Improving Outdoors Literacy For Children At Turn Back Time

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Image : TBT Mushrooms

Table of Contents

List of tables

List of Figures

Image : Playground

0.1

ABSTRACT

Studies show that exposure to nature and play-based learning are critical to early childhood development. Turn Back Time Inc. (TBT) provides the opportunity of outdoors learning to children through various daily activities and experiential play in nature. While TBT possesses a rudimentary trail for outdoors literacy, the lack of long-term structural units stunts the efficacy of their outdoors literature process. The purpose of this study was to research, construct and analyze nature-based literacy stations to improve TBT's outdoor learning facilities and to enhance the literature experience of TBT students.

Executive Summary

Literacy Background

Early childhood literacy, along with play-based learning, is believed to shape the structural design of the brain from a young age, being responsible for increasing mental flexibility and learning potential later in life. In engaging in such methods of learning, children become more likely to develop memory skills, language development and long-term behavioral regulation. In studies done over the timeframe of six months, the experimental groups of children attending a play-based curriculum school scored higher on grammar skills compared to the control group attending standard curriculum (Study International, 2018).

Our Sponsor

Executive Director Lisa Burris established Turn Back Time to teach her children about nature. She witnessed nature's benefits on her children and decided to start the first camp in 2012. Co-director Katie Baker joined Turn Back Time in 2014, already having experience teaching preschool and kindergarten at another school. Coming from a traditional school setting, Katie saw the advantages of nature in children and was devoted to helping Turn Back Time grow and expand. Turn Back Time is located in Paxton, Massachusetts as a nonprofit educational farm environment that aims to serve to educate children with exposure to the natural world through play-based interactive learning in place of dense classrooms. With 58 acres of land, Turn Back Time functions with dozens of children attending year-round, ranging from summer to preschool programs going from 9AM-1PM during the week, engaging its attendees in experiential activities, from interacting with the local farm life to collective group reading (Turn Back Time, 2022).

Goal and Objectives

Turn Back Time's primary issue that we sought to address was their need to increase the outdoors stations to add more literature-related activities for their student attendees. One such method that they utilized for this was a story-walk, a station that held and displayed individual pages of children's books set along a trail in nature. However, the methods used to hold the papers in place were unreliable, often resulting in pages falling off or being blown away by the wind in the timeframe of a few days.

Our primary goal was to build an improved version of this story-walk in order to make it possible for pages to remain mounted for extended periods of time as a long-lasting structure. To accomplish this, we created various objectives to break down the process. Such objectives were:

1. To understand the specific needs of Turn Back Time and the aim of what our design should be optimized for.
2. To analyze data and research while creating potential designs for the story-walk
3. To test and reiterate on designs, improving on feedback given by TBT.
4. Designing a fully-fledged functional story-walk that successfully serves the needs of teacher and student.

Methods

Our methods began with researching the Massachusetts Frameworks to find connecting links between it and our story-walk. We conducted interviews with Turn Back Time's codirector to gain a better grasp of their specific needs and opinions on various designs as well as general criteria. We created an initial survey to gain an understanding of what the staff members at Turn Back Time desired to see built from responses based on questions asked, such as on if story-walk should be built to be movable, the importance of its aesthetic aspects, as well as how much they liked the design of several example story walks in order for us to gain inspiration of what to work towards. The quantity of pages within a children's picture book used within past story-walks was found to have a typical upper limit of 36-38 pages, and after discussion with TBT's codirector the page count the story-walk we designed was set to a goal of holding 40 pages.

We scouted various nearby story-walks in parks and museums in order to acquire a frame of reference for its construction, approach, and methodology applied to maximize audience engagement and measured the dimensions of the laminated papers that would be in use for the story-walk to approximate the frame sizes that we would construct to accommodate them.

We rationalized decisions for the choice our construction materials and designs through decision matrices and pro-con lists and met weekly with our TBT's codirector to gain feedback on our proposed prototypes to gain design pointers in order to further develop our project after creating framework prototypes as proof-of-concepts to show.

In order to perform observations, we utilized the old rudimentary post system Turn Back Time held in storage to set up a makeshift story-walk in order to observe the process of outdoors literacy in order to seek potential points of the design to improve. From both qualitative and quantitative observations as well as feedback from instructors after, we learned that this process often takes place as a guided reading experience where approximately a dozen children are led by an adult that reads the pages aloud to them. Low posts created the issue of children squatting at the pages obstructing visibility for others, while distraction was a common issue with the group fragmenting as children went ahead of the group to look at pages containing illustrations rather than words. With the reinforcement of teacher feedback, it became apparent that illustration pages should best accompany the pages containing the corresponding text to prevent group splitting as a result of attention loss.

To then weigh our options of design choices, we proposed our budget containing our various potential designs. After further suggestions from Turn Back Time to improve the appearance of our design, aesthetic revisions were conceptualized after the creation of a miniature functional proof-of-concept prototype for a sliding frame design prior to the building of a full-sized prototype. After checking back with Turn Back Time and gaining approval of our design, we began construction.

Recommendations and Solutions

With the information obtained and past iterations in mind, we constructed numerous large plexiglass sliding frames mounted 3-4 feet above the ground on trees to solve the issue of visibility and crowding by setting the frame slightly above the children's eye level. In considering the dimensions of multiple laminated sheets, the sliding plexiglass wooden frame was built to be large enough to accommodate two pages at once side-by-side with both either placed horizontally or vertically, considering the possibility of how various story-walk books must be placed either vertically or horizontally to be facing upright. Utilizing the fact that the plexiglass panel was designed to be able to slide out of the frame, the story-walk pages used could easily be swapped and interchanged, and twenty were constructed to hold the total page count of 40, with each frame holding up to two laminated pages. Observations performed after construction confirmed that the new height and capacity of the frames succeeded in preventing crowding and group fragmentation. For further recommendations, we suggested the addition of triangular wooden wedges between story walk frames and the trees they are attached to in order to increase surface contact; such wedges will greatly reduce structural stress caused by wind.

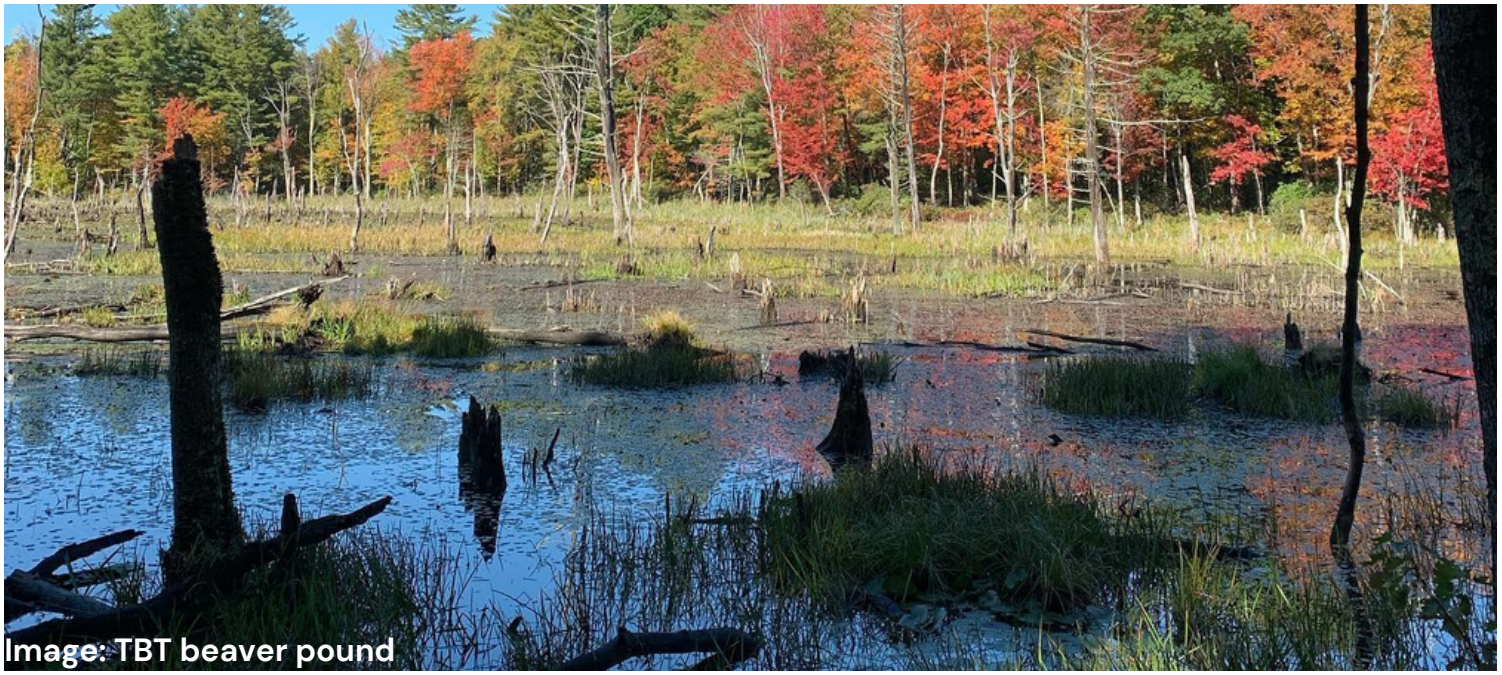


Image: TBT beaver pound

1.0 INTRODUCTION

Image : TBT trail sign

Over the past 20 years, the negative consequences that accompany low test scores have caused a general shift in schools narrowing down curricular efforts to focusing on test preparation, de-emphasizing curriculum that does not place emphasis on test results and student centered, experience-based learning. Despite the fact that active and experiential outdoor learning is demonstrated to be significantly more memorable long-term than rote memorization, its prominence in school activities has gradually declined (James and Williams, 2017). The quality of early-age education is a critical factor in the future development path for children, with a child's brain becoming as active as an adult's at age two, and twice as active by age three. Without proper stimulus during this time, future growth in learning becomes at risk of being stunted (first5la, 2021). Critical educational factors such as early literacy has been found to be a major social determinant of health, with early literacy being connected to high-school graduation rates later on in life – third graders who fail to read at grade level are more likely to drop out of school years down the line, with early difficulty reading leading to dropout rates becoming up to four times as likely.

Of the students who failed to get a high school diploma, 88% had difficulty reading in the third grade, which is considered a critical point due to being the last grade in which children learn to read, and afterwards they read to learn (Weyer and Casares, 2019). In our increasingly technological world, three-quarters of children in the UK now reportedly spend less time outside than prison inmates (Barber, 2019), often engaged on touch-screens rather than spending time outdoors. However, neurons responsible for the brain's reading network gain higher functional connectivity with higher time spent reading, while the inverse occurs with screentime (Hutton, Dudley, Horowitz-Kraus, Dewitt & Holland, 2019). We developed a case study at Turn Back Time Inc, an educational facility for children, by researching the impact of outdoors literacy, understanding the community's demographics, resources and needs, scouting example methodologies of bringing about outdoors literacy to children, developing step-by-step prototypes on feedback and research on material construction in order to complete our goal of bringing about more opportunities for students here to participate in outdoors literature. In order to understand our community's needs, we held meetings with the co-director on a weekly basis while sending out polls to the community and performed observations of their outdoors literacy activities to identify necessary points of improvement. With community needs clarified, we set out to research development in construction, employing decision matrices, pro-con lists and creating prototype structures to modify through the feedback of Turn Back Time, gaining inspiration from visited parks and museums in employing construction methodologies.

Image: TBT butterfly grove

Image : TBT wall art

2.0

BACKGROUND

Turn Back Time is a place of learning and community in the town of Paxton, Massachusetts. Established in 2012 by Lisa Burris, it serves to educate children in the natural world through nature and play-based teaching methods in place of lectures occurring within dense classrooms. The 58-acre farm serves as a place of learning and play for dozens of children year-round, from summer programs to preschool, with nature-based activities ranging from reading in the woods to inspecting the local pond life in person (Turn Back Time, 2022).

Image : TBT Yurt

The site is ever-expanding, with new structures and learning stations being constructed regularly to accommodate the needs of the children and teaching staff on the farm. When a method of teaching has room for improvement, or when there is an opportunity to broaden or enhance the education system at Turn Back Time, an improvement is made to the facility. This is frequently done through sponsored projects, which are aimed at becoming permanent installations that improve the curriculum at the farm, such as weather education stations designed by IQP groups. With a focus on nature education, the farm prides itself on being educational through daily farm activities rather than through the standard curriculum classroom formula, involving enriching the outdoors experience through activity-based learning for children, providing once more the opportunity for children to learn through hands-on play.

2.1 Description of the population served

Thirty percent of students at TBT come from underserved populations, including children below the poverty line, with documented diagnoses, and whose families are involved with the Massachusetts Department of Children and Families (Turn Back Time, PROBS 2022). Turn back time has several programs ranging from Pre-K to adult programming (Table 1).

The Pre-K classes are comprised of students from ages three to six, and operate from September to June. Turn Back Time also operates a Kinderkamp as an alternative to traditional kindergarten and an evening curriculum for homeschooled students as a form of STEAM enrichment. Additionally, summer camps have weekly themes that relate to STEAM in nature.

Programs offered at Turn back Time

Table 1

Program Title	Program Description
Family Farm Time	A visit to the farm's stations with family
Preschool	For students ages 3-5; outdoor and play-based curriculum
Critter Catchers	After-school hiking, fort-building, observation, and creature caring
Adult Programming	Outdoor yoga, art therapy, meditation, basket weaving, birdwatching, foraging, and oil making
Birthday Parties	Ages 3-12
Kinder Kamp	Kindergarten alternative

Programs offered at Turn Back Time::

The most popular program at TBT (Turn Back Time) is preschool. The program operates Monday through Thursday 9:00 AM - 1:00 PM September through June.

TBT's unique way of teaching gives Turn-back time an advantage over other traditional preschool programs due to its blend of outdoor learning with preschool programs. TBT is a licensed preschool program, with the teacher to children ratio as 5:1. The homeschool program is offered for children 4- 11 years old.

2.1.1 Nature Literacy

Image : TBT camp Fire

The primary issue of Turn Back Time was the need for more opportunities to bring literacy to children in an outdoors environment. Early literacy is associated with various factors later in life, such as being linked to high school graduation rates as well as a rise in social, cognitive and language skills (Bubikova-Moan, 2019). With the apparent importance of early literacy, Turn Back Time seeks ways to increase the number of outdoor activities involving reading to further enrich the learning experience of its students.

2.1.2 General perceptions of outdoor learning settings

A study conducted in Thailand recorded the responses of pre-service teachers regarding their opinion on outdoor STEM education and found that out of the 29 teachers, 24 had already used outdoor STEM education in their teaching methods, where teachers believed that their students responded well to being taught outdoors (Khwaengmek et al, 2021). Both the teachers and researchers found STEM education should be a focus in early education. The researchers also noted opportunities for that education to be integrated with the wider community. While a direct comparison of Thailand's early educational system and the United States may possess differences in methodology, the study suggests that there is a positive attitude around using the outdoors in early childhood education.

2.2 Traditional vs Non-traditional classrooms (Pre-k)

When comparing the settings of traditional to non-traditional classrooms, a non-traditional classroom is one that deviates from the standard setting of indoors education methods (such as the utilization of rote memorization and lecture to instruct students) often opting for more hands-on, experiential, or outdoor methods of education. Within the last 20 years, the associated negative consequences of low-test scores have caused schools to narrow their curriculum efforts down onto test preparation, consequently de-emphasizing the material that does not show up on standardized testing and student centered, experiential learning (Shavelson et al. 2010).

However, the advantages and benefits of non-traditional classroom learning systems carry several advantages over its traditional counterpart. One such advantage is in personal interest and attention vested by students; in a 2013 Gallop poll, it was revealed that 45% of students through grades 6-12 were disengaged with the school system of teaching due to the standard curriculum involving rote memorization, lecture and drill. Yet conversely, within a middle school survey involving participants experiencing outdoor learning, 79% reported that it was a worthwhile experience, while many students with special needs or academic interest became highly participatory and engaged in the process despite otherwise often struggling with the standard school curriculum (James, 2017). Furthermore, recorded results have demonstrated that active and experiential learning is significantly more memorable and committable to long-term memory compared to rote memorization, and when the environment is integrated into a school's learning curriculum, the degree of academic achievement rises. For instance, in one key study, children who participated in outdoor learning had their test scores improved by 27%, indicating a boost to academic performance. Not only does outdoor learning improve student interest and learning, but it additionally facilitates the growth of social and personal skills, with outdoor collaboration improving behavioral and intellectual development. In the current age of increasing involvement with electronic devices, the standard amount of time outdoors that children spend has also declined. Currently, approximately 3/4 of children in the UK spend less time outside than prison inmates (Barber, 2019). Despite the importance of outdoor activities for children, both the school system and at-home trend have been heading towards the direction of greater indoor activity at the expense of outdoor experience and learning.

2.3 Literacy

Image : TBT bunny drawing

The impact of literacy at a young age has been extensively studied and has led to numerous important findings; early literacy is directly linked to graduation rates, with third graders unable to read at their grade level being found to be much more likely to drop out of school later in life. Early difficulty reading leads to dropout odds being up to four times as with approximately 88% of people who failed to get a high school diploma being those who also struggled with literacy in the third grade. The third grade is identified as an important pivot point for literacy because it is the final year that children learn to read, after which they read to learn; causing students with underdeveloped literacy skills to further fall behind as time passes (Weyer, 2019). In addition, family income inequality leads to differences in a child's reading level due to environmental influences; families with fewer resources have a harder time exposing their children to early literacy; 61% of children from low-income families do not have children's books at home, and of the 68% of fourth graders below the reading proficiency level, 82% of them are from low-income families. By age 3, this can lead to a 30-million-word gap in terms of the number of words a child has been exposed to. As a result, children from financially challenged families often perform academically lower than their peers and may lag behind within their school years. Early age education plays a critical role in brain development; by age two, a child's brain is as active as an adult's, and by age three it is twice as active. Exposure to learning materials at an early age is highly important for development and has a lasting impact that carries over into adulthood (Little by Little, 2020).

2.3.1 Nature Literacy

Nature is a helpful tool to help children understand novel concepts. There are many ways to teach children – including traditional classrooms, hybrid learning (involving classroom and outside activities), and completely nature-based learning. (Lee & Bailie) Nature-based literacy involves children using materials found in nature, such as rocks, flowers, leaves, dirt, and trees, to learn about different subjects. (Lee & Bailie, 2020)

An example of implementing nature literacy could manifest as children starting their day involved with nature, with the teacher acting as a guide to organize their learning. The teacher would plan certain activities that children would participate in on that day, such as a nature trail. On a nature trail, children select items they find in nature and describe them. They may answer questions about the materials' characteristics and explain why they made these choices. Teachers could ask children to make a house for their toys and consider questions such as what materials they would use to build such a shelter and how the shelter would protect the toys. They would then test their buildings against several variables, such as determining whether they could hold water or withstand weight, then improve them using the feedback received regarding their previous buildings. From such experiences, children would gain practical experience in learning to solve real-world problems rather than in solving theoretical problems on paper with minimal sensory input. Depending on the school's resources, these activities can vary. Schools often have different learning stations. When educators are given appropriate opportunities, they are more likely to implement these methods. Nature-based education can be highly effective early in a child's development, with prior studies showing results of children participating in such activities scoring significantly on vocabulary than those who did not (Bonawitz, et al. 2018).

Today, teachers view nature literacy as an addition to the traditional classroom within a fixed timeframe, although many teachers today do not have appropriate training for nature literacy (Tuuling et al., 2019). Additionally, some instructors may consider it too complex and difficult to organize due to the belief that children are easily distracted outdoors. Educators also have concerns about other restrictions, such as weather, the time available to plan activities, and dangers associated with outdoor play. Although teachers consider nature literacy complex and difficult, most consider nature important to education. Although difficult from a teacher's viewpoint, nature literacy improves children's retention rates, personal and social development, and organizational skills. Teachers who master nature-based teaching have a tremendous advantage over their colleagues, although teaching nature literacy requires effort and deliberate practice.

Literacy learning occurs largely focused on reading, with writing taking a backseat and relegated to the upper grades and English classrooms. Literacy is multidimensional: linguistic and multimodal, cognitive, sociocultural, and developmental (Kucer 2015). Nature-inspired literacy involves using tools, materials, and resources while participating in a fun outdoor activity, which can help children become literate in such subjects and allow them to understand and appreciate the world around them. (Budna, 2015).

Nature literacy outperforms literacy in traditional classroom settings by a large margin (Ernst & Stanek, 2006). Different outdoor activities help children develop their motor, recording, writing, and drawing skills. Rather than memorizing facts from a book, children are instead able to utilize their five senses to associate and recall what they have learned, and can form their narratives about what they learn and gain knowledge to connect their memories.

The traditional way of teaching children involves them memorizing facts from a book, which they are later asked to recall. This is extremely ineffective for long-term retention (Bower & Clark, 1969). It also gives the students an illusion of knowing the material because they can recall information about it in the short term.

In nature literacy, children use all the material available in nature to form memories together to constitute a narrative. The narrative has a crucial function in memory. Humans are six to seven times more likely to remember items that are featured in a story rather than through rote memorization without surrounding context (Bower & Clark, 1969).

Nature literacy also gives students a sense of time and place. Such senses can also improve retention rate. Neurons in the hippocampus, called place cells fire when people visit various locations. These place cells fire on seeing visual landmarks. These cells play an important role in episodic memory (memory of everyday events) (Grieves et al., 2020). Nature literacy exploits these place cells through repeated exposure to remembered locations. In nature literacy, children have unique learning stations, each station triggering a specific place cell, ultimately affecting their everyday memories in retention.

2.4 Designing a learning space to facilitate understanding

Designing a learning station conducive to education requires examining past and present research into this subject matter and considering how classrooms are becoming increasingly open and active at all levels of education. This significantly benefits both the discussion elements of a class and the understanding of those whose learning styles require more active participation and open dialogue rather than lectures and tests. This is observed across all age levels but is especially prevalent in children, which is why this methodology is a staple of our sponsor's education system and a major factor in how we plan to design our learning station. Through nature literacy via a story walk, children can learn through active participation in walking along the outdoor trail, surrounded by nature and greater sensory stimuli, rather than within a standard classroom setting.

Image: TBT butterfly grove garden.

2.5 Story Walks

Story walks are made up of laminated pages of children's books on posts, placed along a path. Story walks allow children to read, or be read to, in a different environment than in a classroom. As our research has shown, there is a measurable difference between students stuck in traditional classrooms and those who are outside more frequently. Story walks promote literacy by enabling students to interact with the story at their own pace and allow them to do other things while still being engaged with the story. While no research into the efficacy of story walks on the literacy promoting of students has been published, anecdotal evidence from curators of story walks is encouraging (Fredericks, n.d.).

It is important to read books to kids every day to keep them actively learning and developing their language skills (Balcazar, 2019). However, it is difficult for teachers to read outside in the rain. Story walks provide a great way to facilitate nature literacy. The picture books displayed in picture books can assist learners with vocabulary because the words and accompanying pictures complement each other. While word print only conveys meaning if children know what the letters stand for, pictures help illustrate the meaning of the words for readers and any verbal or visual gaps are filled by the pictures (Hashemifardnia et al., 2018).

Picture books are also particularly effective for children who are learning English as a second language. In the United States, picture books are mostly written in English. Some children who immigrated from other countries that do not speak English benefit from picture books as an opportunity to develop their English language (McGilp, 2014). Picture books can also encourage an interest in reading and boost social emotional learning (Balcazar, 2019).

3.0 Methods

Image: TBT Yurts

Image: TBT drawing exercises

Our goal was to create an outdoor story walk for the children of Turn Back Time to help facilitate learning and nature literacy at a young age. This would help improve learning and engagement within the scope of activities at the farm. The story walk design was developed based on data collected from interviews, surveys, qualitative and quantitative measurements, and online research. Our research and data were sorted into an array of decision matrices and pros and cons lists to develop the ideal approach to creating the design of the story walk. In the following sections, steps for data collection and analysis will be further discussed.

3.1 Objectives

The primary steps to reach our goal were divided into multiple objectives.

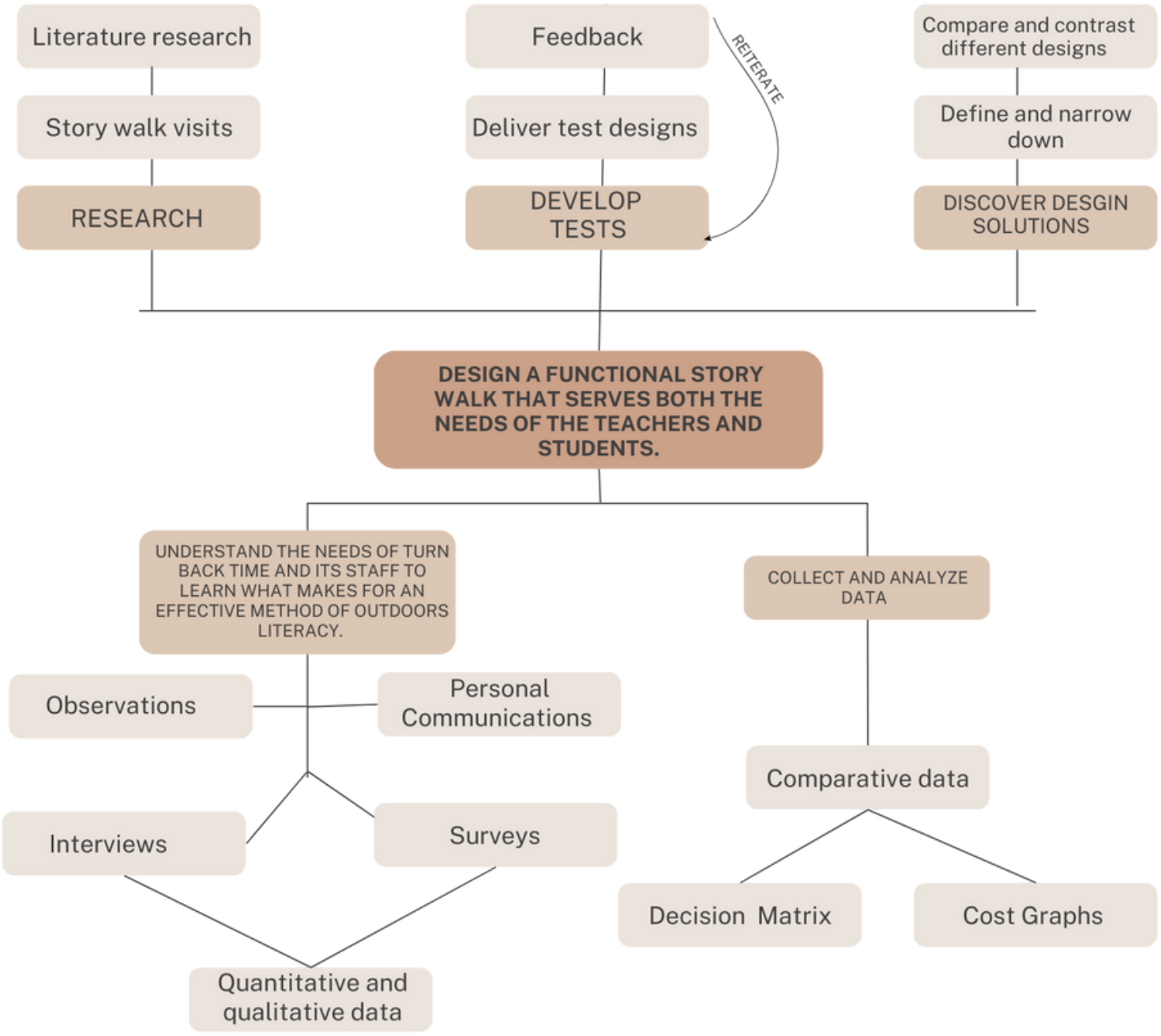
1. Understand the needs of Turn Back Time and its staff regarding outdoors literacy.

2. Collect and analyze data on what the community prefers, gain feedback from Turn Back Time, and research design possibilities.

3. Design story walk prototypes, test and reiterate on them, and improve in response to feedback from Turn Back Time.

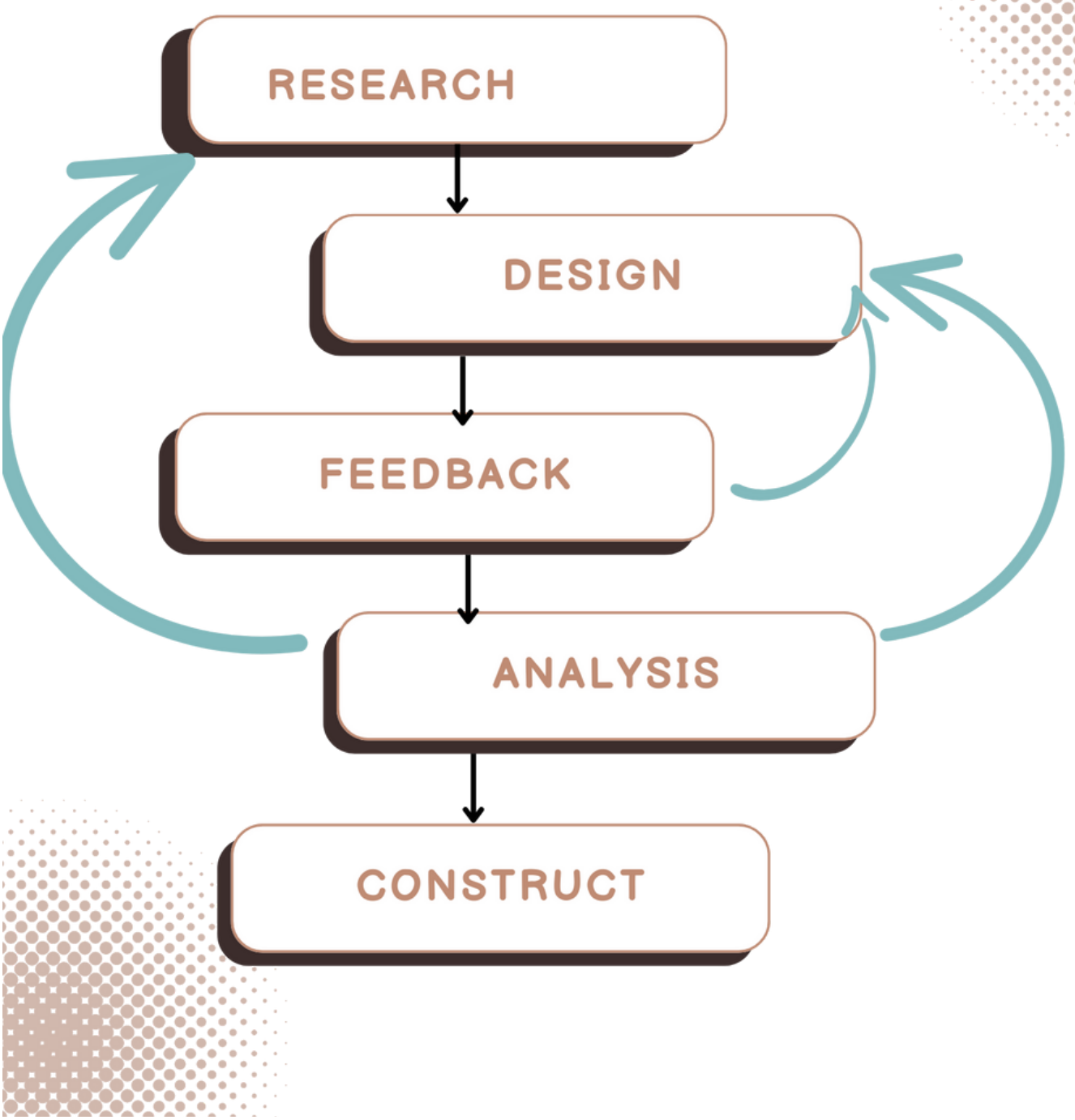
4. Construct a functional story walk that serves both the needs of the teachers and students

Figure 1 Process Breakdown



3.2 Methodology Overview

Figure 2 Design Process



We began our project by speaking to the staff of Turn Back Time to better understand their needs and vision for our project. In doing so, we were able to find out what they wanted children to get out of the experience as well as to better understand the type of story walk that they would like to see built. Next, we performed background research on the required Massachusetts Preschool Frameworks, as well as the impact of outdoors literacy and experiential learning on young minds. To gain a general understanding of how story walks are built, we then scouted nearby story walk examples within parks and museums to accumulate a frame of reference for outdoor literature, its construction, the approach used, and the methodology applied to maximize audience engagement with relevant topics. We then sent a survey to the teachers of Turn Back Time for their opinions on potential design details of our story walk, followed by further research on improving surveying methods prior to surveying parents for their views on early literacy and interviewing our sponsor to identify the primary problems with their current design.

Next, we researched possible materials to use for our story walk and created various prototypes for our first wave of preliminary designs. We presented it to Turn Back Time teachers for feedback and were able to gain several suggestions for where to look for materials to keep costs low as well as a clearer layout direction to shift our story walk towards. Observations of a temporary story walk structure were also performed, allowing us to analyze flaws and areas for improvement.

For our second round of prototypes we ran into further design issues regarding our material flexibility and the aesthetic appeal of our design. To solve this issue, we performed additional research and spoke to an expert for advice on the longevity and viability of certain materials and designed a miniature secondary prototype as a proof of concept before designing a fully sized version. We got more feedback and made a few final design changes to our structure according to their requests. Our budget was then developed off the estimation of material cost to construct twenty of these frames, which we then proposed to Turn Back Time's director. After gaining approval for both the design and budget, we began the construction process for our project. After completing the construction of our deliverable, we were able to perform further analysis and research on usage of the structure, enabling us to give Turn Back Time suggestions for future improvements and additions.

3.3 Understanding The Needs of TBT

By communicating with our sponsor and surveying faculty and parents, we aimed to gain an understanding of the needs at Turn Back Time (TBT) to determine the optimal way to proceed with our project. Through weekly meetings conducted with our sponsor, we were able to obtain information on Turn Back Time's needs, function, organization and population served as well as feedback on our overall design and gained insight into the general perception of outdoors learning, early literacy and reception to story walk construction.

3.4 Collecting and Analyzing Data

Views on Literacy

Attitudes towards early childhood literacy may vary greatly between individuals and between communities. We aimed to gain a general understanding of Turn Back Time's community perception on early literacy to further understand the potential impact of our deliverable to the site, as well as to gain insight into the learning methods that the children of this community would benefit from.

In order to gather data on literacy and learning at Turn Back Time (TBT), we surveyed both teachers and parents at TBT and conducted an interview with our sponsor. All surveys were anonymous and voluntary. Survey questions were primarily open response, with a minority consisting of multiple-choice options based on further research into effective methods of surveying (Bradburn et al., 2004). Questions asked to parents included those of their children's age groups, programs participated in at Turn Back Time, and enrollment period. Parents were also surveyed on what they believed their children enjoyed in terms of activities at Turn Back Time, modules that kept their interest the longest, and the if their child learned best through visual, auditory or sensory methods. Following this, questions regarding their own opinions on the importance and efficacy of early literacy and outdoors learning were asked.

Educator surveys were conducted in a similar manner with open response questions asking them to elaborate on their experiences in what works best for educational methodology and the perceptions they observed of the children towards literacy, experiential outdoors education, and story walks. The information obtained assisted us in discovering the perceptions of Turn Back Time's community towards childhood literacy and its importance to TBT's education process, allowing us to make better informed recommendations for potential learning modules to accompany our story walk.

Learning to Design an Effective Story Walk – Pinpointing Current Problems

Our deliverable goal was to allow more opportunities for outdoor literacy at Turn Back Time by constructing a lasting outdoor story walk that is accessible to student and teacher regardless of weather, while possessing a design that would allow for the convenience of changing the pages frequently and easily.

We began our research by investigating nearby sites with story walks and contacting libraries responsible for their construction. By doing this, we were able to view the various designs to serve as a potential guides for our preliminary designs and gain an early estimate of the cost to construct them. To gain a better understanding of the primary issues with the current outdoor story walk, we interviewed and spoke to teachers at Turn Back Time on the primary issues they face in promoting nature literacy.

In our interview process, both group members were present. Notes on question responses were typed out on a computer before we later organized the information into a visual graph out of our text for improved visualization. (Table 1.5) The information gained gave us a better understanding of the pre-project story walk's limitations that we would seek to address, and what our sponsor would like to see from our design. Following this, we surveyed the teachers of Turn Back Time via links to Google forms. Questions were structured to include multiple choice and open-response format, with example images of story walk structures and various questions on design choices. From the results of this survey, we gained information about how children at Turn Back Time engage in early literacy and the potential modules in our design which teachers believed would fit the needs of TBT through benefiting the children.

Additionally, to further pinpoint current issues with TBT's preexisting story walk, we decided on performing observations of it in action. We discussed the idea with our sponsor and set the preexisting story walk on the proposed outdoors trail that TBT suggested us to place our deliverable on in the future. Observations were done with a teacher acting as the leader to a class of children, with qualitative and quantitative observations taken. Through this process, we were able to gain insight into the major issues with the current story walk system at Turn Back Time that we sought to address in our final design.

Table 1.5 Interview Questions

Questions Asked	Response (Open-ended)
How much time is spent reading at TBT in general for the kids?	We do 1 storytime per group per day, and a story takes 15-20 minutes to read, but there's other literacy that takes place that happens throughout the day. We use reference books, writing, we are looking things up, and we're reading the signs on the trails and the map.
How important is literacy to TBT as an educational institution?	I think we feel that literacy is a component to an early childhood foundation in education and that by experiencing literature and literacy in a fun and natural way children set the groundwork to become lifelong learners.
What are the methodologies used to increase children's attention/interest in reading?	Nature based pedagogy (method) respects a child's involvement and engagement in hands-on learning through nature. We feel that using opportunities to read and connect to literature that has connections based on what's happening in the real world experiences creates a deeper understanding and learning overall. For example, when kids see a snapping turtle, " "Emergent curriculum is a pedagogy we use. It's a way to introduce subject matter to children as it happens organically. For instance, if the children find a snapping turtle in nature, it's an invitation to use books to research snapping turtles and how to care for them and what they need in nature and also an opportunity to look for stories based on fact and fantasy that connect them by the subject of snapping turtles to deepen their understanding of the world around them and to engage them in the process of learning.
Are the story walks for all-year use? Do the children use the story walks in the winter?	I'm hoping that the story walk will give us another opportunity to bring literacy to children in the winter when we're all cold and we don't want to take off our mittens to turn the pages of the book. The story walk will give us an opportunity to read together.
Were they used previously in all-year use?	Not successfully. I would say we didn't successfully find a method for hanging story walks that worked for long-term use.
What are the typical current issues with reading at TBT?	It's hard to read a story outside when it's raining, hard to read a story when it's cold and I'm wearing mittens, it's hard to read a story when the children are sitting still and it's cold out, because their bodies stay warmer when they're moving.
Is there any issue with nailing the posts into trees?	You may have to use a coated screw (...) We might look into methods to reduce the impact on them. We believe that using the trees is one of the benefits of having a nice natural space. You may need to use timberbox screws or deck screws so it doesn't rot out in the tree."
What were the issues with the previous story walks?	They blew away, they were too low to the ground, sometimes we'd staple them to the side of the building but water would get into the lamination page, and they weren't very attractive.

3.5 Designing Prototypes

Testing, Designing and Feedback

Our third objective was to construct, test, reiterate, and improve based on feedback. Initial designs for the story walk were originally conceptualized and created with pre-built materials purchased from online services to serve as a rough concept for our design. Pre-built materials consisted of varying designs of frames made of different material or items with the capability of holding sheets in place outdoors.

We gradually narrowed down our final design through multiple iterations of feedback from TBT co-director Kate Baker. This process began with a general concept of a way to hold story walk pages in place. We searched stores to first find multiple types of frames of different material, which we tested with laminated pages to determine its lasting ability to hold paper in outdoors conditions. We then gathered feedback on opinions regarding its aesthetic appeal, practicality, durability, cost and if it could be successfully mounted on signposts and trees. From the feedback, we redesigned our next prototypes utilizing the ones with the most positive feedback as a base model while incorporating strengths from other prototypes into it, such as changing external details to be more aesthetically pleasing in ways similar to better-looking designs.

As our design progressed, this scope became narrower and better defined with feedback, including general design features on our prototypes such as the size of pages to accommodate. Once again, flaws with current designs were tested by research on its material makeup, followed by outdoors testing for durability, water resistance and ability to hold pages for extended periods of time. Issues of the cost of store-bought prebuilt structures were also discussed with TBT's director. Further feedback followed based on the best current prototype's need for a better appearance and the possibility of creating a sliding frame design utilizing spacers was discussed. Through further brainstorming following visits to local retailers for usable material, we constructed a miniature proof-of-concept prototype from plastic moulding to act both as spacer and frame for our design. We checked in with our sponsor once more for feedback before moving to create a fully sized prototype design.

We performed another round of material research and spoke to an experienced builder for advice on potential materials to use for a long-lasting structure. Using this information, we were able to choose what we would utilize for our final design. Following this, we proposed our budget with our prototype design to show, and with its approval from Turn Back Time, we began the construction process.

Design Criteria

We developed design criteria according to our findings about the needs of Turn Back Time and through the feedback from Turn Back Time's executive director and co-director. Our prototypes aimed to fulfill as many of the criteria as possible, with each iteration improving on the strengths of the last while being developed to further meet each existing criterion. The success of meeting existing design criteria was evaluated primarily by presenting to staff at Turn Back Time for further feedback on their opinions on how well it met each standard.

Image : Design testing

3.6 Final Design and Construction

Our fourth objective was focused on the construction of our final design. Once the objective of designing based on feedback was completed, we each prepared for the construction process for the rest of the story walk frames. This included gathering all the tools that would be required, such as a table saw and chop saw, as well as a final check on how many more plastic mouldings of each size would be needed. Plexiglass and 4x8ft PVC backboards were cut into their proper dimensions utilizing the table saw, while plastic mouldings were cut into shape with the chop saw. Our final selection of adhesive was made, and once applied to all frames, weights were added to the frames to dry overnight. Sealant was further added to increase the longevity and water resistance of our frames after the drying and cleaning of our adhesive.

After construction, extraneous PVC and plexiglass material was built into backup frames with remaining supplies. Instructions for frame building were written and 3D design models were finalized. We checked in with Turn Back Time's co-director once again for confirmation of an ideal way to attach the frames to the trail while considering the health of the trees and were recommended timber screws for our nailing process. After further discussion with staff, we confirmed that there was no problem in utilizing power tools to mount the frames to trees when using our timber screws and were suggested ideas on ways the structure's stability could be improved.

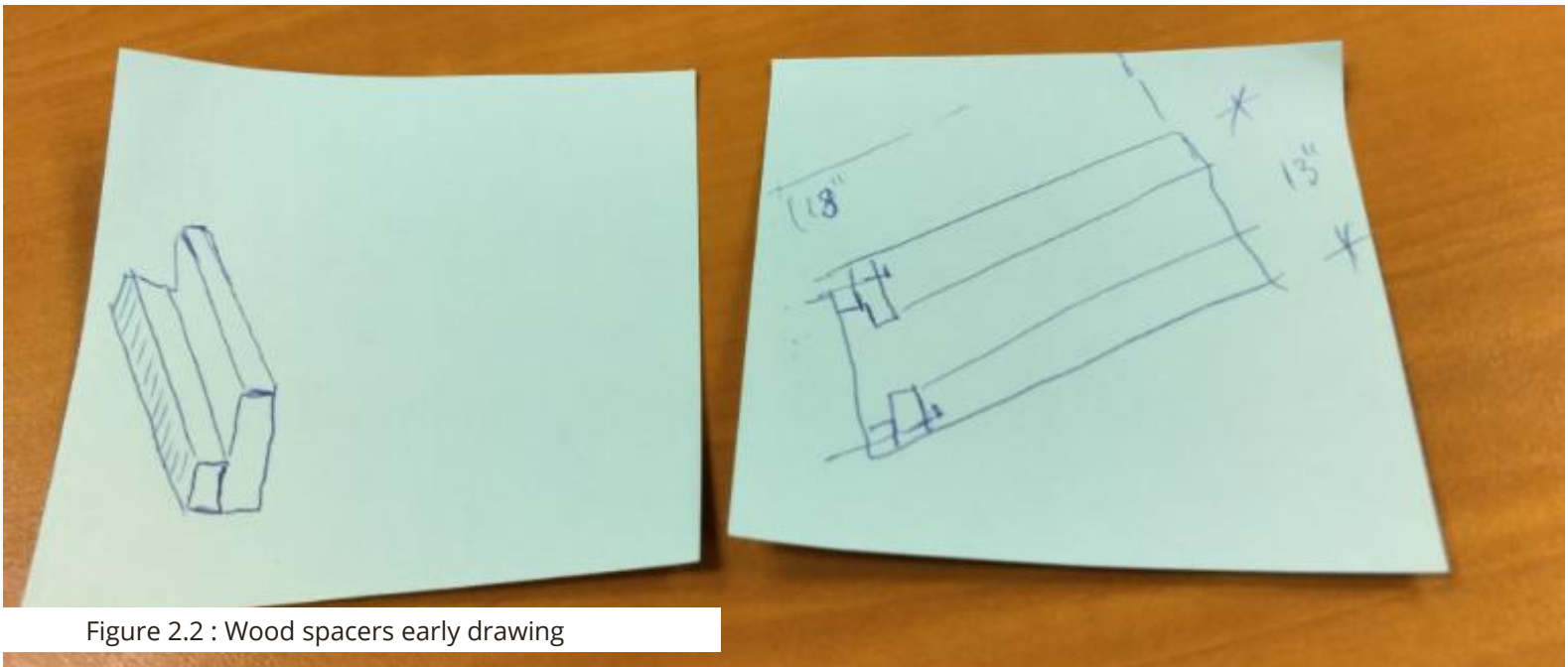


Figure 2.2 : Wood spacers early drawing

4.0 Findings and Results

This section presents our findings from surveying and interviews, including our design matrices, pro-con lists and analytics of our material selection, design blueprints, preliminary designs, observations and research. This analysis assisted us in rationalizing and guiding our decisions towards our final design.

Image: Measuring the book pages

4.1 Story walk visits

We visited various sites around Massachusetts to find examples of other story walks in order to examine how they were constructed to compare with our ideas of how to design our own. We utilized the appearance of the story walks as frameworks and inspirations for our designs. We found that there are two different styles of story walks; temporary and permanent. We took notes on if they implemented a method to change the pages, how they built their structure, and the materials used, and utilized information from the story walk visits to help develop our decision matrices.

Lake street park Shrewsbury MA visited on August 31, 2022

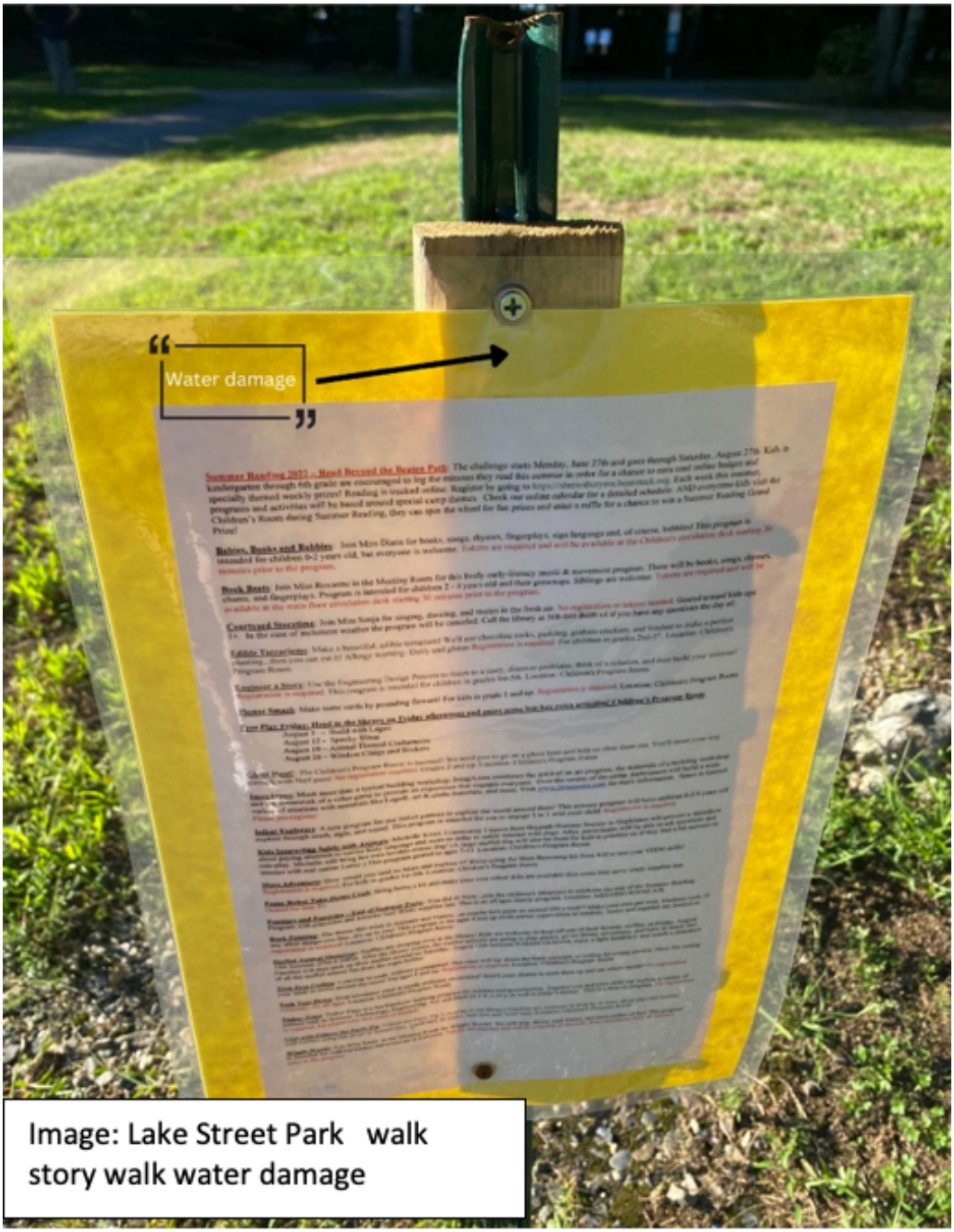


Image: Lake Street Park walk story walk water damage

The first site we visited was the Lake Street Park story walk. This story walk is in Shrewsbury, Massachusetts, and runs from August 8th until August 27th. This design was temporary and was not meant for longevity. The construction was straightforward. One metal post was in the ground, and one piece of strip-board was attached to the metal post. All the book pages were laminated and attached to the strip-board using screws (figure 3.1). The pages were held approximately three feet above the ground.

Figure 3.1 Lake street park story walk

The unique thing about this story walk was its engagement element. The story walk's design incorporates a "Choose Your Own Adventure" style. In that setting, children make decisions that dictate which pages they go to and what happens as the story advances, resulting in several distinct endings.

The Lake Street story walk design was temporary; there were no frames to protect the pages from water damage over time. In making holes in the laminated pages, water was able to get in and destroy the pages. The stripboard was also not pressure-treated wood and was prone to degradation over time.

Table 2. 1 Lake street park Story walk Evaluation

Post	Metal Fence posts
Frame	No frame
Layout	Choose Your Own Adventure
Mounting	Screws

Assessment:

Lake street story walk was an example of a portable, interactive, inexpensive, and easy-to-build story walk, but it was not built or designed for longevity.

Watson Park Blandford, MA, visited September 26, 2022

The second story walk we visited was located near the Porter memorial library in Blandford, Massachusetts, and is a permanent design. There were about eighteen sign boards on wooden posts. Each signpost is covered with plexiglass. Each signpost is about 2 feet long diagonally, and the post is about 3 feet and 2 inches long (Figure 3.2).

Figure 3. 2 Blandford Story walk

Figure 3. 3 Blandford Story walk post measure

The frame around the plexiglass is PVC material painted a brown color. The brown color gives the PVC frame a wood-like look. The backboard and posts are made of wood and painted the same color as the PVC frame. The frame is connected using four triangle metal brackets on each side—the backboard connects to the posts using two bolts, making the structure sturdy.

Table 2. 2 Story walk evaluation Blandford, Massachusetts

Post	Single wooden post in the ground.
Frame	Wood and Brwon PVC.
Layout	Static and one-sided. Pages are only on the right side.
Mounting	Triangle metal brackets hold the frame together.

Evaluation

Unlike Lake street park, this story walk is one-sided; there are posts only on the right. The frame has two screws connecting to the backboard. Two hinges are in the back of the board, making it possible to change the pages of the story walk. The frame, including the backboard, has a 45-degree angle for comfortable reading by adults and children while adding aesthetic appeal to the design. The plexiglass was large enough to accommodate for two children's book pages.

During a personal communication with the Porter library manager, we learned that The Porter Library built the story walk on a grant through Libraries Transforming grant of $3,000 from the American Library Association.

Assessment:

Unlike what we observed in Shrewsbury, MA, the Waston Park story is a permanent story walk. This story walk design is more expensive and requires a commitment to have a permanent structure.

4.2 Discovering Turn Back Time's Needs

To better understand and to find the needs of Turn Back Time, we held weekly meetings with Katie Baker, the co-director of Turn Back Time. This was followed by surveys sent to parents, teachers as well as an interview. These contributed to our analysis of TBT's perceptions of literacy, issues with the preexisting story walk, and the organization's specific project needs.

Image : Weasel Trial TBT

4.2.1 Current Story Walk Analysis

To better identify current problems and potential weaknesses with Turn Back Time's story walk, we conducted an observation of the temporary structure in use. The previous story walk at Turn Back Time was implemented using clippers attached to the trees and metal wires inserted into the ground (Figure X). We spoke to staff and obtained approval to set up the old temporary story walk structure using pre-laminated pages of a book used in the story walk in the past. We took qualitative and quantitative observational measurements, including the time it took students to complete the story walk. The activity took place with a teacher leading a group of 13 children along the trail, acting as the reading guide to the children. We observed and identified a few primary issues with the current story walk structure; the height of the page holders were low to the ground due to the maximum height of the wires, leading to crowding around posts and reduced visibility. Such factors made it difficult for the children to see the story. The structure of the story walk's line of pages also often caused children to lose interest in pages consisting of pure words and to run ahead of the group to look at the illustrations.

We found that the time it took to complete the story walk was approximately nine minutes. Feedback received from teachers confirmed that it would be beneficial to increase the height that the story walk so that it would be at or slightly above children's eye-level to discourage crowding and crawling by posts low to the ground. Based on the results of our observations, we revised our design to create a story walk structure that would be affixed at a suitable height for both child and teacher to alleviate overcrowding while increasing the size of the frame to be capable of holding two pages at once. By doing so, pages containing words accompanied by corresponding image pages could be displayed together, minimizing the group split-off caused by loss of attention.

Image: previous story walk

4.2.2 Views On Literacy: Analysis

In order to analyze Turn Back Time's community perception of outdoor learning and story walks, we surveyed teachers and parents to gain an understanding of their views on early literacy. Questions included that of parent beliefs of TBT's educational value, opinions toward the addition of a new story walk, and open response regarding beliefs towards the efficacy of outdoors learning and hands-on experience compared to that of traditional school settings. (Appendix A). Analysis of responses revealed that all surveyed parents unanimously agreed on Turn Back Time and its activities being educational for their children, with near unanimity on being in favor for the addition of an improved story walk to add to outdoors reading (Figure 4.2). Similar results were found for the prediction of their children's excitement regarding it, demonstrating a high overall degree of enthusiasm towards literacy-based activities (Figure 4.3).

We surveyed Turn Back Time's staff on similar questions, such as their beliefs on the efficacy of outdoors learning compared to traditional classroom settings. We asked about outdoors learning use in information retention, early literacy's importance for future mental development, their beliefs on whether children at Turn Back Time enjoy outdoor reading activities, and if they currently utilize literacy methods outdoors.

Evaluation of teacher responses showed a strong belief in the importance of early literacy, coupled with the unanimous belief that outdoors learning results in stronger information retention than a traditional classroom setting. Both categorical responses indicated a highly positive view towards the viability of outdoor learning.

Parent Responses

Figure 4.1 Parents survey data pie chart one

Do you believe Turn Back Time to be educational for children? (13 responses)

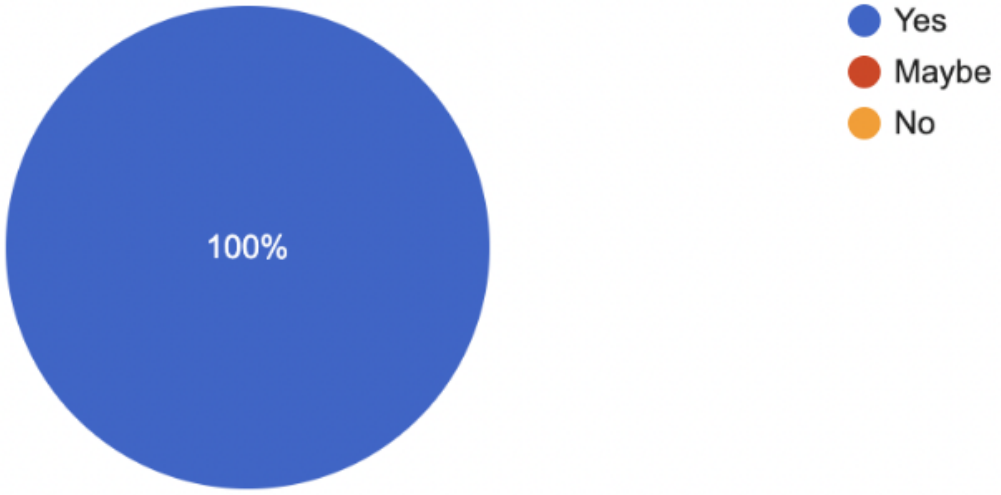


Figure 4.2 Parents survey data pie chart two

Would you be in favor for the addition of an outdoors trail-based reading activity (story walk) to the farm? A story walk is a guided activity in which teachers accompany a class of children through a set path with posts set along the way detailing a children's story. (13 responses)

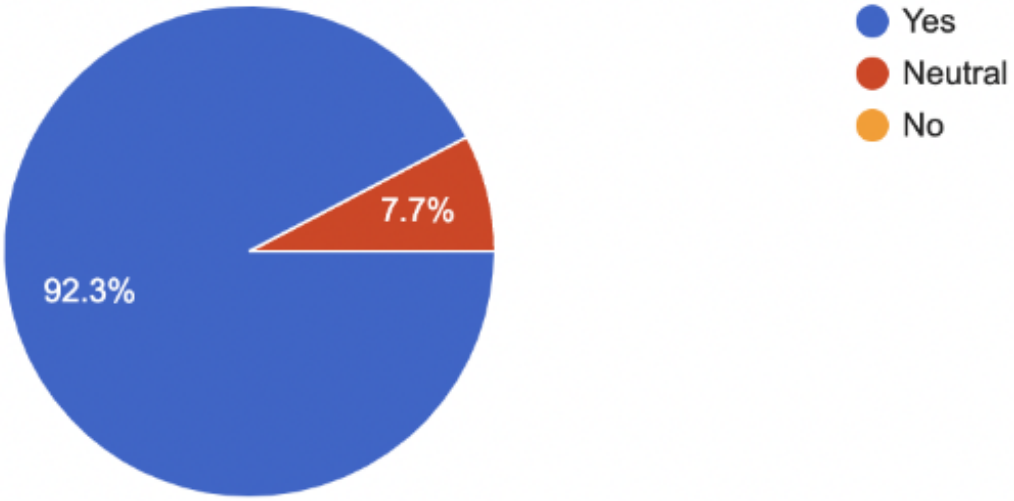


Figure 4.3 Parents survey data pie chart three

Do you think your child would be excited about it? (13 responses)

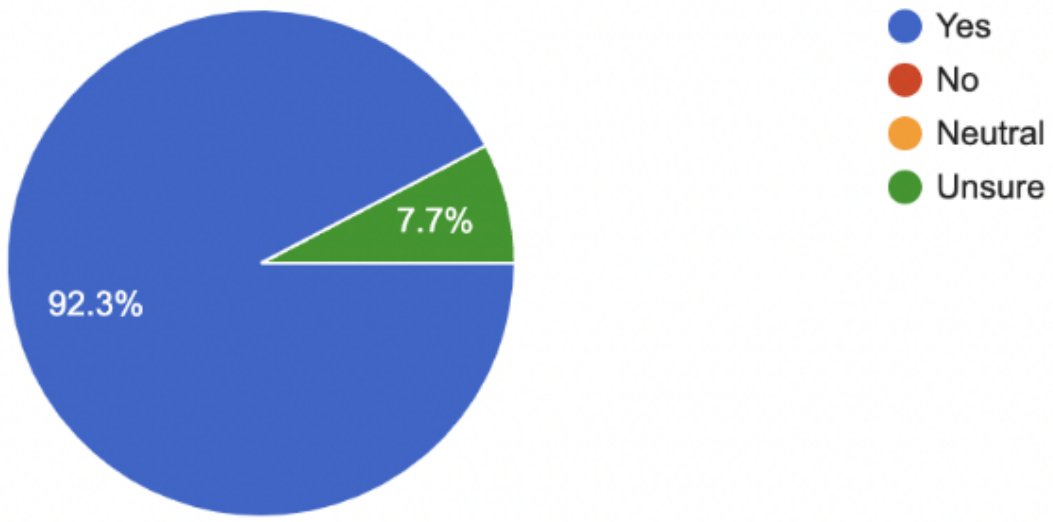


Figure 4.4 Parents survey data pie chart four

Which programs does your child participate in at Turn Back Time? (13 responses)

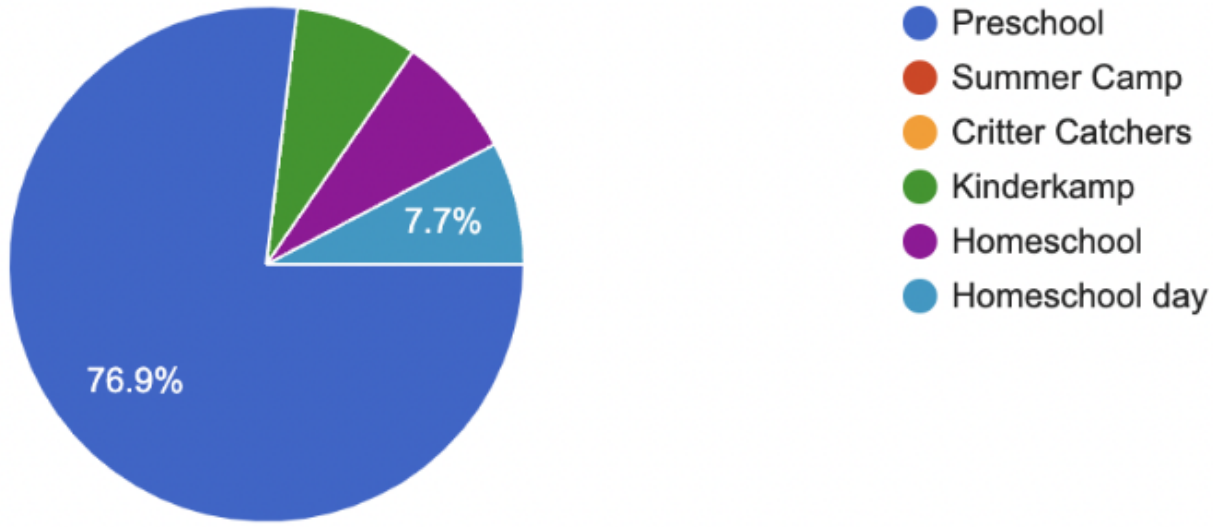
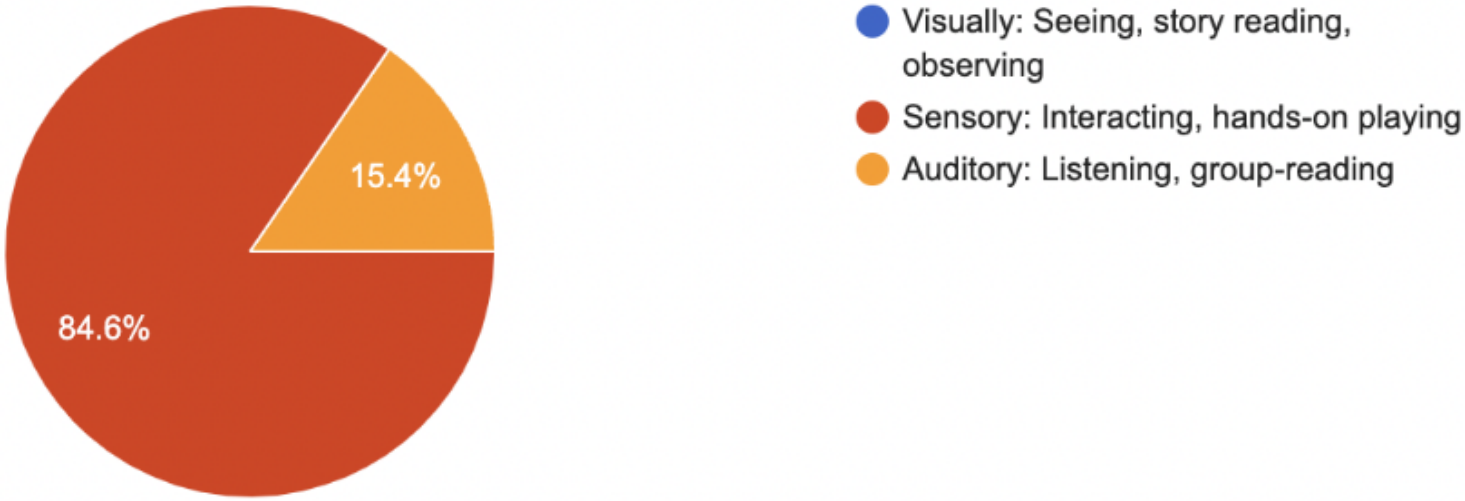


Figure 4.5 Parents survey data pie chart five

How does your child best prefer to learn?
(13 responses)



Teacher Responses

Figure 4.6 Educator survey data pie chart one

Do you believe that experiential outdoors learning is more effective in information retention compared to a traditional classroom setting? (4 responses)

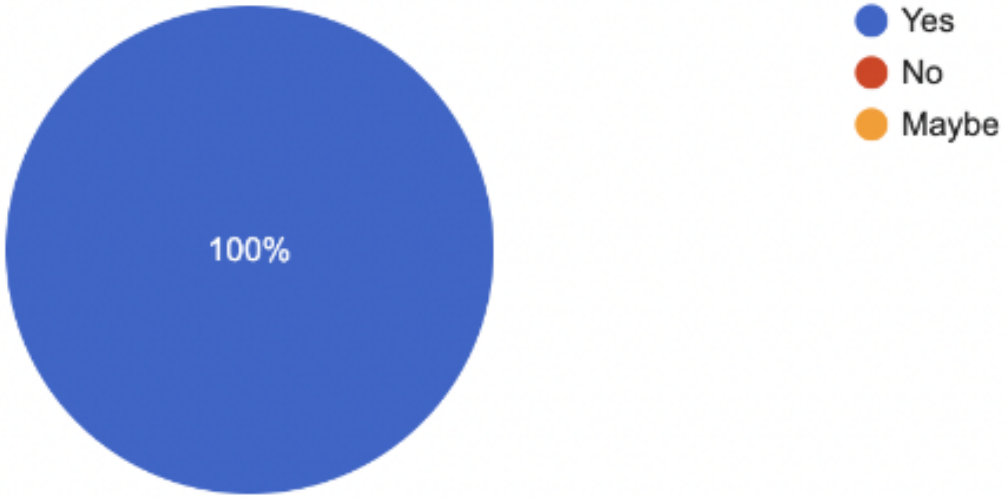


Figure 4.7 Educator survey data pie chart two

How important do you believe exposure to early literacy is for the future mental development of children (How much of a role does it play in influencing their future?) (4 responses)

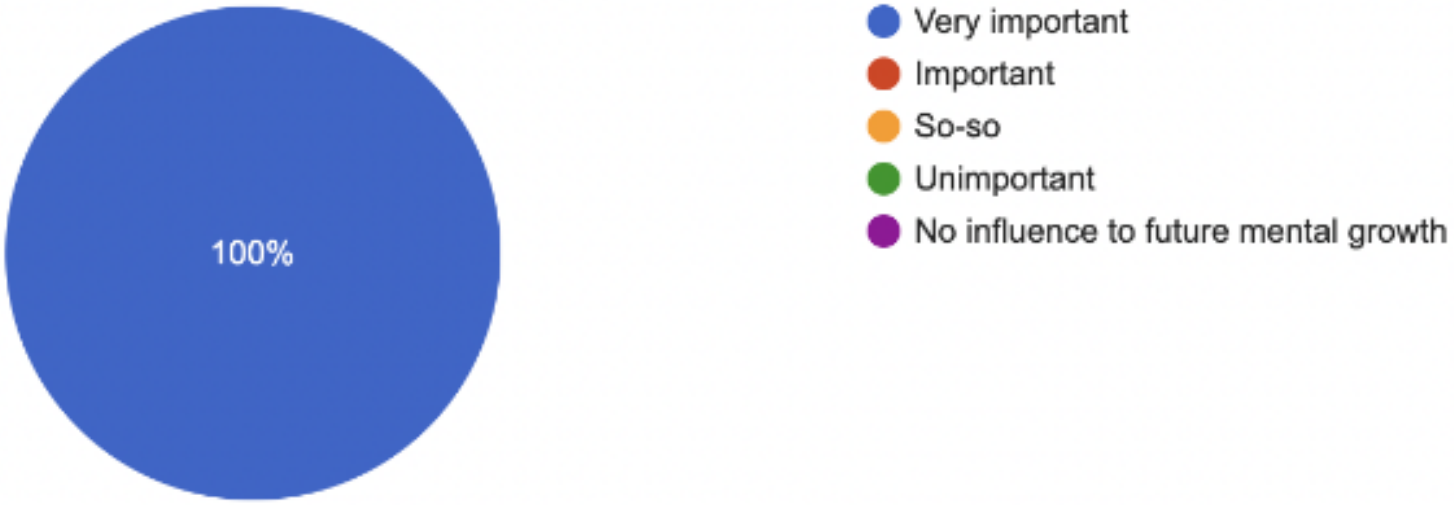


Figure 4.8 Educator survey data pie chart three

Do you feel that the children here enjoy outdoors group reading activities? (i.e. story walks) (4 responses)

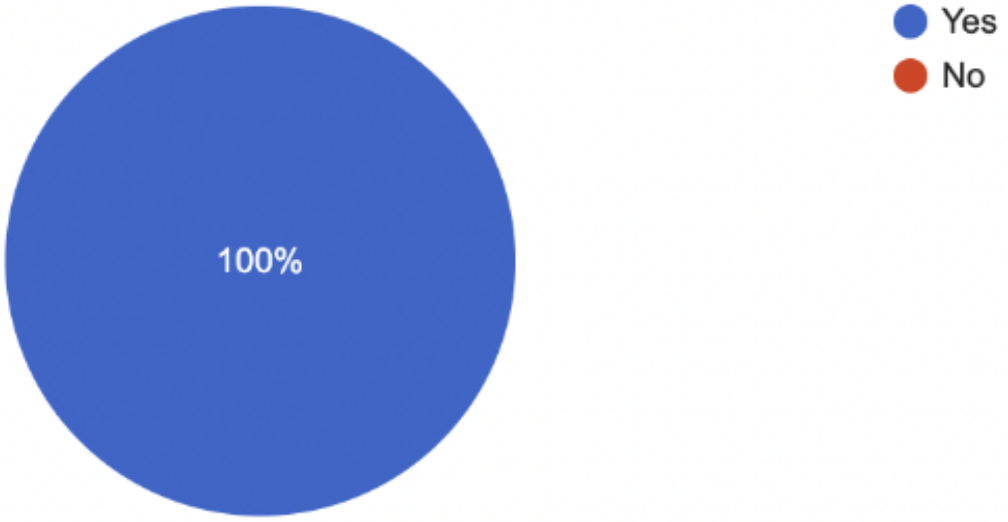
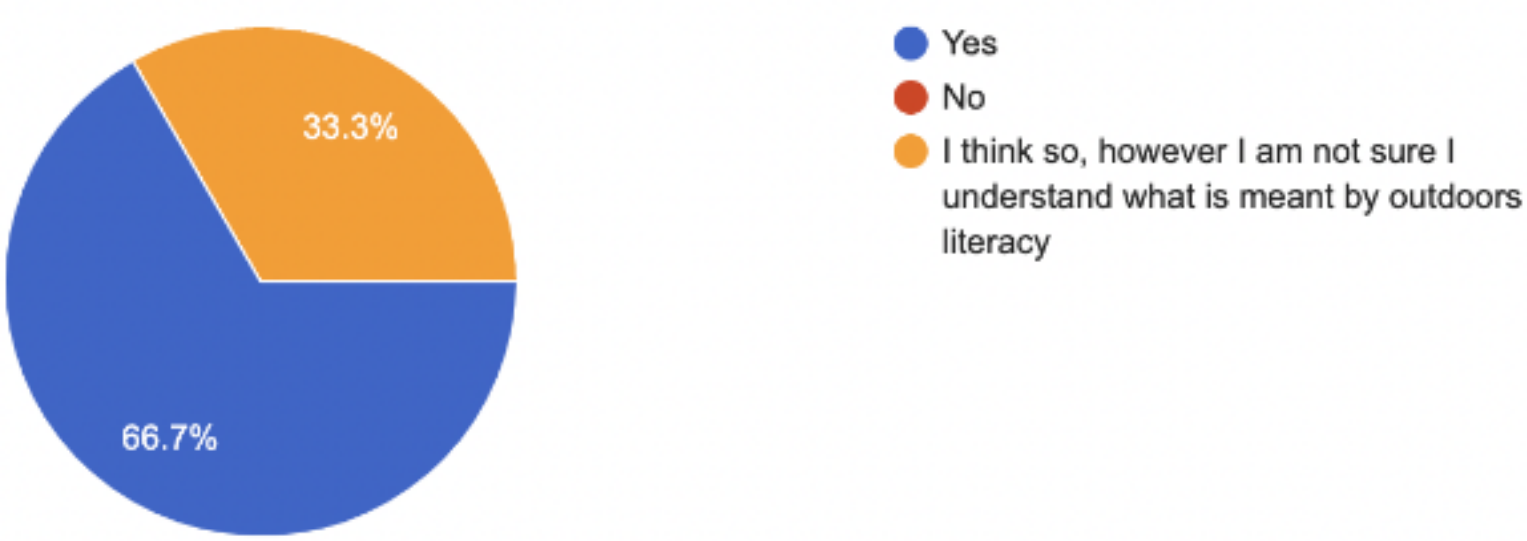


Figure 4.9 Educator survey data pie chart four



Methods of Learning

In the same surveys, questions were sent out to parents regarding the primary ways children preferred to learn and the aspects of Turn Back Time that they enjoyed. Additional questions included the age range of the children, programs they participate in, and their feelings towards Turn Back Time. Teachers were surveyed on the methods they found best for allowing information retention and methods used to keep children focused.

Out of the 13 parent responses, 85% of children were found to be sensory hands-on learners while the other 15% (consisting of two responses) were found to be auditory learners, preferring activities such as listening and group reading (Figure 4.5). All parent responses reported their children having high enthusiasm for Turn Back Time's programs, with varying favorite activities, with the most common activity consisting of outdoors play (Appendix A). Teacher responses for the most effective methods of information retention consisted of repetition and consistency, hands-on nature-based learning, movement and action for reinforcement, and repetition in an engaging situation.

Approximately three quarters of children at Turn Back Time were enrolled in preschool programs (Figure 4.4), with the average age of Turn Back Time students being 6 years old.

4.3 Turn Back Time's Guidelines

To identify the needs of the Turn Back Time, we adopted a surveying and interview strategy to identify the criteria to guide our design. From the information obtained from both personal communication and interviewing Katie Baker (Turn Back Time's codirector), we learned that the primary need of the sponsor was to get children engaged with literacy. She wanted a deliverable that could take place in an outdoors setting in all consistent conditions, regardless of the equipment staff and children wore (such as gloves and mittens during the winter that could obstruct page-turning) that could succeed in preventing pages from blowing away like TBT's temporary preexisting story walk. We were additionally informed that it would be best to construct a story walk of sufficient length to consistently be able to present the full-page count of children's picture books.

To gain a better understanding of what kinds of books and pages we would be mounting on the story walk, the size of each page, and the length of the average book, we referenced several on-site samples of children's storybooks that were used on the story walk trails in the past.

We found that the general size of pages utilized varies greatly; the upper size limit for laminated pages was 9 x 11.5 inches, with smaller variations. Story page counts tended to have an upper limit of approximately 35-36 pages. Conversations with TBT's codirector led to the design decision to create a story walk capable of holding 40 pages on the basis of having additional room to display pages rather than too little.

The pages would be ideally swapped out every week for children to have a diverse and varying supply of reading material to engage with nature literacy (K. Baker, personal communications, September 1, 2022). This information allowed us to orient our design towards being built for convenience in frequent page changes, as well as designing the story walk structure to be capable of holding pages of varying size, eliminating a few design possibilities that could only hold pages of one size.

4.4 Preliminary Designs

Prior to beginning the prototyping phase of the project, we researched the impact of literature and the potential impact from lack thereof, drawing from various online sources on the importance of literature and the Massachusetts Preschool Frameworks.

An initial survey was sent to the educators at Turn Back Time to poll for potential design criteria (Appendix A) and potential modules; results showed that staff at Turn Back Time were more in favor of creating a less movable and longer lasting structure rather than an easily movable story walk. This feedback helped influence our material design criteria in favor of longer-lasting materials. A pro-con list consisting of primarily qualitative observations was created for our initial prototypes to determine the strengths and weaknesses of each design (Table 3).

Designs began with brainstorming and rough concept drawings. Materials were purchased from online services and trips were made to utilize nearby organizations such as FLEXcon, a material manufacturer company that gives out certain materials for free weekly, during the prototyping process in order to remain within budgeting constraints. In our first wave of designing, several early prototypes were built and tested as proof of concept, after which we met with Turn Back Time staff in order to receive feedback on our prototypes on how well each met the criteria of durability, practicality, appearance, etc. Testing was also conducted on the prototypes to test their durability and protective degree, including processes of leaving them in the rain with paper inside to afterwards examine if any moisture entered. The purpose of constructing these prototypes out of premade material in our first wave of designs was to determine a direction to develop our own design towards using the best prototype as a frame of reference.

With additional observations of Turn Back Time's preexisting story walk in use, we further revised our design criteria for one frame capable of holding two pages together so that text and corresponding illustrations would be held at the same location to discourage children from running ahead of the group to view illustrations during group reading activities.

We conceptualized a cut plexiglass and backboard design (Appendix B, Figure 7.1) proposed it to Turn Back Time, and were given alternative suggestions for the appearance of the story walk structure based on the example appearance of a past story walk visited; a plexiglass covering with four framed sides (Appendix B, Figure 7.7). We discussed the idea further with Turn Back Time, deciding that our version would allow for the changing of pages through a sliding plexiglass frame and ruled out hinges in order to reduce cost. We searched for ways to create space between the sliding plexiglass and the pages within to avoid excessive contact between the story pages and the moving plexiglass, and eventually found U-shaped plastic mouldings which could serve as both spacer and external frame. We constructed a miniature prototype with U-shaped plastic mouldings to ensure that our design could work with a larger, fully sized version before moving to create a full-sized prototype. We estimated the cost to construct twenty of these in order to hold forty pages and proposed the design and budget to Turn Back Time. After gaining approval for both our budget and design, we began our construction process on the remaining sliding frames.

Image: QIK frame

Image: Magnetic frame

Image: Artwork Frame

Image: Acrylic Sign Holders

Table 3. 1 Design Pros and Cons list

Design	Pros	Cons
QIK Frame	• Aesthetically appealing • Holds pages consistently when mounted against a backboard • Velcro allows for the frame to be set horizontally or vertically • Made of longer-lasting material • Ease of switching pages frequently	• High cost • Needs a backboard to be put against in order to hold pages well • Can only hold one page
Magnetic Sign Holder	• Inexpensive • Easy use	• Insufficient size to completely encapsulate dimensions of large, laminated pages • Short lasting time
Acrylic Wall Sign Holder	• Inexpensive	• Very limited capacity for page size • Unappealing appearance
Artwork Frame	• Aesthetically appealing • Possesses a hinged frame to open and insert pages	• Very high cost • Bulky shape; impractical for mounting on posts or attaching to trees

4.5 Material Analysis

Our initial searching began with the utilization of online services to find potential materials to build with, following multiple visits to local stores. One of the primary challenges we faced was finding viable material for the prototyping and construction of our story walk. Managing the material cost and finding the right balance between a sufficiently durable material at a sufficiently inexpensive price, while also having enough in quantity for us to create an aesthetically pleasing homogenous story walk either utilizing the same materials, or materials similar in strength and visual appearance was challenging. The primary criteria material was evaluated on was through durability, appearance, and cost.
Visits to TBT- suggested sites also took place to find affordable material without cost, although sufficient material for structure building was not successfully found. Prototyping and concept testing initially occurred with unused material found on-site and online purchases before moving closer to our finalized design. We researched the longevity of various materials usable in our story walk through a combination of online research and personal communications with an experienced construction worker. Various material types were considered, on which we put together pro-con lists to evaluate and rationalize our decisions before confirming its viability with our prototypes. (Table 3.2)

Table 3.2 PVC vs. Pine

PRESSURE TREATED PINE	CELLULAR PVC TRIM
ECONOMICAL	EXPENSIVE
STRONGER THAN PVC	HOLLOW INSIDE BUT CAN STILL HOLD WEIGHT DUE TO THE CELLULAR CONSTRUCTION
NATURAL	CUTTING PVC CREATES PVC DUST WHICH IS NOT BIODEGRADABLE.
IT WILL EVENTUALLY ROT. EVEN EVEN IF PRESSURE TREATED	IT WILL NOT ROT.
WATER CAN CAUSE TWISTING, CUPPING, WARPING, CHECKING	NO MOISTURE-RELATED DAMAGE
MILDEW GROWTH	MINIMAL MILDEW GROWTH
MUST BE SANDED AND STAINED	LOW MAINTENANCE
PRONE TO SPLINTERING	PVC IS FLEXIBLE
	PVC WILL EXPAND WITH HEAT AND SHRINK IN THE COLD
	WHITE COLOR AND NO REPAINT, STAIN, OR COAT

4.6 Budget

We proposed a simple and efficient design at our first budget proposal meeting. The design included four screws, plexiglass, and a backboard made from wood. Our initial proposed design was simple and low cost. However, based on feedback from Turn Back Time, we realized that our design was too lacking in aesthetic appeal and was not moisture resistant.

Acknowledging TBT's feedback, we reiterated our design. After further changes, we settled on utilizing U-shaped plastic mouldings in our final design as it could act simultaneously as a spacer and frame, allowing for a convenient plexiglass sliding frame to be built with a good external appearance and water resistance. After constructing a prototype of this updated design, we got our design and budget approved.

Materials such as acrylic, PVC sheets and plastic mouldings were purchased from Home Depot in bulk and cut into proper size using power tools; out of the total budget of $665.73, $200 was provided by Worcester Polytechnic Institute.

Table 3.3 Budget

Material	Cost	Total
Acrylic Sheets	$81.98 x 4	$327.92
Plastic Moulding 8ft	$8.98 x 17	$152.66
PVC Sheet 4x8ft	$63.98 x 2	$127.96
Glue	$11.28	$11.28
Silicone Sealant	$9.98	$9.98
Tax	$35.93	$35.93
Total		$665.73 - $200 = $465.73

4.7 Construction

Once our budget and design were approved, we began construction.
Purchased materials were brought via truck to Turn Back Time. We primarily used a table saw to cut the boards and acrylic sheets; miter saws were used to make 45-degree angles in the U-shaped molding. Certain materials, such as epoxy were brought from home and utilized in this construction project. PVC backboard was cut into 24 by 14' rectangles while acrylic sheets were cut into 23 by 13' sheets. Once we had the necessary amount of long and short U-shaped plastic moulding cuts, we applied epoxy resin to the plastic mouldings, which were attached to the PVC backboard. Stones and bricks were used to hold down the mouldings overnight while drying, and silicone sealant was applied the next day to further increase the water resistance of the story walk frames after completion of washing and cleaning of residual dirt.
For our last step, we attached our frames to the story walk trail using two timber screws each; one near the top and bottom of the PVC backboard.
Certain challenges were faced during this construction process. When cutting the acrylic on the table saw, we had to be careful to avoid cracking the material; during the adhesion process, epoxy would often dry as we were applying it, causing us to need to increase our pace and make store trips for new epoxies. Some of the epoxies leaked to the tables and caused the table to bind with the frame. We used a scraper to separate the frames from the tables while being careful not to damage the structure or the table. For the epoxy to dry correctly, we put stones on top of the frames to hold them together. These stones usually had dirt and other debris, so we cleaned all the frames after allowing the epoxy to dry. When sealing the acrylic to the molding, we used masking tape to prevent sealant from getting to the plexiglass.

4.8 Challenges and Limitations

Primary challenges faced in the process of this project involved finding balances between budget and material quality; in terms of physical building, both group members began the project without prior experience or knowledge regarding construction, resulting in a learning process during the cutting of material in utilizing power tools, epoxy adhesion of parts and the attachment of frames to the trail.

5.0 Conclusion

From the results of our project, Turn Back Time expressed satisfaction with the design of our final deliverable in terms of aesthetics and convenience. Observations performed after the completion of our project story walk revealed that the preexisting issues we sought to address were successfully resolved; the height of the frames was highly effective in reducing group crowding, increasing page visibility and eliminating crawling while the process of swapping out pages within the frames was kept convenient and easy. The issue of children splitting up to move ahead of the group was alleviated with the addition of frames capable of holding multiple pages, allowing for a more orderly outdoors literacy experience for teachers and children alike. As Turn Back Time frequently utilizes outdoor literacy, we were informed that this would likely be one of their most frequently used project deliverables, and teacher responses reported satisfaction with the new height of the story walk and the ease of reading to groups of children (Katie Baker, personal communication, October 13, 2022). Due to a lack of time remaining, there was no method to test or guarantee the natural longevity of our structure, although we left four spare frames constructed from extraneous material as potential replacements in case of breaking, and recommended methods to increase the life expectancy of the frames when attached to the outdoor trail.

Image: Constructed story walk in use

5.1 Recommendations

For further improvements to the longevity of the story walk structure, we recommend to Turn Back Time to add wedging to the back of the frames to increase the surface contact between the frame and tree. (Figure 5) As the current surface area between the frame and cylindrical trees is low, strong winds may be able to shake and decrease the stability of the frames. With the addition of more surface contact area behind the frames, the resistance of the frames towards strong wind will improve greatly. With the total construction of 24 frames with four as spares, we recommend using the four extras as replacements in case of frames breaking.

To increase the degree of sensory and visual learning for increased hands-on interaction, activities such as placing pages out-of-order on the story walk for children to find and reorder are suggested, or to use the frames to a way to display children's drawings outdoors; to help them learn about physical design concepts, spare frames can be used to display how sliding occurs in the presence of grooves, etc. We recommend utilizing the frames in creative ways to increase the hands-on engagement of children in addition to being a method of establishing outdoors literacy through children's books.

Figure 5. 1 Sketchup design with wedges bottom view

Figure 5.2 Sketchup design with wedges; screw positions

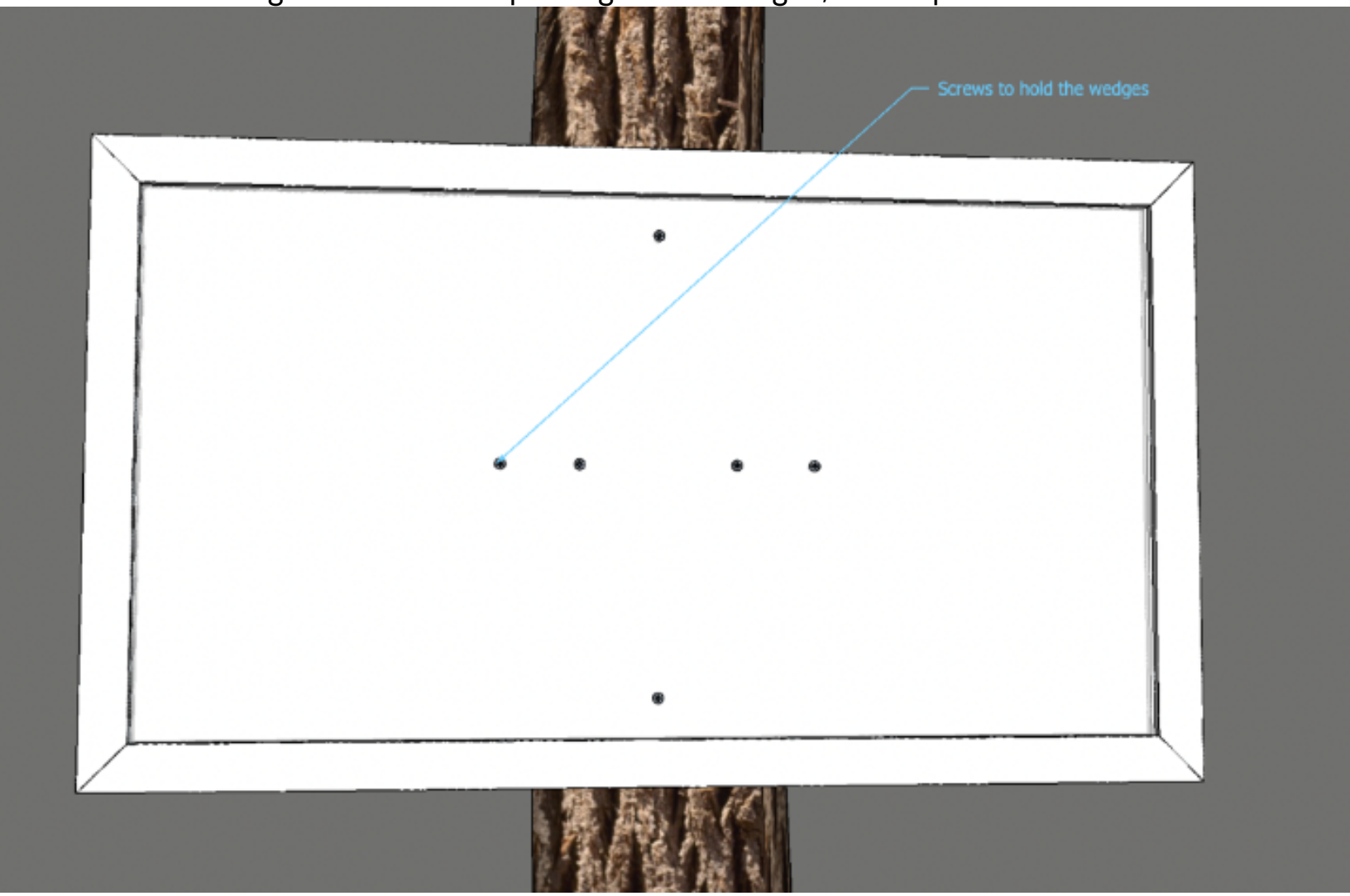
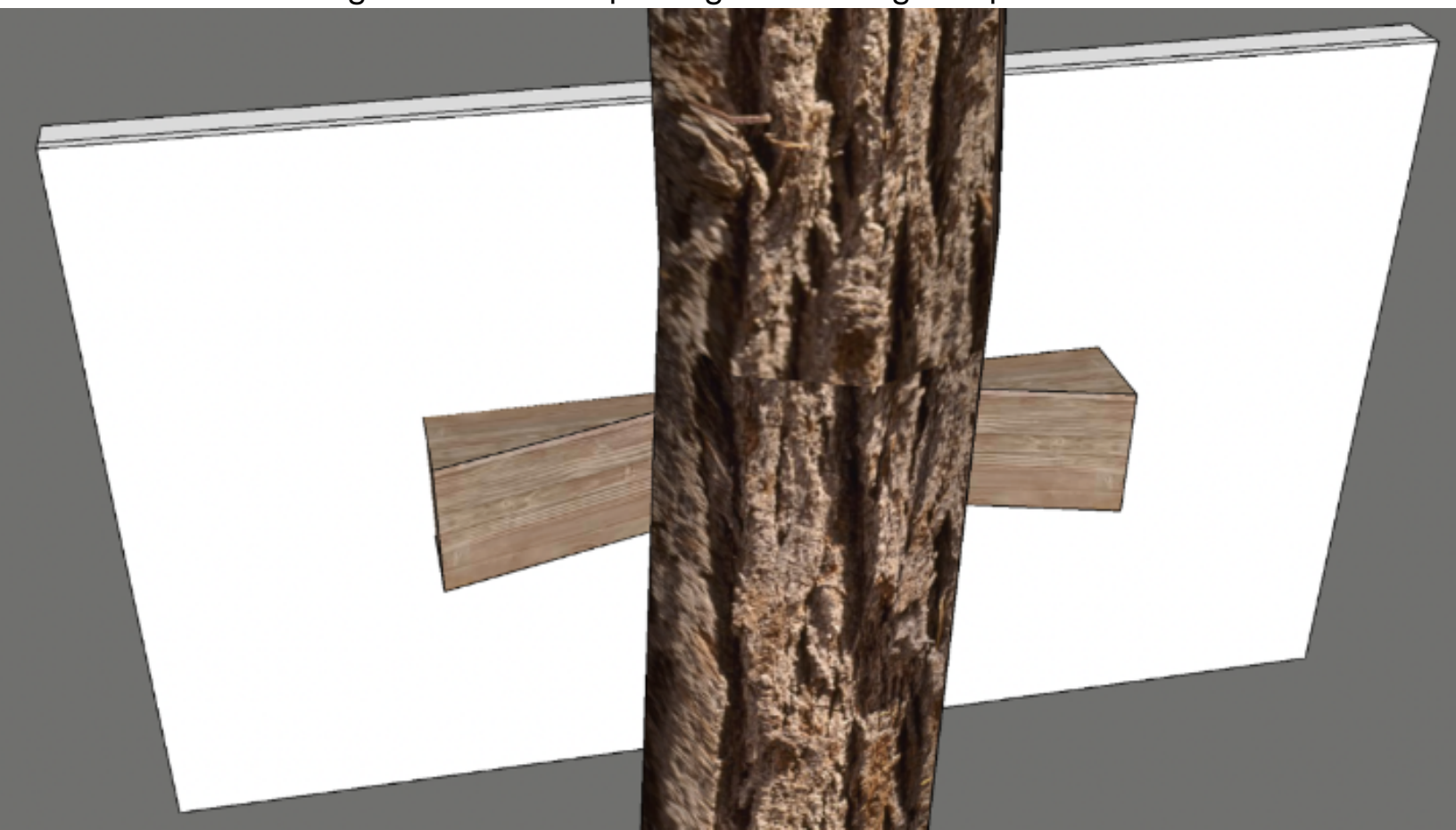


Figure 5.3 Sketchup design with wedges top view



5.2 Acknowledgments

All group members were glad to have this once-in-a-lifetime experience and opportunity at Turn Back Time. Over the course of this term, we were able to gain knowledge and experience regarding teamwork, planning, construction, writing, presenting and to experience Turn Back Time's amazing community along with countless unforgettable memories.
We would like to give our thanks to Lisa Burris, Katie Baker and Derren Rosbach for guiding us through the design and process of our project, as well as the rest of the Turn Back Time community. We hope that our deliverable lasts to continue benefiting Turn Back Time and to bring further opportunities of literacy to young minds. We enjoyed developing and building with Turn Back Time and aspire to keep in touch and someday revisit this place of learning.

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Appendix A: Surveys

Survey Questions	Responses
What are some of the early literacy methods used at TBT?	**Open-ended**
Should the story walk be portable? (We are considering having buckets full of gravel that would keep it sturdy) 	**Linear scale rating from 1-10**
Do you like this option? 	**Linear scale rating from 1-10**
Why do you think making the story walk portable is good or bad?	**Open-ended**

Should the Story Walk be a Structure? 	**Linear scale rating from 1-10**
Why do you think making the story walk a structure is good or bad?	**Open-ended**
Is this enough for a story walk? 	**Linear scale rating from 1 -10**
Is having bags around the story walk useful? (We were thinking kids could draw on the story walk as they go along) 	**Linear scale rating from 1-10**

What do you think of this option? The pages could easily be swapped and are protected against environmental factors. 	**Open-ended**
Should we put numbers on each signpost?	• **Yes** • **No** • **Other**
What else could we do to make the story walk fit the needs of Turn Back Time?	**Open-ended**
Would you like us to have an interview with you?	• **Yes** • **No**

Educators Survey

Feedback	Questions
Open-ended	Based on your observation and experience, do you feel that most children here enjoy reading as an activity?
Open-ended	In your experience, what educational methods are best for information retention?
☐ Yes ☐ No ☐ Maybe ☐ Other :	Do you believe experiential outdoors learning is more effective in information retention than traditional classroom learning?
☐ Yes ☐ No ☐ Other :	Do you feel that the children here enjoy outdoor group reading activities? (i.e., story walks)
☐ Yes ☐ No ☐ Other :	Do you currently educate using outdoors literacy?
☐ Very important ☐ Important ☐ So-so ☐ Unimportant ☐ No influence on future mental growth	How important do you believe exposure to early literacy is for the future mental development of children (How much of a role does it play in influencing their future?)
Open-ended	What methods do you employ to keep the attention of children focused?

Parents Story Walk Questionnaire Survey

Feedback	Questions
Open-ended	How old your is your child?
☐ Preschool ☐ Summer Camp ☐ Critter Catchers ☐ Kinderkamp ☐ Other:	Which programs does your child participate in at Turn Back Time?
Open-ended	How long has your child been enrolled at Turn Back Time?
Open-ended	How does your child feel about Turn Back Time's programs?
Open-ended	Which activity aspect of Turn Back Time does your child enjoy most? (Outdoors playing, interacting with the animals, group reading, etc.)
Open-ended	What activity at Turn Back Time or activity generally keeps your child's interest and attention focused the most?
☐ Visually: Seeing, story reading, observing ☐ Sensory: Interacting, hands-on playing ☐ Auditory: Listening, group-reading ☐ Other:	How does your child best prefer to learn?
☐ Yes ☐ No ☐ Maybe ☐ Other:	Do you believe Turn Back Time is educational for children?

Open-ended	Which activities at Turn Back Time have taught your child the most? Explain.
Open-ended	Do you x that outdoor learning through play and hands-on experience at the farm allows for greater information retention for children than in a traditional school setting? Explain.
Open-ended	In your opinion, how critical is literacy for children starting from a young age? Should higher efforts be made to familiarize them with reading?
☐ Yes ☐ No ☐ Neutral ☐ Other:	Would you be in favor for the addition of an outdoors trail-based reading activity (story walk) to the farm? A story walk is a guided activity in which teachers accompany a class of children through a set path with posts set along the way detailing a children's story.
☐ Yes ☐ No ☐ Neutral ☐ Unsure ☐ Other:	Do you think your child would be excited about it?
Open-ended	Is there anything else you would like us to know?

Figure 6. 1 Activities TBT students enjoy the most

Figure 6. 2 Stations and activities that keep TBT students focused

Figure 6. 3 TBT students feeling pie chart

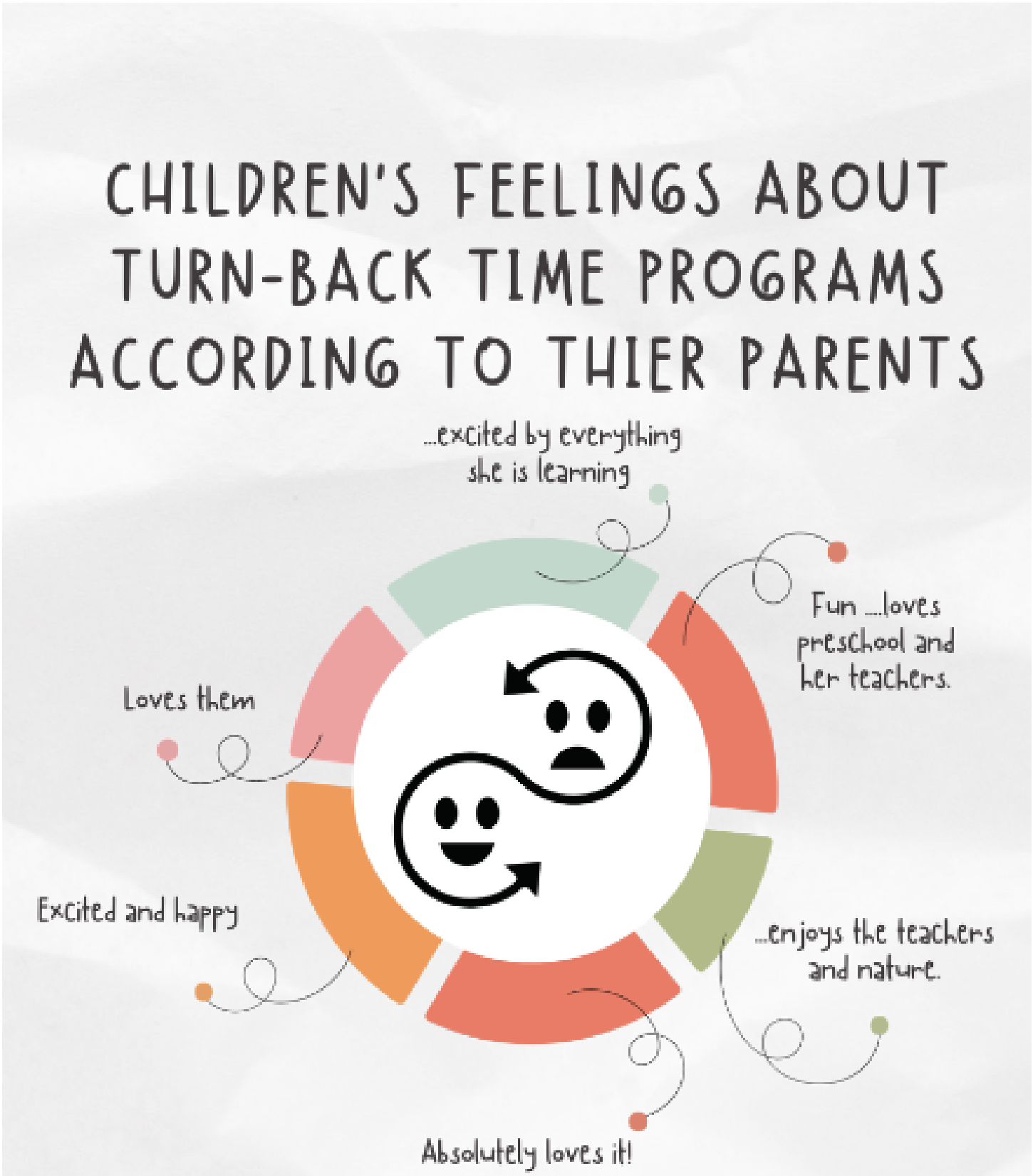


Figure 6. 4 TBT student enrollments

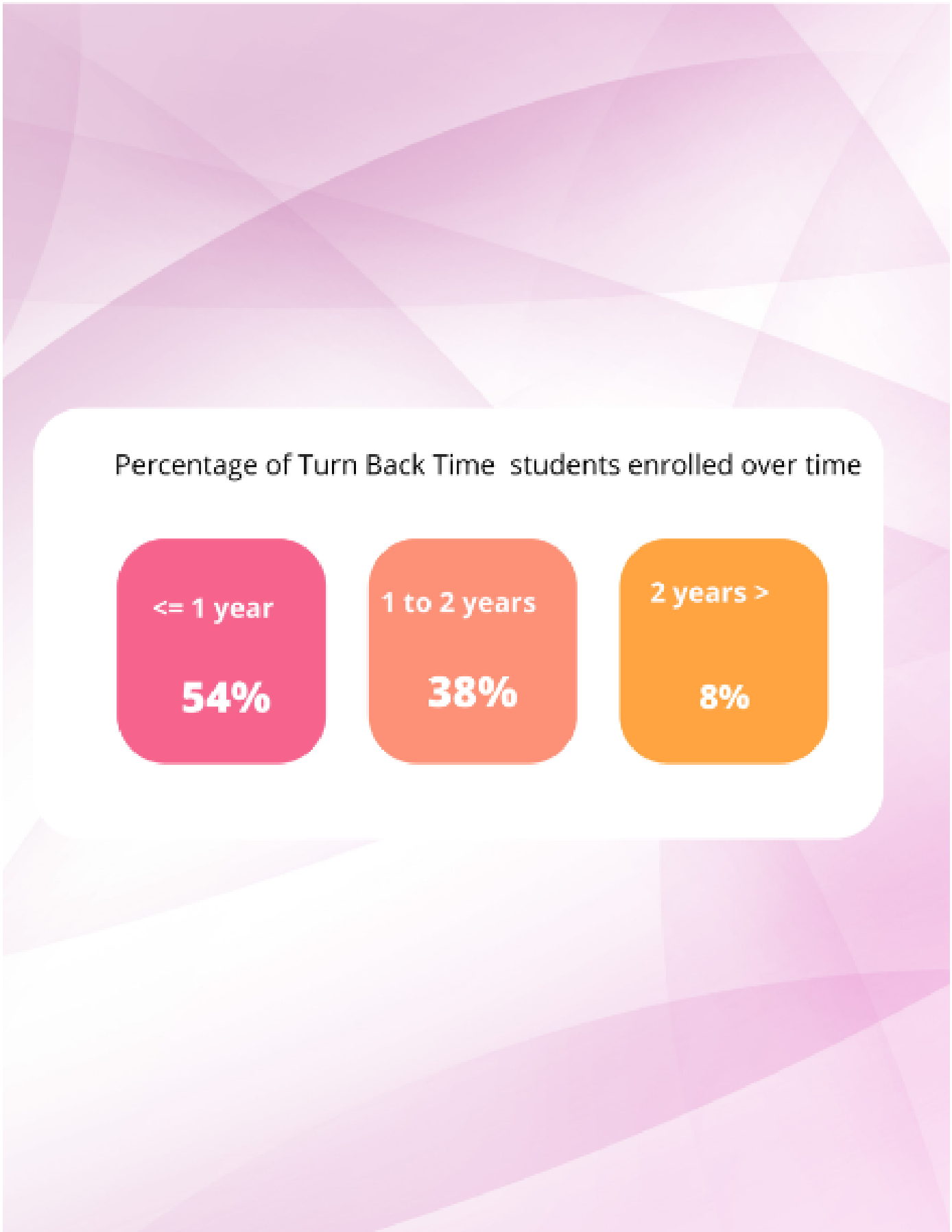


Figure 6. 5 Average number of students in TBT programs bar chart

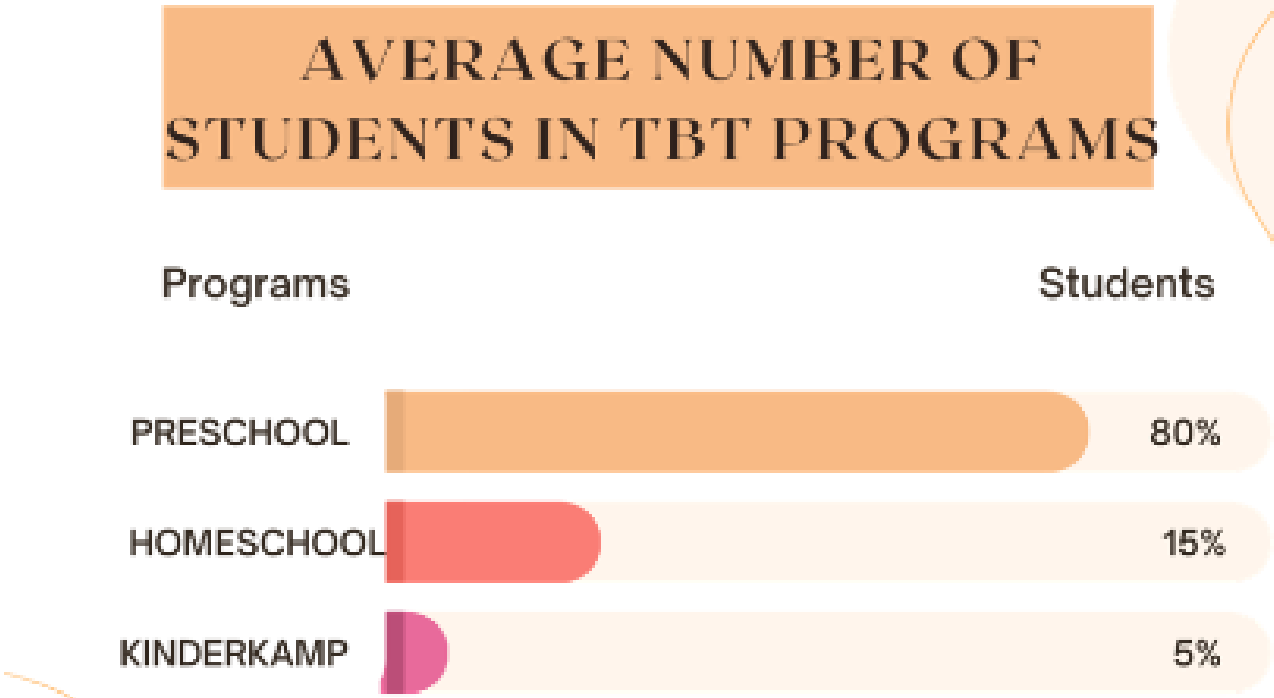


Figure 6. 6 TBT students preferred learning methods pie chart.

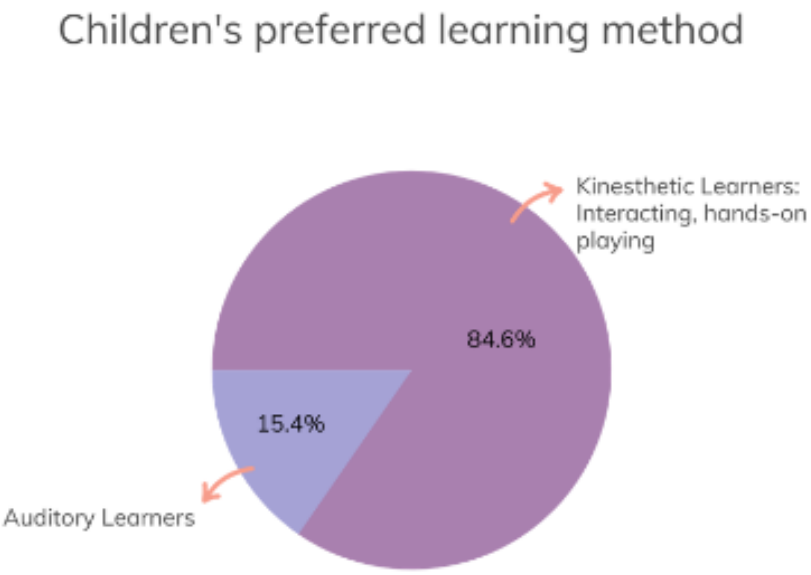


Figure 6. 7 Average age groups of students at TBT

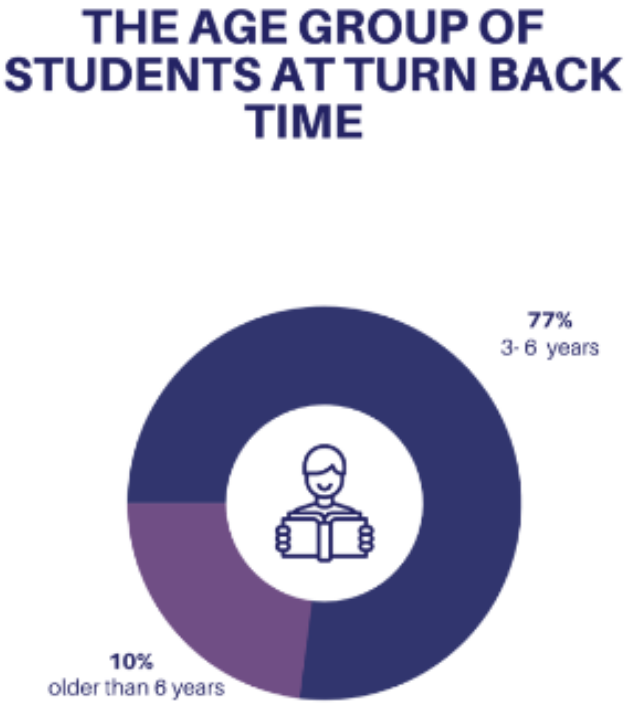
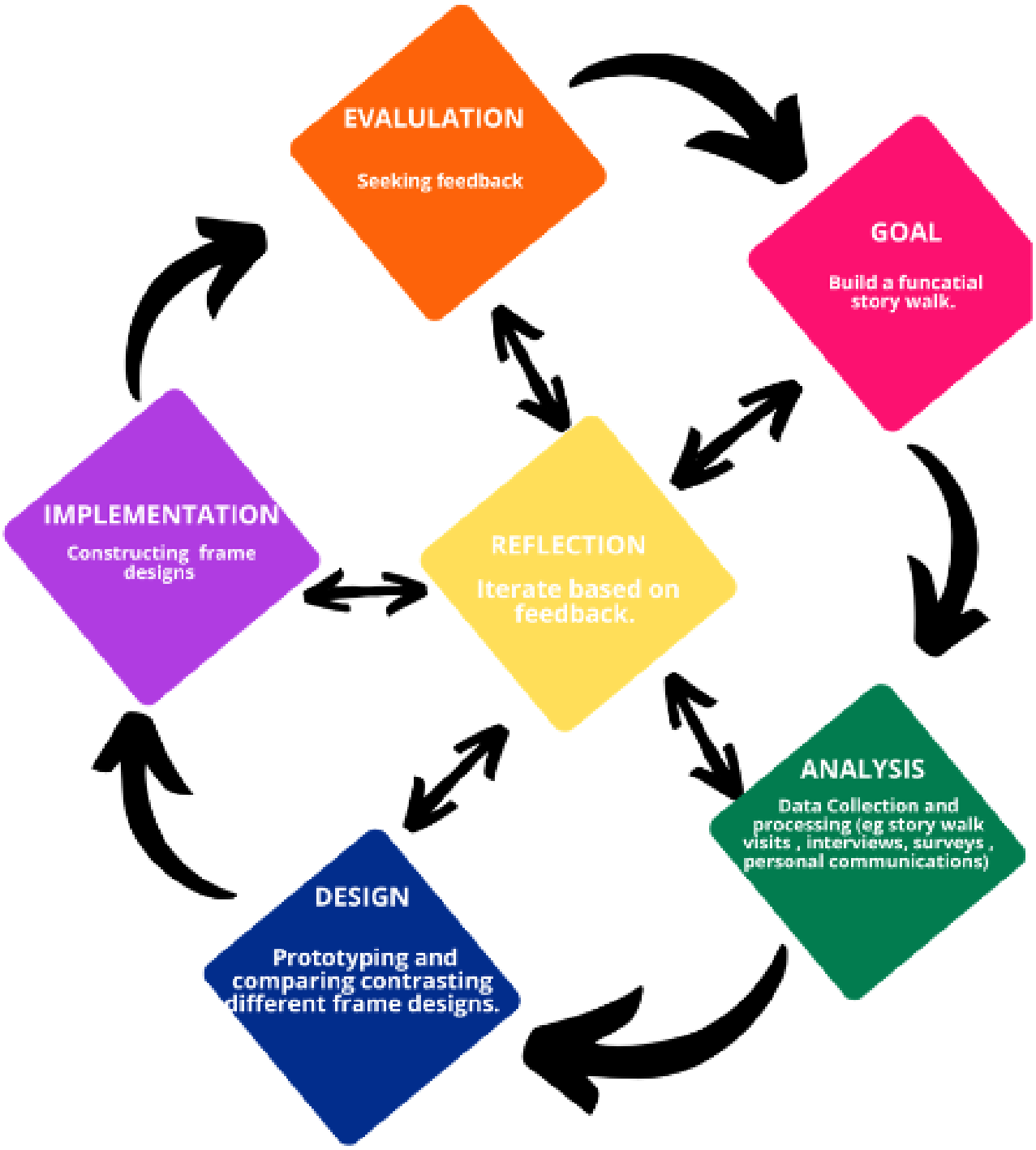


Figure 6. 8 Design Process



Appendix B: Design iterations

1

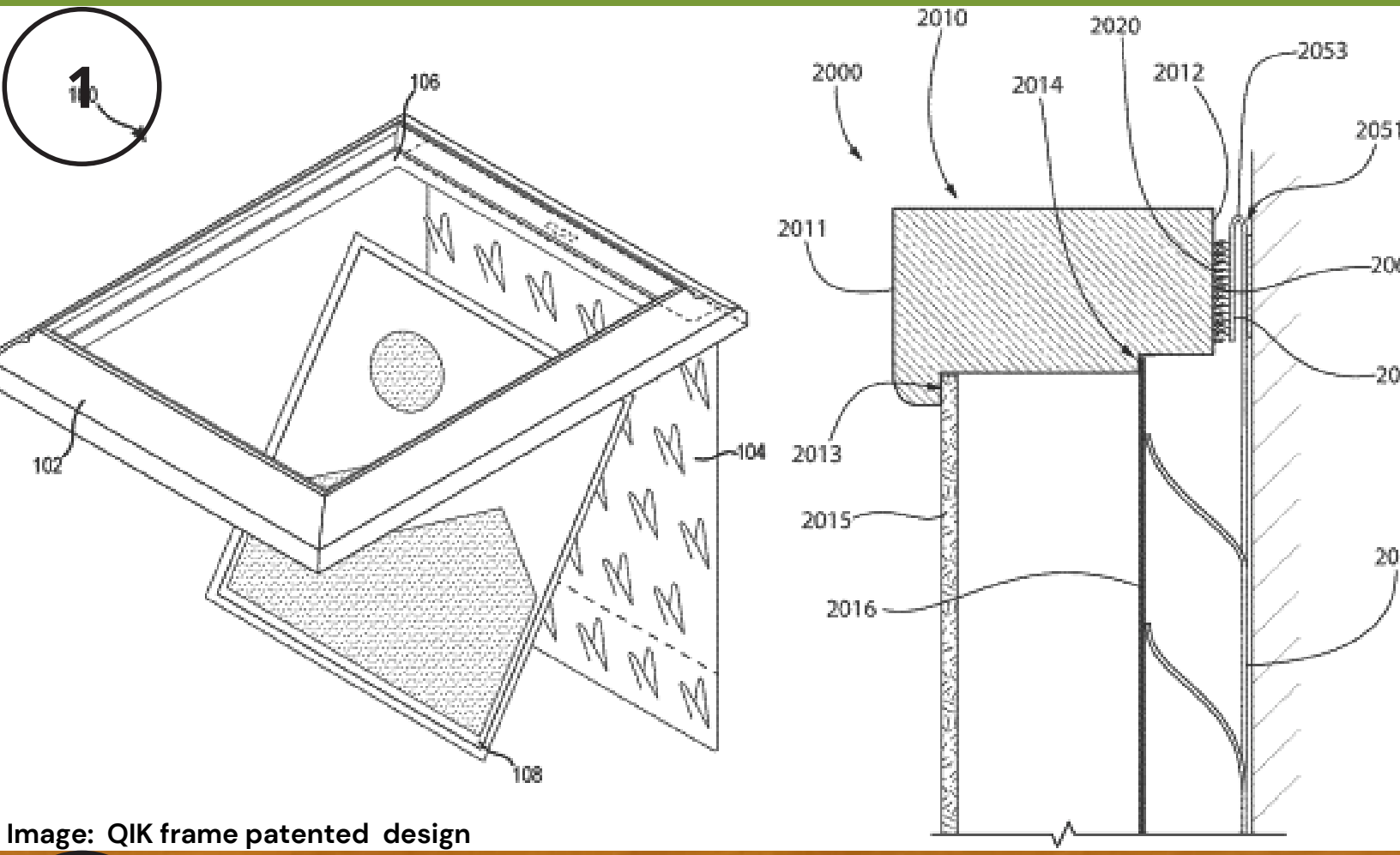


Image: QIK frame patented design

2

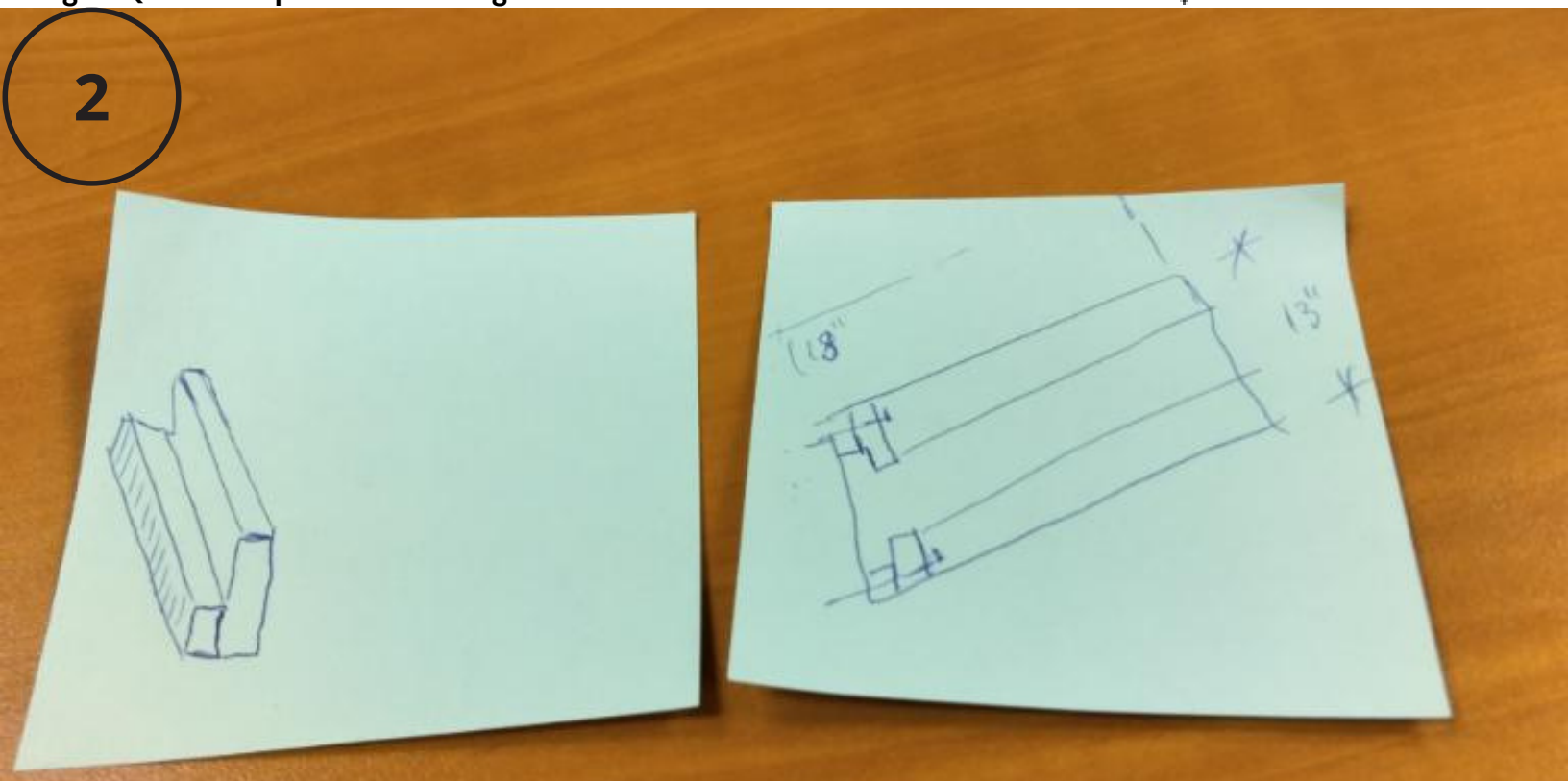


Image: Sketch of design using wood spacers

Cut acrylic desgin

3

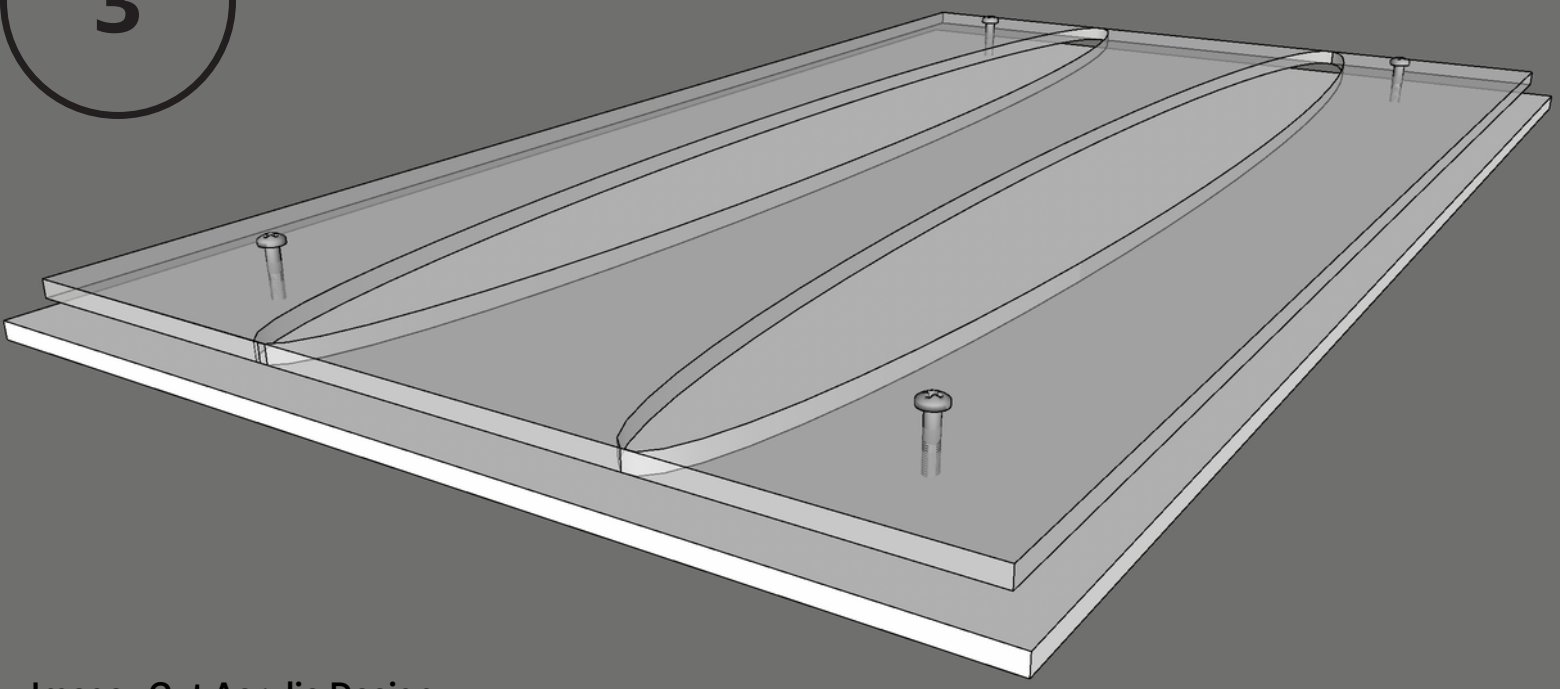


Image: Cut Acrylic Design

4

Final Design

Adding U-Shape molding →

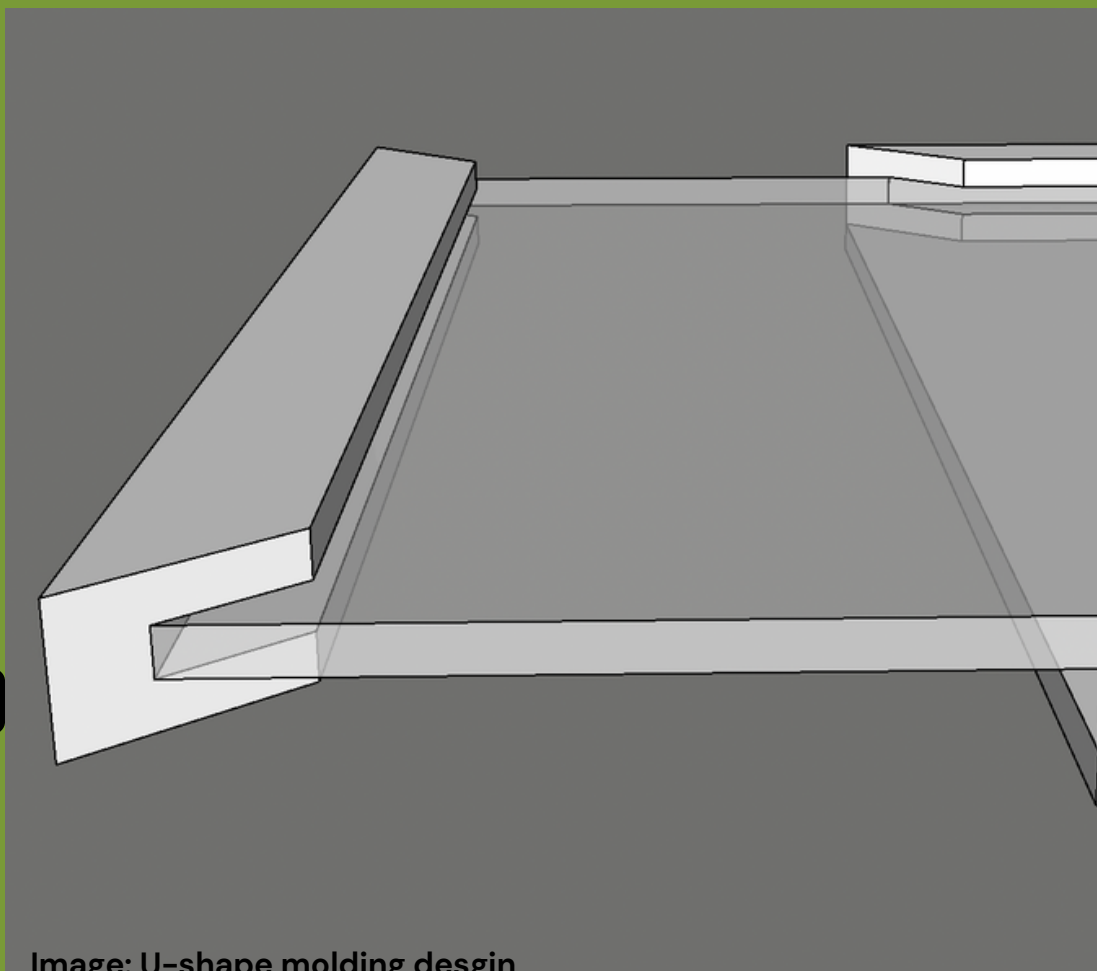


Image: U-shape molding desgin

5

Adding Wedges

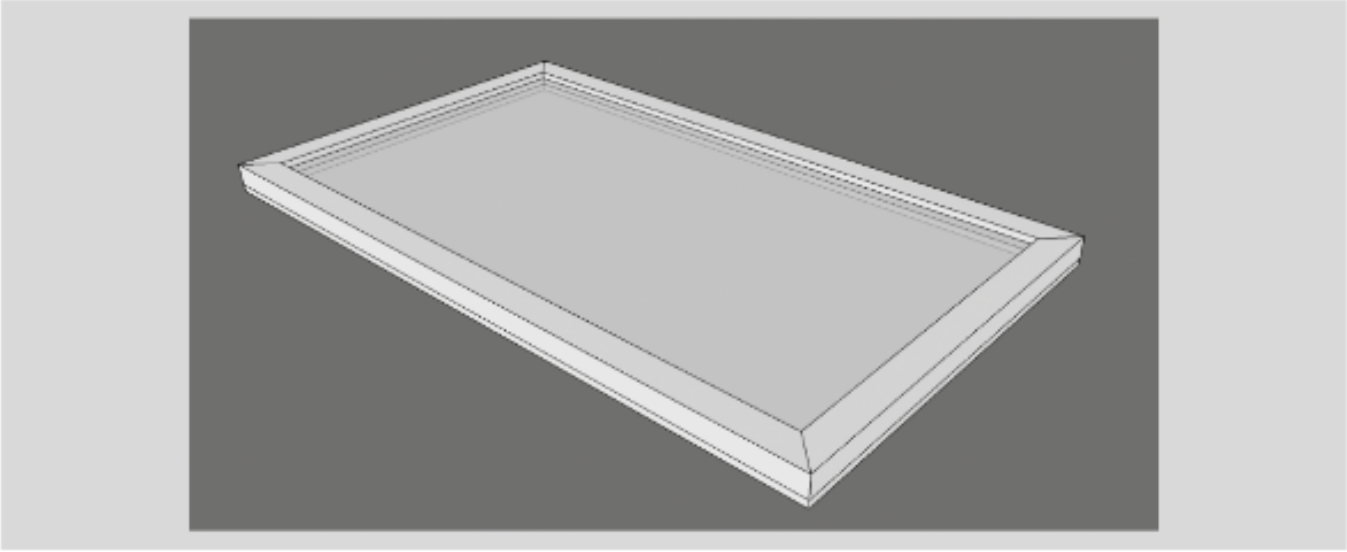
Wedges provide extra contact points

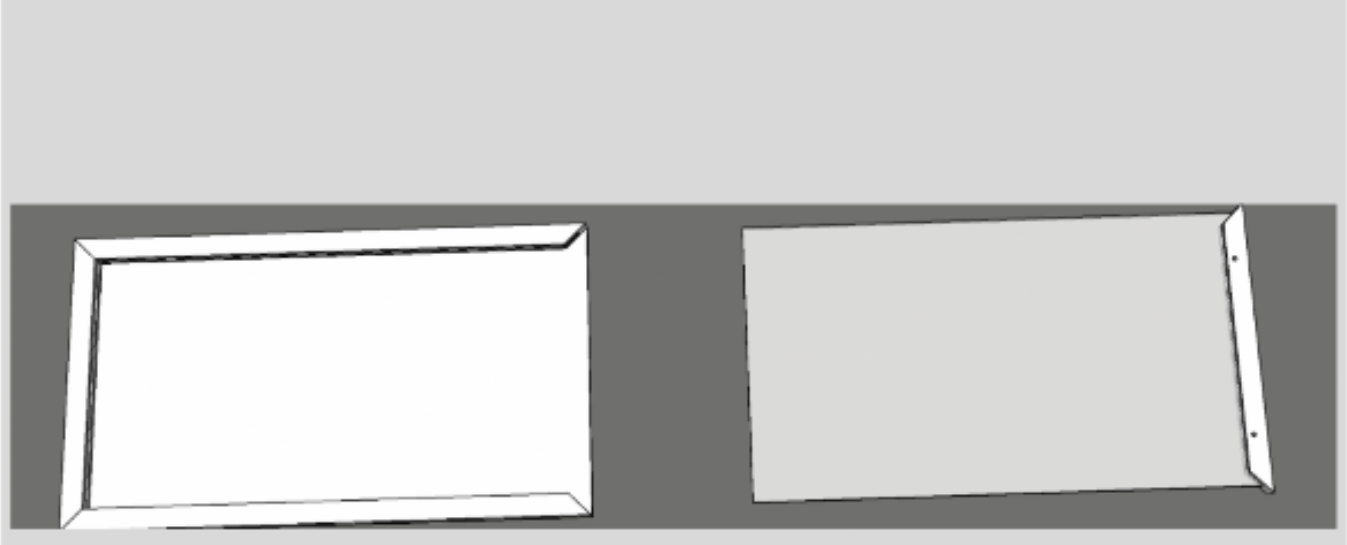
Image: Wedges design

Appendix C

Building the story walk frames

STEP BY STEP INSTRUCTIONS





Materials Needed

2x	1/4 in. 4ft in. 8ft white PVC trim
4x	3 feet. x 6 feet. x 0.093 in. Acrylic Sheet
19x	8 feet white lattice cap molding
2x	10.1 oz. silicon sealant
5x	8.0 oz. 2-part epoxy
1x	50 Qty cabinet timber screws

Tools

Table saw

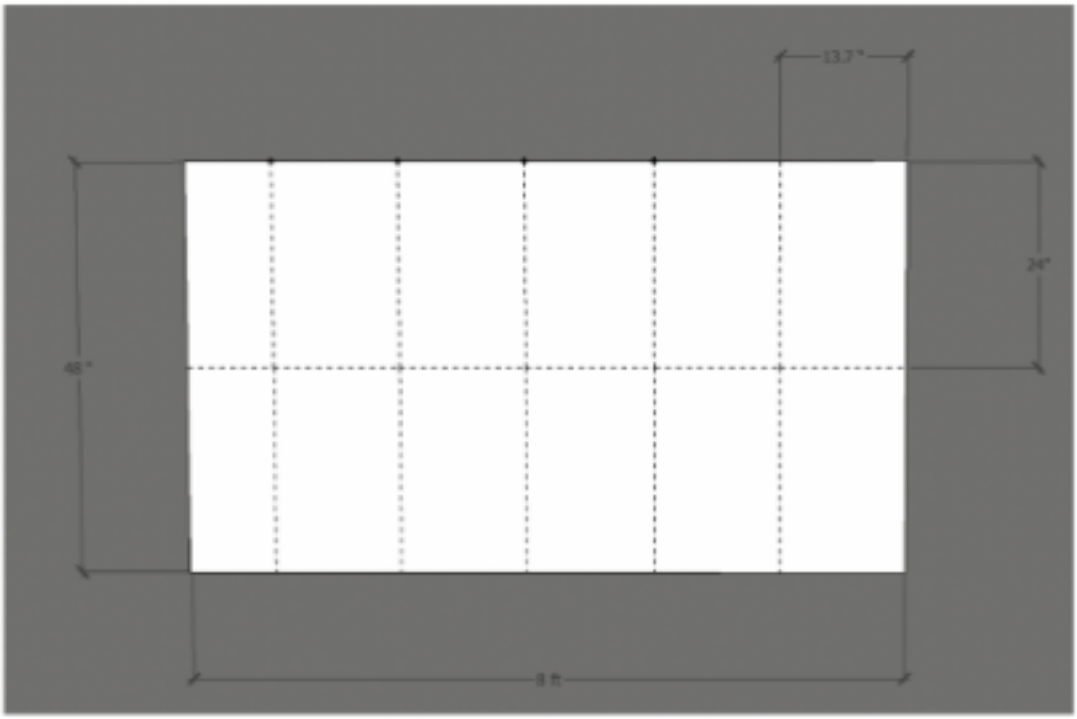
Miter saw

Glue gun

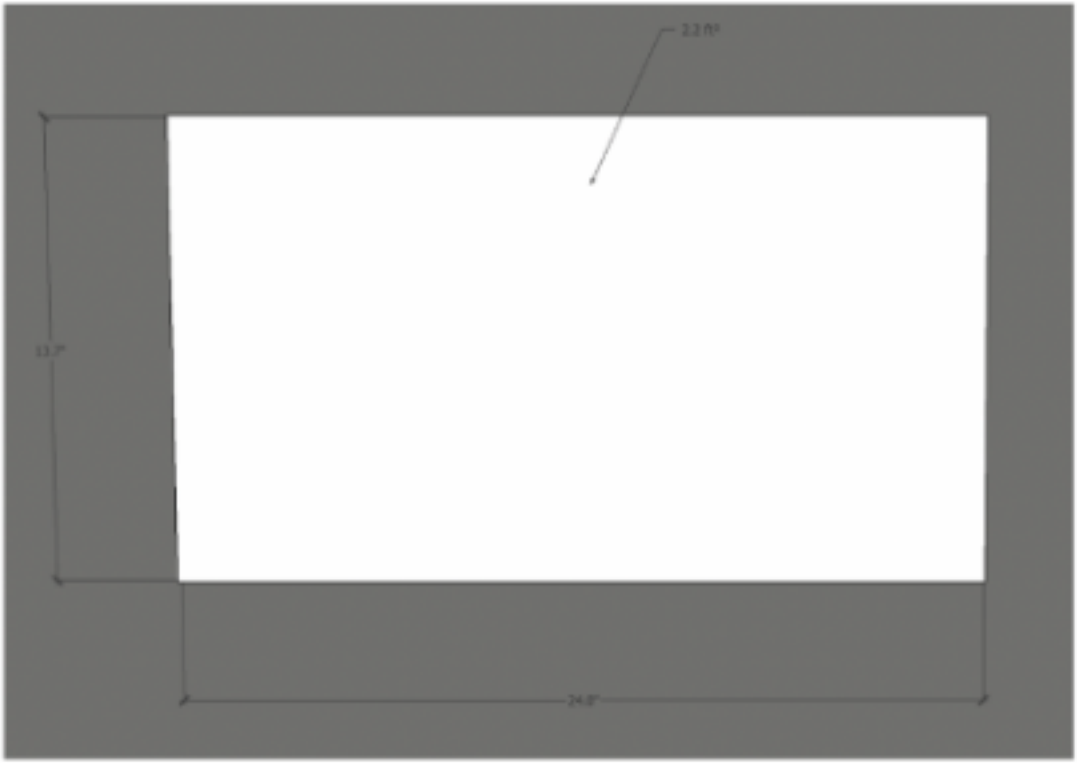
Cordless Drill

1 Cutting the backboard

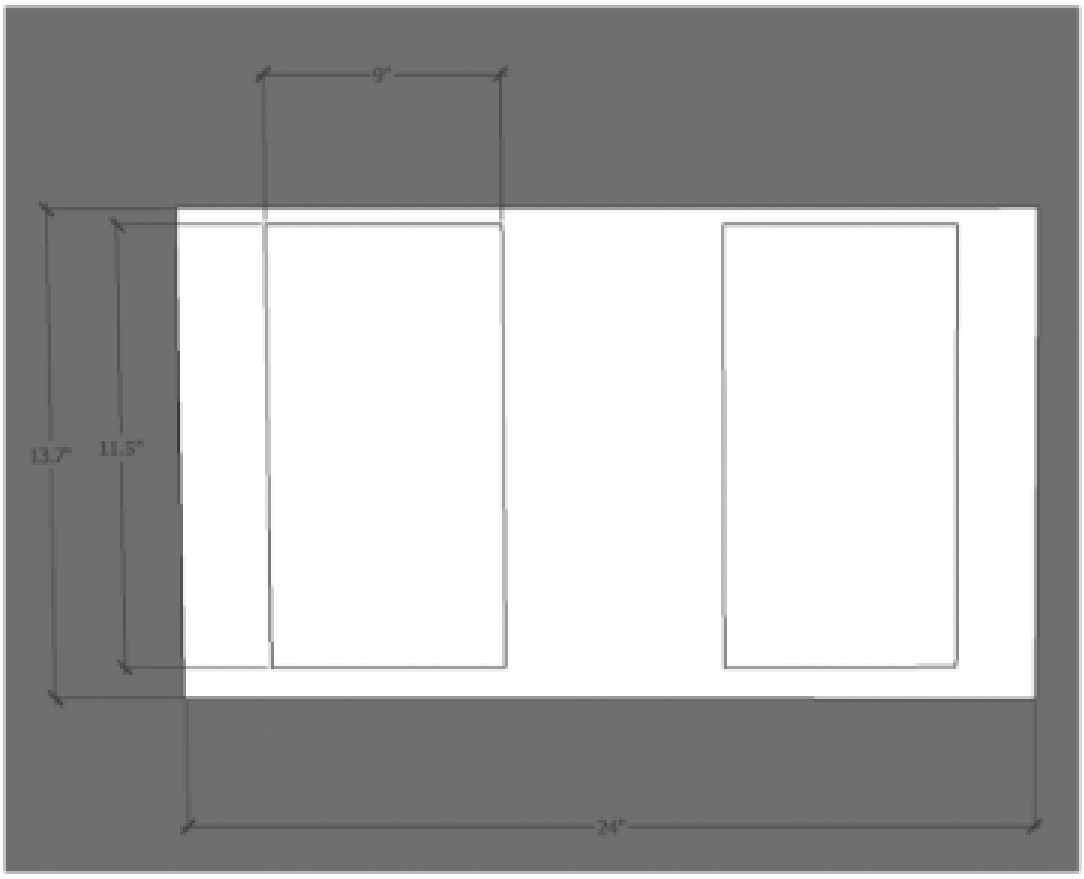
Cutting the PVC board through the dotted lines using a table saw



Cutting two ***2x*** 4ft in. x 8ft PVC boards makes ***24x*** 13.7 in. 24 in. boards



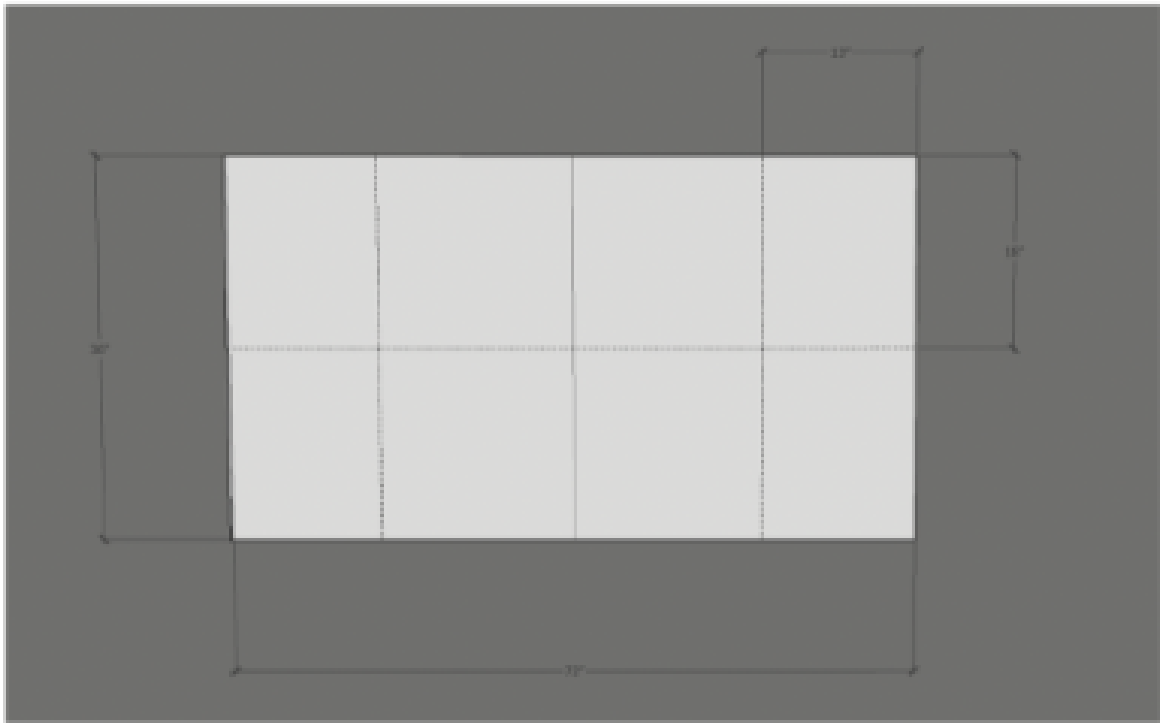
The largest size laminated pages are 9" by 11.5 ". This is enough to accommodate pages to be put vertically or horizontally.


9"
13.7"
11.5"
24"

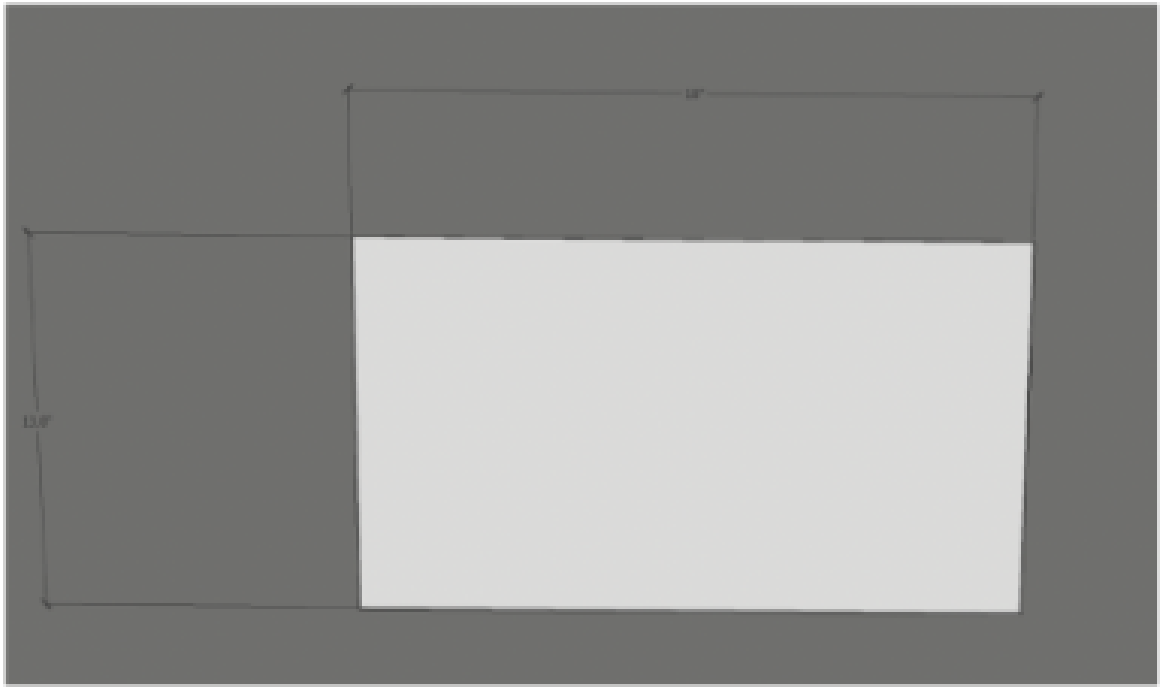
2

Cutting the Acrylic Sheets

Cutting Acrylic sheets in the dotted lines

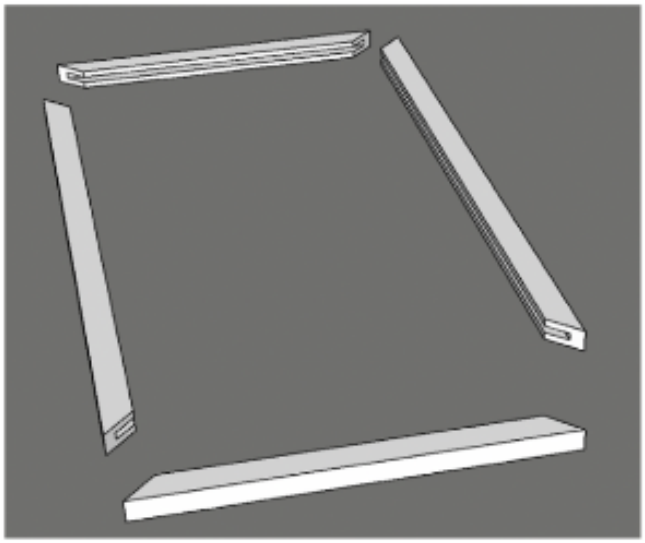


4x 36" x 72" Acrylic sheets make ***24x*** 13" x 18" Acrylic panels



3 Cutting the U shape molding

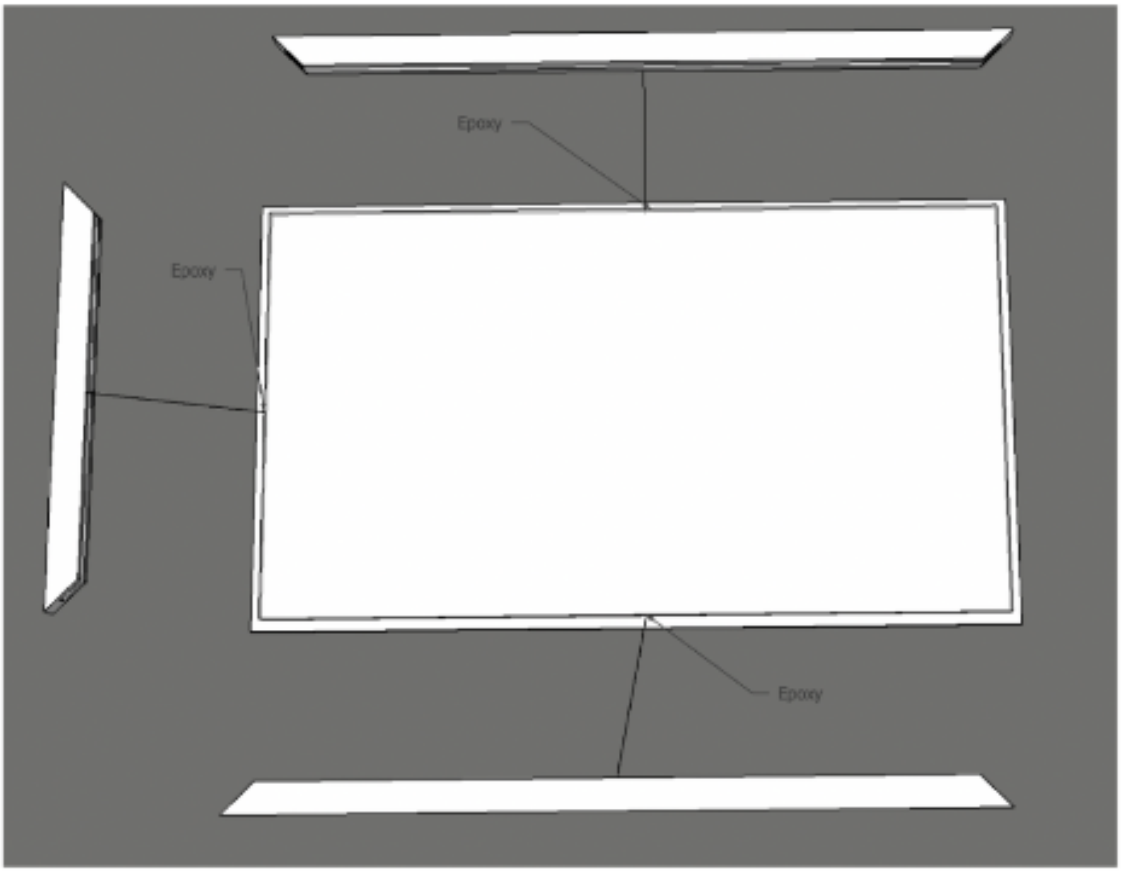
All the U-shape modeling is cut to a 45-degree angle.



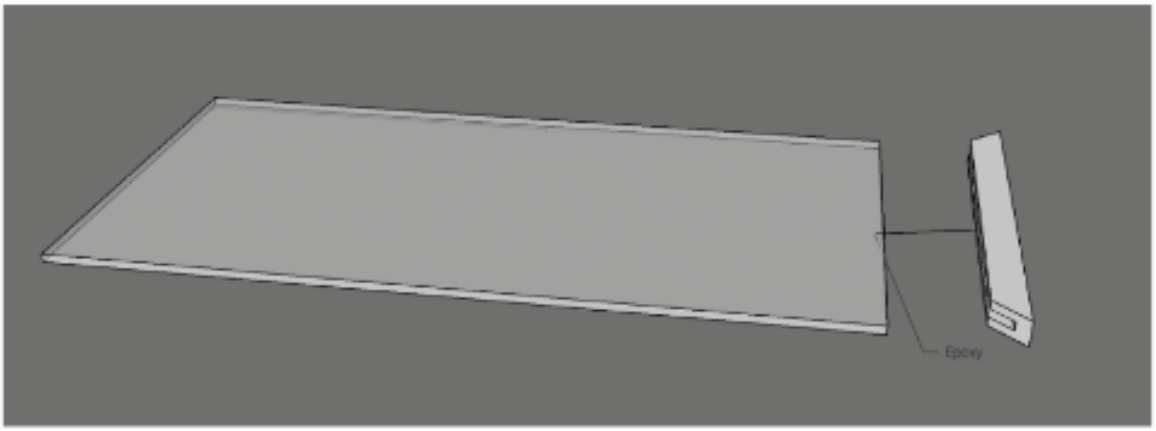
Four pieces of u shape molding are cut.

4

Applying Epoxy



Epoxy is applied to three sides of the board then we attach the three pieces of u-shape molding



Epoxy is also applied to the molding and acrylic sheet

4.1 Letting Epoxy dry

We put weight on each u-shape molding to keep the pieces intact.

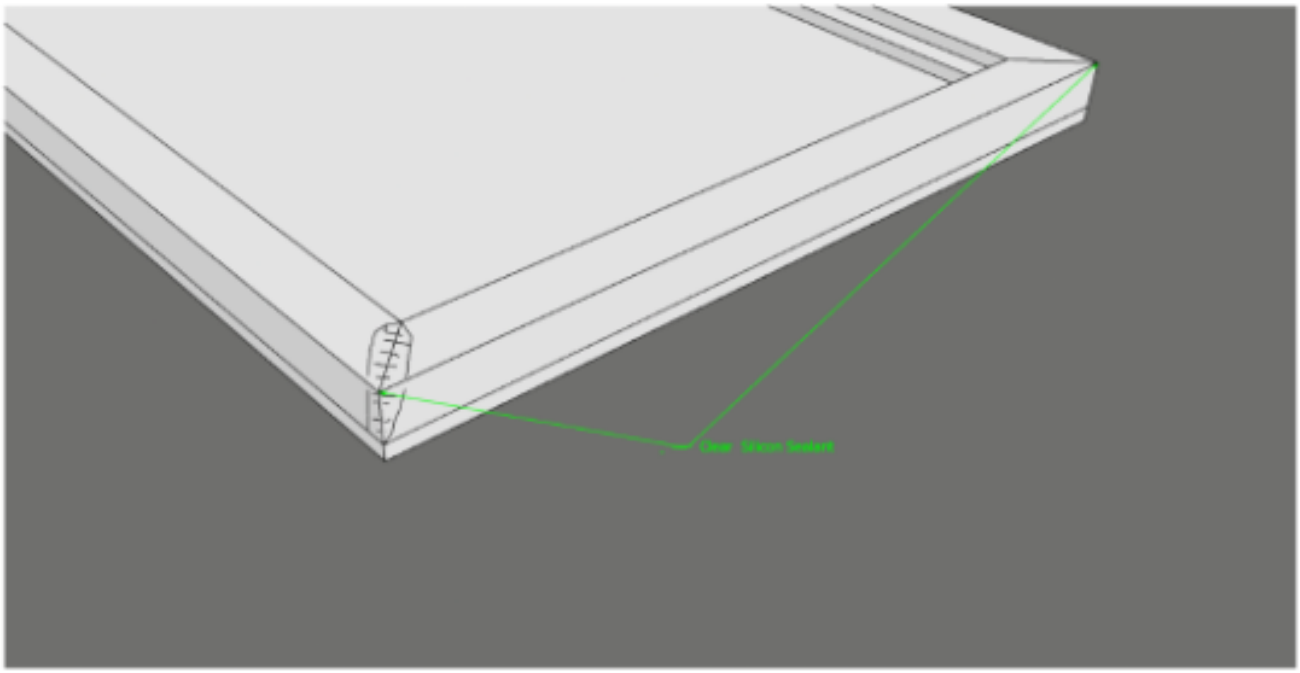
When gluing the sections together, some glue might leak out over time resulting in the frame attaching to the tables.

5

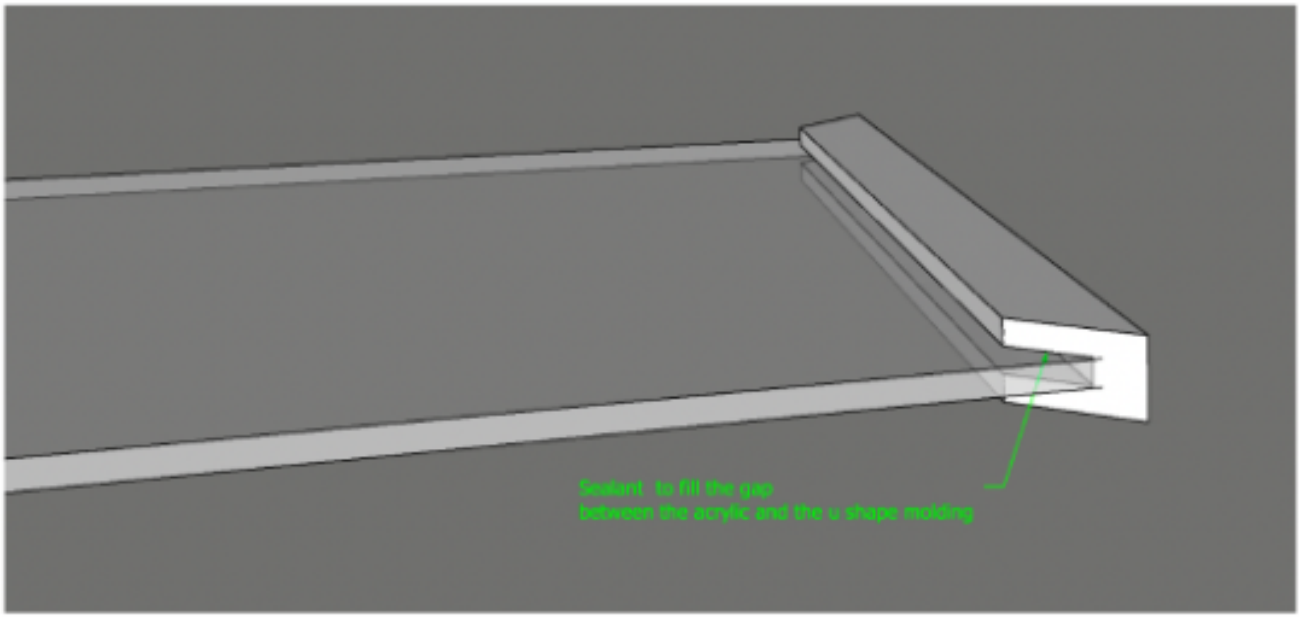
Washing

Before applying sealant to the edges of the frames a rinse is needed to clean any derby.

5.1 Sealing



Sealing the edges of the frames to make the frames water resistant.



Applying sealant between the Acrylic and the U-shape molding protects the Epoxy from water damage, and it creates a more water-resistant structure.

We cover the plexiglass with masking tape and use an ice cream stick to push the sealant the inside of the molding.

Keeping the protective film helps in case any sealants fall on the plexiglass.

clear silicone sealant requires 24 Hours to cure

Figure 7.1 Sketchup Initial Prototype

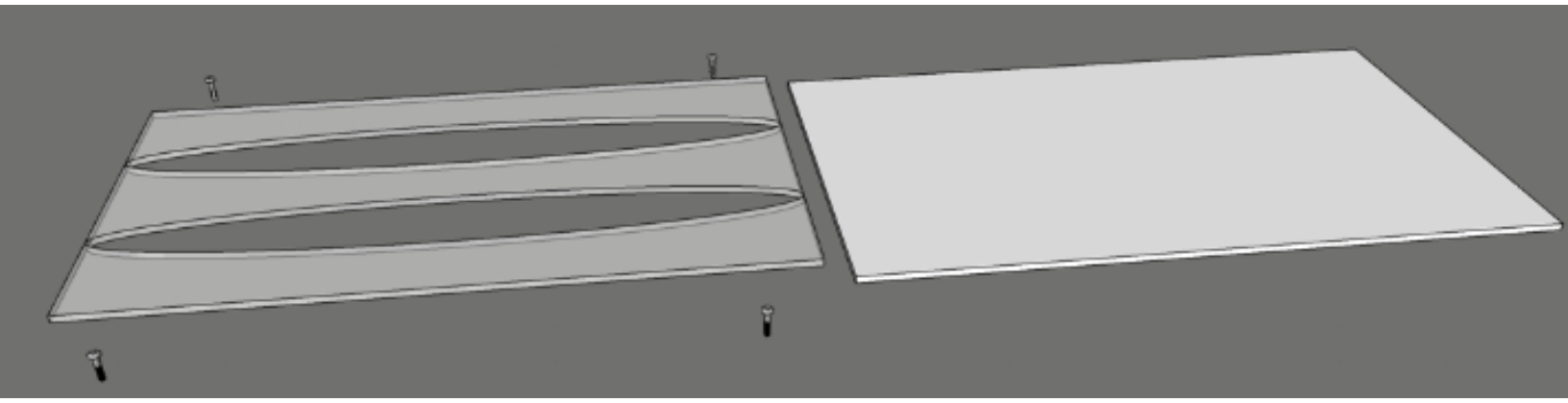


Figure 7.2 Sketchup Initial Prototype Top View

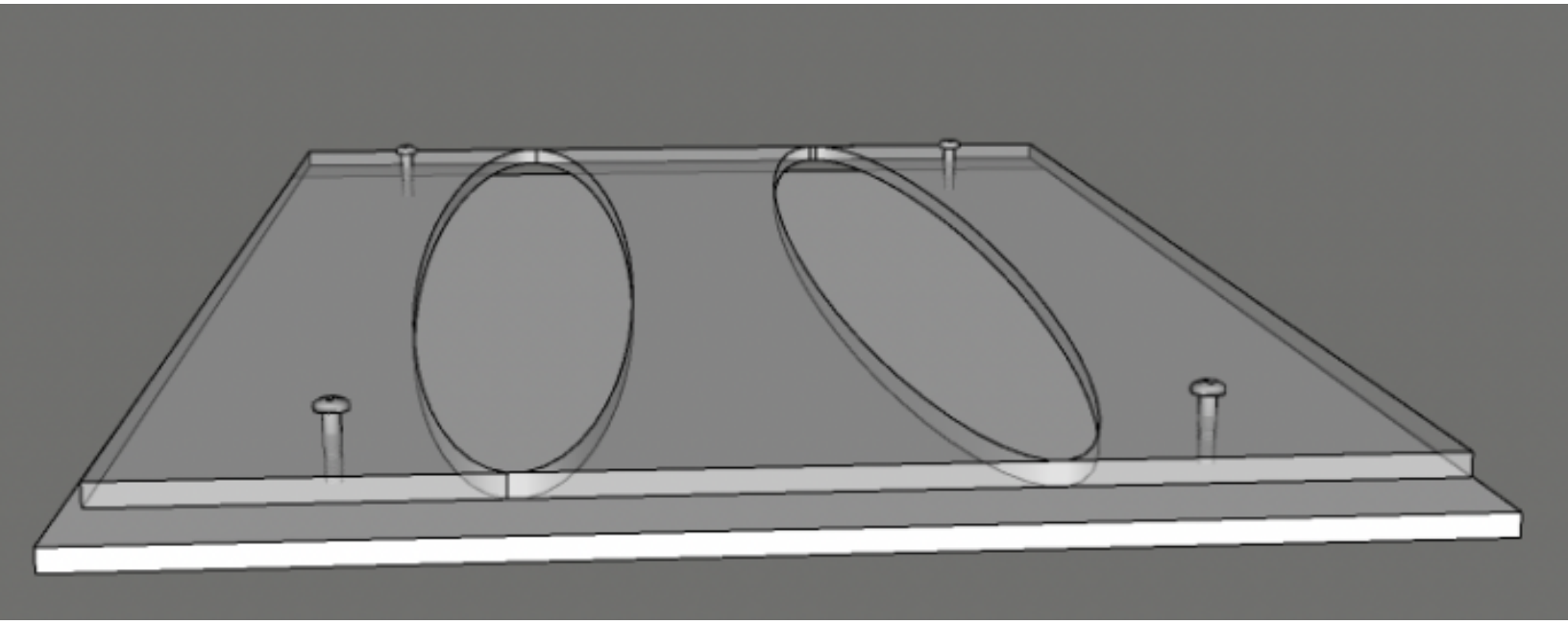


Figure 7.3 Sketchup Initial Prototype Side View

Figure 7.4 Sketchup Initial Prototype 2D Plane

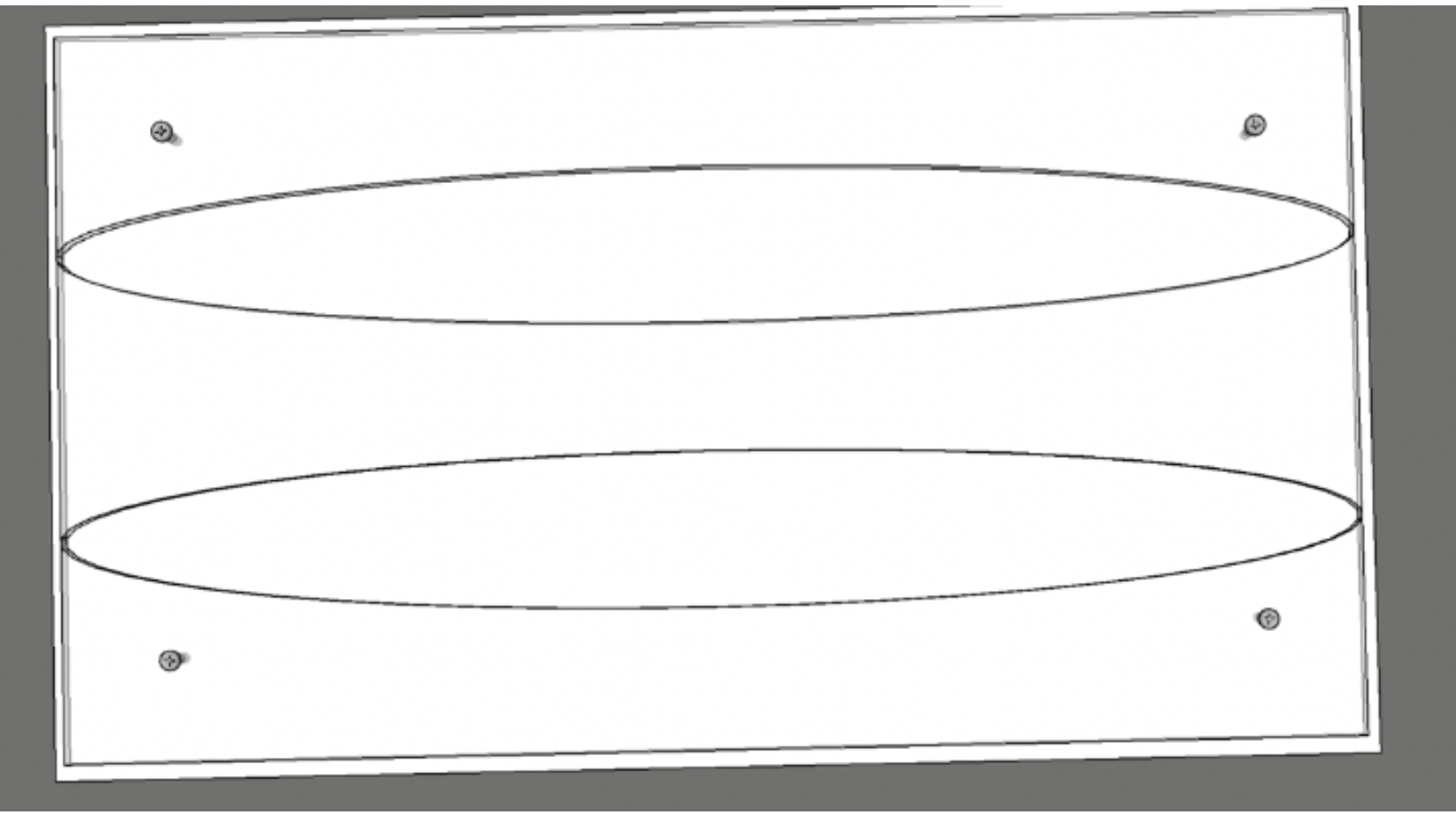


Figure 7. 5 Sketchup of the model using screws

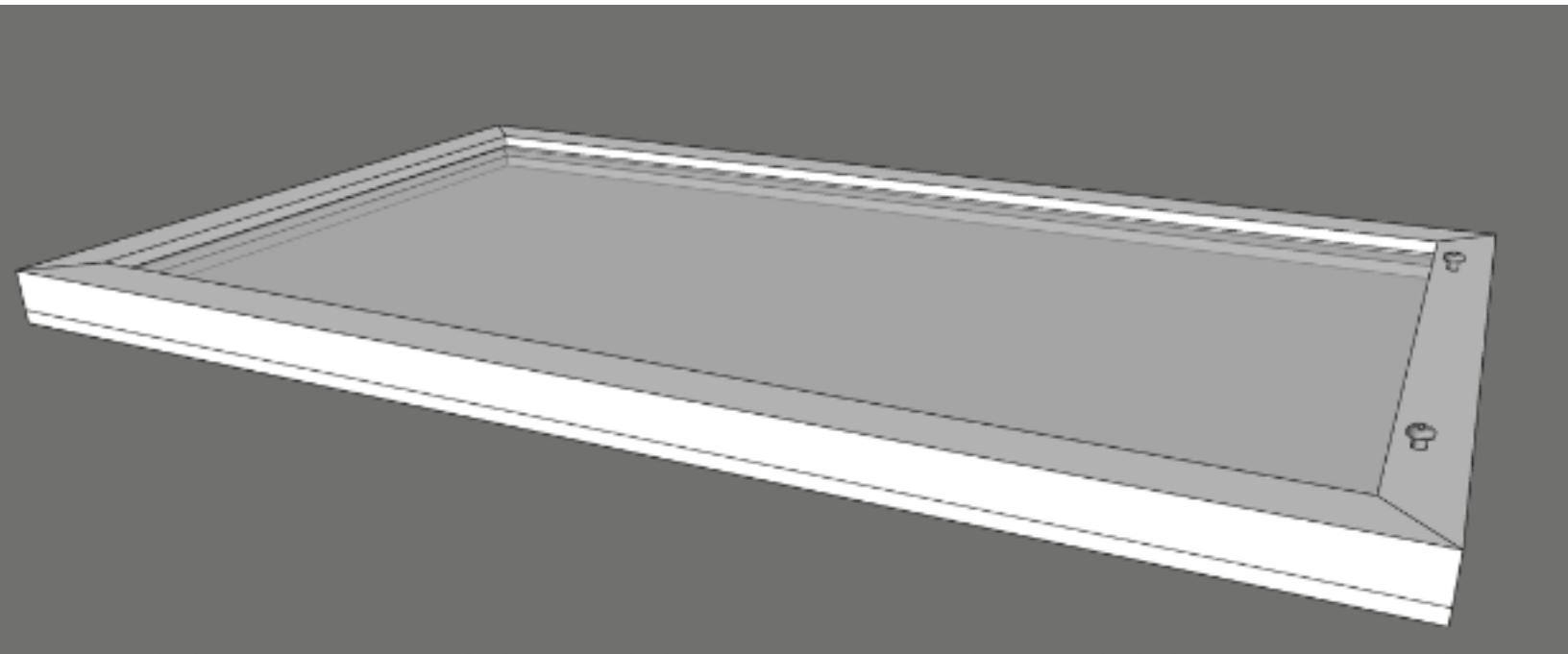


Figure 7. 6 Sketchup of attaching acrylic to molding using screws

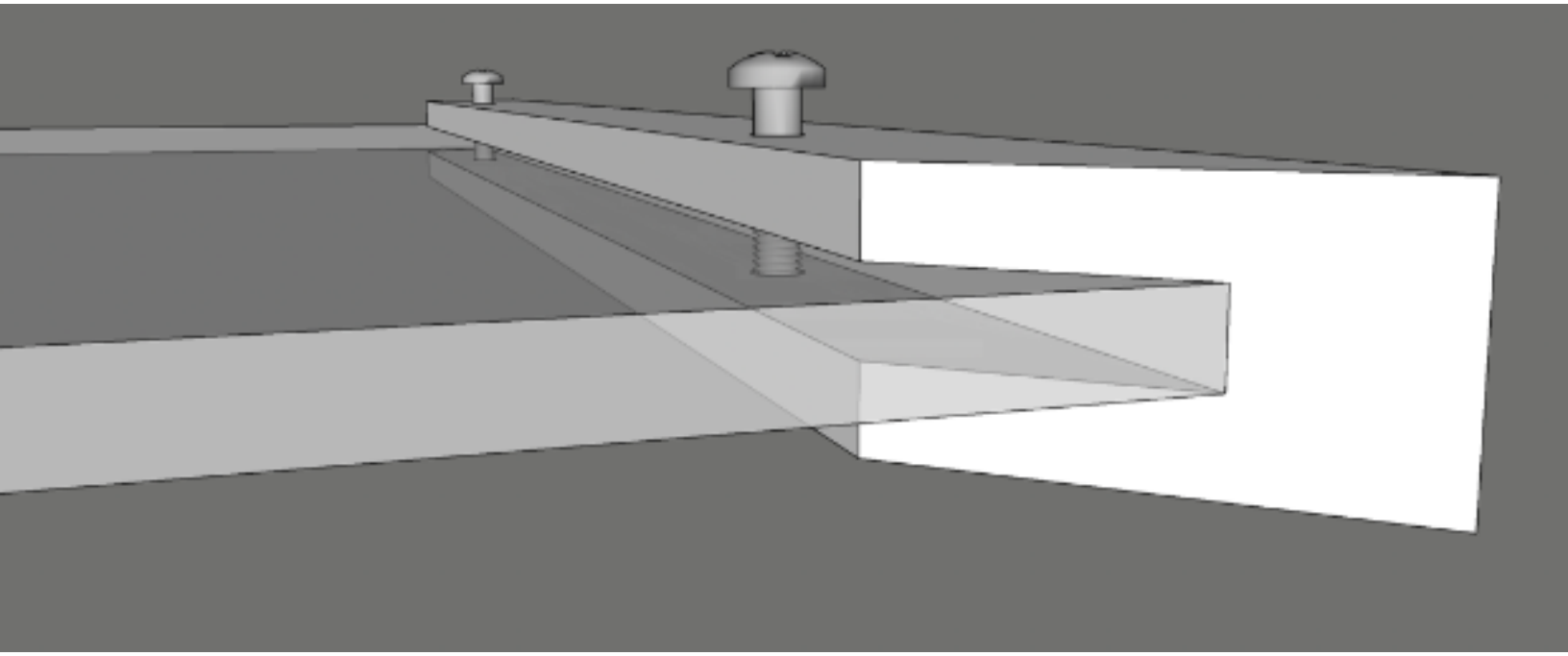


Figure 7. 7 Sketchup final prototype

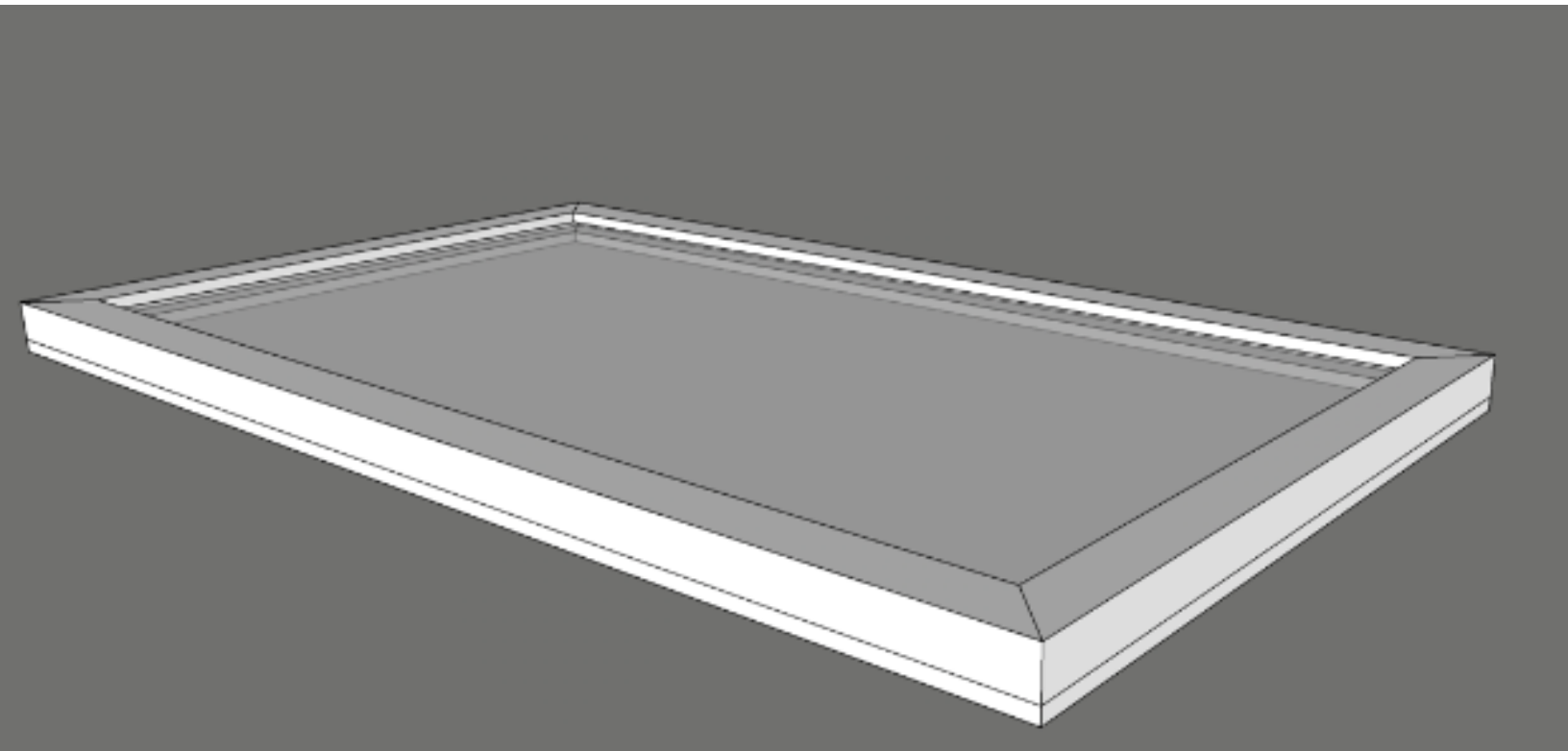


Figure 7. 8 Sketchup final design with sliding acrylic

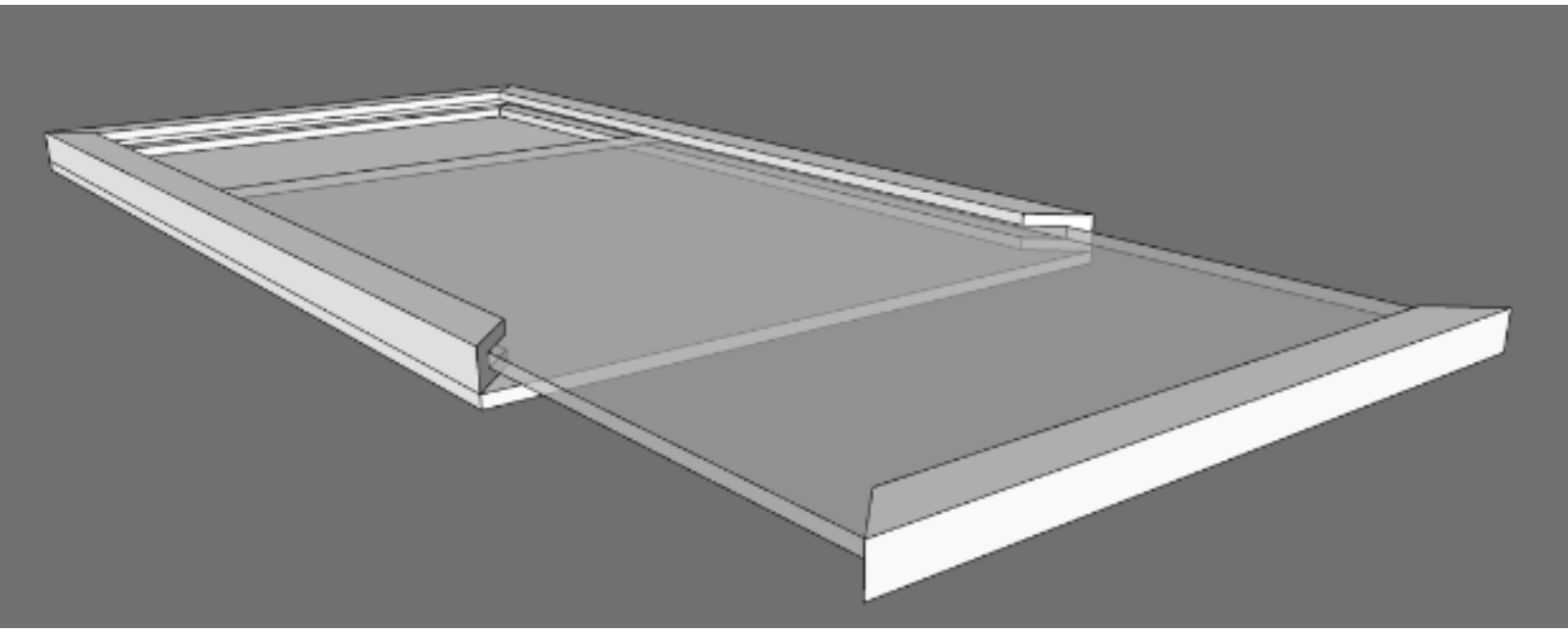


Table 4 Design Decision Matrix.

	29%	29%	43%	100%	
Option	Cost	Aesthetics	Durability	Score	
Magnetic frame	6	1	3	3	III
QIK frame	1	6	2	3	II
Acrylic holder	5	2	4	4	III
Artwork Frame	2	4	1	2	II
Acrylic to plywood	4	3	5	4	IIII
Acrylic to PVC board	3	5	6	5	IIII
Notes:					

The higher the score, the better the design is in that category. * The ability to change pages easily

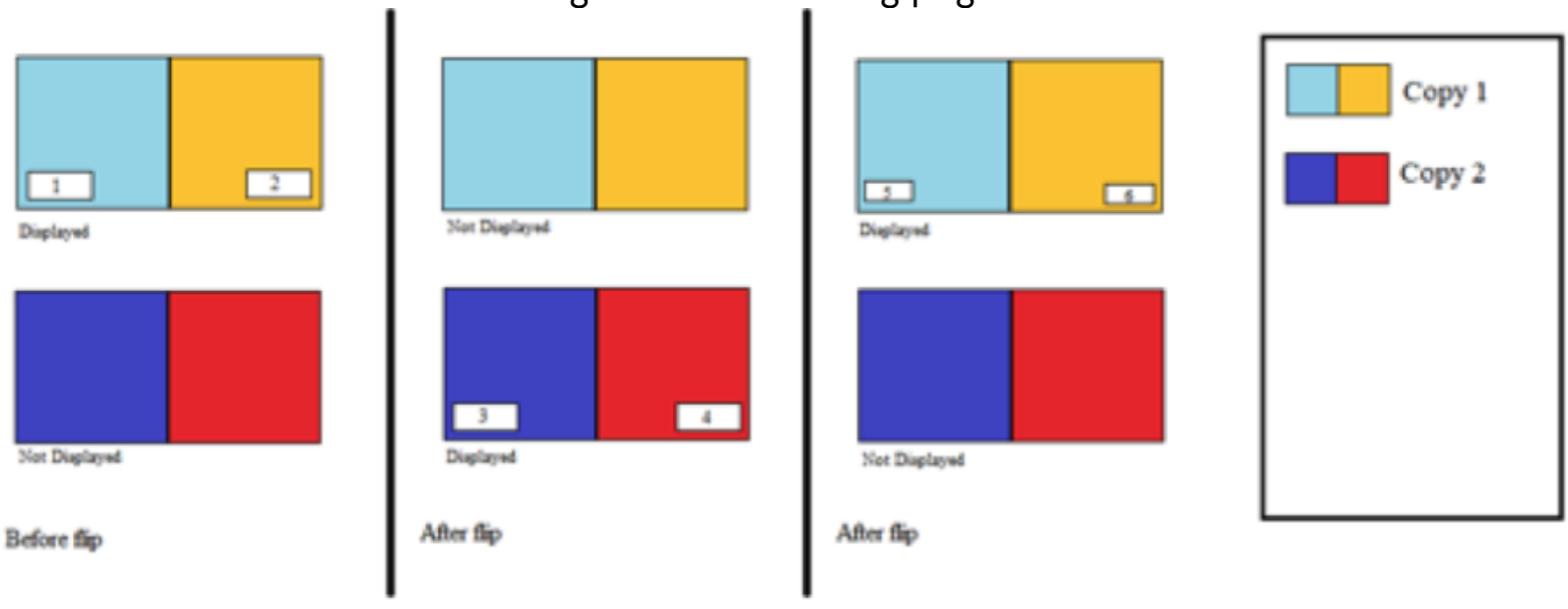
Appendix D

Story walk book selection and preparation – Gabriel Pardo Cota.

In order to select a book for the story walk I spoke with Kaeleigh Hart, a librarian (appendix). She recommended nature-related books that could be used in a story walk. I learned that there are no copy right issues to use a book for a story walk as long as the pages are not reproduced, altered, or profited from. I chose a book by Lois Ehlert called Nuts to You because it is relevant to nature, particularly the New England climate during the fall. Nuts to You features an Eastern gray, which is a common squirrel native to New England. This book reflects what animals in this habitat do in autumn. Specifically, the Eastern gray squirrel coming out to gather acorns to store for the winter hibernation. The book reflects what the students see in real life.

I then purchased a book and took out, labeled, and laminated the pages. I bought two copies so that both sides of the sheet of paper do not have to be flipped for the story walk. I then labeled the pages but on alternating copies. I only labeled the pages on the one side of the sheet being displayed. The image shown below is the way I labeled the pages between the two copies. The books do not stay open by themselves, so it was hard to take a picture of my method. Since the picture books are double-sided, two copies were needed. But when I was labeling, I put copy 1 on the top and copy 2 on the bottom. I labeled the pages 1 and 2 on copy 1, 3 and 4 on copy 2, 5 and 6 on copy 1, and the pattern repeated until the end.

Figure 9.1 Laminating pages



Some paperback picture books have a simple spine. They are essentially just two very long sheets of paper that are stacked, folded in half, and stapled at the crease. But the book I chose was not very easy to cut. It was a paperback (meaning not a hardcover book) but the spine was not stapled, but rather hardened and glued. So it was hard to cut the story book in half and I had to cut two or three sheets out at a time.

My recommendation to others who want to prepare a book for a story walk is to try to look for a paperback book specifically with staples so it is easy to remove the staples and then just cut the story book in half after labeling. But in my case since the book used a hard spine instead, I had to label the pages but cut a few pages at a time rather than the whole book.

I then proceeded to carefully cut the pages using scissors and put them in plastic laminating sheets. I turned on the laminator and waited for it to warm up. Once it was ready, I carefully stuck the paper with the sealed end of the sheet facing the machine. The machine slowly sticks the two folds together by heating them up, making sure the plastic folds line up. I stacked the laminated pages in order.

The first image above shows the insertion of the story walk page into the laminator. The two plastic folds have not yet been glued together, so you could still technically open them up and remove the page. The second image shows the laminating process halfway through the laminator. Now the plastic folds are getting glued together to make it look like a single fold with a page trapped inside of it.

If I had to do it again, I would recommend laminating the pages but merging the two separate copies together when they are done laminating so I could put the pages in order. The frame was built with a sliding door so the pages do not stay in there permanently. They would have to be switched out every week for a new story, but to bypass the organizing obstacle, I would recommend building a basket with two slots: one for the old story walk pages, and the other for the new story walk pages.