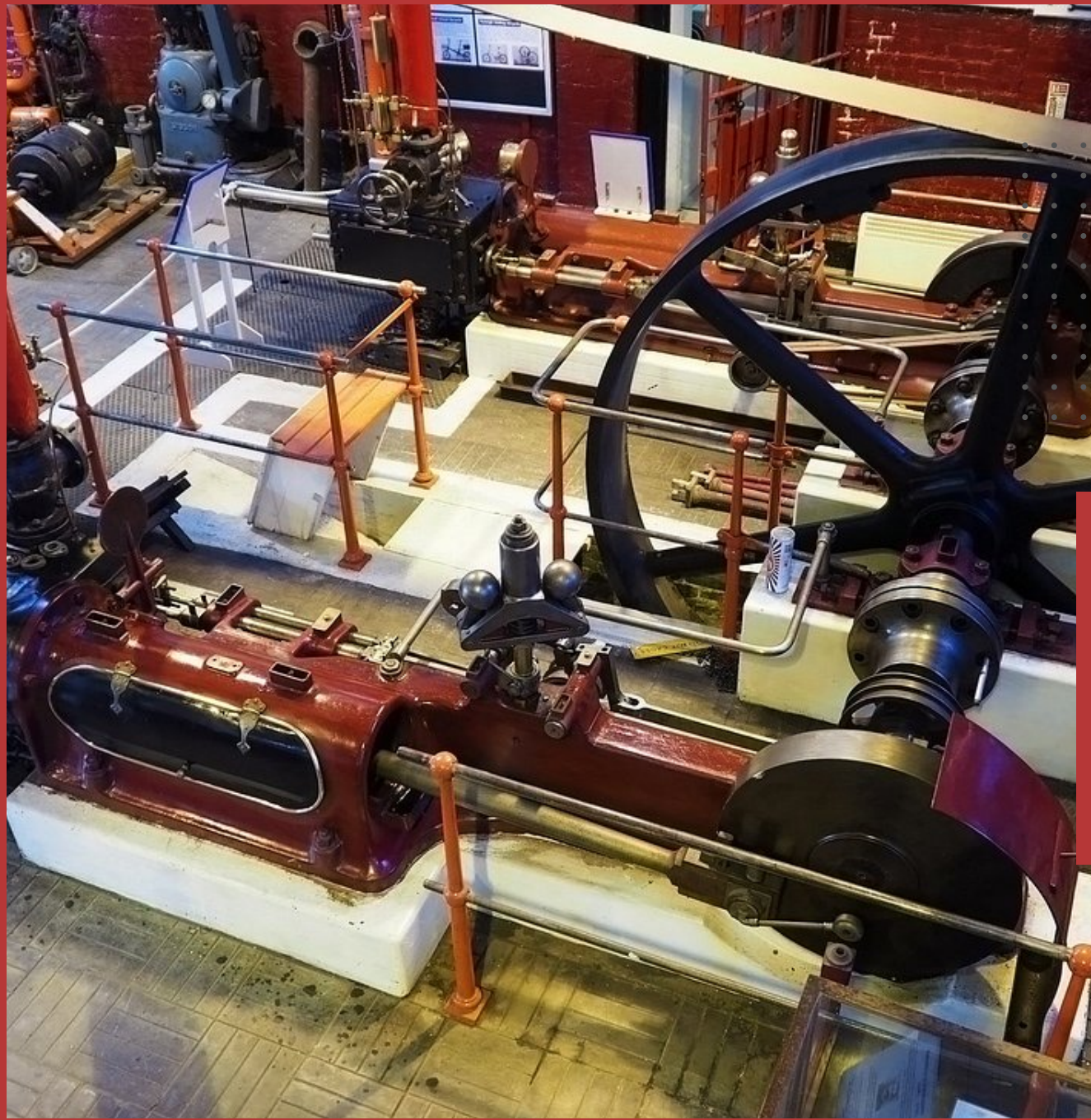




WPI



Walthamstow Pumphouse Museum Victorian Steam Engine

**CREATING STEM
WORKSHOPS FOR
ELEMENTARY-AGED
CHILDREN**



WPI Students outside of the Walthamstow Pumphaouse Museum

TEAM MEMBERS

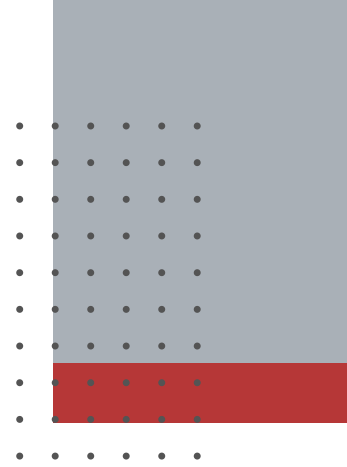
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This report represents the work of four WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review.

TABLE OF CONTENTS



Abstract.....	iii
Introduction.....	01
Background.....	02
Methodology.....	13
Results.....	21
Recommendations.....	33
Conclusion.....	36
Bibliography.....	37



WPI Students during final presentation

ABSTRACT

Our project aimed to assist the Walthamstow Pumphouse Museum in creating hands-on workshops for elementary-aged children to promote greater interest in STEM. We focused on expanding the offerings of the museum's community maker space, the Tool House, to target local youth ages 7-12. To better understand the needs and wants of both the museum and the local community, we deployed two surveys, interviewed active museum volunteers, and conducted observations of the museum's current offerings. Our data showed children benefit greatly from hands-on learning opportunities that are both entertaining and educational. We created two comprehensive outlines for hands-on workshops accompanied by related post-activity worksheets.



Main Pumphouse at the Walthamstow Pumphouse Museum

INTRODUCTION

The Walthamstow Pumphouse Museum is a registered charity in Walthamstow, London, with exhibits related to developments in the transportation industry. The museum has a lot to offer its guests, from its unique exhibits to a community maker space available to all guests. The museum's Board of Trustees and volunteers who help keep the museum running wish to expand their community outreach and promote greater interest among children in STEM (science, technology, engineering, and mathematics)-based subjects. While the museum's vibrant atmosphere and current offerings are attractive to a wide range of visitors, there is a missing demographic of the ages 7-12, and the museum would like to create additional activities to cater towards this age group.

The museum aspires to create hands-on workshops catered toward primary school children with the goal of piquing their interest in STEM. We were presented with this opportunity to work with the museum's volunteers to develop comprehensive written outlines for two example workshops. In creating these workshops, we investigated ways in which hands-on learning can aid information retention and engagement, how the use and expansion of the Toolhouse can provide opportunities for increasing children's interest in STEM, and opportunities for reaching a wider demographic, particularly youths within the 7-12 age group.

BACKGROUND

The Walthamstow Pumphouse Museum

The museum sits on a piece of what is historically known as Low Hall Farm. The land was originally purchased in 1875 by the Walthamstow Urban District Council to build a sewage pumping station, which now serves as the museum's center. The main pumphouse building is a Grade II Victorian era pumping station that was built in 1885. The museum is exclusively funded by donations, memberships, and items purchased so that they may keep their doors open and accessible to the public. It is run entirely by volunteers with leadership from 7 board members.

Currently, the Walthamstow Pumphouse Museum's main draws are its exhibits : engines, pumps, a model railway, old tube carriages, and a full-size early 20 th -century workshop. The Pumphouse has two Grade II Marshall steam engines, each of which is run once a month, along with a variety of smaller engines and pumps. The early 20 th century workshop is used to demonstrate how workshops and renditions of production lines worked. Additionally , the museum has information related to these developments and about the history of sewage treatment and management in Walthamstow.



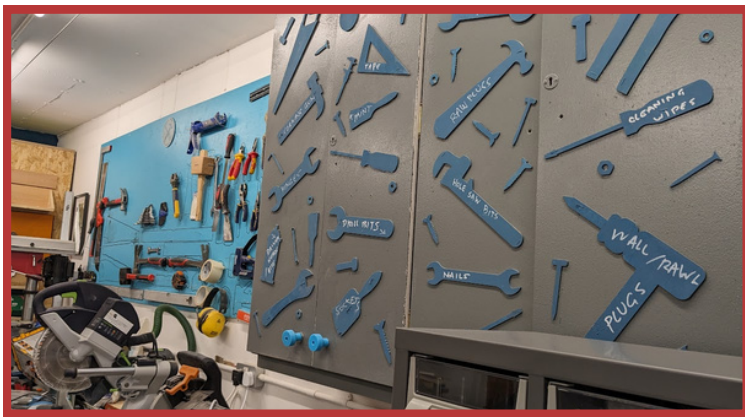
Outside of the Main Pumphouse

Recently, the museum began hosting workshops related to woodworking and metalworking, and recently opened “The Tool House” in collaboration with the Fixatorium, a local group with the goal of using technology for social good. The Tool House serves as a community and volunteer-driven makerspace with the goal of promoting engineering and making related tools more accessible. The Tool House is currently open to the public on Thursdays, and Sundays from 10:00 am to 4:00 pm (The Tool House , n.d.). Daily and monthly memberships are available for purchase, or guests have the option to become a volunteer in exchange for use of the facilities. The Tool House features various tools and workshops related to electronics, woodworking, home improvement, and 3D printing. The Pumphouse is an educational resource and an artifact of history that has been preserved and repurposed for the benefit of the community.

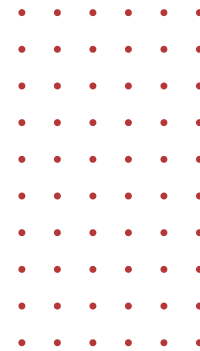


Museum staff on opening day of the ToolHouse in June 2023

The Walthamstow Pumphouse Museum’s newest initiative is to incorporate STEM workshops for local youth into its currently offered programs. The museum would like to learn from other organizations that have proved successful in this endeavor, such as the Slöyd Experience in the US. The Slöyd Experience works with children ages 6-14 introducing them to woodworking to promote personal growth and build confidence. The program is instructor led and designed to put the children in control of their learning. The Pumphouse museum strives to implement hands-on educational programs that foster engagement while simultaneously providing a safe environment for learning. Along with observing other organizations and their practices, the Pumphouse is also interested in hearing from individuals in the local area such as teachers and home educators.



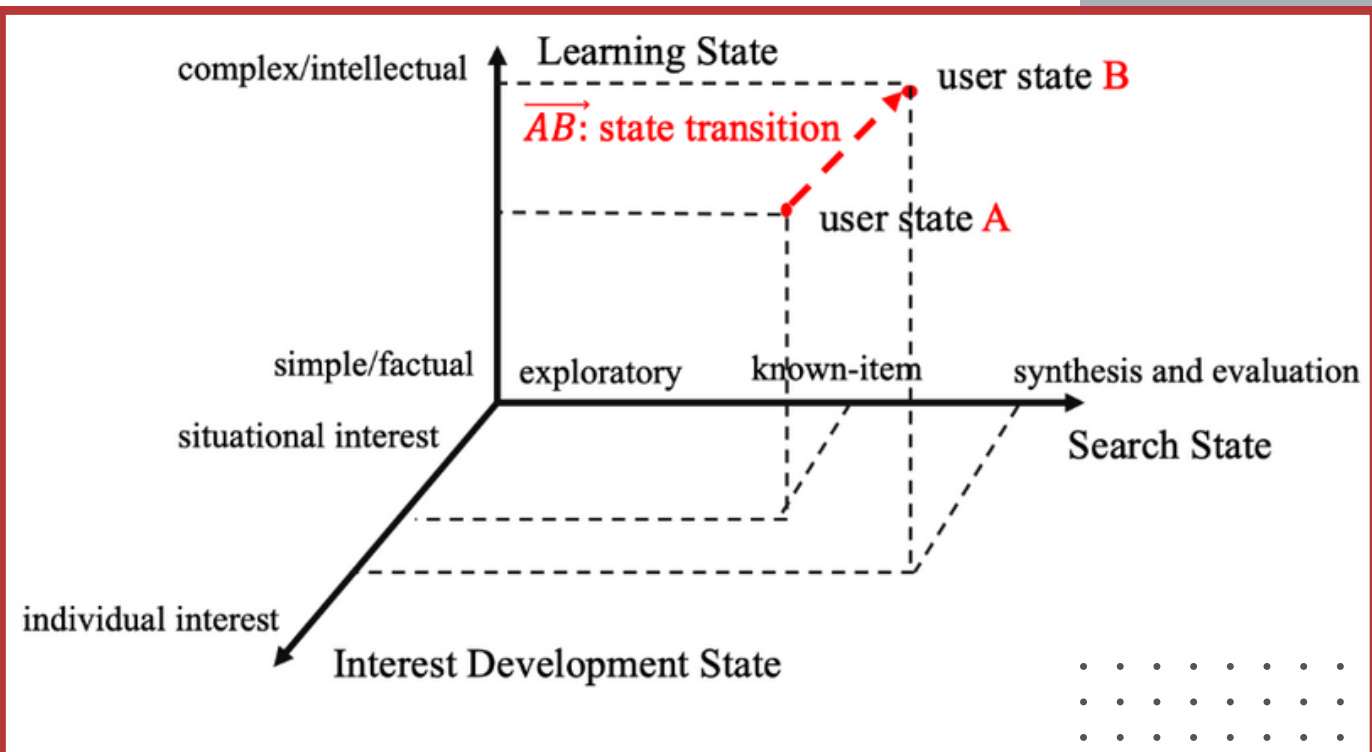
Inside of the Tool House



Active Learning in Primary Education

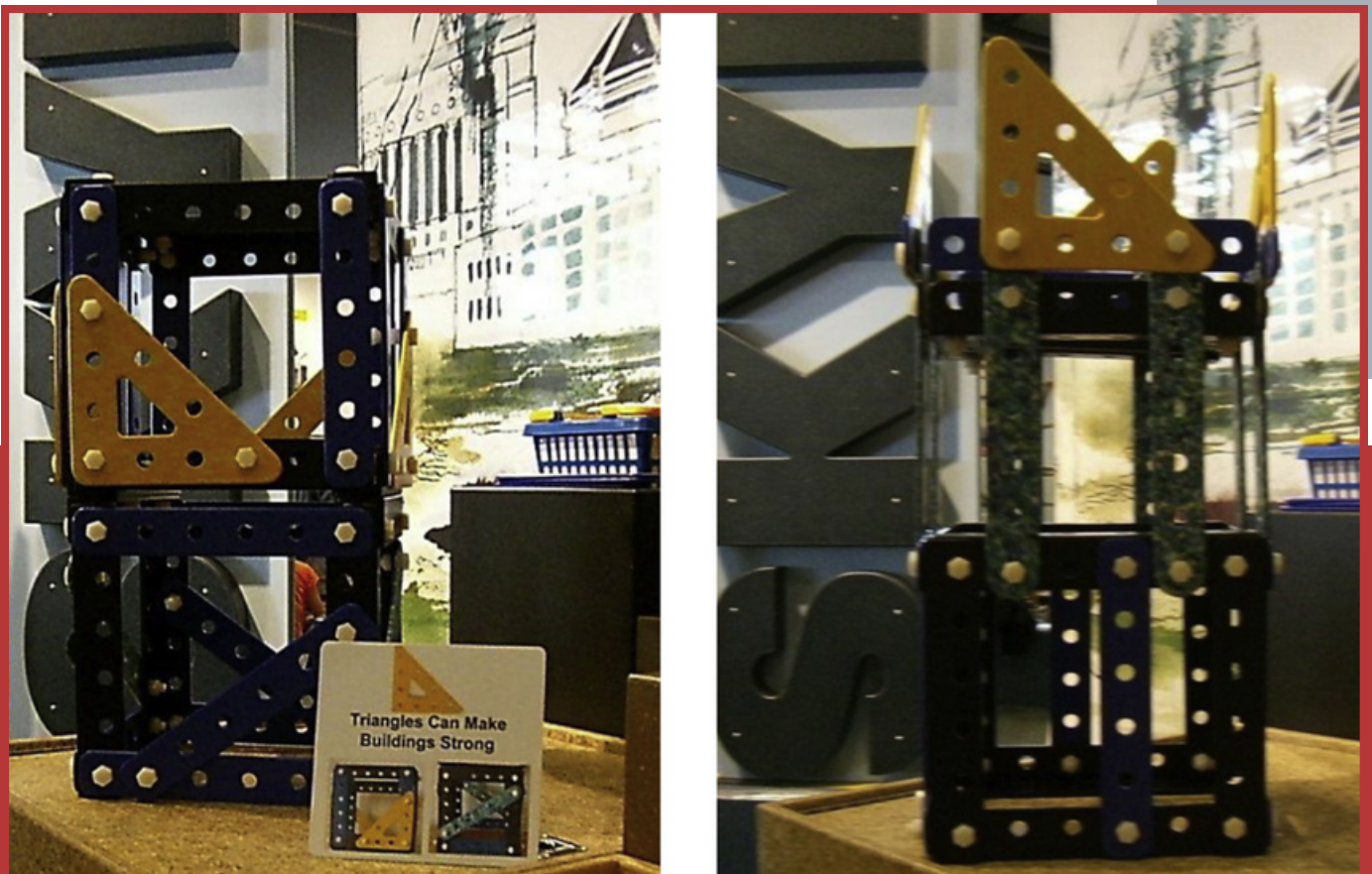
Concepts related to STEM are often relatively complex and can be difficult to understand. Because of this, it is imperative that educational efforts intended for a young audience utilize an approachable way to describe these concepts while still accurately portraying the main ideas. Out-of-school learning environments are effective tools for addressing complex STEM topics because they offer motivational structures and more opportunities for the students to make choices and experience the consequences (Heeg et al., 2022). These informal learning experiences are also typically more meaningful for the student because they are put in an authoritative role and have control over their own learning. This can lead to a heightened sense of accomplishment due to their feelings of ownership, encouraging the continuation of learning and exploration.

Hands-on activities are particularly beneficial in elementary education because they demand a greater level of focus to complete. Children retain learned information and taught skills better when they are learning in an immersive environment where they are fully present. The Interest-Search-Learning (ISL) Model is a prime example of this (Liu & Jung, 2021). The model explains the reciprocal relationship between learning and interest; higher level learning occurs when an individual is personally interested in a topic because they are self-motivated to further that learning and continue exploring. This continued pursuit of new information, “Search,” is a significant part of the foundation of learning. Impactful and complex learning comes from a combination of individual interest and high-level searching (Liu & Jung, 2021). Searching for skills based upon an initial exposure can be carried forward into a child’s future and further develop their learning style and specific interests.

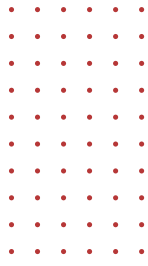


Interest Search Learning Model Diagram

Parents can help facilitate this process by engaging alongside their child(ren) and asking “ Who, What, Where, Why, and How type-questions” (Haden et al., 2014). These types of questions help children subconsciously encode new information, deepen their understanding, and improve their retention. When children engaging in a hands-on activity receive descriptive feedback after completing a step or modifying their creation, they retain this knowledge and are better able to accomplish similar tasks in the future. Additionally, children who received “tips” from a third party were able to recite and reference more STEM concepts immediately after completing a hands-on activity (Haden et al., 2014). While children benefit from having the opportunity to take control of their own learning process, adults around them can also make a significant impact in what information a child takes note of and retains in the long term.



Model structures built in Skyscraper Challenge



A Museum's Role in Educational Outreach



Volunteer Running DIY Workshop



Volunteer in Fire Engine Room



Old Tube Carriage Exhibit

The “museum effect” is the idea that regardless of a person’s purpose in visiting a museum, upon their exit, they are an improved version of themselves (Zbucha et al., 2022). This improvement is furthered if visitors engage with the museum with the goal of learning. Museums, therefore, have a natural potential for partnership with schools because they share a common goal of and potential for educating. The value of a museum-school partnership is largely determined by the planning and considerations that occur ahead of time. Establishing a collaborative relationship between the museum and local schools is critical to the success of such a partnership.

Educational projects are made more effective when teachers share relevant curriculum as well as socioeconomic context with local museums (Zbucha et al., 2022). The learning material and approach can then be designed or adjusted to address the specific needs of the intended audience and promote more active learning.



Example of simulation experiment

The COVID-19 pandemic drastically affected how museums interact with other institutions, including schools. Because students were unable to physically visit, many museums created online classroom experiences heavily focused on interaction. Museum educators sought to create these experiences while still capturing the attributes of successful informal learning—interaction, free-choice learning, hands-on experience, and authentic learning (Lee et al., 2023). Hands-on programs were designed with everyday materials available in most households in mind. If other materials were necessary, experimental kits could be delivered to people at their homes. Some museums also created simulation experiments for more complex activities. These simulations emulated an authentic lab experience because they offered users choices so they could make the same learning mistakes as they could in person (Lee et al., 2023). Museums also considered how the tools they developed could continue to be used after the pandemic to maintain a high level of accessibility and expand the population they engage with. This unique situation created an opportunity for museums to develop virtual programs that still featured the attributes of successful informal learning.

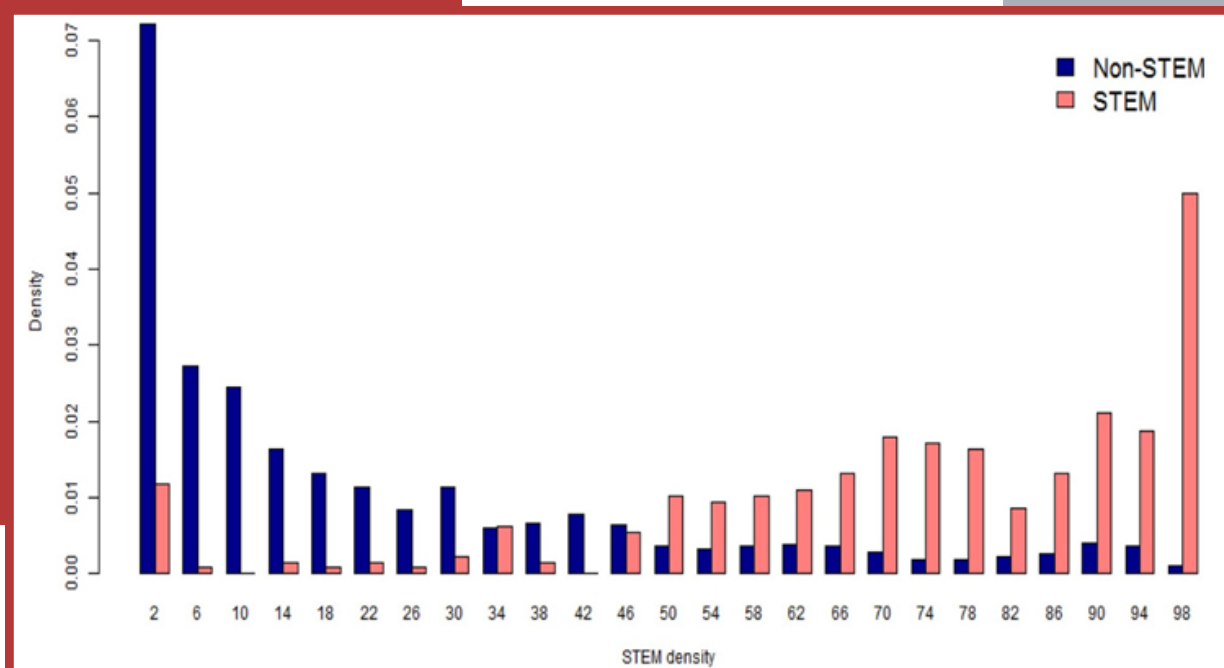
STEM Education in the United Kingdom

Science, Technology, Engineering and Math, typically acronymized to STEM, are growing fields of education and careers that are rapidly becoming significantly influential in the current world. Concepts and ideas related to the STEM subfields are revolutionary beyond just their individual scopes and contribute to the production of innovative new inventions. These innovations are greatly intertwined in the fabric of our society. Dedicated research and education are incredibly important to tackling current and future world problems and early exposure to STEM is beneficial and critical.

While demand for professionals and advancements in STEM fields are increasing, there are not nearly enough individuals pursuing careers in STEM fields (Haden et al., 2014). This deficit has been coined the “STEM pipeline problem” in the past decade or so. While increasing the number of students enrolled in post-secondary STEM programs could begin to satisfy the demand, it may be significantly more beneficial to teach more STEM based skills to all types of students (Grinis, 2019). STEM-based skills, ranging from logical problem solving to teamwork to independent thinking, are applicable in many industries and professions and everyday life situations.



Outside of the Main Pumphouse



STEM density of STEM and non-STEM occupations

Employers across many different industries in the UK, as well as worldwide, seek out potential employees with STEM skills (Grinis, 2019). Although learning STEM skills is extremely beneficial in the long-term, many young students are disadvantaged in their ability to pursue a STEM education. The General Certificate of Secondary Education (GCSE) Exams are the UK's standardized national qualifications, of which math and science are core subjects. At around age 13 or 14, students decide if they would like to pursue qualification in double science -a combination of biology, chemistry, and physics - and receive two GCSEs or triple science - a more in-depth study of each subject - and receive three individual GCSEs. It is very advantageous to choose the triple science route if a student is interested in continuing their scientific studies after GCSEs; however, many UK schools in deprived areas do not offer triple science. In fact, most students do not have a choice which route they pursue (Diversity and Inclusion in STEM , n.d.). Students may never be given the opportunity to further explore STEM related interests if not from an outside source.

Population of Waltham Forest

Waltham Forest is one of the most diverse areas in the UK with 53% of its population being from a minority background. The average age is 35.6 years old, making it a relatively young borough compared to the national average of 40.2 years old. According to the English Indices of Deprivation 2019, the most recent version of the indices, Waltham Forest ranked 82nd most deprived local authority out of a total of 317. Waltham Forest has 45,000 students, most of which are primary school students. These students are spread across the borough's 51 primary schools. For the 2022-2023 school year, only 42.7% of students entered achieved a score of 5 or above, on a 9-point scale, on their English and Mathematics GCSEs (Statistics about the Borough, n.d.). Waltham Forest is a complex and continually changing borough in London that could greatly benefit from community engagement and expanding opportunities.



Artistic map of Waltham Forest



Interior of main Pumphouse

Museums are powerful learning spaces which can support the school curriculum as an informal learning environment. They provide an immersive and hands-on experience which is impactful to an individual's learning. This is increasingly true for elementary-aged children because this kind of experiential learning promotes learning. The Walthamstow Pump House Museum is particularly important to its community because of the young and diverse population. The goal of this project was to explore and evaluate hands-on visitor engagement and student interest in STEM-based subjects among children in a museum setting.

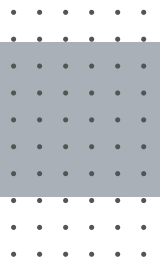
METHODOLOGY

Research Questions

The team developed three research questions to help guide initial research and decision-making related to the development of methodology. We created clear objectives for the project and allowed for the identification of the most important components, thus establishing a structure for the research conducted. These research questions prompted an in-depth analysis of the impact of different factors in education and culture on the subsequent engagement, retention, and reception of STEM-based subjects by youth. Several methods of data collection were explored to address the research questions most effectively, including surveys, interviews, and observations. The research questions were:

1. What traits of hands-on, STEM-based programs and activities help elementary aged children better understand and retain new information?
2. What social and cultural norms have impacted youth's interest in STEM?
3. What STEM subjects do elementary-aged children learn in local school curriculums that can be taught in more depth through hands on activities?

To accomplish this, we designed a mixed methods study to collect data from an identified cross-section of museum visitors and workshop participants. The museum was interested in connecting with a larger portion of the local community, especially elementary-aged children. This age range was defined as seven to twelve years of age. By providing a more interactive experience while maintaining the current relationship with the existing exhibits, a larger demographic can be reached.



Methods Choices and Rationale

The team used mixed methods to collect data to understand what composes engaging educational workshops in a museum setting. To better understand the museum's needs, the team collected and evaluated qualitative and quantitative data. This data was collected primarily through interviews and surveys. Interviews were conducted with museum volunteers while surveys were deployed to local parents of elementary-aged children who frequent the museum and members of the greater community. Questions included in interviews and surveys addressed the type of popular learning styles amongst local children (e.g., kinesthetic, auditory, visual, reading and writing) and elementary curriculum topics. Quantitative data primarily came from observations of guests' interaction with exhibits. The team was interested in how much time guests spent at popular exhibits, specifically the model railway and tube carriages.



Tool House logo plaque



Posted survey flyer in local coffee shop



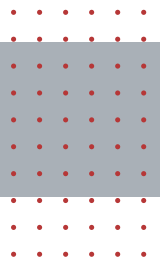
Inside fire engine room

Surveys

The team created and deployed surveys for parents of local elementary-aged children. The surveys were short and merited quick responses from the target audience which made it easily accessible, thus encouraging more responses. In terms of structure, there were 8 questions in both the museumgoer and non-museum-goer surveys. Questions were structured as multiple choice, multiple selection, or Likert scale style (a scale with two poles and neutral answer). Surveys were completed by parents who previously brought their children to the museum and those who had not. This gave the team a better idea of the needs and desires of the local community. Surveys also helped the team understand why parents did or did not bring their children to visit the museum and how they may have been encouraged to increase the frequency of their visits. Survey responses from parents helped the team learn what topics children were interested in and their children's learning styles.



Team inside old tube carriage exhibit



Inside fire engine room

To encourage museum visitors to participate in the survey, the team spoke to visitors located in popular areas such as the main engine building and tube carriages. The team then prompted families to complete the surveys, providing a quick introduction and an emphasis that the data would not be kept, and that the survey was completely optional with the ability to skip any questions and quit at any time. Survey questions prompted responses regarding the current use of the museum, what types of activities children were most interested in, their learning style, and other similar questions.

SCAN HERE

Help Our Research Group!

We are a University Student Group looking to both *improve* and *create* hands-on workshops

We Need Your Feedback!

Scan QR code above using phone camera

This short survey **benefits children** of all ages who come to the **Walthamstow Pumphouse Museum**

Community Survey Flyer

For community members who were not actively visiting the museum, flyers with QR codes were posted at local coffee shops, grocery stores and community centers. These flyers were linked to a second survey with questions more relevant to participants with varying levels of awareness of the Walthamstow Pumphouse Museum. In this survey, participants were prompted with one of two sets of questions depending on their familiarity with the Pumphouse museum and whether they had children. These survey questions prompted responses regarding interest in museums in general and learning style.



Team interviewing museum volunteer

Interviews

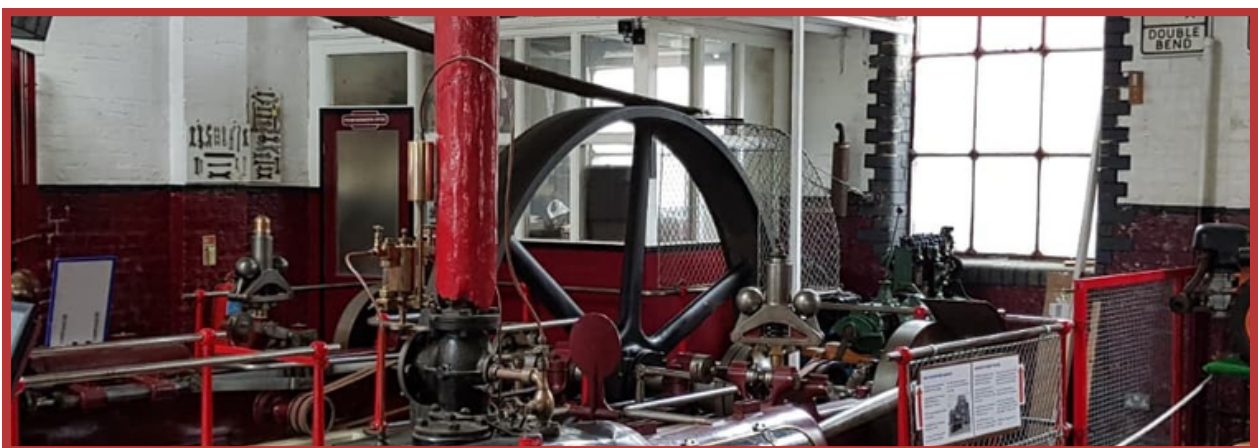
Interviews provided a more comprehensive idea of what types of programs and activities would best accommodate the needs of the Pumphouse Museum and the local children. Interviewing volunteers gave the team feedback from experts on the museum who frequently interact closely with children and visitors. The interviews were valuable in that they allowed for more open-ended responses and feedback and ideas the team had not previously considered. The team conducted interviews with four museum volunteers, each with a different role.

The team interviewed volunteers because they are the most familiar with the museum and its strengths and weaknesses. Volunteers were able to provide us with insights on how the museum runs, what exhibits are most popular, the Pumphouse's outreach and community dynamics, and any of the volunteers' existing workshops. The team spoke to four volunteers, each with different roles at the museum to obtain diverse responses. Volunteers were interviewed on Sundays, when the museum was open, and during a convenient time for them and their schedules. Interviews began with a brief introduction informing volunteers of their right to refuse questions, opt out of the interview entirely, and have questions repeated or reworded. Interview questions focused on the volunteer's history with the museum, opinion on its existing role in the community, and ideas for potential hands-on activities.

Observations

To best understand how local children interact with the museum before and after workshops are deployed, the team observed museum visitors throughout their visit. Through observation, the team collected quantitative data (e.g., how much time guests spent at exhibits) and qualitative data (e.g., comments and reactions to exhibits). The observed guests were not recorded on camera, photographed, or required to disclose personal information. The team took notes including common age ranges, if there was parent-interaction (i.e., if the parents participated or asked questions to their children during play) and if it was a child-led experience (i.e., the child had the initial interest in the exhibit). Dwelling time was kept on randomly selected families of children with varying ages regarding how long they interacted with the tube driver cabin and how long they spent in the model railway room. The team observed from a distance to keep the participants' reactions genuine.

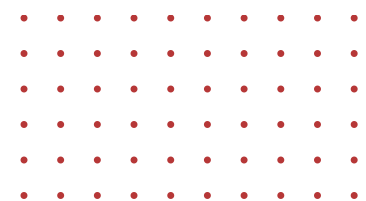
The museum's Tool House is not only a community space, but also used for general workshop classes such as their successful "DIY (do it yourself) Workshop" hosted by volunteers. The team attended this workshop to understand the organizational flow and current workshop curriculum. While sitting in the audience, the team took notes on what they offered for hands-on activities, their safety lessons, what order they proceeded in, and what worked well for their audience. The team also spoke with attendees on how they found the class, and what they could take away from it. This workshop was beneficial to our data collection because we were able to experience an existing workshop firsthand and understand how to modify certain components for our deliverables.



Main Steam Engine inside Pumphouse building

Challenges and Limitations

While we strived to establish a full picture of the local population and their needs, there were many challenges and limitations that we worked to mitigate. One of the challenges the team faced was reaching the portion of the target demographic that did not already visit the museum. To ensure the project was relevant to a broad and diverse audience, it was important to understand why active visitors continued to come to the Pumphouse Museum and especially why others chose not to visit. Another challenge was incentivizing people to participate in research. To obtain the best research and data, the team needed unbiased research from a wide range of subjects. The non-museumgoer survey's population sample size was small, with seven survey responses. This can be primarily attributed to the lack of direct interaction between the respondents and the team members. Given that the target population did not go to the museum or did not know about it, there was less incentive for them to take the survey. The team found that the in-person prompting of respondents was far more successful, yielding about four times as many responses. Additionally, when posted in person at the museum, guests had the option to scan the QR code and answer the survey on their own time and without feeling observed. The team found that guests felt more at ease when it was stated in the introduction that the survey did not need to be completed immediately. Many of the participants had just arrived and felt that they did not have enough information to take the survey when it was first scanned. Accessing teachers was another challenge in the data collection process because of their busy schedules and our team being an external party to them. We contacted multiple teachers that our sponsor had existing connections with, but we were unable to connect with them to conduct an interview. Thus, it was important to account for this factor and work effectively with limited resources and data due to limited responses.



Map displaying location of Walthamstow Pumphouse Museum



WPI students in ethics presentation

Ethics

The project required studying human subjects, so the team needed to pay attention to ethical concerns. The workshops the team created were geared toward children, so it was important to understand how children interacted with the exhibits and the deliverables. To gain this perspective without interacting with the children directly, the team spoke with parents who visit the museum. This way, the parents were able to choose to give out as much information about their children as they felt comfortable with. The team also completed a background check to ensure the safety of any interactions with minors. In surveys, the team did not collect personal identifying information with the data to encourage honest responses and ensure confidentiality. The data collected was declared to be deleted seven weeks after the end of the project duration. During observations, the team was cautious that museum visitors did not change their behavior because they felt like they were being observed. Any interviews conducted with audio recording included a verbal statement of rights for the interviewee and verbal consent to continue recording. It was also imperative that the surveys and interviews were accessible to all parties. Accommodation was implemented as needed to ensure that participants were comfortable.



Exterior of the Tool House

RESULTS

The museum's audience is growing and is largely made up of families

From the survey distributed to active museum visitors, 31 responses were gathered, and the following information was collected:

- 59% were first-time visitors
- 84% were likely to visit again
- 94% visited with family
- 63% of visitors were from Waltham Forest

Approximately two-thirds of the survey population were first-time visitors and 84% were likely to visit again, indicating the positive impression the museum leaves on both new and existing visitors. This also indicates an increase in the museum's total audience. The workshop's target age range is not currently a significant portion of the museum's audience; therefore, the integration of workshops will bring in new visitors and even further expand their demographic.

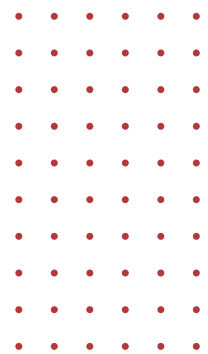
The Walthamstow Pumphouse Museum is both family and community oriented. It is a unique and educational space for families to bring their children on a Sunday. Our survey data confirms this with 94% of the participants reporting they visit with family. Roughly two-thirds, 63%, of the survey population were from Waltham Forest, emphasizing the role the museum plays as a valued space in the local community. The addition of hands-on workshops for children will preserve these focuses and provide another opportunity for members of the community to visit the museum as a family.

Families value accessibility and inclusivity in community organizations

The volunteers interviewed collectively mentioned the community-driven nature of the museum and its accessibility and inclusivity as major draws for visitors. These are also reasons for the volunteers' continued dedication to the museum; they value the Pumphouse Museum because it is run by the community, for the community. Multiple volunteers mentioned the museum is a great place for families to come on Sundays for free and get their children out of the house, allowing them to explore and learn. One volunteer stated that visitors enjoy the museum's environment and spirit.



Children engaging in arts & crafts



The museum maintains accessibility with free admission and low-cost access to the Tool House. From our conversations with volunteers, we determined accessibility is a key contributing factor to why local community members visit the Pumphouse. In one volunteer's opinion, Walthamstow Pumphouse Museum stands out because it is tucked away in a northeast London suburb, making it especially accessible.

In recent years, the local community's demographics have shifted and become younger, more culturally diverse, and more familial. Volunteers emphasized the importance of sharing and passing down knowledge to the next generation, especially in such a diverse community with young children. To allow as many participants as possible, volunteers strongly recommended keeping the museum's offerings at low or no cost.



•Volunteers performing maintenance and preparing pumps for demonstration



Documentation accompanying Model Railway room

The Walthamstow Pumphouse Museum is an underutilized resource in the community

From the seven responses in the survey for the greater community, the following data was obtained (Appendix B in Supplemental Materials):

- 43% of respondents had not visited the Walthamstow Pumphouse Museum
 - 33% because they could not visit during opening hours
 - 67% because they had never heard of it
- 85% of respondents regularly visit museums

The data showed that the museum's limited hours of operation pose barriers. Currently, the museum is only open on Sundays due to limited volunteer availability. Of the respondents who had never visited the museum, 33% claim that it is because they cannot visit during operating hours. The introduction of workshops will expand the hours of operation and provide additional opportunities for the community to visit. Although 43% of the survey population had never visited the Walthamstow Pumphouse Museum, 85% claimed to regularly visit museums. The museum therefore has a chance to reach more community members.

Visitors value the presence of hands-on activities at museums

The importance of visual and interactive components in an educational activity was further proven by the team's survey data. From both surveys we learned the most popular reasons for visiting museums, whether it be the Walthamstow Pumphouse Museum or others, were for education and entertainment. The most popular learning styles were also consistent across both surveys-- kinesthetic and visual learning overwhelmingly took the lead. Our hands-on workshops addressed these preferences and motivations through visual instruction and kinesthetic activities that are entertaining and educational. The workshops emphasized physically interactive learning paired with visual demonstration, catering to both popular learning styles while also providing entertainment.



Team working in Tool House

Children are more engaged when they take the lead

The team conducted observations on a typical museum day, open to the public with two team members posted in one of the tube carriages. There are two tube carriages on the museum grounds, with the second tube having access to the drivers' cabin at the front, and the first tube parallel with a view of the cabin. 29 families were observed interacting with the driver's cabin. From those 29 families, the following data was collected (Appendix B in Supplemental Materials):

- 23 were child-led experiences
- Average time of child-led experiences was 1 minute and 59 seconds
- Average time of parent-led experiences was 1 minute and 34 seconds
- 19 of the families had parent-interactions



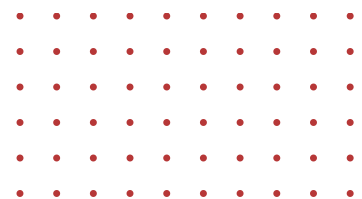
Team exploring tube carriage exhibit

Child-led experiences in the tube exhibit had a longer play time than its counterpart, parent-led experiences. The children interacting with the tube carriages were overheard speaking with general transportation knowledge such as mimicking the announcer in the underground stations. We observed that the children enjoyed having a space to move, run, jump, and interact with the moving buttons and levers. The tube carriage provided an open space for self-guided exploration.

The tube carriage is an area catered towards their younger audience due to the open and interactive nature of the space. Parent-interaction occurred more often than parent-leading, indicating the parents were more likely to ask engaging questions with their child, while the child controlled the time in the tube. Ultimately, child-led experiences made up most of the tube carriage observations. This means that given the space, children make the most of these hands-on learning opportunities by directing their own experience while being supported and affirmed by others. Although the longest average time on the tube was parent-led and had no parent-interaction situations, the team noted that this may be due to the ages being outside of the focus demographic (i.e., younger than age 7).



Model Railway room



Parents improve their children's engagement through interactions

Similar observations were conducted in the model railway exhibit. The model railway room is a smaller area within the main pumphouse building. It contains the in-progress model railway set up with an area for volunteers to run and upkeep the tracks, and a section for visitors to view. The model railway room had 22 observed families total and the following data was recorded:

- 9 were child-led experiences.
- Average time of child-led experiences was 6 minutes and 58 seconds.
- Average time of parent-led experiences was 2 minutes and 50 seconds.
- 9 of the families had parent-interaction.



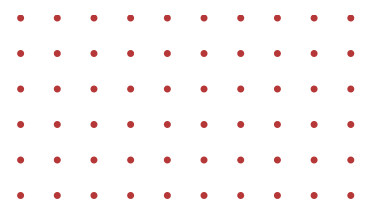
Team exploring main pumphouse

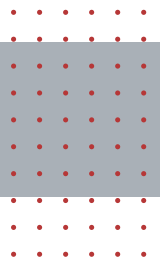
The child-led experiences recorded make up 41% of the total families observed, and those groups spent more average time involved with the model train room than parent-led experiences. Of those families not exhibiting child-led behavior, we observed that the children had entered the room by being physically moved, or via verbal instruction. The children interacting in the room could observe the model trains running on a loop on the track and ask questions to their parents or the volunteers.

The highest average time was for child-led, no parent interaction at 7 minutes 30 seconds. This is largely due to a group of children wandering the museum without adult accompaniment who were particularly interested in the trains. That said, the average times for families with parent interaction were still high. Those parents had asked questions or offered guidance to extend their children's interest in the exhibit. Parent interaction was especially effective at this exhibit because it is not interactive, but solely visual. The team concluded children may need guidance with their education, however they are the ones deciding to stay and learn as much as possible within that area. With hands-on workshops in mind, we determined the children will learn best with room to explore, freedom to discover, and assistance or guidance when needed.



Entrance to the museum

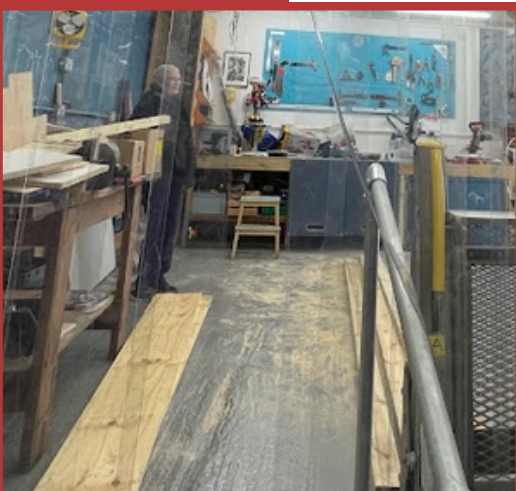




Wall of historical fire engine models



Exterior of Tube carriages

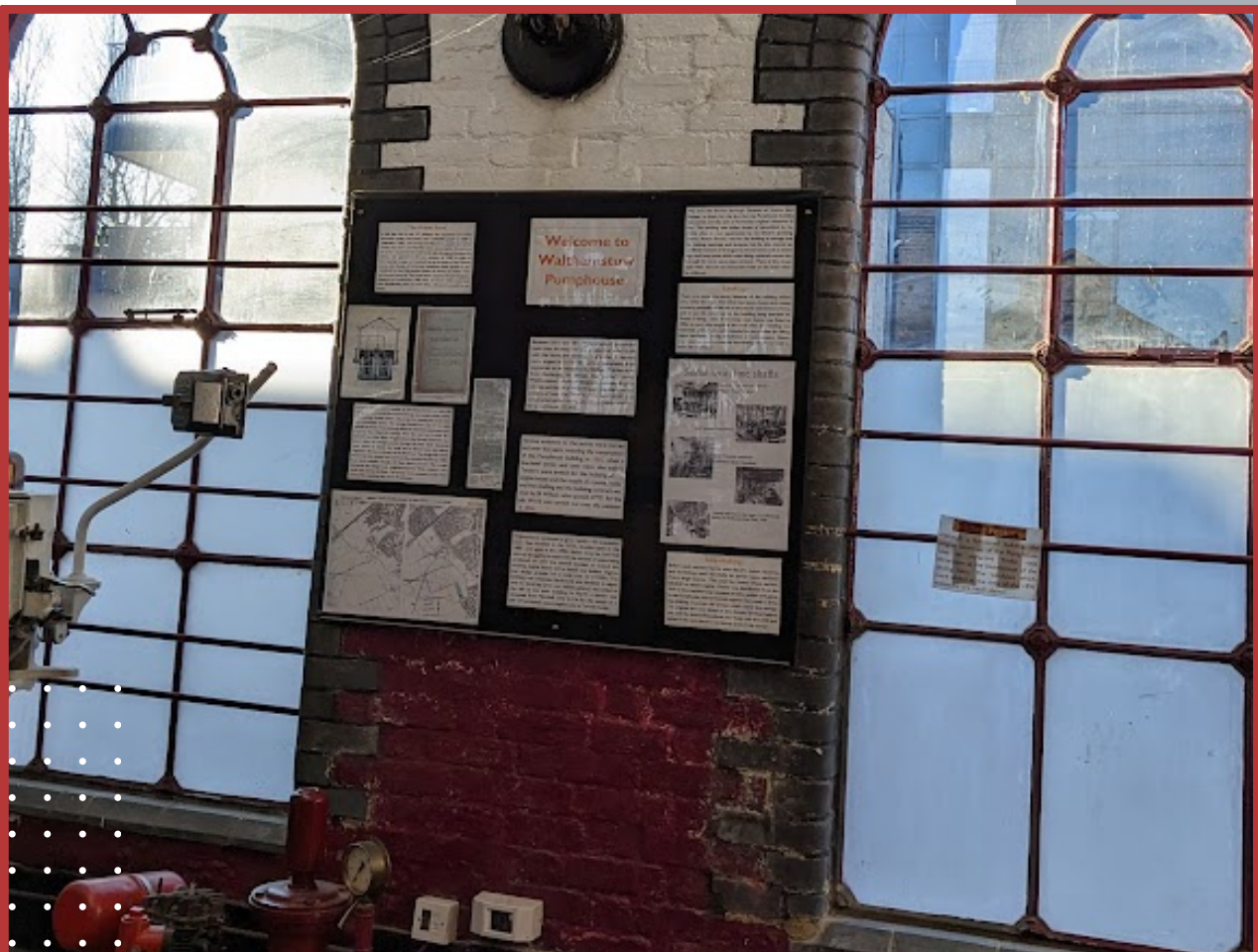


Interior of the Tool House

A safe hands-on environment builds confidence

Our observations included attending a DIY workshop hosted by two of the museum's volunteers. The target audience was adults interested in learning more about simple hand tools, power tools, and tips for at-home projects. The workshop began with a brief safety discussion establishing basic workspace guidelines. The instructors then introduced various tools one by one, explaining the purpose of each and providing specific safety tips. Participants were encouraged to ask questions at any point, which often enriched the discussion and provided a deeper understanding and clarification. Following the demonstration portion, participants were able to practice using the tools with the instructors' guidance. Many of the participants expressed increased confidence in their abilities after using the tools themselves.

We determined that a detailed and specific safety demonstration at the beginning of our workshop is necessary, especially given the age range of our target audience. This will familiarize participants with all tools and materials they will be interacting with in advance and reiterate the importance of safety. The participants enjoyed passing the tools and materials around and getting a closer look at them in addition to the information being provided verbally. In our workshop design, the children will have a similar opportunity to explore various materials and safe tools. For example, the children will be able to choose from varied materials for certain portions of the workshop, such as twine, ribbon, or yarn for the string of a yo-yo. This will combine kinesthetic and visual learning styles, which are effective for the target age range. The workshop will also be an environment where the children are encouraged to ask questions and share their thoughts with the group to promote deeper discussion and understanding.



Inside main pumphouse

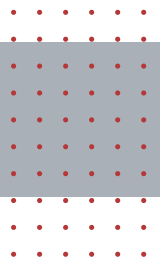
Takeaways

The results of our data collection were critical in the design of our workshop design deliverables. Our workshop outlines included a visual demonstration in addition to the hands-on activity to effectively maintain the children's engagement. The low-cost activities were based in STEM subjects to promote greater interest amongst children. Parent interaction can improve children's engagement, so parents were included in our workshop design. Safety is critical in improving confidence around the tools in the workshops and was a key part of our workshop design.



Team outside museum entrance

RECOMMENDATIONS



Yo-yo workshop in progress

For museum professionals and educators, we have several recommendations for outreach and engagement. These recommendations can help organizations like the Walthamstow Pumphouse Museum to plan, implement, and evaluate programming that promotes interest among young learners. We recommend museums and other informal learning spaces create hands-on, STEM-based workshops for children. When creating such workshops, there are a few key components we recommend be included.

Create safety guidelines

Due to the hands-on nature of the proposed workshops, safety is a prominent concern. We recommend the workshop include a safety waiver that a parent or guardian must sign prior to their child participating in a workshop. The team provided the Walthamstow Pumphouse Museum with examples of waivers from organizations with comparable workshops. A waiver would inform parents of potential dangers in advance and limit liability.



Coloring activities in main pumphouse

To keep the workshop space safe and workable, the team recommends there be a maximum of four children enrolled in each workshop. The Tool House is limited in space, and it is important that the instructor and all participants have room to work comfortably. This will also ensure the instructor has an easier time assisting and can devote more time to each participant.



Inside Tool House

At the beginning of every workshop, the instructor should give a brief safety demonstration. This includes introducing each of the hand tools the participants will be using and demonstrating how to use them properly. The instructor should also discuss basic workshop safety and establish some rules on appropriate workshop etiquette. Rules may include walking carefully and keeping your eyes on what you are working on.

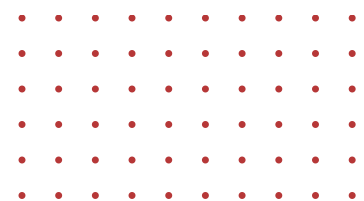
Encourage parent involvement in activities for children

The team suggests that parents be present for the workshops for several reasons. In our research, we learned that children's information retention notably increases when asked questions about what they are actively learning. Additionally, parent involvement improves child engagement, as they can redirect the child's attention and provide a familiar environment in which the child can comfortably explore and learn. Parents should be encouraged to share their own knowledge and affirm their child's success during the workshop to build the child's relationship with STEM. Parents will be more involved in the workshop experience and will be able to start meaningful conversations with their children afterwards.

The workshop's intent is to reach an older demographic of children than the museum currently attracts, but the team suggests that the museum still require parent supervision, as they do in the general museum, as an additional safety measure. This allows for more help for the volunteers to be successful in the workshop's flow.



Electronics workspace in the ToolHouse

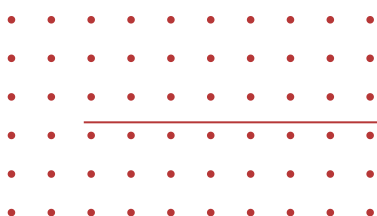


Workshops should also include a worksheet geared toward parents that specifies the objectives of the workshop and identifies important steps and takeaways. This serves as a guide to prompt the children to think about what they accomplished and what they can learn from it. This will increase retention of the information learned and make the workshop more impactful. It also adds a take-home aspect to the workshop, which will extend the experience beyond the workshop itself. This increases the child’s sense of accomplishment and ownership, making their efforts more rewarding.

Recruit volunteers from the local community

Enthusiastic individuals with interest and experience in working with youth are integral to the smooth functioning and success of the workshops. Outreach to local secondary or university students creates the opportunity for a mentorship program which would improve the workshops educational value and community impact. This could include advertising in community centers and talking with local schools. Many schools have programs that facilitate educational interactions between older and younger students, including tutoring and mentorship programs. The museum should contact schools with a description of the workshop offerings. This would be beneficial to the Walthamstow Pumphouse Museum specifically because the increased outreach could lead to a growth in the number of volunteers. The lack of volunteers has led to the minimization of hours and days of operation for the museum, so bringing in more volunteers for these workshops could be beneficial to the museum's greater functioning.

The Walthamstow Pumphouse Museum should recruit volunteers to lead the proposed workshops by advertising on their social media platforms and through their mailing lists. Social media is a widely used source of information for the ideal demographic to lead the workshops, making it an effective way to reach a large audience. The Walthamstow Pumphouse Museum has an active social media manager, so the team suggests the continuation of relevant posts and advertisements of upcoming events. The team acknowledges that trends are always changing and advises the museum to be flexible in how they reach out to younger generations across all platforms.



CONCLUSION

Our team valued the benefits and challenges this project presented. Working with the Walthamstow Pumphouse Museum allowed the team to immerse ourselves within the London community as well as apply research and ideas in a real setting. We appreciate the time and assistance our sponsor provided throughout this process.

Through a mixed-method process, we were able to gather valuable data to present to the museum. From there, our findings were applied to workshop ideas, general suggestions and statistics relative to how the museum is currently operating. The suggestions supplied are based on a comprehensive data analysis, and if implemented, may aid in greater STEM participation amongst elementary aged children and encourage a broader demographic. These suggestions accompany the main goal of adding a hands-on workshop to the museum's present offerings.



Team presenting final project

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