

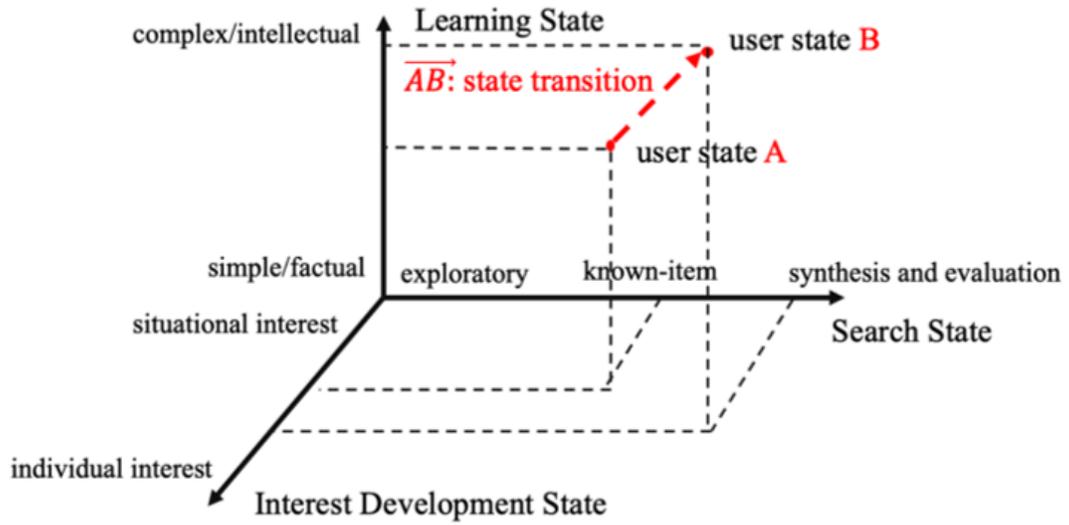
## *Authorship*

<b><i>Section</i></b>	<b><i>Author(s)</i></b>	<b><i>Editor(s)</i></b>
<b>Abstract</b>	Grace	Margaret
<b>Introduction</b>	Skyler	All
<b>Background</b>		
The Walthamstow Pumphouse Museum	Evan	All
Active Learning in Primary Education	Grace	Margaret
A Museum's Role in Educational Outreach	Evan	Grace
STEM Education in the United Kingdom	Margaret	Grace
Population of Waltham Forest	Skyler	Evan
<b>Methodology</b>		
Research Questions	All	All
Methods Choices and Rationale	Skyler	Evan
Surveys	Evan	Margaret
Interviews	Grace	Skyler
Observations	Margaret	Grace
Challenges and Limitations	Margaret	Evan
Ethics	Skyler	Grace
<b>Results</b>		
The museum's audience is growing and is largely made up of families	Skyler	Grace
Families value accessibility and inclusivity in community organizations	Skyler	Evan
The Walthamstow Pumphouse Museum is an underutilized resource in the community	Grace	Evan
Visitors value the presence of hands-on activities at museums	Evan	Margaret

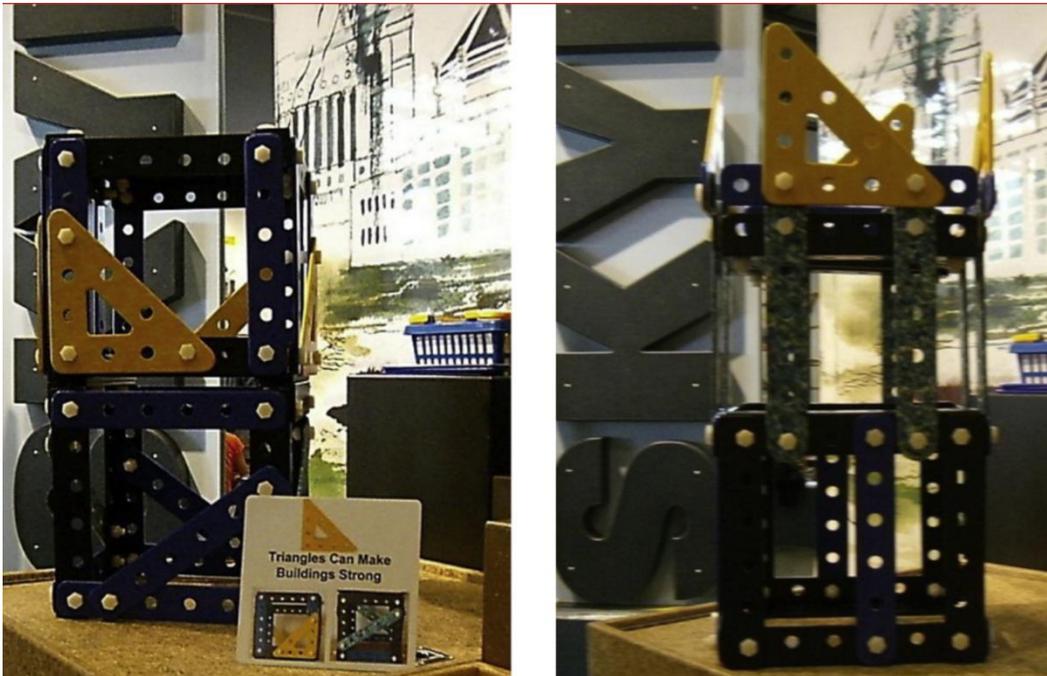
Children are more engaged when they take the lead	Margaret	Grace
Parents improve their children's engagement through interactions	Margaret	Skyler
A safe hands-on environment builds confidence	Evan	Skyler
Takeaways	Grace	Margaret
<b>Recommendations</b>		
Create Safety Guidelines	Skyler	Margaret
Encourage parent involvement in activities for children	Evan	Skyler
Recruit volunteers from the local community	Skyler	Grace
<b>Conclusion</b>	Margaret	Evan

# Appendices

## Appendix A (Figures)



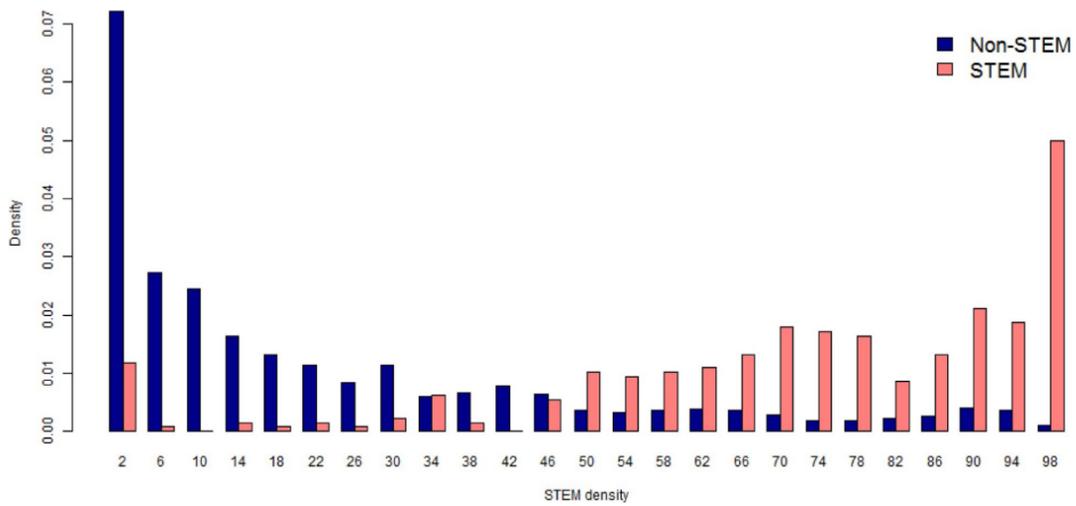
Interest-Search-Learning Model Diagram



Model Structures built in Skyscraper Challenge



Examples of simulation experiment



STEM density of STEM and Non-STEM Occupations



QR Code Survey Flyer

## Appendix B (Tables)

**Table 1. Average Times of Families Interacting with the Tube Carriage**

Average Time	Parent-led	Child-led
Parent-interaction	1:22	2:09
No Parent-interaction	2:34	1:43

**Table 2. Average Times of Families Interacting with the Model Railway Room**

Average Time	Parent-led	Child-led
Parent-interaction	4:21	5:54

No Parent-interaction	1:32	7:30
-----------------------	------	------

## ***Appendix C (List of Interview Questions)***

### *Interview Questions for Volunteers*

1. How long have you been volunteering at the Pumphouse Museum for? What role(s) do you have here?
2. What drives you to volunteer at the museum?
3. Do you have a particular interest in any part of the museum (ex: steam engines, tube cars, etc...)?
4. If so, please explain how you came into this passion?
5. Are there any similar museums you have volunteered at/been involved with in the past/present?
6. What do you think makes the Walthamstow Pumphouse Museum special/stand-out?
7. What exhibit do visitors tend to be most interested in? Why?
8. How do you think the museum currently plays a role in the surrounding community?
9. We are working with the museum to develop new workshop offerings (specifically trying to cater towards ages 7-12)
10. What ideas for hands-on activities do you have in mind?
11. Is there any additional information that would be beneficial to us?

## ***Appendix D (List of Survey Questions)***

### *Survey Questions for Museum Visitors*

1. How often do you visit the Walthamstow Pumphouse Museum?
  - This is my first time
  - I've visited a few times
  - A few times per year
  - Once a month
  - 2+ time per month

2. What has been your most enjoyable and/or educational experience at the Pumphouse Museum?
3. Do you typically visit...
  - alone?
  - with friends?
  - with family?
4. What area are you from?
  - Camden
  - Royal Borough of Greenwich
  - Hackney
  - Hammersmith and Fulham
  - Islington
  - Royal Borough of Kensington and Chelsea
  - Lambeth
  - Lewisham
  - Southwark
  - Tower Hamlets
  - Wandsworth
  - City of Westminster
  - Barking and Dagenham
  - Barnet
  - Bexley
  - Brent
  - Bromley
  - Croydon
  - Ealing
  - Enfield
  - Haringey
  - Harrow
  - Havering

- Hillingdon
  - Hounslow
  - Royal Borough of Kingston upon Thames
  - Merton
  - Newham
  - Redbridge
  - Richmond upon Thames
  - Sutton
  - Waltham Forest
  - Other
5. What motivates you to visit a museum or similar places in general?
- Entertainment
  - Education
  - Convenience
  - Other
6. How likely are you to (re)visit the Walthamstow Pumphouse Museum in the near future?
- Extremely unlikely
  - Somewhat unlikely
  - Neither likely nor unlikely
  - Somewhat likely
  - Extremely likely
7. For parents of children ages 7-12, how would you describe their learning style?
- Kinesthetic – hands-on approach, learning through physical tasks and actions
  - Visual – learn best through watching others and visual elements
  - Auditory – best learn by speaking with others and talking through ideas
  - Read and write – retain information best by reading tasks and writing/rewriting in your own words

*Survey Questions for Greater Community*

1. Have you ever been to the Walthamstow Pumphouse Museum?
- Yes

- No
- 2.
- a. If “yes” Q1: How often do you visit?
- I've visited once
  - I rarely visit
  - I visit frequently
- b. If “no” Q1: Is there a reason you have not visited?
- I've never heard of the Pumphouse Museum
  - I'm not interested in the museum
  - I cannot visit during operating hours
  - My children are not interested in the museum
  - Other
3. How often do you visit museums in general?
- Never
  - Rarely
  - Somewhat often
  - Often
  - Frequently
4. Where are you from?
- Walthamstow
  - Waltham Forest
  - London
  - UK
  - Other
5. How would you describe your learning style?
- Kinesthetic- hands on approach, learning through physical tasks and actions
  - Visual- learn best through watching other and talking through ideas
  - Auditory- best learn by speaking with others and talking through ideas

- Read and write- retain information best by reading tasks and writing/rewriting in your own words

6. What motivates you to visit a museum?

- Entertainment
- Education
- Convenience
- Other

7. Do you have children?

- Yes
- No

8.

a. If “Yes” Q7: How would you describe your child's learning style?

- Kinesthetic- hands on approach, learning through physical tasks and actions
- Visual- learn best through watching other and talking through ideas
- Auditory- best learn by speaking with others and talking through ideas
- Read and write- retain information best by reading tasks and writing/rewriting in your own words
  - 9. Please share a time when your child was particularly engaged by a museum exhibit or activity.

b. If “No” Q7: Please list the name(s) of a museum or exhibit you found particularly engaging.

## Wooden Yo-Yo Workshop – Ages 10-12

*Designed by WPI research students*

### Walthamstow Pumphouse Museum, Toolhouse

\*Parent supervision is required at all times

\*Limited space to four children total in this workshop

\*Instructor needs to provide clear and accurate demonstrations of the tools – especially the handsaw, mallet, and drill

\*Instructor needs to go over the risks and safety hazards of using the specific tools listed below

\*1.5 - 2 hours allotted

#### **Items Needed:**

- Wood (preferably cylindrical, rectangular used in this example)
- Dowel (size varies depending on drill bit used)
- String (varying options)
- Drill
- Drill bit (7.5 mm)
- Mallet (hammer used in pictures)
- Handsaw
- Wood clamp – screwed into the table
- Pencil
- Sandpaper
- Ruler
- Tape

#### **Steps:**

1. Grab a uniform piece of wood – can be round or square, must be equally weighted
2. Measure two equal sections of the wood with a pencil to desired yo-yo thickness – example is two measured sections to 2 cm of thickness (about 0.79 in) - **Measure twice, cut once!**
3. Place the unmeasured sections in the wood clamp, leaving the area you want to cut in open space
4. Tighten to keep wood secure – rotate the bar until the wood isn't shifting and stays in one place - **Mind your fingers!!**
5. Carefully grab a handsaw – with both hands, and parent supervision, place the handsaws teeth on the line closest to the edge – **The teeth are the sharp bits on the saw!**
6. Push the handsaw forwards and back on the line to cut through the wood
7. Once the first section of wood has been cut off, repeat steps 5-6 on the second line
8. Pick out sandpaper, go back and forth on the edges cut to smooth and buff out any splinters on the two blocks or circles – **Which sandpaper is working? What do you notice about the sandpaper?**
9. Use a ruler as a guide to mark the center of the wood
  - a. **Hint:** For a square, draw diagonal lines from one corner to the other, and where they intersect is the center! Draw a dot here

b. **Hint:** For a circle, use a ruler and pencil to draw a horizontal line through the center of the circle. Rotate the circle so the line is vertical and draw a second horizontal line. Where the lines intersect, that's the center! Draw a dot here

10. Grab a drill and a 7.5 mm (about 0.3 in) drill bit
11. Measure 1.5 cm of length from the tip of the bit, wrapping a piece of tape after the 1.5 cm mark - **This shows where you will stop drilling**
12. Place the sections in the wood clamp, making sure you can see the faces you marked when you look down on them
13. Carefully place the drill on the dot of one of the sections – **Make sure the drill bit is perpendicular to the block (Straight up and down)**
14. Slowly pull on the button until the drill starts to turn, followed by squeezing the button in short bursts until the tape is at the surface – **Use two hands and keep it steady!**
15. While pulling the drill back up, hold down the button- **This will bring the drill back up out of the hole!**
16. Repeat steps 13-15 on the second section of wood
17. Through trial and error, find the correct dowel size that fits snugly in the hole drilled – **It should be a tight fit!**
18. Using a mallet, carefully tap the dowel in so that it stays in place
19. Place the other section of wood onto the other end of the dowel to complete the yo-yo shape, hammer gently into place – **Stop when it doesn't sound hollow anymore!**
20. Pick a piece of string and tie one end around the dowel – **Make sure it's tight!**
21. Take the other end of the string and tie a small loop – This will go around your finger
22. Wrap the string around the dowel, keeping the loop on your finger
23. Release the yo-yo and watch it spin! - **Did the string get twisted up? Is it not working right? Why is that? Try picking a different string**

**Steps 1-4**

Measuring and placing the wood in clamps



**Steps 5-7**

Sawing off the sections of wood



**Step 8**

Smoothing out the wood edges and splinters



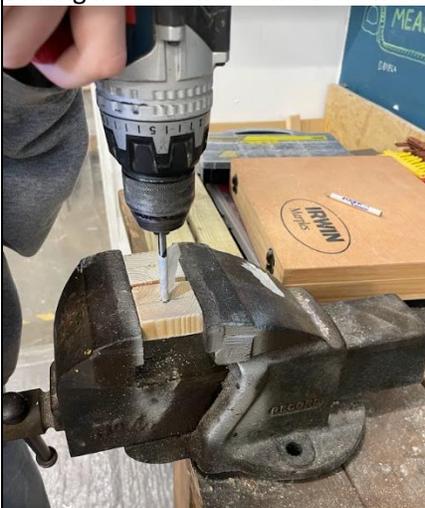
**Step 9**

Measuring off the middle of the blocks



**Steps 10-16**

Drilling into the wood with the marked off drill bit



**Step 17**

Placing the dowel in the drilled hole



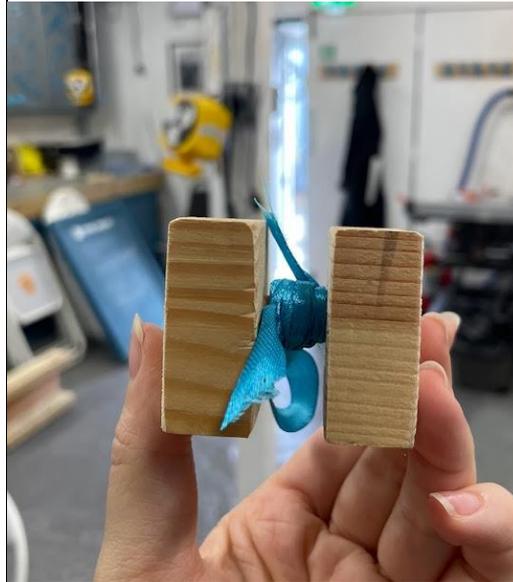
**Steps 18-19**

Hammering into place the dowel and block section



**Steps 20-22**

Tied ribbon around the dowel, and tied loop



# Wooden Yo-Yo Worksheet – Ages 10-12

Time	Activity	Things to think about
25 minutes	Introduction to Activity	How will your yo-yo look? What causes a yo-yo to work? What materials do you need?
15 minutes	Steps 1-4	Why is it important to measure the wood? Why should the two pieces of wood be equally weighted?
10 minutes	Steps 5-7	How efficient/effective were your cuts?
10 minutes	Steps 8 & 9	Why do you use different sandpaper grits? Do you know any other methods to find the center of an object?
10 minutes	Steps 10-16	Did you run into any complications when drilling? Why must you be so precise in this step?
5 minutes	Steps 17-19	Why do we use a mallet and not a hammer? Did you choose the right size dowel? Why or why not?
10 minutes	Steps 20-22	Why did you choose the type of string that you did?
20 minutes	Debrief	What would you have done differently if you were to do this again? What do you wish you had known before the workshop? What did you learn from this workshop?

The Walthamstow Pumphouse Museum taught me about how to:

## Build a Yo-yo from Scratch

### Key learnings:

1. Knowledge of how to safely handle and operate the different tools needed in the workshop.
2. What causes a yo-yo to work? *Hint: think about the different types of energy*

### Activity supplies:

Wood	Dowel	Drill & Drill Bits	String	Mallet	Ruler
Handsaw	Wood Clamp	Pencil	80 Grit Sandpaper	Tape	

**Step 1, Brainstorm design ideas:** Draw out a design for your yo-yo on paper. Think about what materials you will need and how they will be used.

*What makes a yo-yo work? What shape should the yo-yo be?*

**Step 2, Gather Materials:** Based on your design, gather only the required materials.

**Step 3, Create the Body of the Yo-yo:** Using your materials and concept design, begin building your yo-yo.

*Discuss: Did you need all the materials you grabbed? Were there more materials you would have liked to have had after completing the yo-yo?*

**Step 4, Assemble the Yo-yo:** Connect the two separate pieces of the body with the dowel and then tie the string around the centerpiece.

**Step 5, Test out your Yo-yo:** See if your yo-yo works as you expected.

*Discuss: Did your yo-yo work properly when you created your design? If so, how was this design able to work as desired?*

## **\*Wooden Yo-Yo Workshop – Ages 7-9**

*Designed by WPI research students*

### **Walthamstow Pumphouse Museum, Toolhouse**

\*Parent supervision is required at all times

\*Limited space to four children total in this workshop

\*Instructor needs to provide clear and accurate demonstrations of the tools

\*Instructor needs to go over the risks and safety hazards of using the specific tools listed below

\*1 – 1.5 hours allotted

#### **Items Needed:**

- Wood (precut/premarked and cylindrical)
- Dowels (various sizes depending on drill bit used)
- String (yarn, ribbon, twine, cotton, etc.) - **have them decide which string is best to use**
- Eggbeater drill - **no power tools for this age range**
- Drill bit (7.5 mm)
- Mallet
- Sandpaper
- Ruler
- Tape
- Wood clamp – screwed into the table

#### **Steps:**

1. Grab two uniform pieces of wood – can be round or square, must be equally weighted
2. Using sandpaper, go back and forth on the edges cut to smooth and buff out any splinters
3. Find the mark that indicates the center on the pieces of wood
4. Grab an eggbeater drill with the 7.5 mm (about 0.3 in) drill bit
5. Measure 1.5 cm (about 0.59 in) of length from the tip of the bit, wrapping a piece of tape after the 1.5 cm mark - **This shows where you will stop drilling**
6. Place the sections in the wood clamp, making sure you can see the marked faces when you look down on them
7. Carefully place the drill on the dot of one of the sections – **Make sure the drill bit is perpendicular to the block (straight up and down)**
8. Apply pressure to the drill as you turn the handle to rotate the drill bit
9. Drill until the tape touches the face of the wood closest to you
10. Stop applying pressure and instead pull the drill vertically out of the wood as you continue to rotate the drill bit
11. Repeat steps 7-10 on the second section of wood
12. Through trial and error, find the correct dowel size that fits snugly in the hole drilled – **It should be a tight fit!**
13. Using a mallet, carefully tap the dowel in so that it stays in place

14. Place the other section of wood onto the other end of the dowel to complete the yo-yo shape, use the mallet to knock it gently into place – **Stop when it doesn't sound hollow anymore!**
15. Take a piece of string and tie one end around the dowel – **Make sure it's tight!**
16. Take the other end of the string and tie a small loop – **This will go around your finger**
17. Wrap the string around the dowel, keeping the loop on your finger
18. Release the yo-yo and watch it spin!

**Step 2**

Smoothing out the wood edges and splinters



**Step 6**

Preparing the wood for drilling.

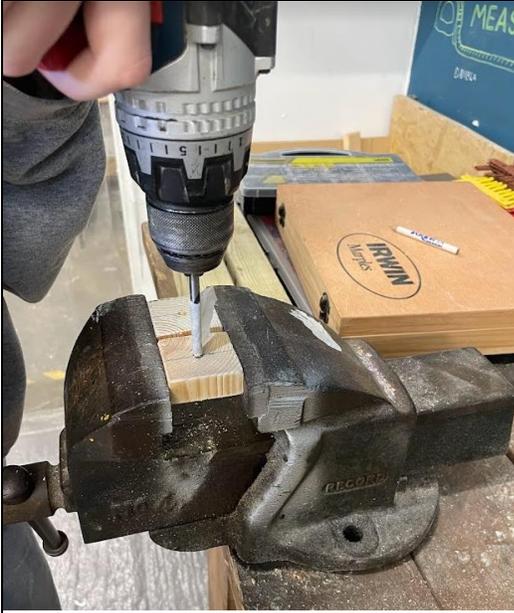


**Steps 7-10**

Drilling into the wood with the marked off drill bit

**Step 12**

Placing the dowel in the drilled hole



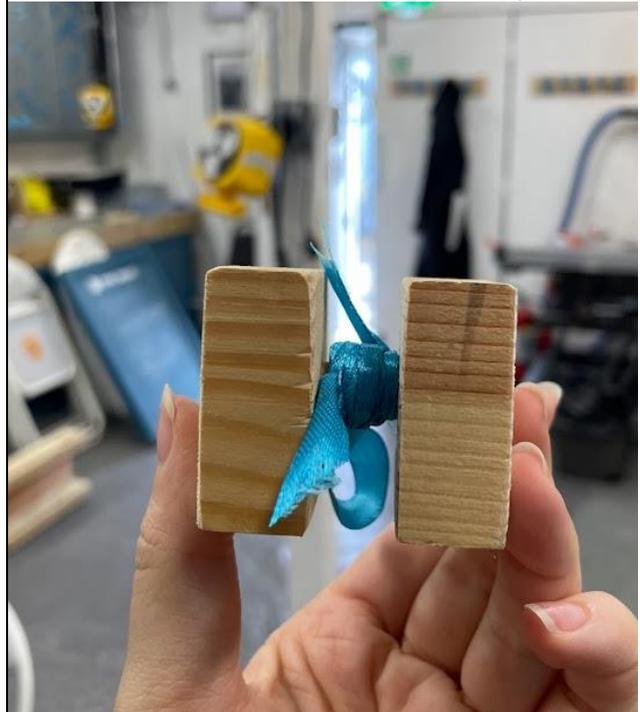
**Steps 13-14**

Hammering into place the dowel and block section



**Steps 15-17**

Tied ribbon around the dowel, and tied loop





## \*Wooden Yo-Yo Worksheet – Ages 7-9

Time	Activity	Things to think about
25 minutes	Introduction to Activity	How will your yo-yo look? What causes a yo-yo to work? What materials do you need?
5 minutes	Step 1	Why should the two pieces of wood be equally weighted?
15 minutes	Step 2	Why do you use different sandpaper grits?
20 minutes	Steps 3-11	Did you run into any complications when drilling? Why must you be so precise in this step?
5 minutes	Steps 12-14	Why do we use a mallet and not a hammer? Did you choose the right size dowel? Why or why not?
10 minutes	Steps 15-17	Why did you choose the string you chose?
20 minutes	Debrief	What would you have done differently if you were to do this again? What do you wish you had known before the workshop? What did you learn from this workshop?

The Walthamstow Pumphouse Museum taught me about how to:

### Build a Yo-yo from Scratch

#### Key learnings:

1. Knowledge of how to safely handle and operate the different tools needed in the workshop.
2. What causes a yo-yo to work? *Hint: think about the different types of energy*

#### Activity supplies:

Wood	Dowel	Drill & Drill Bits	String	Hammer
Handsaw	Wood Clamp	Pencil	80 Grit Sandpaper	Tape
Ruler				

**Step 1, Brainstorm design ideas:** Draw out a design for your yo-yo on paper. Think about what materials you will need and how they will be used.

*What makes a yo-yo work?*

*What shape should the yo-yo be?*

**Step 2, Gather Materials:** Based on your design, gather only the required materials.

**Step 3, Create the Body of the Yo-yo:** Using your materials and concept design, begin building your yo-yo.

*Discuss: Did you need all the materials you grabbed? Were there more materials you would have liked to have had after completing the yo-yo?*

**Step 4, Assemble the Yo-yo:** Connect the two separate pieces of the body with the dowel and then tie the string around the centerpiece.

**Step 5, Test out your Yo-yo:** See if your yo-yo works as you expected.

*Discuss: Did your yo-yo work properly when you created your design? If so, how was this design able to work as desired?*

## **\*Loom Workshop – Ages 7-12**

*Designed by WPI research students*

### **Walthamstow Pumphouse Museum, Toolhouse**

\*Parent supervision is required at all times

\*Limited space to four children total in this workshop

\*Instructor needs to provide clear and accurate demonstrations of the tools

\*Instructor needs to go over the risks and safety hazards of using the specific tools listed below

\*1 – 1.5 hours allotted

#### **Items Needed:**

- Cardboard
- Scissors
- Yarn
- Ruler
- Pencil

#### **Steps:**

1. Start with a rectangular piece of cardboard (can be any size, roughly the size of a piece of printer paper is a good starting point).
2. Make an even number of evenly spaced marks using a ruler along the top and bottom of your loom. **Make sure you have the same number of marks on the bottom and the top!**
  - a. Recommend 8 or 10 marks, about 1-2 cm apart
3. Using scissors, carefully make 1 cm (about 0.39 in) cuts at each of the marks. **You have created your loom!**
4. Grab some yarn and tie a knot at the end.
5. String the yarn through the first cut at the top left of your loom, making sure the knot is on the back of the loom.
6. Pull the yarn tight so the knot is right against the back of the loom and wrap the string down, threading through the bottom left slit.
7. Wrap the yarn up the back of the loom and thread it through the second slit on the top
8. Repeat this process until the yarn has been threaded through all slits and is at the back of the loom – **Wrap tightly!**
9. Cut the yarn, leaving enough room to tie a knot, and tightly tie it around the nearest string on the back of the loom- **Now you are ready to begin weaving!**
10. Grab a (pre-rolled) cardboard needle with your choice of yarn color\*
11. Find the loose end and tie it tightly to the top of the leftmost string on the front of the loom
12. Weave the yarn to the right, alternating between bringing the needle under one string and over the next until you reach the right side of the loom.
13. To weave to the left, repeat the same method but make sure the strings you went over going to the right, you go under when going to the left and vice versa
14. Repeat steps 12-13 until you have reached the bottom of the loom
  - a. To switch colors, finish a row and cut the yarn, tie it to the outermost string, and repeat the process from Step 11 to begin weaving with the new color

15. Cut the yarn with enough to tie a knot, and tightly tie the tail to the outermost vertical string. **You're all done weaving!**
16. Flip the loom over to the back and carefully cut each of the vertical strings down the center of the loom
17. Flip the loom to the front and remove all the vertical strings from the slits, careful to not let the woven yarn off
18. Starting at the top right, grab two neighboring vertical strings and tie them together to secure the woven yarn.
19. Repeat this step across the top and on the bottom until all vertical string ends have been tied off
20. Next, either cut the loose ends, or tie them together to form a loop to hang your weaving or in a pattern. **Be creative!**

\*For cardboard needles:

1. Cut a small piece of cardboard, roughly 3 cm wide and 8-10 cm long.
2. On the short side, cut a small slit, this will be used to hold the end of the yarn
3. Thread the end of the yarn through the slit and then wrap the yarn around the needle, perpendicular to the slit
4. Try to make the yarn as evenly spaced as possible so it isn't too thick!
5. Once there is enough yarn on the "needle", cut the end!

**Step 3**

Loom with slits cut



**Step 5**

Threading yarn through first slit



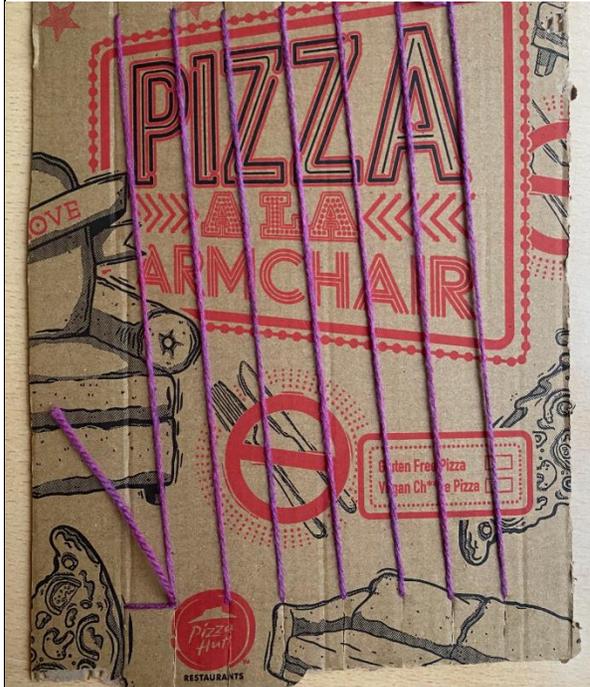
**Step 8**

Wrapping the vertical strings



**Step 9**

Securing vertical strings



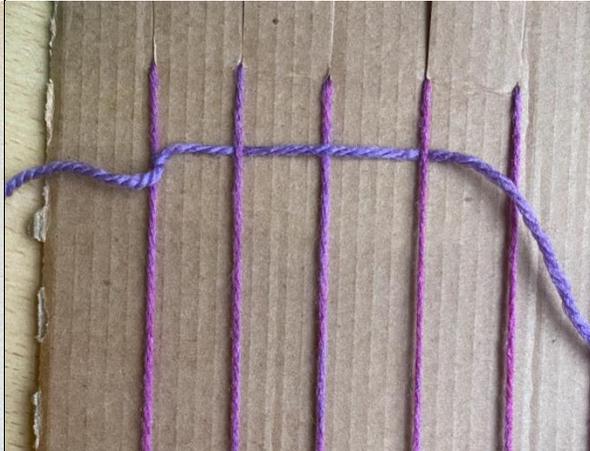
**Step 11**

Tying on weaving yarn

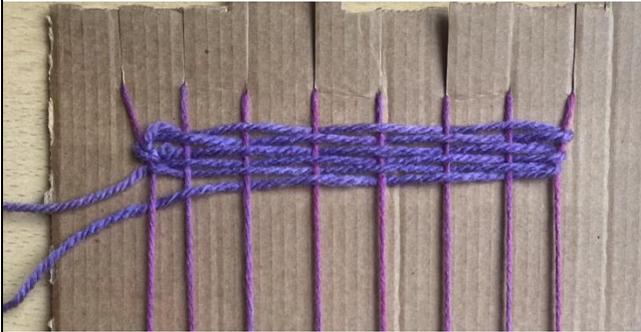


**Step 12**

Beginning weaving to the right



**Step 14**  
Weaving



**Step 15**  
Securing weaving yarn



**Step 18**  
Tying off the vertical strings



**Step 20**  
Finishing off weaving!



## \*Loom Worksheet – Ages 7-12

Time	Activity	Things to think about
10 minutes	Introduction to Activity	What will your loom look like? What materials do you have? What materials will you use?
5 minutes	Steps 1-3	How many marks will you make? How will the number of marks affect the product?
15 minutes	Steps 4-9	
45 minutes	Steps 10-20	Did you run into any challenges? If so, why and how did you fix it?
10 minutes	Activity Debrief	What would you have done differently if you were to do this again? What do you wish you had known before the workshop? What did you learn from this workshop?

The Walthamstow Pumphouse Museum taught me about how to:

### Build a Loom from Scratch

#### Key learnings:

1. Useful things can be made from simple and inexpensive means.
2. Working with your hands can increase engagement and learning retention.

#### Activity supplies:

Cardboard	Scissors	Yarn	Ruler	Pencil
-----------	----------	------	-------	--------

**Step 1, Brainstorm design ideas:** Draw out a design for your loom on paper. Think about what materials you will need and how they will be used.

*How will you design your loom?*

*What kinds of materials do you need to make the loom?*

**Step 2, Gather Materials:** Based on your design, gather only the required materials.

**Step 3, Create the Loom:** Using your materials and concept design, begin building your loom.

*Discuss: Did you need all the materials you grabbed? Were there more materials you would have liked to have had after completing the loom? What challenges did you face while creating your loom?*

**Step 4, Start Weaving:** Following the workshop instructions provided, start weaving.

*Discuss: Did your loom work properly when you created your design? If so, how was this design able to work as desired?*

**Step 5, Finish your weaving:** Now you have your final product!