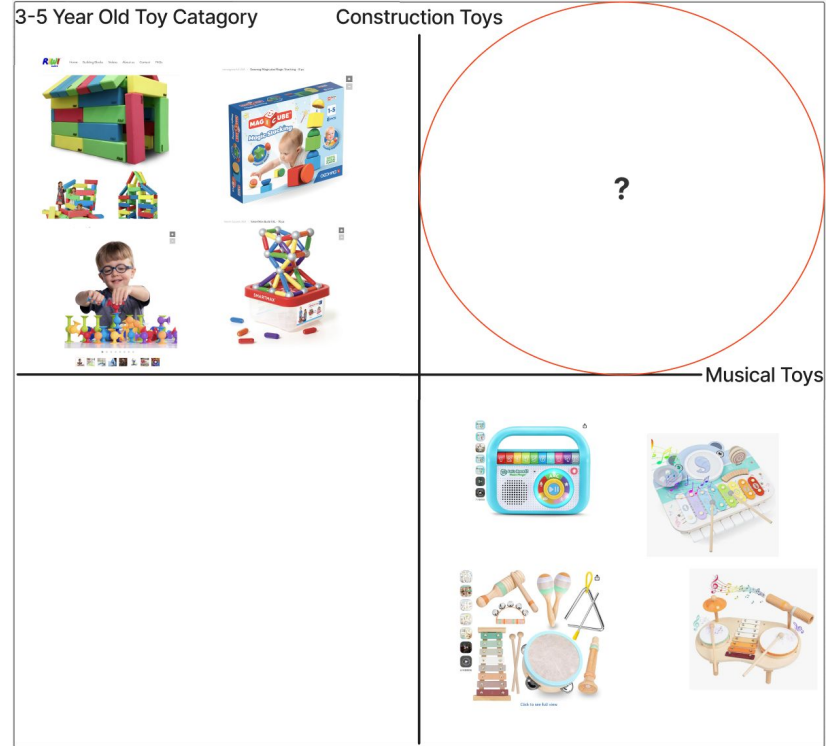
Music is Fun for All Children

Musical toys are enticing to children of all genders, ensuring that we can reach as many children as possible.

Final Concept - The Why

A Rare Gap in the Toy Market

There are currently no toys in this age group that do this, a rare gap in the oversaturated toy market.



Final Concept - The Why

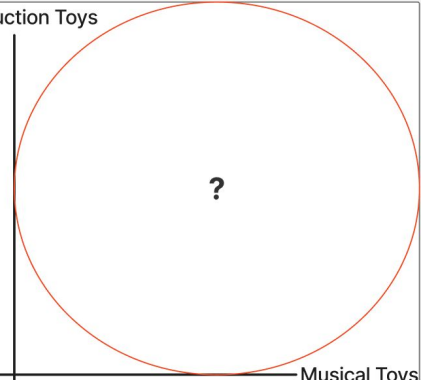
A Rare Gap in the Toy Market

There are currently no toys in this age group that do this, a rare gap in the oversaturated toy market.

3-5 Year Old Toy Category



Construction Toys



Musical Toys



E-BLOX Build Your Own DJ Set Building Blocks STEM Circuit Kit, Wireless Compatible, Mix & Create Your Own Music, Great Science Project for Kids, Birthday Gift, Boys, Girls, 8+

[Visit this & Blog Store](#)

-13% \$46⁰⁵

List Price: \$52.09

prime

FREE Returns

Pay \$46.05 \$0.00 after using available Amazon Visa rewards points

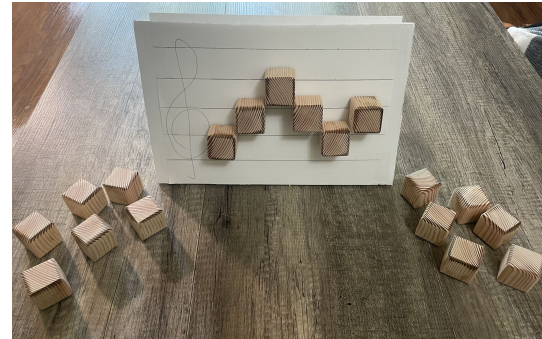
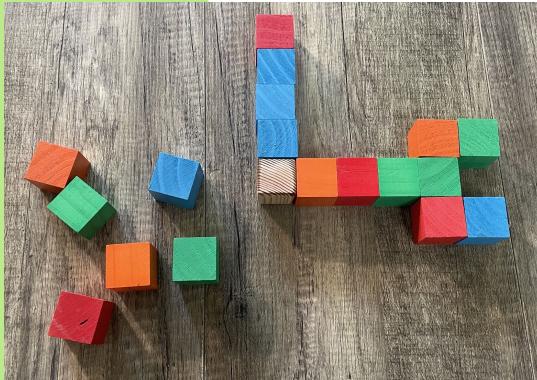
May be available at a lower price from [other sellers](#), potentially without free Prime shipping.

- LIFE OF THE PARTY – Be DJ at your next party with our BYO DJ Set. Build it, select songs by SOUL (USA), and insert sound effects like horns, scratches, and drings! Compatible with our Circuit Blox and Power Blox lines, LEGO, and other major brick brands.
- WIRELESS COMPATIBLE – Mix sound effects with music from your MP3 player or smartphone. Once connected, play your own music out the 16-DEE speaker and insert DJ sounds to your own music.
- DJ CONSOLE INCLUDED – The box transforms into your own DJ table. Easy to build in 2 simple steps! Lock in your favorite DJ sounds with a push of a button.
- STEM TOY – Designed to stimulate creativity and teach kids to investigate the world through creative reasoning and the

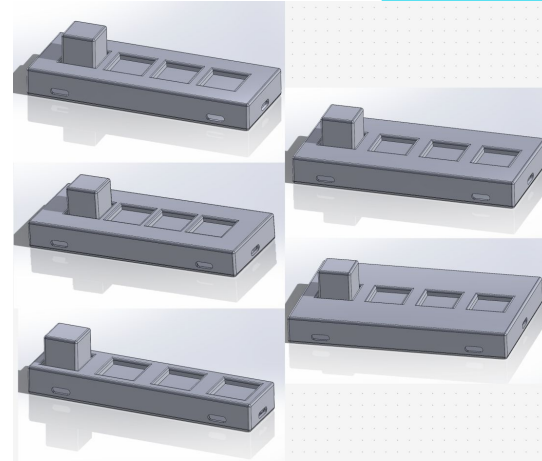
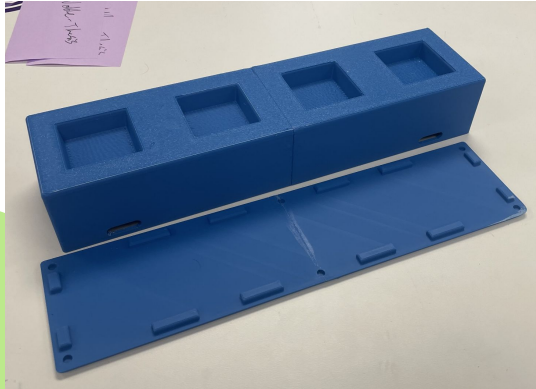
Parent Interviews



Prototype Iterations



Prototype Iterations



Product Requirements By Priority

First Priority:

- The composition of the tune must be determined based on the construction of the toy set, and that construction must be determined by the child/person playing with the toy.
- The toy must be appealing to purchasing adults and children of all genders.
- Power must come from a single location

Second Priority:

- The child must be able to play with the toy alone, interacting with at least the most basic functions and play journey.
- The sound played must be pleasing
- The toy should have various ways to play with it

Product Requirements By Priority

Nice to Have:

- The toy should only play the music when it is wanted, indicated by intentional prompting
- The storage of the toy should be easy to manage and keep all parts of the toy together
- The toy should be playable to those that are color blind

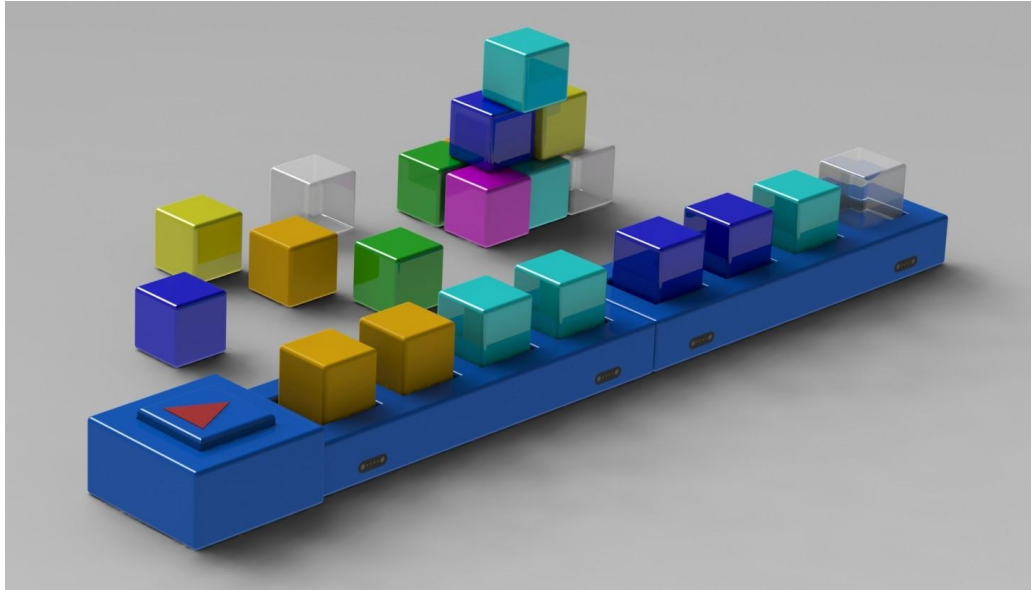
Mandated:

- The toy must meet ASTM standards for safety
- The toy must be durable enough to be knocked over, pushed, and even thrown without compromising functionality, and cause minimal harm to who/whatever it was thrown at
- The toy must be easy to clean

The background is a solid light blue. A large orange semi-circle is positioned on the right side of the frame. Scattered around the semi-circle and the rest of the background are several white geometric patterns: zigzag lines, small circles, and triangles.

**I Present To
You...**

The Build-A-Song

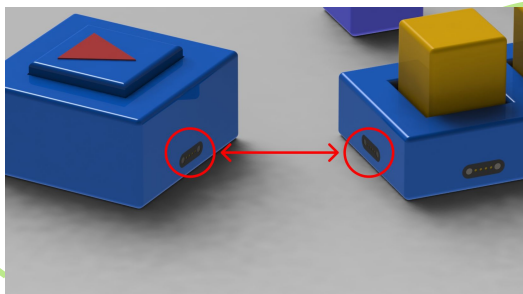


A toy that allows children to build their own songs
while developing foundational STEM skills like
creativity, problem solving, pattern recognition, and
more!

Key Design Features

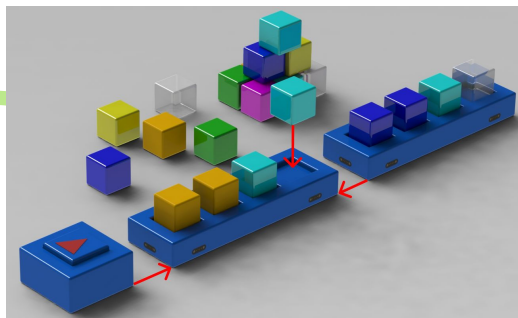
Easy Quick Connect

Start Block and Boards snap together with the easy Magnetic Connectors



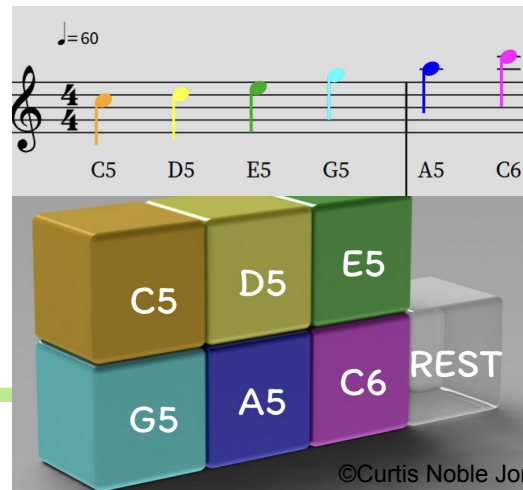
Expandable

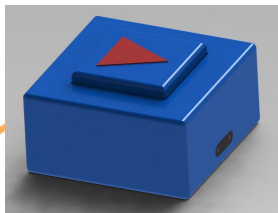
Connect more boards together for longer songs, and fill the slots with the colored blocks



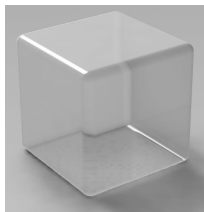
Creative

Each block color plays a different note, allowing the child to build their own songs





x1



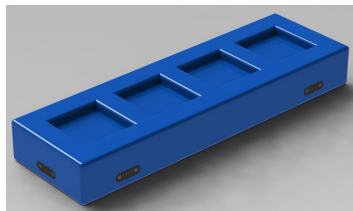
x8



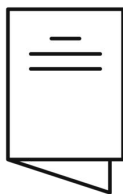
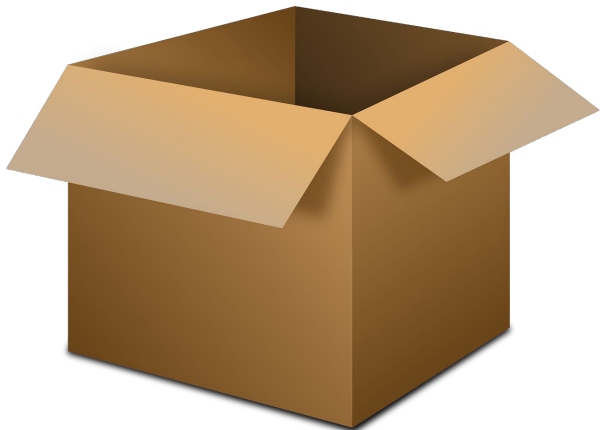
x15



x1



x8



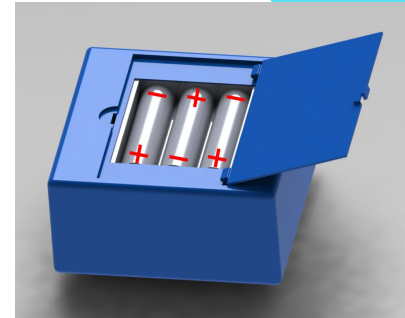
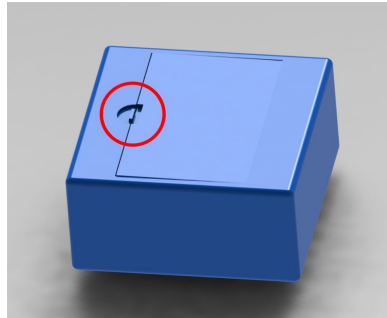
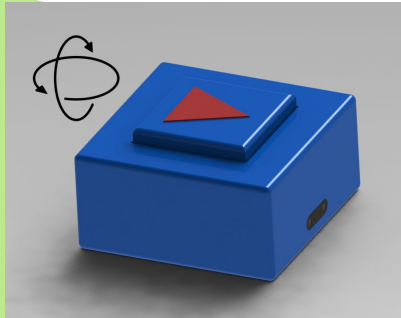
x1

Out-of-the-Box Experience

Out-of-the-Box Experience

Batteries

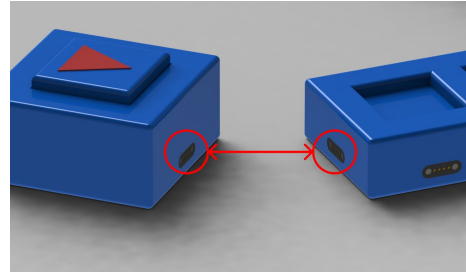
Let's open the underside of the
Play Button and put in 3 AA
batteries!



Out-of-the-Box Experience

Let's Build A Song!

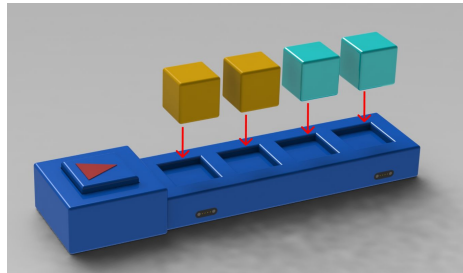
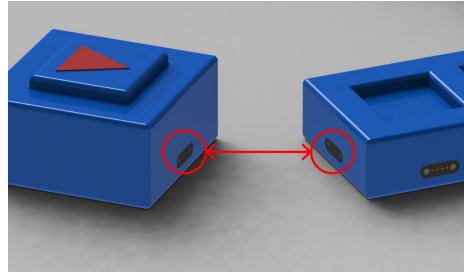
First, let's connect the **Play Button** to our first **Board**. We can do this by putting the magnetic plugs together.



Out-of-the-Box Experience

Let's Build A Song!

First, let's connect the **Play Button** to our first **Board**. We can do this by putting the magnetic plugs together.



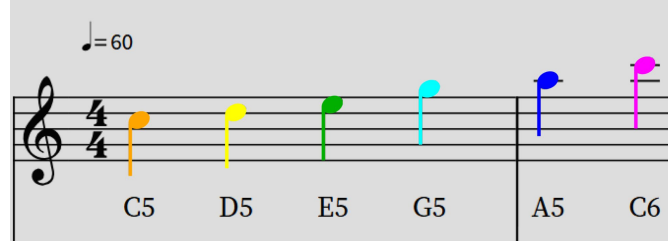
Let's Build A Song!

Now we can put **Blocks** into the **Board**'s slots. Try using different **Blocks** and see what sounds they make when you hit the **Play Button** !

Out-of-the-Box Experience

Let's Build A Song!

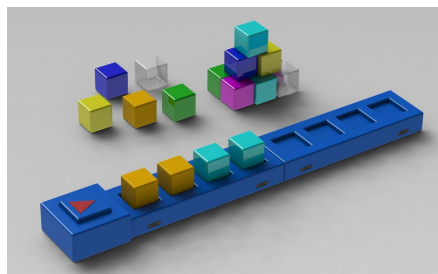
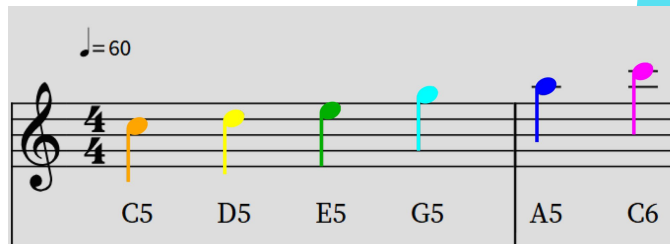
Hey! Different colors play different notes! This chart shows what note each **Block** plays!



Out-of-the-Box Experience

Let's Build A Song!

Hey! Different colors play different notes! This chart shows what note each **Block** plays!



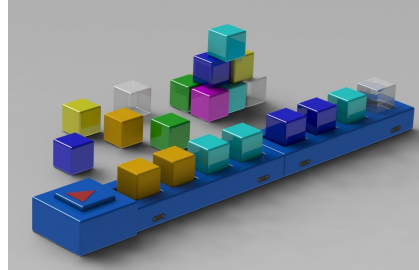
Let's Build A Song!

Let's add a second **Board** to make a longer song! We can add a **Board** to any plug on the other side of the **Play Button**.

Out-of-the-Box Experience

Let's Build A Song!

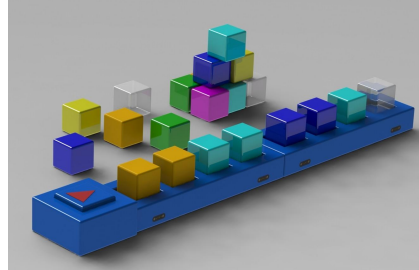
Now try building with the **Blocks** like they are shown here, and hit the **Play Button**!



Out-of-the-Box Experience

Let's Build A Song!

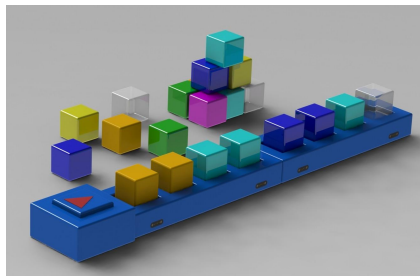
Now try building with the **Blocks** like they are shown here, and hit the **Play Button**!



Out-of-the-Box Experience

Let's Build A Song!

Now try building with the **Blocks** like they are shown here, and hit the **Play Button**!



Let's Build A Song!

Hey! I know that song! That's the beginning of Twinkle Twinkle Little Star! What other songs can you build?

Want more or bigger songs? Expansions!

Expansion Set

This will contains 4
Boards , 4 **Clear Rest
Blocks** , and 8 of each
Colored Blocks .

Additional Play Button

This contains an
additional **Play Button**
in case your child
wants to play with their
siblings or friends and
build different songs.

Prices



Base Set

Price of Starter Set

The Base Set will cost
\$49.99



Expansion

Price of Expansion Set

The Expansion Set will cost
\$25.99



Play
Button

Price of Additional Play Button

The Additional Play Button
will cost \$9.99

The Build-A-Song

Open-Ended

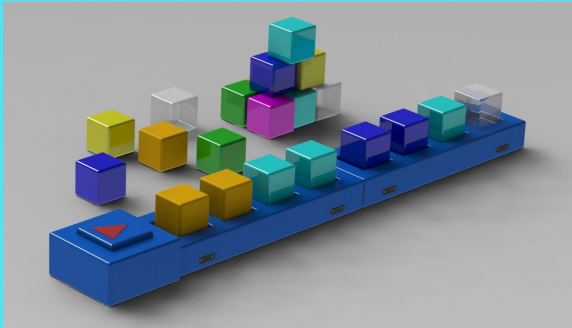
The child can create their own songs that they can be proud of!

Fosters Creativity

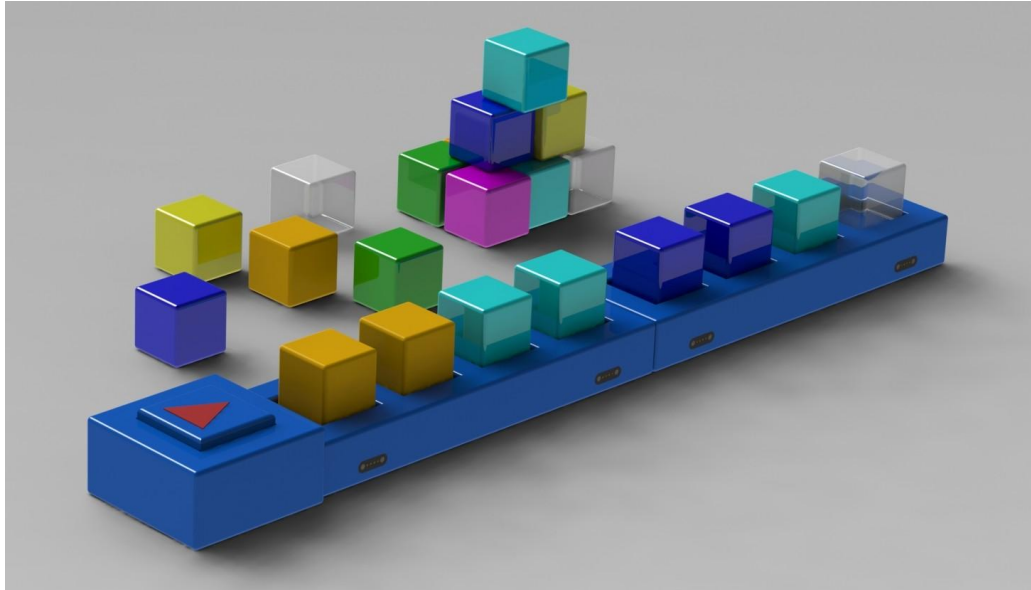
Fosters creativity with a near limitless possibilities that'll never get old!

Reaches out to all genders

Fun, engaging, and approachable for every kid!

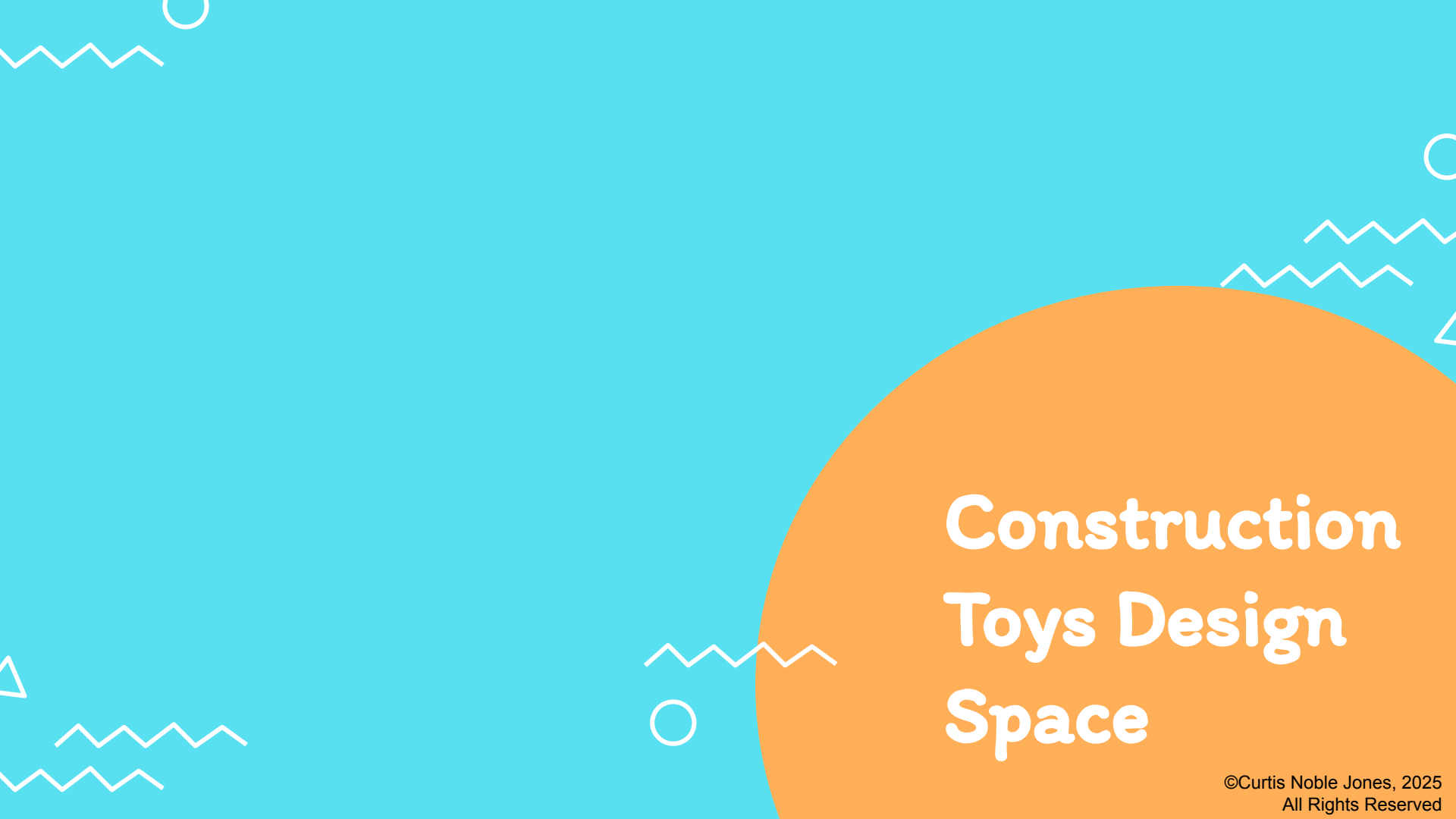


Thank You!



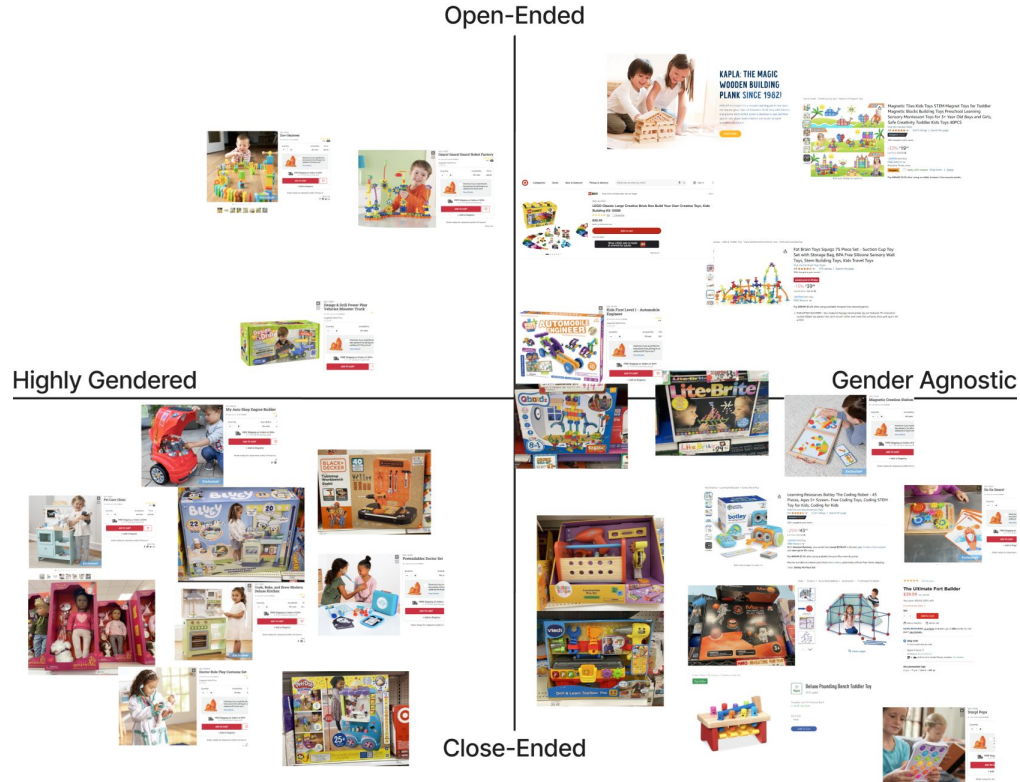
Are there any Questions?

Appendix

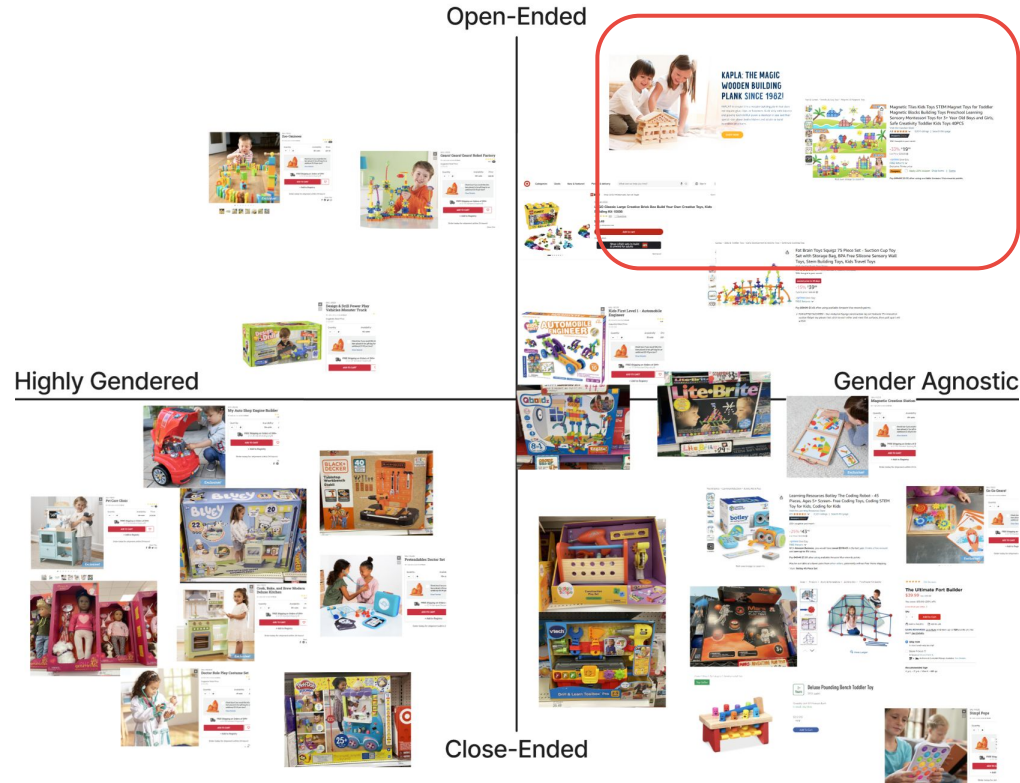


Construction Toys Design Space

Research: Market Research



Research: Market Research



Research: Market Research



KAPLA: THE MAGIC WOODEN BUILDING PLANK SINCE 1982!

KAPLA® is simple! It is a wooden building plank that does not require glue, clips, or fasteners. Build only with balance and gravity! Each KAPLA plank is identical in size and their special size allows both children and adults to build incredible structures.

SHOP NOW

Toys & Games › Novelty & Gag Toys › Magnets & Magnetic Toys



Magnetic Tiles Kids Toys STEM Magnet Toys for Toddler Magnetic Blocks Building Toys Preschool Learning Sensory Montessori Toys for 3+ Year Old Boys and Girls, Safe Creativity Toddler Kids Toys 40PCS

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4.8 ★★★★★ 5,074 ratings | Search this page

Amazon's Choice

10K+ bought in past month

-33% \$19.99

List Price: \$29.99

✓ Prime One-Day

FREE Returns



Exclusive Prime price

Coupon

☐ Apply 20% coupon Shop items | Terms

Pay \$19.99 \$0.00 after using available Amazon Visa rewards points.

Research: The Leaders in the Space

	Open-Ended Play	Cause/Effect	Compatibility with Everyday Materials	Aesthetic Versatility and Neutrality	Durability and Safety
	5	4	3	4	5
	5	4	4	5	5

Research: The Leaders in the Space

1

2

3

4

5

	Confidence and a Sense of Belonging	Agency and Ownership	Curiosity and a Love of Exploration	Perseverance and Problem-Solving
	4	4	3	4
	4	5	4	4

Research: The Leaders Are Outdated



KAPLA: THE MAGIC WOODEN BUILDING PLANK SINCE 1982!

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SHOP NOW

Hasn't Changed Since 1982



Hasn't Changed Since 1997

Design Notes and Diagrams

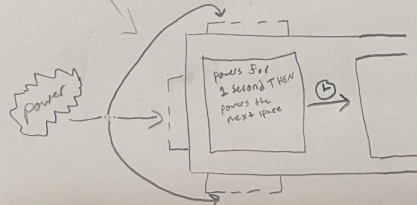
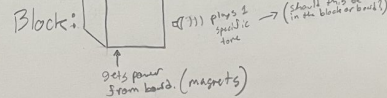
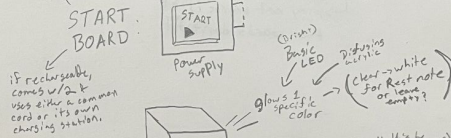
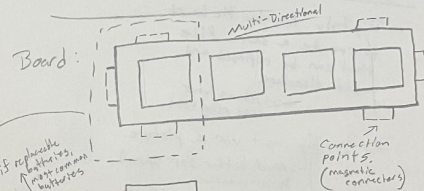
Mechanics Part Needs

- Sound 10-100 points per sine wave with updates higher than 20 kHz
- Must sound human or update by which is cat/dog?

Animal	Heating Range
Human	20-30,000
Dog	42-45,000
Cat	45-64,000
Rat	200-70,000

- Only 1 power source able to play a string of boards that may loop around a room/house.
- 4 @ 60 bpm = 1 sec per tone (output note)
- Notes on the 5th Octave (500-2000 Hz)
 - ↳ Needs double checked.

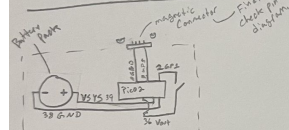
Overall Design



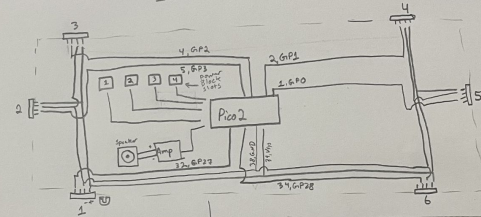
- Sparkfun (vibes LED)
- Board speaker easier
- each board will need a brain
- Block detection → mag. pattern hall switches
 - ↳ color sensor
 - ↳ RFID chip & reader
 - ↳ magnet strength w/ hall sensor
 - ↳ color mag. to check held
 - ↳ color mag. to read/decode.

Wiring Diagrams

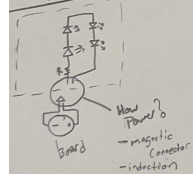
START BUTTON



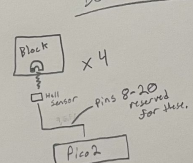
Board



Block



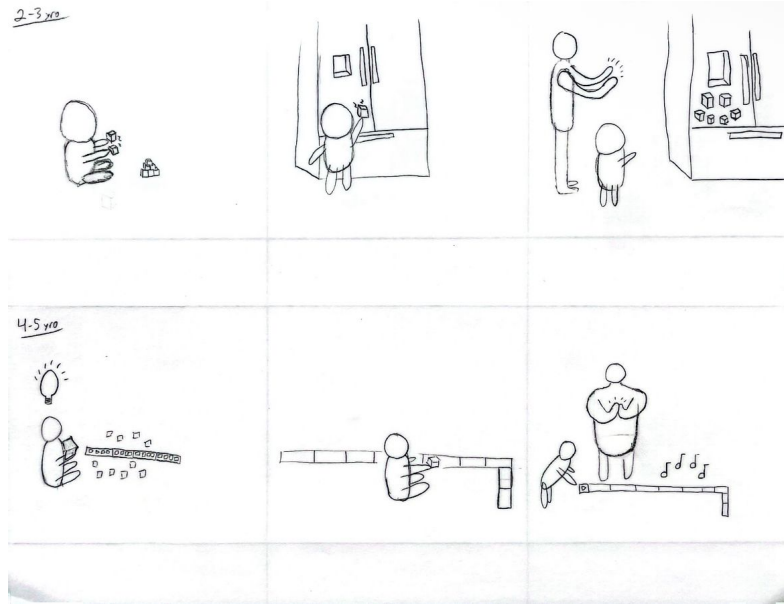
Board Cont.



Components:

- Mag. Connectors
- Hall effect sensors (NOT switches)
- Speaker
- Amp
- Large Button
- Battery pack
- Assorted LEDs
- Assorted Resistors
- Assorted Capacitors
- Assorted Magnets
- Pico 2's
- Wires

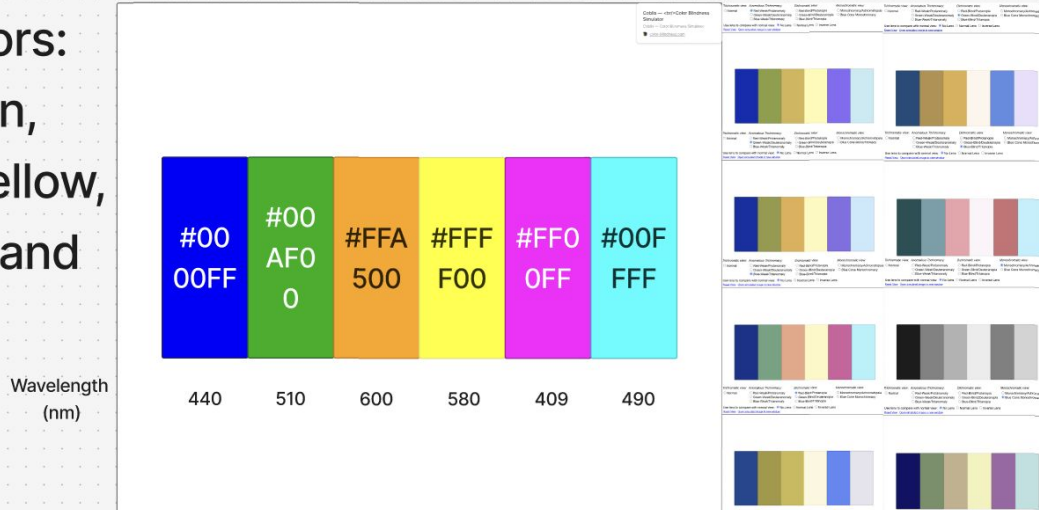
The Toy Can Grow With The Child - A Storyboard



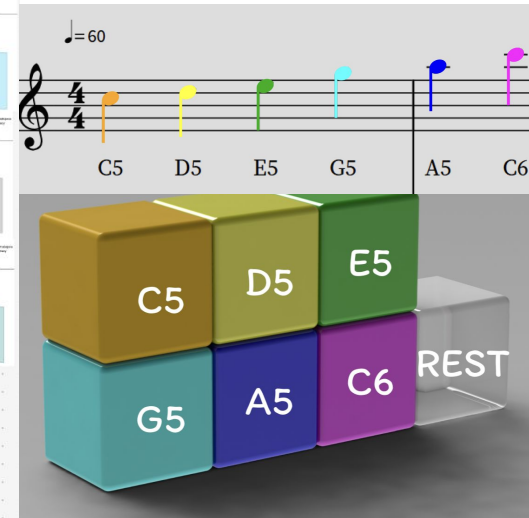
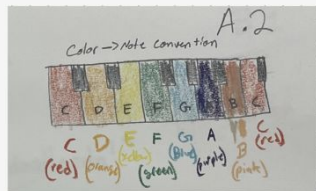
Choosing Block Colors

Block Colors:
blue, green,
orange, yellow,
magenta, and
cyan

Color Blind Simulator Test



Possible Block Color-to-Note Distinction

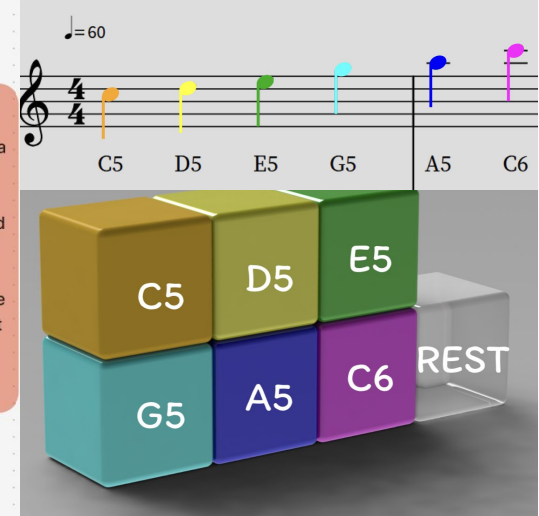


Choosing Block Tones

NOTE FREQUENCY CHART | HEROIC AUDIO

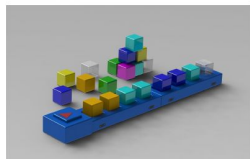
	Octave 0	Octave 1	Octave 2	Octave 3	Octave 4	Octave 5	Octave 6	Octave 7	Octave 8	Octave 9	Octave 10
C	16.35	32.70	65.41	130.81	261.63	523.25	1046.50	2093.00	4186.01	8372.02	16744.04
C#	17.32	34.65	69.30	138.59	277.18	554.37	1108.73	2217.46	4434.92	8869.84	17739.69
D	18.35	36.71	73.42	146.83	293.66	587.33	1174.66	2349.32	4698.64	9397.27	18794.55
D#	19.45	38.89	77.78	155.56	311.13	622.25	1244.51	2489.02	4978.03	9956.06	19912.13
E	20.60	41.20	82.41	164.81	329.63	659.26	1318.51	2637.02	5274.04	10548.08	
F	21.83	43.65	87.31	174.61	349.23	698.46	1396.91	2793.83	5587.65	11175.30	
F#	23.12	46.25	92.50	185.00	369.99	739.99	1479.98	2959.96	5919.91	11839.82	
G	24.50	49.00	98.00	196.00	392.00	783.99	1567.98	3135.96	6271.93	12543.86	
G#	25.96	51.91	103.83	207.65	415.30	830.61	1661.22	3322.44	6644.88	13289.75	
A	27.50	55.00	110.00	220.00	440.00	880.00	1760.00	3520.00	7040.00	14080.00	
A#	29.14	58.27	116.54	233.08	466.16	932.33	1864.66	3729.31	7458.62	14917.24	
B	30.87	61.74	123.47	246.94	493.88	987.77	1975.53	3951.07	7902.13	15804.26	

- Same note progression as a learners tung drum
- These notes allow for any order of notes and it should sound decent and not too annoying
- Less opportunity for failure
- Don't annoy parent = Don't get thrown away

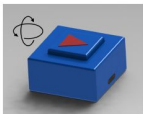


Quick Start Guide

Build-A-Song Quick-Fun Guide



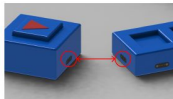
This toy needs power. Let's put in the batteries!



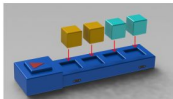
⚠️ Mind the + and - on the AA batteries!

Let's open the underside of the **Play Button** and put in 3 AA batteries!

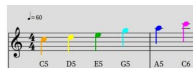
Now Let's Build A Song!



First, let's connect the Play Button to our first Board. We can do this by putting the magnetic plugs together.



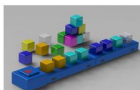
Now we can put Blocks into the Board's slots. Try using different Blocks and see what sounds they make when you **hit the Play Button**!



Hey! Different colors play different notes! This chart shows what note each Block plays!



Let's add a second Board to make a longer song! We can add a Board to any plug on the other side of the Play Button.

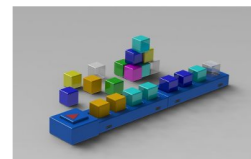


Now try building with the Blocks like they are shown here!



Hey! I know that song! That's the beginning to **Twinkle Twinkle Little Star**! What other songs can you build?

Build-A-Song Quick-Fun Guide



Troubleshooting:

- If the toy doesn't turn on, check that the connectors are pressed together and the batteries are good.
- If one colored block doesn't glow, or its note is not played, make sure the block is fully in the slot

Example Songs:

Each color corresponds to a note. The example songs will use the colors for simplicity. Any time you see a "-", this means a "rest" or a pause in the music. These are played with clear blocks.

Color	Traditional Note	Color	Traditional Note
Orange (O)	C5	Cyan (C)	G5
Yellow (Y)	D5	Blue (B)	A5
Green (G)	E5	Magenta (M)	C6

Twinkle Twinkle Little Star

O O C C | B B C - | G G Y Y | O O O - |
C C G G | Y Y O - | C C G G | Y Y O - |
O O C C | B B C - | G G Y Y | O O O - |

Mary Had A Little Lamb

G Y O Y | G G G - | Y Y Y - | G C C - | G Y O Y | G G G G | Y Y G Y | O - -

Thank You

I hope you enjoyed this presentation on my project, The Build-A-Song.

If you are interested in learning more about this project or any other project of mine, feel free to reach out!

You can reach me at:

Jonescn@rose-hulman.edu

CREDITS: This presentation template was created by **Slidesgo**, including icons by **Flaticon**, and infographics & images by **Freepik**.