Design and Prototype of Portable Water Exhibit and Educational Kits for the Santa Fe Children's Museum

An Interactive Qualifying Project

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Abstract

The goal of this project was to create a portable, hands-on STEM water exhibit and educational kits for the Santa Fe Children's Museum (SFCM) to promote water conservation and understanding of the water system in Santa Fe. The project aligns with the SFCM's mission of fostering learning, play, and community, specifically addressing water supply and usage issues in the city of Santa Fe. Through a mixed methods approach, the team evaluated the design elements for effective water exhibits, clarified the educational goals and exhibit design criteria, and developed, tested, and refined prototype exhibit elements and educational kits. We assembled 140 kits for the SFCM to distribute and recommended how the museum could further evaluate and improve the kits and exhibit in the future.

Acknowledgements

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Executive Summary

The Santa Fe Children's Museum (SFCM) launched a project to improve water conservation awareness among its audience, particularly children, through interactive exhibits and educational kits. This project highlights the museum's mission to foster learning, play, and community engagement, with a special emphasis on addressing critical local issues, such as water usage and conservation in Santa Fe, New Mexico. Through a mixed methods approach, the team evaluated the design elements for effective water exhibits, clarified the educational goals and exhibit design criteria, and developed, tested, and refined prototype exhibit elements and educational kits.

Key Findings

- **Importance of Interactive Engagement:** The project underscored the critical role of interactive elements in museum exhibits, particularly for educational purposes. Our research and testing revealed that hands-on experiences significantly enhance engagement levels in children. These interactive experiences aid in breaking down complex environmental concepts, like water conservation, making them more comprehensible and memorable for young learners. The design of the exhibit and educational kits therefore prioritized interactivity, with features that encourage exploration and active participation.
- **Role of Parents in Learning:** A key finding of the project research was the substantial impact of parental involvement on the educational experience of children in museum settings. Through surveys and interviews, it was evident that when parents are actively engaged in the learning process, children show higher levels of interest and comprehension. This insight led to the inclusion of elements in the exhibit and educational kits that foster joint activities and discussions between parents and children, thus enhancing learning experiences outside the formal educational setting.

- **Focus on Environmental Education:** The project highlighted the effectiveness of museum exhibits as platforms for environmental education, particularly in the context of water conservation and sustainability. The water-themed exhibit and kits were designed not just as educational tools, but also as means to raise awareness about critical environmental issues relevant to the Santa Fe region. This approach aligns with the growing need for environmental education and awareness among the younger generations, equipping them with knowledge and attitudes necessary to face future environmental challenges.
- **Response to Local Environmental Concerns:** One of the pivotal findings of this project was the importance of tailoring educational content to address local environmental issues. The city of Santa Fe, with its unique environmental challenges, particularly regarding water resources, provided a context-specific backdrop for the project idea. This local focus resonated with the community, making the educational content more relatable and impactful. This localization of content not only enhanced the relevance of the educational material, but also fosters a sense of community and responsibility among the learners.
- **Adaptability and Scalability of Educational Tools:** The development of portable and adaptable kits as part of the project findings emphasized the need for flexible educational resources. These educational kits, designed to be easily transported and used in various settings, demonstrate the potential for replicating similar educational initiatives in other contexts. The adaptability of these tools ensures they can be modified to suit different age groups, learning environments, and educational needs, thus broadening their impact and utility.

Prototypes Developed

- **Portable Water Exhibit:** The exhibit design features interactive components to educate about water conservation and the local water system.

- **Educational Kits:** The “Oil and Water Go-Kit” and “Water Filtration Go-Kit”, designed for children aged 5-9, facilitate hands-on experiments and discussions on environmental science and conservation topics.

Recommendations

Based on our findings we recommend:

- **Further Collaborations:** It is recommended that the SFCM pursue the continued partnerships with other local organizations for the development of future exhibits and educational initiatives.
- **Refinement of Prototypes:** Continue improvement of the design and functionality of the portable exhibit and educational kits is advised, taking into account feedback from multiple testing phases.
- **Enhanced Educational Materials:** The development of comprehensive educational materials to supplement the exhibit and educational kits is suggested, ensuring an engaging and informative experience for both parents and children.

Authorship

Section Titles	**Main Author(s)**	**Main Editor(s)**
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Introduction

The Santa Fe Children's Museum (SFCM) is dedicated to engaging and educating children through various exhibits, programs, and activities. The museum's mission statement highlights "discovering the joys of learning, play, and community" (Santa Fe Children's Museum, 2023). Among other crucial themes explored at SFCM are water supply and usage because these are crucial concerns faced by residents of the city of Santa Fe and the surrounding region. These themes are explored in a special set of water-related, interactive exhibits that include a splash table, flowing water table, and bubble-making and exploration station. The goal of the project is to further these efforts by designing and prototyping a portable, hands-on STEM water exhibit as well as educational kits for the Santa Fe Children's Museum that promote water conservation and understanding of the water system. This initiative aligns with SFCM's mission and seeks to bridge the gap between the city's water awareness and conservation efforts and the community. We achieved this goal through the following three objectives:

- **Objective 1:** We evaluated the design elements that are most important in creating effective water exhibits and hands-on programs for children and families. This evaluation included a review of academic literature, observations at other museums, and interviews with museum experts.
- **Objective 2:** We clarified the educational goals and exhibit design criteria for the proposed water exhibit and educational kits. This objective involved interviews with SFCM staff, parents, local scientists, educational professionals, and city water authorities.
- **Objective 3:** We developed, tested, and refined prototype exhibit elements and educational kits focused on water usage and conservation in the city of Santa Fe. We used feedback from SFCM staff and visitors in an iterative design process to develop and finalize the exhibit and kits.

We used a mixed methods approach to achieve our objectives, including: an assessment of best practices in other museums through observation and interviews; surveying SFCM members;

interviewing city officials, SFCM staff, and parents; and, building and testing prototype traveling exhibit ideas and educational kits. In the following sections, we elaborate on our background research and our methods to achieve these objectives. The ultimate goal of the SFCM in developing the proposed exhibit is to enhance the community's understanding of water conservation.

Background Chapter

In this background chapter, we delve into the significance of play-based learning, its application in children's museums, and the role of interactive exhibits in fostering meaningful educational experiences. We will also touch upon the importance of water conservation in the city of Santa Fe and the challenges faced by the community. Additionally, we will explore the Santa Fe Children's Museum's initiatives and their alignment with current educational trends and community needs. By understanding the broader context and the specific challenges and opportunities in Santa Fe, this chapter serves as a foundation, providing readers with a comprehensive understanding of the context in which our project is situated.

Play-Based and Family Learning

Over the last five decades, hundreds of studies have explored the fundamental role and impact of play-based learning in children's education. Through play-based learning, children acquire essential skills, such as: problem-solving abilities, listening, writing, and creativity. These skills are acquired while the children are also entertained, which creates the desire to keep learning and playing. Play-based learning allows children to thrive mentally and physically. For example, in a study of 3rd grader students playing a variety of language games, Tekman, & Yeniasır (2023, p.39) found that "play-based learning settings are extremely effective on the sustainability of education and that these settings increase student motivation considerably especially in the development of language skills, such as speaking, writing, reading, and listening". In another study conducted at the Early Learning Centre in Melbourne Australia, Salmon (2016) monitored how children were *thinking* while playing and observing the behavior of children talking together. After watching children act out the lifespan of spiders, Salmon (2016, p.488) concluded that "play naturally sparks curiosity, imagination and develops creativity from an early age, which can lead to innovation later in life."

Parents play important roles in how their children learn in museums and these roles must be considered when designing play-based learning programs. Between 1994 and 1998, the Philadelphia-Camden Informal Science Education Collaborative (PISEC)[1] explored how museums can encourage active family learning. In Phase 1 of this study (known as The Family Science Learning Project), researchers observed child-parent interactions and conversations at the test exhibits in each museum. The authors identified five behaviors that promote learning in children and could be tracked through observations, including: (1) parents asking a question, (2) parents answering a question, (3) parents commenting on or explaining the exhibit, (4) parents and children reading text silently, and (5) parents and children reading text aloud (Borun & Dritsas, 1997, pg.179). In Phase 2, they modified the test exhibits to enhance their attractive, holding, and communicative powers. These "powers" were based on the Models of Visitor Learning developed by Bitgood & Shettel (1996). The researchers concluded that to encourage active family learning an exhibit should have seven specific characteristics (Borun & Dritsas, 1997, pg.189-190). Such exhibits should be: (1) "Multi-sided–family can cluster around exhibit." (2) "Multi-user–interaction allows for several sets of hands (or bodies)." (3) "Accessible–comfortably used by children and adults." (4) "Multi-outcome–observation and interactions are sufficiently complex to foster group discussion." (5) "Multi-modal–appeals to different learning styles and levels of knowledge." (6) "Readable–text is arranged in easily understood segments." (7) "Relevant–provides cognitive links to visitors' existing knowledge and experience."

These criteria remain pertinent in the design of family-friendly exhibits even now, and a considerable amount of research has corroborated and extended these findings. For example, a study conducted at the Philadelphia Please Touch Museum (PTM), gives a better understanding

[1] Philadelphia-Camden Informal Science Education Collaborative (PISEC) is a formal partnership between the Academy of Natural Sciences of Drexel University, The Franklin Institute, the New Jersey Academy for Aquatic Sciences, and the Philadelphia Zoo (https://ansp.org/education/programs/pisec/).

of the involvement of parents at children's museums. To begin, parents were put through two separate questionnaires, the first on the value of play at the PTM, and the second on ranking the parental role and involvement in the museum (Downey, Krantz, & Skidmore, 2010). During this process, the researchers identify three barriers to parental engagement in the children's museum: (1) "Most parents lack a clear understanding of the learning benefits of play;" (2) "Parents lack confidence in and knowledge of how to play with their children;" and (3) "The nature, design, and content of children's museums may discourage parent involvement" (Downey, Krantz, & Skidmore, 2010, pg. 27-29). Similarly, this notion of the importance of the parental role was studied at the Pacific Science Center in Seattle. Researchers interviewed families before they went into the science center, video recorded families while they went through the center, and then interviewed them at the end of their visit (Zimmerman, Perin, & Bell, 2010). Zimmerman, Perin, and Bell explored two essential research questions: (1) "What facilitation practices do parents use to support the development and maintenance of children's science-related interest during science center visits?" and (2) "How do parents facilitate science and math engagement through assisting youth to connect non-science related interests to science and math topics?" (Zimmerman, Perin, & Bell, 2010, pg. 71-72). The research identified three common practices parents employed: (1) parents support existing interests through gesture and conversations that connect interest to exhibits (2) parents make observations and read museum signage (or encourage youth to read and observe) to bring in new information (3) parents evoke and support familiar social practices in the museum (Zimmerman, Perin, & Bell, 2010, pg. 72).

Haden et al. (2014) conducted a study that explored the effects of facilitated learning in a museum environment. Before entering an exhibit, the authors briefed a sample of family groups about the exhibit they were going into, teaching them about engineering principles and intuitive questioning. The study found that encouraging parents to ask their children "wh-questions," (i.e., who, what, when, and where) before and during time at an exhibit enhanced learning for both children and parents as these lines of questioning keep information fresh in the minds of both children and parents. Using this information to 'prime' parents before they and their children enter the exhibit, encourages children to feel more engaged and keeps parents engaged in

learning along with their children. It also encourages parents to bring the learning materials home and continue the conversation about ideas after the museum visit.

In early childhood development, four critical learning objectives play foundational roles: attitude, behavior, skills, and knowledge. Attitude influences how children approach learning and their interactions with others; positive attitudes can foster a love for learning and resilience in the face of challenges (Dweck, 2006). On the other hand, behavior encompasses a child's actions and reactions in various settings; consistent and positive behaviors can enhance social integration and academic success (Bandura, 1977). Skills represent the practical abilities children acquire, which enables them to perform specific tasks, while knowledge pertains to the information and understanding gained from the world around them. Both skills and knowledge are crucial as they lay the groundwork for future academic achievements and life competencies (Kolb, 1984). Together, these four dimensions support the holistic development of children, preparing them for the complexities of the broader world and ensuring they grow into well-rounded individuals.

Ecology has emerged as an increasingly pressing concern on a global scale, given the persistent issue of climate change. This awareness is being imparted to younger generations through various channels, such as discussions among parents, educational modules addressing topics like the water table in schools, museum exhibitions dedicated to ecological matters, and numerous other sources of information. In a notable study conducted by Ferreira, Cruz, and Pitarma in 2016, the introduction of ecology as a subject into preschool environments was undertaken with the aim of fostering environmental consciousness at an early age and promoting a lifelong commitment to awareness and learning in this field. They did this by guiding them through three separate activities that introduced them to recycling and keeping their space environmentally clean. It was found that the best way to keep the children's natural curiosity in the environment and teach the study of ecology was to use relaxed and engaging educational content and incorporating art (Ferreira, et al., 2016).

Developing Interactive Exhibits in Museums

Interactive exhibits in children's museums play a pivotal role in enhancing play-based learning experiences. Such exhibits provide hands-on experiences that foster engagement,

retention, and deeper understanding of concepts. In this section, we discuss the educational structure, value of interactives, and methods used to evaluate exhibits.

Many museum exhibits, especially in children's museums, are designed to be interactive and engaging, aiming to provide a memorable learning experience for visitors. The evaluation of these exhibits is crucial to ensure they meet their educational objectives and provide a meaningful experience for visitors. Achiam, Kramer and Lindow (p.20, 2016) emphasize scaffolding as a "key strategy to enhance museum learning for children." In educational settings, scaffolding involves breaking down the learning process into chunks, and then providing a tool or structure with each chunk. Within the context of children's museum exhibits, scaffolding would include guided interaction, layered information, hands-on activities, and feedback mechanisms. With guided interaction, museum educators and interactive exhibit designers actively guide visitors by posing thought-provoking questions and providing hints to encourage deeper comprehension. Layering information is an essential element in successful exhibits and programs, beginning with fundamental facts and gradually delving into more complex topics. Hands-on activities play a pivotal role, as scaffolds are empowering young learners to apply their newfound knowledge tangibly. Lastly, interactive exhibits should incorporate feedback mechanisms, offering immediate responses to visitor interactions. This real-time feedback allows children to adapt their understanding or approach based on the information they receive, nurturing a dynamic, and engaging learning experience.

This process highlights the importance of structured guidance and support in facilitating effective learning experiences in museum settings. Several approaches have been developed to evaluate the effectiveness of museum exhibits in achieving their educational goals:

- **Visitor Surveys and Feedback:** One of the most common methods of evaluating museum exhibits is through visitor surveys and feedback. These surveys can be conducted on-site or online and typically gather information about visitors' experiences, learning outcomes, and overall satisfaction with the exhibit (Allen, 2004). This direct feedback from visitors provides valuable insights into the strengths and weaknesses of an exhibit.

- **Observational Studies:** Observational studies involve researchers or museum staff observing visitors as they interact with exhibits. This method allows evaluators to understand how visitors engage with the exhibit, the duration of their engagement, and any challenges they may face (Diamond, 1999). Observational studies can also help identify any safety concerns or areas where visitors may become confused.
- **Formative and Summative Evaluations:** Formative evaluations are conducted during the exhibit development process and aim to inform the design and content of the exhibit. Summative evaluations, on the other hand, are conducted after the exhibit has been implemented and aim to assess its overall effectiveness and impact (Hein, 1998). Both types of evaluations are essential for ensuring the exhibit meets its intended objectives.
- **Educational Impact Assessments:** These assessments focus on the educational outcomes of museum exhibits. They evaluate the extent to which visitors have gained new knowledge, skills, or attitudes as a result of their interaction with the exhibit (Falk & Dierking, 2000). This can be done through pre- and post-visit tests, interviews, or focus groups.
- **Collaborative Evaluations:** Collaborative evaluations involve partnering with external organizations, such as schools or community groups, to assess the impact of museum exhibits. This approach allows for a broader perspective and can provide insights into how the exhibit aligns with educational standards or community needs (Adams et al., 2007).

Case Studies of Water Exhibits

In this section, we evaluate several popular water-themed exhibits from various children's museums, in an effort to shed light on their design, educational impacts, and relevance. In the realm of children's museums, water-themed exhibits have proven to be a compelling avenue for immersive and educational experiences.

FlowWorks (Houston Children's Museum, Houston, Texas)

Interactive exhibits, such as those found in children's museums, are designed to foster engagement, retention, and a deeper understanding of various subjects (Allen, 2004). The Houston Children's Museum's exhibit called *FlowWorks* stands as a testament to this design philosophy. As described on the museum's website, *FlowWorks* offers an immersive experience into the intricacies of water dynamics, emphasizing the flow, pressure, and power of water" (see Figure 1). Distinctively, "it's more than hands-on—it's 'hands-in,' requiring visitors to dip their hands in to make it work!" (Children's Museum Houston, n.d.).

Figure 1 Houston Children's Museum, FlowWorks

The design of the *FlowWorks* exhibit reflects a pedagogical approach that emphasizes experiential learning, resonating with the broader objectives of children's museums to provide memorable learning experiences (Diamond, 1999). By requiring visitors to physically engage with the exhibit, FlowWorks taps into kinesthetic learning styles, allowing children to grasp complex concepts through tactile experiences (Falk & Dierking, 2000). This "hands-in" approach, while playful, is a calculated strategy to enhance comprehension and retention, aligning with the methodologies and frameworks developed to evaluate the effectiveness and impact of museum exhibits (Hein, 1998). Furthermore, the exhibit's alignment with the Texas Essential Knowledge and Skills (TEKS) standards ensures its content is both relevant and beneficial to the educational objectives of students in Texas. Such alignment suggests a collaborative effort, resonating with the idea of collaborative evaluations involving external organizations to ensure alignment with educational standards or community needs (Adams et al., 2007). The museum's decision to involve "former

classroom teachers, disciplinary experts, and exhibit fabricators" in the design process (Children's Museum Houston, n.d.) underscores its commitment to creating an educational experience that is both engaging and academically rigorous.

River Adventures (Please Touch Museum, Philadelphia, Pennsylvania)

Another exemplary water-themed exhibit that champions interactive and engaging learning is the *River Adventures* exhibit at the Please Touch Museum in Philadelphia (Figure 2). This exhibit invites children to embark on a journey of discovery, exploring the wonders of river ecosystems, water cycles, and the importance of water conservation. As highlighted on the museum's website, the *River Adventures* exhibit is a "dynamic water play area" where children can "navigate waterways, experiment with boats, and learn about the properties of water" (Philadelphia Children's Museum, n.d.). The design philosophy behind the exhibit is rooted in the belief that children learn best when they are actively involved in their learning process. By allowing children to manipulate water currents, build dams, and observe water flow, the exhibit taps into the natural curiosity of children, fostering a deeper understanding of hydrodynamics and environmental science (Falk & Dierking, 2000). The exhibit's design is a testament to the museum's commitment to providing a multisensory learning experience, catering to various learning styles, from visual and auditory to kinesthetic (Allen, 2004).

Figure 2 Please Touch Museum, River Adventures

The River Adventures exhibit also emphasizes the importance of environmental stewardship. Through interactive displays and hands-on activities, children are introduced to concepts such as water conservation, the impact of pollution on river ecosystems, and the role of humans in preserving our natural resources (Diamond, 1999). The importance of teaching

children about the environment promotes more environmental responsibility and sets up the knowledge to address these issues. This focus on environmental education aligns with the broader educational objectives of many schools and communities, highlighting the museum's dedication to addressing contemporary issues and fostering a sense of responsibility in its young visitors.

Water Filtration (Glazer Children's Museum, Tampa, Florida)

The Glazer Children's Museum in Tampa, Florida, offers another example of an interactive water-themed exhibit with its "Water Filtration" display. As detailed on the museum's website, this exhibit provides children with hands-on experience of understanding the importance and process of water filtration. The children are encouraged to "explore the journey of water as it travels from natural sources, undergoes purification, and finally reaches our homes" (Glazer Children's Museum, n.d.).

Figure 3 Glazer Children's Museum, Water Filtration

The Water Filtration exhibit at the Glazer Museum is a testament to the museum's commitment to fostering a deeper understanding of essential life processes and the importance of clean water. Allowing children to engage with various filtration materials and observe the

transformation of dirty water into clean, potable water, the exhibit not only educates, but also instills a sense of wonder and appreciation for the science behind every day processes (Falk & Dierking, 2000). This hands-on approach is in line with the museum's overarching philosophy of promoting active learning, where children are not just passive observers, but active participants in their learning journey (Allen, 2004).

Moreover, through the Water Filtration display, children are made aware of the challenges faced in ensuring clean water access and the critical role of sustainable practices in preserving this vital resource (Diamond, 1999). This emphasis on sustainability and environmental awareness aligns with the broader educational goals of many institutions, reflecting the museum's dedication to equipping its young visitors with knowledge and values that are relevant in today's world.

Key Takeaways from the Case Studies:

Across the museums and methodology research examined, several common themes and strategies emerge. We have compiled this list of themes and strategies based on our review of the three case studies discussed above:

- **Local Relevance:** Museums design exhibits relevant to the local environment and culture, making the learning experience more relatable for visitors.
- **Interactive Engagement:** Museums prioritize hands-on experiences, ensuring deep engagement and understanding, especially in children's settings.
- **Scaffolding in Learning:** Museums use scaffolding, providing structured guidance and feedback, to enhance children's learning experiences.
- **Experiential Learning:** Exhibits are designed for immersive and tactile experiences, catering to various learning styles, especially kinesthetics.
- **Evaluation Importance:** Museums employ diverse methodologies, from visitor surveys to collaborative evaluations, to assess exhibit effectiveness and impact.

- **Environmental Focus:** Water-themed exhibits often emphasize environmental education, instilling a sense of responsibility in young visitors about water conservation and sustainability.
- **Collaboration and Alignment:** Museums collaborate with external entities to ensure content relevance and alignment with educational standards, underscoring their commitment to meaningful learning experiences.

Educational Kits

Many museums 'extend' the learning experience available in the museum by producing educational kits for schools and other groups. For example, the Columbia Play Project aims to establish a comprehensive children's museum, featuring various labs and rotating exhibits, to promote playful learning experiences for children (Vancouver Family Magazine, 2023). The Center of Science and Industry (COSI) Connects Kits serve as one notable example of STEM (Science, Technology, Engineering, and Mathematics) educational kits designed for children. They demonstrate a practical approach to delivering hands-on STEM learning experiences directly to homes, making education accessible outside of traditional learning environments. By providing a structured, yet engaging set of activities, these kits aim to foster curiosity and knowledge in STEM fields among young learners, which can be particularly beneficial in nurturing early interest and understanding in these critical areas of education ("COSI Connects Kits," n.d.).

The Santa Fe Children's Museum's Efforts to Educate Water Issues

The Santa Fe Children's Museum is concerned with developing awareness of water conservation issues among parents and children given the water scarcity throughout the city. In

Figure 4 Thoughts Flow Interactive Water Table

the Santa Fe Children's Museum, there are multiple water exhibits, for example, the Thoughts Flow Interactive Water Table, Splash Table, and Bubbles Station; however, the museum is focusing on expanding these ideas, including a portable water exhibit (Santa Fe Children's Museum, 2023). Creating an exhibit for children, while also being family friendly, will most likely begin when our project group is physically present in the Santa Fe Children's Museum. Currently, in the Santa Fe Children's Museum, there are interactive displays that encourage active participation from children, fostering the development of problem-solving abilities and analytical reasoning. For example, the museum's Thoughts Flow Interactive Water Table (Figure 4) encourages children to discover the balance between water pressure and energy by experimenting with different gates and barriers (Santa Fe Children's Museum, 2023). Comparatively, the Splash Table exhibit also encourages children to become more imaginative by becoming captains of their own boats throughout the water (Figure 5). Lastly, the Bubbles Station exhibit (Figure 6) focuses on "soapy sensory exploration," where children can explore different sizes and shapes of bubbles by using bubble wands (Santa Fe Children's Museum, 2023).

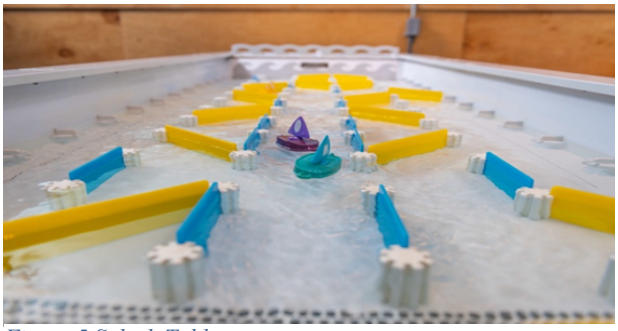

Figure 5 Splash Table

Figure 6 Bubble Table

Figure 9 Fine Art Friday

Figure 7 Science Saturday

Figure 8 Alfresco Activities

The museum also offers weekly workshops, such as “Fine Art Friday,” to expand creativity and learning through different areas of drawing and painting (Figure 7). Following with “Science Saturday,” to engage children with interactive learning experiences, including demonstrations with snakes and reptiles or the world of indoor tornados alongside scientists (Figure 8). Lastly, Alfresco Activities, or outside learning environments, to recognize the value of physical play and where the museum contains open-air zones designed for bodily exercise and hands-on exploration through the community garden and other gardening courses (Figure 9).

Water Conservation and Usage in Santa Fe

Santa Fe is located in an arid climate and depends on four different sources for its water usage: the Santa Fe River, Buckman Direct Diversion, City Wellfield (seven wells that are in city limits) and Buckman Wellfield (13 wells between the Rio Grande River and Santa Fe) (CoSFW). Figure 10 shows that 41% of Santa Fe's water comes from the Buckman Direct Diversion, 39% of its water comes from the Canyon Road Water Treatment Plant that siphons from the Santa Fe River, and 20% is from wells.

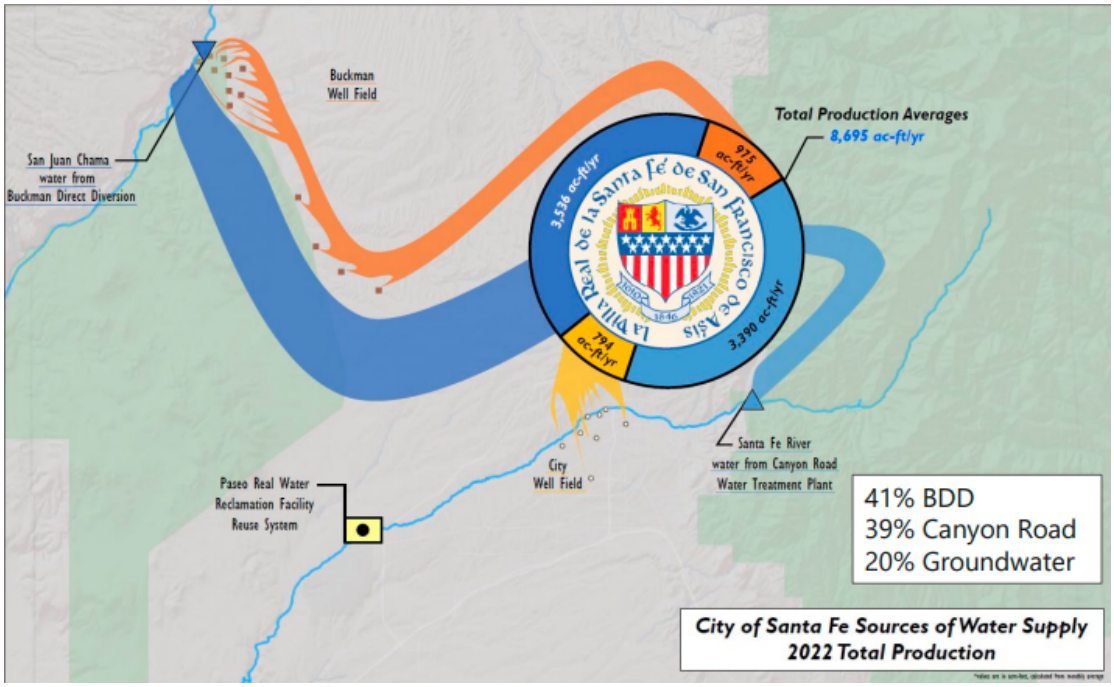

Figure 10 Santa Fe Sources of Water Supply, 2022 Total Production

Santa Fe's water conservation program is known as one of the most successful in the nation. For example, Figure 11 shows that even though the regional population continues to grow, water usage has halved in the past 27 years, from 165 to 88 gallons per capita per day (GCPD) (CoSFW, n.d.). The decline in consumption can be attributed to several factors, including policies that limit water use and an extensive education and outreach program. For example, from May 1st to October 31st, unless under special circumstances. It is illegal to water outdoor plants from 10am to 6pm (Save Water Santa Fe). The city of Santa Fe's educational outreach program was created as a part of their "Watershed Management Plan" to educate the community about the critical water systems that support Santa Fe and to increase public

awareness about water conservation. The city has developed separate educational efforts for youth and the general public, since different approaches will be more effective with different audiences. These plans include creating hikes through the watershed for the general public, as well as a brochure for the nature trail overlooking the watershed.

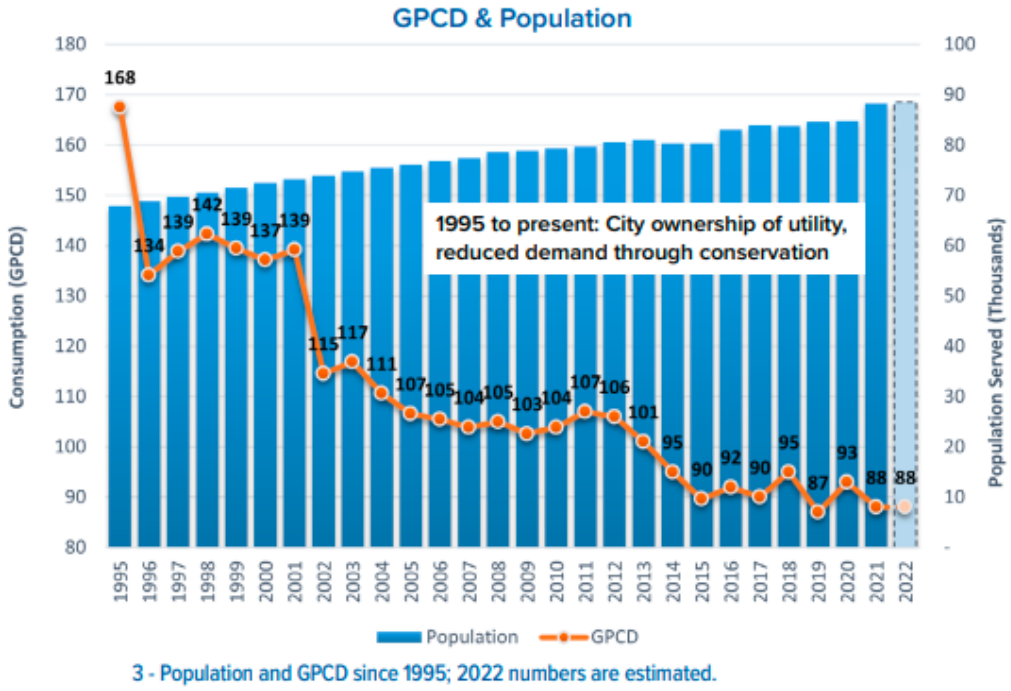

Figure 11 Population Growth and Water Consumption (GCPD), 1995-2022

While water conservation efforts have effectively reduced per capita consumption, the city finds that it needs to set aside more water resources to protect against droughts and wildfires, especially as the threats grow with climate change. Starting in May of 2022, wildfires surged through New Mexico due to extremely dry spring conditions that can be seen in Figure 12. Although these conditions were followed up in June and July by a higher-than-average precipitation rate. Even though the rain conditions washed out the wildfires, soot, ash, and other materials from the wildfires polluted much of Santa Fe's surface water sources, causing more work needed to be done to filter the water into a usable condition, or even not being able to use the polluted water.

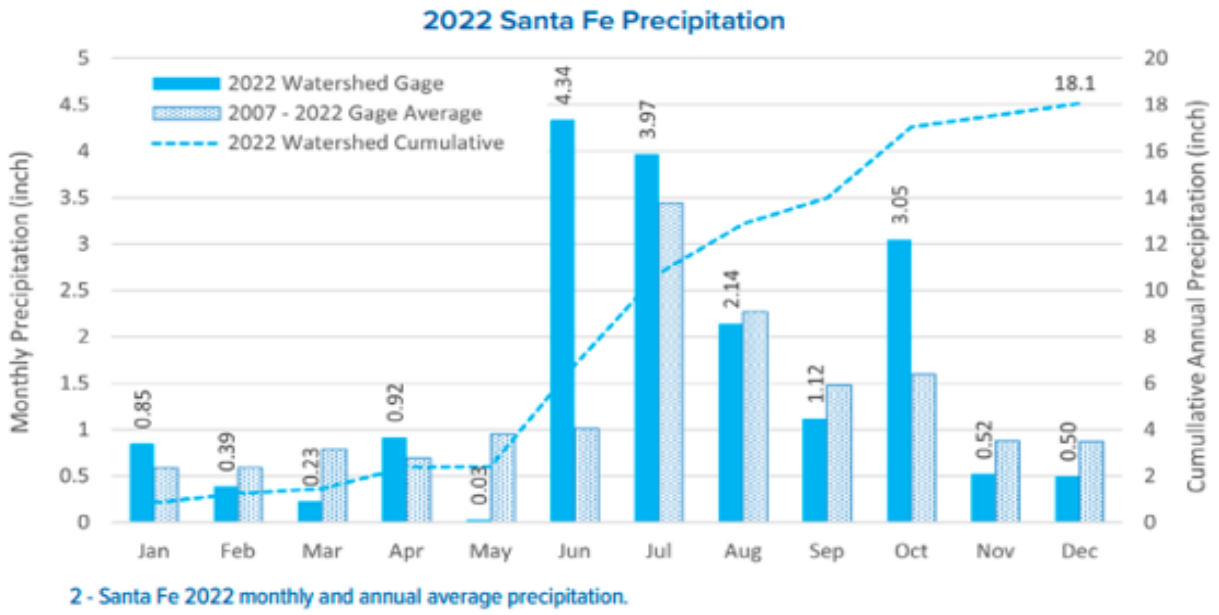

Figure 12 Santa Fe Precipitation for 2022 vs Average of Previous Years

Conclusion

Museums can play an essential role in educating children and parents about fundamental issues, such as climate change. Many museums have developed interactive water exhibits that use play-based learning to engage and educate children about water issues. Located in an area of high desert, SFCM is committed to working with the city to promote education about water and water conservation. SFCM has developed several exhibits with water as a theme but would like to develop a portable exhibit and education kits on water issues that can be used to extend the learning experience in the community. In the next section, we describe how our team is helping SFCM develop this exhibit and educational materials.

Methods Chapter

Introduction

The goal of our project was to design a mobile hands-on STEM water exhibit and associated educational kits for the Santa Fe Children's Museum to promote water conservation and understanding of the regional water system. We identified three main objectives:

- **Objective 1:** We evaluated the design elements that are most important in creating effective water exhibits and hands-on programs for children and families. This evaluation included a review of academic literature, observations at other museums, and interviews with museum experts.
- **Objective 2:** We clarified the educational goals and exhibit design criteria for the proposed water exhibit and educational kits. This objective involved interviews with SFCM staff, parents, local scientists, educational professionals, and city water authorities.
- **Objective 3:** We developed, tested, and refined prototype exhibit elements and educational kits focused on water usage and conservation in Santa Fe. We used feedback from SFCM staff and visitors in an iterative design process to develop and finalize the exhibit and kits.

We used a mixed methods approach to achieve our objectives, as indicated above.

Objective 1: Evaluate Best Practices

Building on our initial review of the research on family learning, interactive exhibit design, and case studies of water exhibits and educational kits at other museums, we toured two popular children's museums such as the Boston Children's Museum and the Explora Learning Center in Albuquerque.

In another effort to evaluate best practices, we volunteered with a fifth-grade class from Tesuque Elementary School on a tour of the Santa Fe Watershed. This experience provided us

with a valuable opportunity to gain a deeper understanding of Santa Fe's water resources. Moreover, it allowed us to observe firsthand what our target audience, children, already knew about water and what aspects of water-related topics genuinely excited them.

Objective 2: Clarify Goals and Design Criteria

To clarify SFCM's goals and to identify the design criteria for the proposed portable exhibit and education kits, we conducted informal observations and interviews with parents at the SFCM; interviews with SFCM staff members; interview with a local scientist; interviews with Santa Fe Watershed educators; observations and interviews with Santa Fe elementary school teachers; and interviews with Santa Fe water officials.

Informal Observations and Parent Interviews

Our team consulted with SFCM staff to review and refine the interview and observation process. We received permission from the museum to do testing on the busiest days of the week for optimal feedback. Parents were informed when they came up to the prototype that the team was testing. No names, photographs, or any identifying information was collected during the observations. We observed from a distance to minimize intrusion. We observed and recorded how parents interacted with the exhibit, and their children, and how long families stayed at the given exhibit. We also interviewed a small sample of parents after their children were done testing the prototype. Appendix B includes the interview consent script and topics used during the conversations. All interviews were conducted anonymously and took no more than five minutes of the interviewee's time. We selected potential interviewees at random and intercepted them at opportune times and locations to minimize interference with their visit.

Interviews with SFCM Staff and Volunteers

We interviewed ten SFCM staff and volunteers to clarify the desired topics, learning outcomes, and design specifications for the proposed mobile exhibit and educational kits, such as

cost, size, and preferred materials. We consulted with our sponsor liaison, Hannah Hausman, to identify interviewees. We conducted face-to-face interviews using the list of questions and topics in Appendix C. We began each interview with the preamble located in the Appendix. We asked interviewees for permission to quote them and gave them an opportunity to review any materials we used from the interviews prior to publication.

Interview with A Local Scientist

At the recommendation of Hannah Hausman, we interviewed local scientist Mark Ross-Lonergan, a postdoctoral particle physicist working for Los Alamos National Labs who also volunteers in teaching mathematics at the museum and in local schools. The interview was completed over Zoom and followed the same basic protocols as described above. During our conversation with Ross-Lonergan, we asked about Santa Fe's involvement in water conservation education, Los Alamos and Los Alamos National Labs involvement in water conservation education, the museum's outreach impact, and improvements the city and the museum could make in water education. See the interview questions in Appendix D.

Interviews with Santa Fe Watershed Educators

Our team interviewed two educators from the Santa Fe Watershed association. The interviews were conducted in person. The same protocols were followed as described above, to ensure both educators understood the team's mission. Please refer to Appendix E for a preliminary list of questions and topics. Questions included topics of the Watershed's education outreaches, SFCM and the Watershed working together, and how our team would be able to help the Watershed's efforts on educational outreach programs.

Interviews with the City of Santa Fe Water Officials

The team met multiple times with the City of Santa Fe Water officials and Save Water Santa Fe Manager Christine Chavez. Two meetings also included Education and Compliance

specialist, Ramon Coriz. These interviews were designed to give us a better understanding of water supply and conservation, in general, how the City of Santa Fe and SFCM can collaborate to raise awareness of these issues. We conducted these interviews in person following the protocols described above. Appendix F includes the topics covered during the meetings. We tailored the questions according to the expertise of the interviewee and the direction of the conversation.

Objective 3: Prototype Phase

Using data collected in the prior objectives; we designed and prototyped the exhibit elements and the educational kits. Our prototyping had three iterative phases: (1) prototype design in consultation with SFCM staff and volunteers; (2) prototype testing with visitors; and (3) prototype revision.

(1) Prototype Designs with Consultation

Building on what we learned from the prior objectives, we developed three ideas for possible prototypes: one portable exhibit that comprised a cross-sectioned well and pulley system and two go kits. The first go kit used oil, food coloring, and water to demonstrate the concept of water pollution. The "sister" go-kit used the oil and water mix from the first kit, a coffee filter, cotton balls, and activated carbon to demonstrate how filtration can remove pollution from drinking water. We sketched out these ideas and discussed them with museum staff and city water officials before building the prototypes. We present detailed descriptions of the prototypes, including figures and photographs, in the findings chapter that follows.

(2) Testing the Prototype(s)

After checking to ensure that the prototypes were sturdy, stable, and safe enough to be presented on the museum floor, we solicited feedback from visitors. We consulted with SFCM staff to identify a suitable location in the museum that got enough traffic to allow testing but did not obstruct the flow of patrons unduly. We posted a sign explaining that exhibit testing was in

progress, and we stationed members of the team at appropriate locations to actively solicit parents and children to play with prototypes. Using the preamble in Appendix G, we explained the purpose of the research and that their participation was entirely voluntary and anonymous, and that they could stop their participation at any time and for any reason. We told the parents or caregivers that we wished them to encourage their child(ren) to play with the prototype briefly, after which we asked them a few short, anonymous questions about their experience. We interacted with only the adults in the family group, although we asked questions about their child's experience with the prototype. We conducted testing only in the presence of SFCM staff or volunteers. Participating parents and children were given "Go Kits" to extend the museum experience and reinforce learning outcomes.

(3) Prototype Revisions

We modified the exhibit and "Go-Kit" prototypes to reflect the feedback from the public and museum staff. After revision, the prototype(s) were presented again in front of the museum staff for recommendations and more feedback before being brought back out on the museum floor for testing with the public following the protocols above. This testing and revision continued, time permitting, until we and the museum staff were satisfied that the prototype exhibit met the needs and expectations of the museum. Once completed, mobile testing commenced to ensure the exhibit could be safely moved in both the Van of Enchantment and a staff member's vehicle. To do this, we disassembled the exhibit and reassembled it, making sure that it could be safely taken apart and put back together and that it worked correctly.

Conclusion

The team endeavored to design a mobile hands-on STEM water exhibit and two educational kits for the Santa Fe Children's Museum, with a primary focus on promoting water conservation and enhancing understanding of the regional water system. The project was structured around three main objectives: evaluating crucial design elements for effective water exhibits and programs, clarifying educational goals and design criteria through extensive

interviews and observations, and developing, testing, and refining prototype exhibit elements and educational kits. The approach was characterized by a rigorous mixed methods methodology, blending qualitative and quantitative data to inform decision-making. The following findings section illustrates the takeaways from the team's methodology.

Findings Chapter

The findings include the educational “Go-Kits” and portable water exhibit “Well, Well, Well,” conceived by the team. Developed during a seven-week period, the "Go-Kit" program showcases the Santa Fe Children's Museum's commitment to ensuring science education remains accessible and engaging for young learners, even when physical visits to the museum were not possible. The "Oil and Water Go-Kit" and the "Water Filtration Go-Kit," cater specifically to children aged 5-9, offering hands-on experiments that foster an understanding of environmental science and conservation. Additionally, the team created a portable exhibit, designed to simulate a well water system, providing an immersive and interactive learning experience that underscores the institution's commitment to innovative and impactful education.

Grab and Go-Kits

The Santa Fe Children's Museum initiated the "Grab and Go-Kit" program during the COVID-19 pandemic as part of its ongoing commitment to provide educational resources for children. This program, born out of the necessity to adapt to the constraints imposed by the pandemic, aimed to ensure that science remained an engaging and accessible subject for young minds, even when physical visits to the museum were not possible. The “Oil and Water Go-Kit” and “Water Filtration Go-Kit” are educational resources designed for children aged 5-9 that the team produced for the Santa Fe Children’s Museum. These kits were modeled on previously popular “Go-Kits” the museum currently offers. The intention is to keep science a topic of conversation at home, even if the children cannot physically get to the museum. These kits are structured to facilitate hands-on experiments, fostering an understanding of environmental science and conservation in young learners.

The educational themes for designing the "Go-Kits" were directly influenced by the team's visit to the Explora Museum. At Explora, a substantial filtration exhibit was encountered that explored water's properties and its importance within the context of Santa Fe. The design idea further evolved through discussions with the Educational Director of SFCM, Leona Hillary.

Initially the kits focused on the properties of water rather than the problems of and solutions to water pollution. Based on feedback, we included a feather in the kits to demonstrate the impacts of oil in water with nature, specifically birds feathers. SFCM's design criteria were relatively flexible. The top priorities were making each activity hands-on and engaging, incorporating inquiry questions for children to discuss with adults afterward, and ensuring the materials were safe for children. The most important educational concepts the team illustrated with these examples is the way pollution can affect the environment and a very general idea of how water filtration works.

Process for Designing the Kits

The initial phase of prototyping for each kit involved a comprehensive assessment of the museum's existing program offerings, revealing that many of these kits consisted of only 4-5 materials and instructional pamphlets for guiding children through the experiments. Subsequently, our team engaged in a brainstorming process, generating several concepts and eventually narrowing them down to two activities based on their collaborative nature. Considering the budget constraints, we conducted careful material selection to ensure cost-effectiveness, while staying within the museum's financial parameters. The team diligently tracked these material costs using Google Sheets, with a specific budget target of approximately $3.00 per kit. To gather valuable feedback and insights, our team participated in meetings with our sponsor and the Santa Fe Children's Museum's educational director. These discussions proved instrumental in refining the instructional guides and solidifying the design of the kits. Then, each kit was put to the test during a "Science Saturday" event, receiving positive feedback from both parents and children.

Feedback from Educational Directors

One of the main points of feedback we received was how our instructional guides were worded too maturely for our intended audience. The team had to face the challenge that none of our members were trained in or studying elementary education. Our group was grateful to have the Head of Education at the Santa Fe Children's Museum, Leona Hillary, as a strong, guiding

resource. Our first meeting with Hillary was mapping out our team's ideas for the two educational Go-Kits and the prototype exhibit. Overall, the team learned: (1) how the museum purchases kits, (2) how the museum uses exhibits at schools, (3) how to aim them to reach the correct education level, and (4) about local water issues. After our first meeting with Leona Hillary, the team incorporated her advice and made changes to the designs. The second meeting primarily focused on improving the pamphlets included with the Go-Kits. During the pamphlet editing phase, Hillary noted that the team had a solid foundation for background information and only minor details needed to be changed. Next, she addressed the inquiry questions and how in both Go-Kits, the questions were targeting an older audience than intended. To address this, we worked on having the questions be more direct and concise. For example, using "how" or compare and contrast questions instead of using "what" and very broad "yes" or "no" questions. Then, the team and Hillary discussed the directions sections, which only needed slight changes. Finally, after the last editing changes, the team was ready to start on the third iteration of the pamphlets.

Subsequently, the team interviewed Christine Chavez, the manager of water conservation with the City of Santa Fe, and Ramon Coriz, Education and Compliance Specialist. See Appendix (E) for the specific questions and topics discussed in this meeting. To begin the meeting, the team addressed the updated work on the Go-Kits and prototype design process since the previous meeting. During this time, Chavez solidified previous plans made about the city sponsoring the project as well as including shower timers, backpacks, and educational booklets within the Go-Kits. Christine Chavez referenced a recent conference speech by Professor Rudi Thompson of the University of North Texas. Our team noted this conversation as particularly significant due to the information given on the study of outreach efforts to children and parents. The research included points on children's learning habits and the disparities between adults and children in breaking unhealthy habits. The study underscored the positive impact of allowing children to take home kits, which can facilitate behavioral changes based on the information contained in these kits. As well as giving children "actions" to follow can also increase their likelihood of changing their behavior. The information the team learned from this conversation correlates with other research the team identified within the Background Chapter.

After our group participated in multiple meetings with Christine Chavez, we met with Julie Hasty, the Director of Education for the Santa Fe Watershed Association. By gathering new information from our tour of the Randall Davey Audubon Center, we were able to refine and present our Go-Kit design process. During this meeting, Hasty explained Project WET, a global program that provides water educational resources to teachers. Hasty explained how this program is used throughout Santa Fe, including the Audubon Center for 3rd grade, the Santa Fe Botanical Garden for 4th grade, and the Santa Fe Watershed Association for 5th grade. The lesson plans included in the programs all use the five E model, a model focused on helping children understand educational content over time. The five E's include: Engage, Explore, Explain, Elaborate, and Evaluate. Hasty even showed us example books of curriculum geared towards the 5-10 age ranges and worksheet questions to expand our own ideas for water conservation and filtration.

Go-Kits Final Products

The "Oil and Water Go-Kit" (Appendix G) focuses on the concept of oil and water separation. It addresses inquiry questions, such as why oil and water do not mix, using the experiment as a parallel to real-world oil spills. The resource emphasizes the environmental impact of such events and the importance of learning about oil pollution and its impact on water resources. The kit includes a jar, water coloring, a feather, and oil. The children simply shake up the liquid and dip the feather within the mixture and observe. The experiment itself is simple, yet illustrative, involving the mixing of colored oil and water in a glass container, observing the reaction, and using a feather to demonstrate the effect on wildlife. This kit not only provides a practical demonstration of the oil-water separation, but also prompts discussions about the ecological consequences of oil spills, and the importance of using eco-friendly products.

In contrast, the "Water Filtration Go-Kit" (Appendix H) delves into the process of water purification. This kit involves a cut plastic water bottle, coffee filter, charcoal, cotton ball, rubber band, and water with debris/oil contamination. The children use the water bottle as a funnel for the charcoal, cotton ball, and coffee filter with a rubber band securing the materials. The contaminated water is poured through this filter. It educates young minds about the natural

impurity of water and the necessity of filtration to make it safe for consumption. The kit simulates the filtration process using household items, like a coffee filter, cotton balls, and charcoal, explaining how this process removes physical impurities such as dirt and small rocks. While the experiment visually demonstrates the cleaning of water, it also underlines that filtration alone may not eliminate all germs and bacteria, implying the need for additional purification steps. This hands-on activity is paired with critical thinking questions to encourage discussions about the broader implications of water filtration and its role in ensuring health and safety.

Both kits are more than just science experiments; they are interactive learning tools that blend practical activities with environmental education. Each activity contains a pamphlet detailing the instructions in English and in Spanish to accommodate the large population of native Spanish speakers in the area. The kits both contain inquiry questions to further engage learners about the topics and to spark conversation between the adults in their lives. They aim to instill a sense of responsibility and awareness in children about the importance of environmental conservation and the impacts of pollution on ecosystems. Through these kits, children not only learn scientific concepts, but also develop an understanding of the real-world application and significance of these concepts in protecting and preserving the environment.

Portable Water Exhibit Prototype Process

After researching various museum water exhibits and reviewing information from the interviews above, our design process of prototyping began. This section details the drafting of our exhibit designs through drawings and collaborations with various Santa Fe organizations, followed by building and revising the exhibit with recommendations from the project team and staff from the Santa Fe Children's Museum.

The Design Process

Following the research of other museum exhibits, such as the Explora Science Center and Children's Museum of Albuquerque, and interviews with city water officials, the team identified

an initial concept for a portable water exhibit. The initial concept was to construct a well water system to highlight where and how Santa Fe gets most of its water. The first design of the exhibit showcases a rough sketch of the team's initial ideas when starting to plan the process of building the prototype (Appendix I).

This initial concept split the exhibit into six separate 'well' divisions, three containing different purities of water, and three containing sand. For example, one contained clean water, one contained water contaminated with pollutants, illustrated by food coloring, and the third was visibly contaminated with rocks and debris. The sand portions of the exhibit would have contained graphics, illustrating different facts about the city of Santa Fe and the water system, as well as fully giving the illusion of the well system underground. Attached to the three water wells would have been cranks and pulleys, which would have allowed visitors to extract water from each division using plastic buckets. The idea behind the cranks and well systems would have been to teach children about where a large part of their water comes from and how much effort it takes for systems to extract water from a well. The visitors and children would then have been able to pour the water from each of the contaminated wells into the second step of the exhibit, a water filtration system.

The water filtration system would have taught children about the importance of filtering water to a usable and clean state, which would have led into the third step of the exhibit. The third part of the exhibit would have included a diorama of the city of Santa Fe. The children would then have been able to pour the filtered water into the "city" with the intention of teaching how cities distribute water. The goal of this diorama would be to show how everyone in the town has enough water in their homes. After speaking with Hector Solis, the museum's Director of Facilities and Exhibits, the team decided to brainstorm a second mockup of the design. This design only included the well system to give a better grasp on the subjects presented and to make it clearer during the building process.

An additional informational topic the team discussed with Leona Hillary was the museum's previous and current use of portable exhibits. For our design, it was important to understand the limits of a portable exhibit design. We identified five key design criteria. The exhibit should: (1) weigh less than 50 lbs; (2) be manageable by one person alone; (3) take less

than 30 minutes to set up and break down; (4) comprise cheap, easily replaced materials; and (5) be able to withstand the weight of water without collapsing or leaking.

The second iteration of the design draft (Appendix J), focuses solely on the creation of the portable water exhibit and how the project team envisioned the final product. This design had some aspects that would not be included in the final design, such as the lid that could be locked, as well as the bar that contained each pulley system as a handle. The lid was excluded from the final design due to transportation concerns and how the water would have to be changed/taken out of the exhibit after each use. Using the pulley system bar as a handle proved to be an ineffective way to transport the exhibit as well. Instead, we decided to include handles each side of the tank to help distribute the weight and make transportation easier. After these concerns were addressed, the exhibit moved from the drafting and designing phase to construction very quickly.

The Building Process

Part 1: Tank Construction

Using 3/4" thick acrylic, outer walls of the water tank were constructed and drilled with pilot holes to ensure the exhibit wouldn't crack when being screwed together. Following this, shallow slots were cut into the interior sides and bottom of the exhibit. These slots would allow thin acrylic sheets to be securely held in place, which would act as barriers between each of the well systems (Figure 13). Once the slots were completed, the exhibit was then sealed at the connection points using aquarium sealant to stop any leakage that would occur and to keep the "pollutants" in their own sections. To make sure the exhibit could properly hold large amounts of water, the team would partially fill the tank and observe any leakage over the course of thirty minutes time intervals. Any leakage would be noted and sealed over again, leaving the exhibit to dry before being checked for any excess water. This process continued over the course of four

days until the water leakage was insignificant enough to move ahead with the rest of the construction (Figure 14).

Following the finishing of the sealant, two handles were attached to the acrylic halfway up each side to help with the act of transportation. The top bar, which would be used to hang the pulley systems, was then constructed using a 1.5-foot PVC pipe with two right angle connectors on each end. The bar would then be attached to the exhibit using two more pieces of PVC pipe. The two PVC pipes would be placed above the handles on each side of the acrylic using two 1-inch C clamps and drilled into the tank. The newly drilled holes were then sealed for a second time using an aquarium sealant, to ensure the exhibit was watertight.

Figure 13 Base of Prototype

Three pulley blocks were then zip-tied above each well segment on the top bar PVC pipe. A rope would run through each pulley block and attach to a plastic bucket that contained an aquarium weight, which could be raised and lowered into each well system. Instead of creating three new sections of the tank, the team sketched, cut, and laminated green and brown construction paper, sealing it to the inside of the exhibit. In our meeting with Julie Hasty, she encouraged the group to add a diagram of the soil and ground layer to show how there is "not just a big lake underground." Hasty voiced her concerns about how Santa Fe does not have a significant rainstorm system. She encouraged our team to highlight the effects of erosion and to teach about water filtration throughout New Mexico.

Figure 14 Team Working on Building Exhibit

Therefore, the paper designs are used to show water traveling in between the different cracks and crevices that lie underneath the ground.

While finishing the first part of the design process, our team had the opportunity to review the prototype with Mark Ross-Lonergan. As noted earlier, Ross-Lonergan works for Los Alamos National Laboratory (LANL) and offered to answer a series of questions about the city of Santa Fe and his time volunteering at the Santa Fe Children's Museum. For example, specifically geared toward our prototype, he suggested we include an X amount of water, alongside a bathtub or gallon water bottle, to "have a connection to the most relevant amount for the child to visualize." He explained how this visualization is all about abstracting numbers and how there is not just an unlimited amount of water underground. Comparative to Julie Hasty's answers, our team decided to move forward with our designs after gathering feedback. Figure 15 showcases the finished product of Part 1, with the project team then moving into Part 2 of the exhibit.

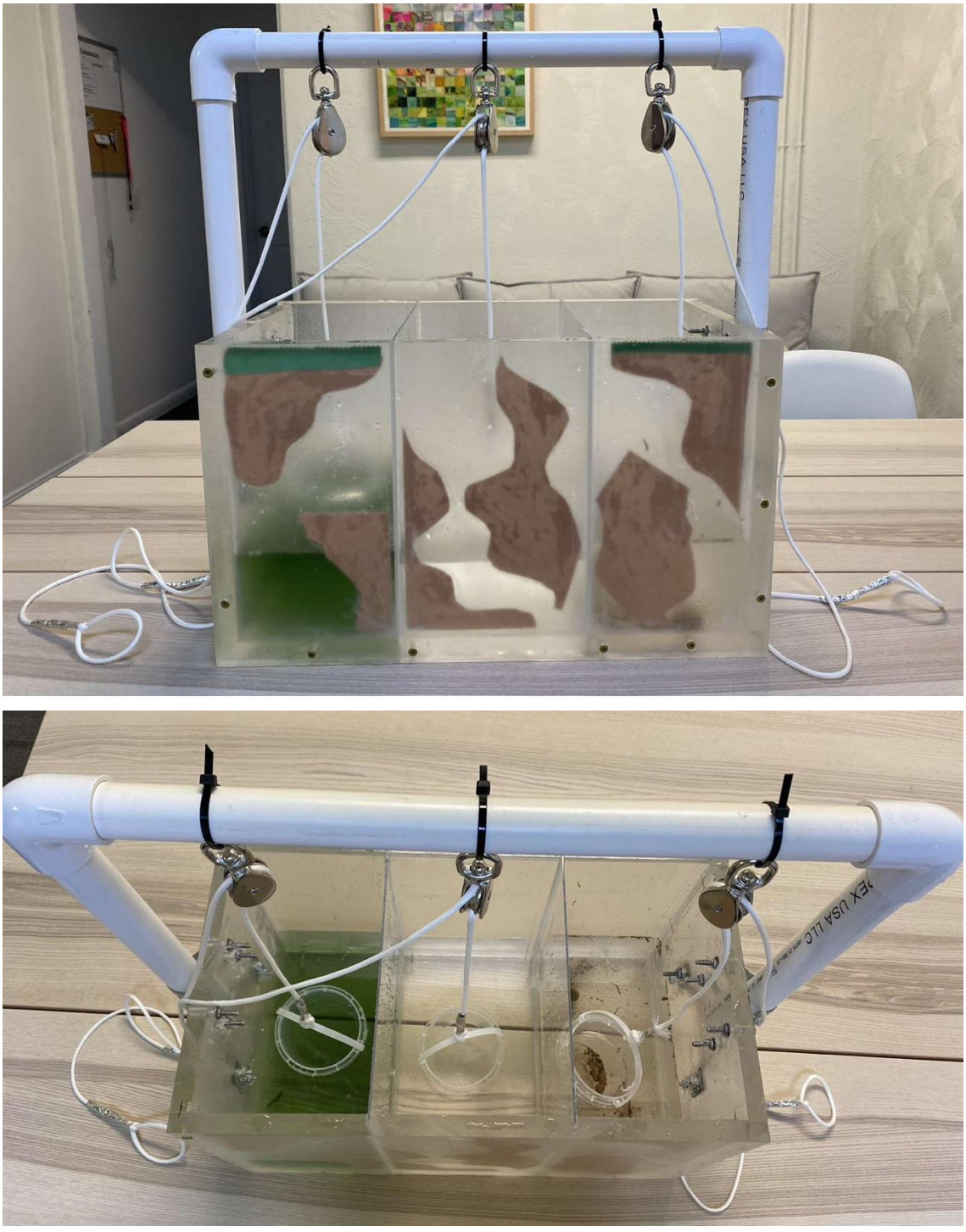

Figure 15 Finished Product of Part 1

Part 2: The Filtration System

To begin creating the water filtration system, the team used two 1-gallon water jugs and cut an inch off each of the bottoms. From the inside, we added two coffee filters to cover the lid and neck of the jug. The coffee filter on the top contained a layer of activated charcoal and an additional layer of cotton balls. After presenting our ideas to Leona Hillary, the team decided to attach both water jugs to the sides of the exhibit. This was done by zip-tying each jug to the PVC pipes on the sides of the tank. To catch all the water that would be filtered through the jugs, ¼ inch airline tubing was attached and sealed through the lids of the jugs. The other end of the tubing was then attached to the inside of the middle section of the exhibit using aquarium suction cups (Figure 16).

Figure 16 Filtration System Attached to Prototype

Part 3: The Enviroscape

Throughout designing our prototype exhibit, the Santa Fe Watershed Association donated an Enviroscape to the Santa Fe Children's Museum. An Enviroscape is a portable, plastic model of a watershed used to teach children about the movement of water and its effects on nature. Our team was approved to use this donation as part of our exhibit to replace creating our own diorama showcasing the city and making it waterproof. The Enviroscape can be seen in Figure 17.

Figure 17 Enviroscape from Santa Fe Watershed

The Testing Process

The project team conducted three rounds of prototyping at the Santa Fe Children's Museum. The prototype was set up in the water section of the museum floor each time and the project team stood as facilitators to receive feedback and teach visitors how the exhibit worked. Above the exhibit was colorful signage created by the project team (Appendix K). Parents were asked for permission before any members of the team spoke directly to children.

Round 1: December 1st, 2023

The first round of testing on Friday December 1st did not include the Enviroscape, as space was limited, and the project team wanted to test the exhibit and water filtration for any failure before adding in the Enviroscape. The team tested the exhibit from 4pm to 5pm.

Throughout more and more children coming to play with the exhibit, the project team observed the left filter becoming clogged and falling from the side of the pipe. Therefore, failing to drain into the wells, and threatening to collapse and spill, so we ended testing for that day. We decided to focus on creating an improved water filtration system before testing on the floor again. We gathered valuable feedback from 10 family groups. Parents expressed a desire for depth measurements to be included, aiding in understanding the required water retrieval depth. Additionally, they suggested the need for clearer signage to convey the exhibit's purpose effectively. The children called for increased engagement, as some found the exhibit somewhat lacking in interactivity. Our team's own observations revealed issues such as exposed screws interfering with the

Figure 18 Improved Filtration System

buckets and the exhibit's overall height being too tall for most children. Furthermore, the exhibit's intended purpose was not immediately evident to visitors.

After testing, we replaced the gallon jug filters with 1-liter bottles (Figure 18) We cut an inch off the bottom of each bottle, inverted them, and zip-tied each to the exhibit. To prevent the charcoal from bypassing the coffee filters and blocking the drainage tube, we added 1.5-inch layers of cotton on the bottom near the cap. Followed by activated charcoal, sand and gravel, and another layer of charcoal on the top. This new design filtered out more of the food coloring and thereby enhanced the messages we were trying to convey about filtration. The new design also prevented charcoal from escaping and blocking the tubing. To attach the tubing to the filtration system, we drilled a hole in the cap and heat-welded the tubing into the cap. Additionally, to make the exhibit more fun and engaging, we added laminated paper to the rocks and debris section, portraying various animals and other life forms. These “animals” would then be pulled up in the bucket from the well to encourage children to save wildlife. To address the parental concerns about scale, we added marks to the side of the exhibit illustrating at which depth most well water is typically found.

Round 2 and Round 3: December 6th and December 7th, 2023

The second and third rounds of exhibit testing occurred on simultaneous days to gather as much feedback as possible from various age groups. On December 6th, two families visited the exhibit and played with the new water filters design. The filters were able to handle three buckets of water before filling to capacity, but never clogged. Each filter continued draining, as well as cleaning the water, which was a significant improved from the previous filters. The team tested the exhibit from 10:00 AM - 11:00 AM and ended the testing due to a low wave of visitors at the museum.

For the third round of testing, our team worked during the museum’s free admissions time from 4:00 PM - 6:00 PM, occurring every Thursday. On December 7th, ten families visited the exhibit, with some being from the first round of testing. Following the updated filtration design, additional depth markings and new laminated pieces of paper were added to the exhibit. Our team observed that most children stayed for about ten minutes playing with the exhibit. To

further increase engagement, the project team handed out stickers to the kids who were able to fish out all of the laminated pieces of “animals” from the rocks and debris section of the prototype. Feedback on this day showed that the families and children greatly enjoyed the new additions to the prototype and would play with the exhibit again if it came back to the museum floor.

Conclusions

Children's museums emphasize interactive, hands-on exhibits as research and experience reveal that interactive play is the most effective approach to learning. Many children's museums feature water exhibits and activities because they are especially popular with their audiences. While SFCM has several water activities and exhibits already on the floor, the museum is especially interested in developing more to highlight the importance of water supply and conservation issues in the Santa Fe region. The City Water Division was keen to collaborate with SFCM to enhance the city's outreach and educational efforts on water supply and conservation. The city officials not only provided feedback on the concepts and educational materials during their development, but they also generously provided funding for the Go-Kits. While research reveals that child-parent interaction is essential in promoting learning among children, SFCM and the City Water Division further emphasize this approach as such interactions are effective in educating parents about local water issues. In collaboration with volunteers and staff at the Santa Fe Children's Museum and the Santa Fe Water Division, the team designed, tested, and revised a portable prototype exhibit and two educational "Grab and Go-Kits." The Santa Fe Children's Museum wanted a portable water exhibit for use in programs outside the museum to extend their outreach and educational efforts as well as "Grab and Go-Kits," since research has revealed that such takeaway activities are effective in reinforcing learning outcomes in children and parents.

The team worked to create a prototype of a portable water exhibit to educate children about the water system in Santa Fe, the issues regarding water pollution in groundwater, and the role of filtration in mitigating the effects of pollution and debris in water. We created a prototype mimicking a "well system" with three separate tanks that included clean water, water "polluted by oil," which contained food coloring, and water with debris, such as rocks and gravel. Visitors would use a pulley system to extract water from each of these well systems, with water from the contaminated tanks being poured into a water filtration system attached to the exhibit that flows into the clean section of water. The water from the clean well would then be used in a diorama that would teach children about Santa Fe's watershed and managing the water they use in their everyday lives.

The team also created two educational "Go-Kits" addressing the topics of water pollution and water filtration, to reinforce the ideas associated with the portable exhibit. These kits are intended to have more adult supervision and involvement in creating the experiments and answering inquiry questions to educate both the parent and child about these issues. The water pollution kit involves mixing watercolor, oil, and water to teach children about how oil contaminates water, along with a feather, to signify how an oil spill affects wildlife. The second kit aims to teach children about water filtration and how this process is important for the daily usage of water. Families would use the materials provided to create a water filter to either clean the water from the previous experiment, or from dirty water they can create themselves. The disposal of the oil at home is another point of learning each kit intends to teach, as it can not just be poured down the drain to dispose of, since cold oil congeals and can clog drains, pipes, and water filters.

Further Museum Collaborations

Given the success of the collaboration between the Santa Fe Water Division and the Santa Fe Children's Museum on this project, we recommend the museum further pursue collaborations with the city and other organizations relating to water conservation, usage, and pollution to continue their water conservation education efforts, or more broadly when creating future exhibits and Grab and Go-Kit designs.

Recommendations

Exhibit Prototype

Construction of the Portable Water Exhibit

For the construction of the exhibit, incorporating see-through acrylic would be useful in making the tank more transparent. This design would make it easier for children to observe the interior and allow distant viewers to see inside. However, this choice does present a caveat: transparent or translucent acrylic may diminish the visibility of the screws securing the exhibit. This is a consideration, as it could compromise the illusion of the design being a conventional well with prominently visible screws both in the frame and on the handles. Precisely measuring the screw length to maintain structural integrity, while minimizing any intrusion into the water tanks, would contribute to a more visually appealing experience for users. Additionally, an easier way to discard water for cleaning purposes would be useful in future iterations. The current prototype does not include any method of drainage; however, the team utilized an aquarium siphon to mitigate this oversight. Initially, our team had intentions of incorporating cranks into the pulley system, aiming to provide an accessible alternative to having the children manually pull the rope for the retrieval of the buckets. Regrettably, due to time constraints and space limitations, we were unable to execute this planned addition, but we encourage the use of cranks in the next phases of prototyping. The team also encourages more testing rounds using the Enviroscape, as it can be a great tool to teach children about the Santa Fe Watershed and highlight the importance of the clean water they need for their town.

Additional Instructions

The intention of this design is to be a portable exhibit used to travel with an educator to different locations, as well as becoming a pop-up exhibit in the museum with someone nearby to explain how it works, so signage explaining the exhibit wouldn't need to be created. However, creating an educational pamphlet for parents to discuss with their children would need to be implemented either during the exhibit pop-up event or along with the child on their way home if the demonstration is on the move. The pamphlet can contain information about the Santa Fe

Watershed, water conservation tips for children and parents, and conversation topics that parents can use to generate awareness with their children about ecology and the environment.

Go-Kits

Throughout the development phase of the Educational Go-Kits, the team generated a plethora of ideas for science experiments. However, challenges related to adhering to budgetary constraints and aligning with the intended learning outcomes were encountered. Prospectively, having a listing of such constraints while brainstorming may streamline the process. A second recommendation is to minimize the quantity of "free-floating" small materials, as these items also necessitate additional packaging. For example, ziplock bags, pouches, and jars ultimately increases the cost of the kit. One of the activities presented by the team involved the use of vegetable oil. Consequently, the team felt it necessary to provide a disclaimer on the proper disposal of such material, as they should not be poured down the drain. However, there is always a risk that the disclaimer may not be followed or read carefully. Therefore, a third recommendation is to avoid including materials that cannot be disposed of in a drain or regular trash can. The team placed a strong emphasis on accessibility, leading to the commitment to provide instructions in both English and Spanish. Additionally, efforts were made to minimize the quantity of materials needed from the child's home to participate in the activities. These efforts should remain a priority for the future.

Additionally, there were difficulties when crafting questions with the appropriate language being accessible and comprehensible to the target age group. To mitigate this challenge, the team recommends working with teachers or individuals with an educational background in early childhood development. Furthermore, drafting the inquiry questions and receiving approval before developing the rest of the activity instructions would also be optimal. Relating the science activities to real-world scenarios is also a recommendation for future iterations. Including elements like how the feather reacts to oil or why a child would not want to drink oily water further emphasizes the lessons learned and encourages children to utilize those teachings in their everyday lives.

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Appendix A: Consent Interview Script

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 30 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

Appendix B: Parent Prototype Testing Interview Questions

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 5-10 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. The report, and this interview, will remain completely anonymous. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

1. What are some thoughts on the prototype?
2. Do you understand the message we are trying to convey?
3. Are there any additions to the prototype that you think should be made?

Appendix C: Museum Staff Interview Questions

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 30 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

1. How long have you worked at the museum?
2. What is your role in the museum?
3. Have you ever worked with the portable exhibits? How long do those exhibits typically take to go up/down?
4. Have you had any experience building/working on exhibits?
    a. (IF Yes) How big should a prototype of our exhibit be?
    b. (IF Yes) What are some key features of popular (portable) exhibits?
    c. (IF Yes) Any design ideas the group should be thinking of while in our prototyping phase?
5. What would you say are the most popular exhibits at the SFCM?
    a. What features of these exhibits make them the most popular?
6. What differences between boys/girls do you see while children interact with exhibits?
    a. What are features that could be implemented to appeal to both?

7. What differences between younger/older children do you see while they interact with exhibits?
    a. What are features that could be implemented to appeal to both?
8. What features of an exhibit encourage interaction between parents and children?
9. What are some of the most important messages SFCM should convey to children (and parents) about water supply and conservation in Santa Fe?
10. How can/does the museum help to change public behaviors?

Appendix D: Interview Questions for Local Scientists

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 30 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

1. Can you talk about your position?
2. TOPIC: Santa Fe Children's Museum and City of Santa Fe
3. How much would you say Santa Fe educates the youth on water conservation?
4. What could be put in place to better educate the public?
5. TOPIC: Los Alamos National Laboratories.
6. What does Los Alamos National Laboratories do to teach the public?
7. How has Los Alamos National Laboratories helped with outreach?

Appendix E: Interview Questions for Watershed Educators

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 30 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

1. Can you briefly explain your position at the Watershed?
2. Can you briefly explain your background?
3. What educational programs does the Watershed run?
4. What are some tips for writing information/questions children can grasp?

Appendix F: Interview Questions for City Water Officials

We are a group of students from Worcester Polytechnic Institute (WPI) conducting a research project in collaboration with the Santa Fe Children's Museum to produce a prototype of a portable water conservation exhibit.

We would be delighted if you would take 30 minutes to answer some questions about the museum and water conservation. Your participation in this interview is completely voluntary and you may stop at any time. We shall be taking notes during our conversation and may wish to quote you in our final report. Do you mind if we quote you by name, or would you prefer we anonymize your responses? We will, of course, give you an opportunity to review any quotations prior to publication. We will also be happy to provide you with a copy of our report when it is completed. Thank you for your support in this research.

Do you have any questions before we begin? If you have any concerns or questions after the interview, you can contact us at or sf23.sfcm@gmail.com our faculty advisor, Dominic Golding, at golding@wpi.edu.

6. Can you talk about your position at the city?
7. Can you talk on the Waterwise program?
8. TOPIC: Explaining our Go-Kits and asking about pricing information.
9. Do you have any ideas to really connect Santa Fe and our portable prototype exhibit?
10. How can the City of Santa Fe (and the Save water Santa Fe program) collaborate with our team?
11. TOPIC: Talking about the Enviroscape of Santa Fe in a presentation format.

Appendix G: Oil Jar Activity Go-Kit Pamphlet

SANTA FE CHILDREN'S MUSEUM

Grab & Go KIT

Oil Jar

save water SANTA FE

WORCESTER POLYTECHNIC INSTITUTE 1865

Did you know that everyday activities, such as using oil-based products and the runoff from streets when it rains, can actually lead to oil getting into our water sources? Let's take a closer look! Sometimes, when we use things like motor oil or even when cars drive on the streets, tiny drops of oil can end up in our water. This can also happen when it rains, and the water washes oil and dirt from the streets into our rivers and lakes.

This simple, yet impactful experiment, will demonstrate how easily oil can contaminate our water supply, affecting animals and their habitats. Prepare for an engaging, hands-on exploration using water and oil to bring awareness on the impact of water pollution!

Materials Included

Liquid Watercolor
¼ Cup of Vegetable Oil
1 Feather
1 Glass Jar

Materials from Home

½ Cup of Water

Instructions

Begin by adding in a few drops of the liquid watercolor to the jar of oil. Seal the jar well and shake - to achieve vibrant coloring! Next, add in ½ cup of water to the jar. Now, shake up it up again and let it sit for five minutes! Watch as the oil and water react with each other! Would you want to drink this water?
Take the feather and dip it into the mixture. If this happened to your feather could you fly? After the reaction has settled, discuss what you have learned. Find a grown-up or friend to talk about the Inquiry Questions asked below! When you're all done, dispose of the materials safely. You can reuse the jar for future experiments or recycle appropriately.

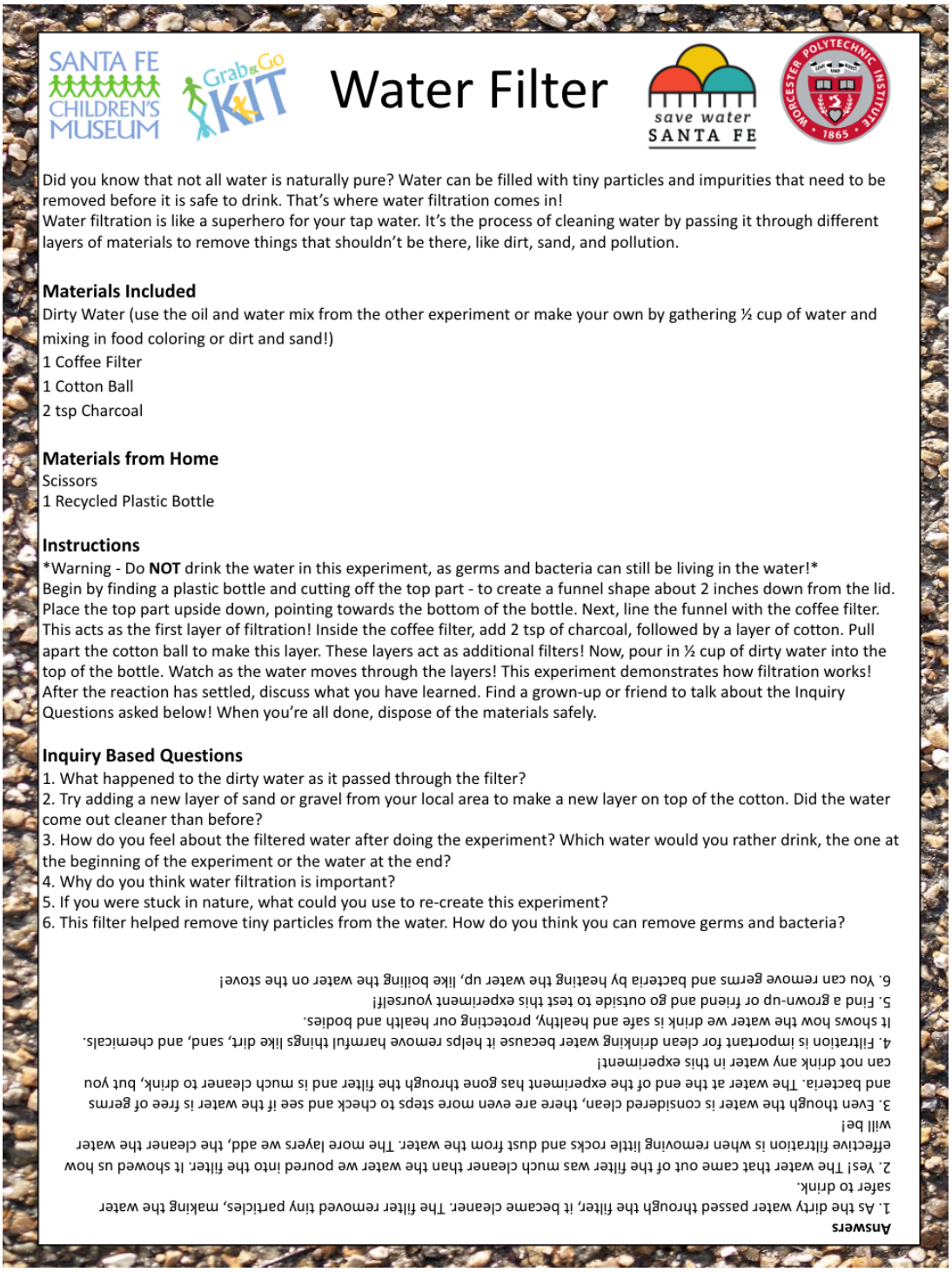
Inquiry Based Questions

1. Why do you think oil and water don't mix together?
2. How is the reaction of the colored oil and water in your experiment similar to an oil spill in nature? How might the reaction be different?
3. Why is it important to learn about oil pollution and its effects on water?
4. How would you know what is safe to put down the drain? Who would you call if you did not know how to clean up?
5. What do you think we can do to help protect our water from pollution?
6. Can you think of other ways in which oil might accidentally end up in the water, besides our experiment?

Answers

1. Oil and water don't mix because they have different properties. Oil is greasy and not as dense as water, so the reaction naturally separates.
2. The reaction is similar because both our experiment and real oil spills show that oil and water don't mix well. As the oil stays on the surface, anything that comes into contact with it will be contaminated. The reaction is different because a real oil spill requires a team of people to help clean the environment and check if it's safe for wildlife again.
3. Learning about oil pollution is important because it teaches us how to care and protect our water sources, which are essential for both humans and wildlife.
4. To determine what is safe to put down the drain, you should always read labels and follow guidelines. If you are unsure if something is safe or not, you should talk with or call your local department or library for more information.
5. We can protect our water from pollution by using eco-friendly products and disposing of waste properly.
6. Oil can accidentally end up in our water through activities like dirty car maintenance and oil tank leaks.

Appendix H: Water Filtration Go-Kit Pamphlet



SANTA FE CHILDREN'S MUSEUM

Grab & Go KIT

Water Filter

save water SANTA FE

WORCESTER POLYTECHNIC INSTITUTE 1865

Did you know that not all water is naturally pure? Water can be filled with tiny particles and impurities that need to be removed before it is safe to drink. That's where water filtration comes in!
Water filtration is like a superhero for your tap water. It's the process of cleaning water by passing it through different layers of materials to remove things that shouldn't be there, like dirt, sand, and pollution.

Materials Included

Dirty Water (use the oil and water mix from the other experiment or make your own by gathering ½ cup of water and mixing in food coloring or dirt and sand!)
1 Coffee Filter
1 Cotton Ball
2 tsp Charcoal

Materials from Home

Scissors
1 Recycled Plastic Bottle

Instructions

*Warning - Do **NOT** drink the water in this experiment, as germs and bacteria can still be living in the water!*
Begin by finding a plastic bottle and cutting off the top part - to create a funnel shape about 2 inches down from the lid. Place the top part upside down, pointing towards the bottom of the bottle. Next, line the funnel with the coffee filter. This acts as the first layer of filtration! Inside the coffee filter, add 2 tsp of charcoal, followed by a layer of cotton. Pull apart the cotton ball to make this layer. These layers act as additional filters! Now, pour in ½ cup of dirty water into the top of the bottle. Watch as the water moves through the layers! This experiment demonstrates how filtration works! After the reaction has settled, discuss what you have learned. Find a grown-up or friend to talk about the Inquiry Questions asked below! When you're all done, dispose of the materials safely.

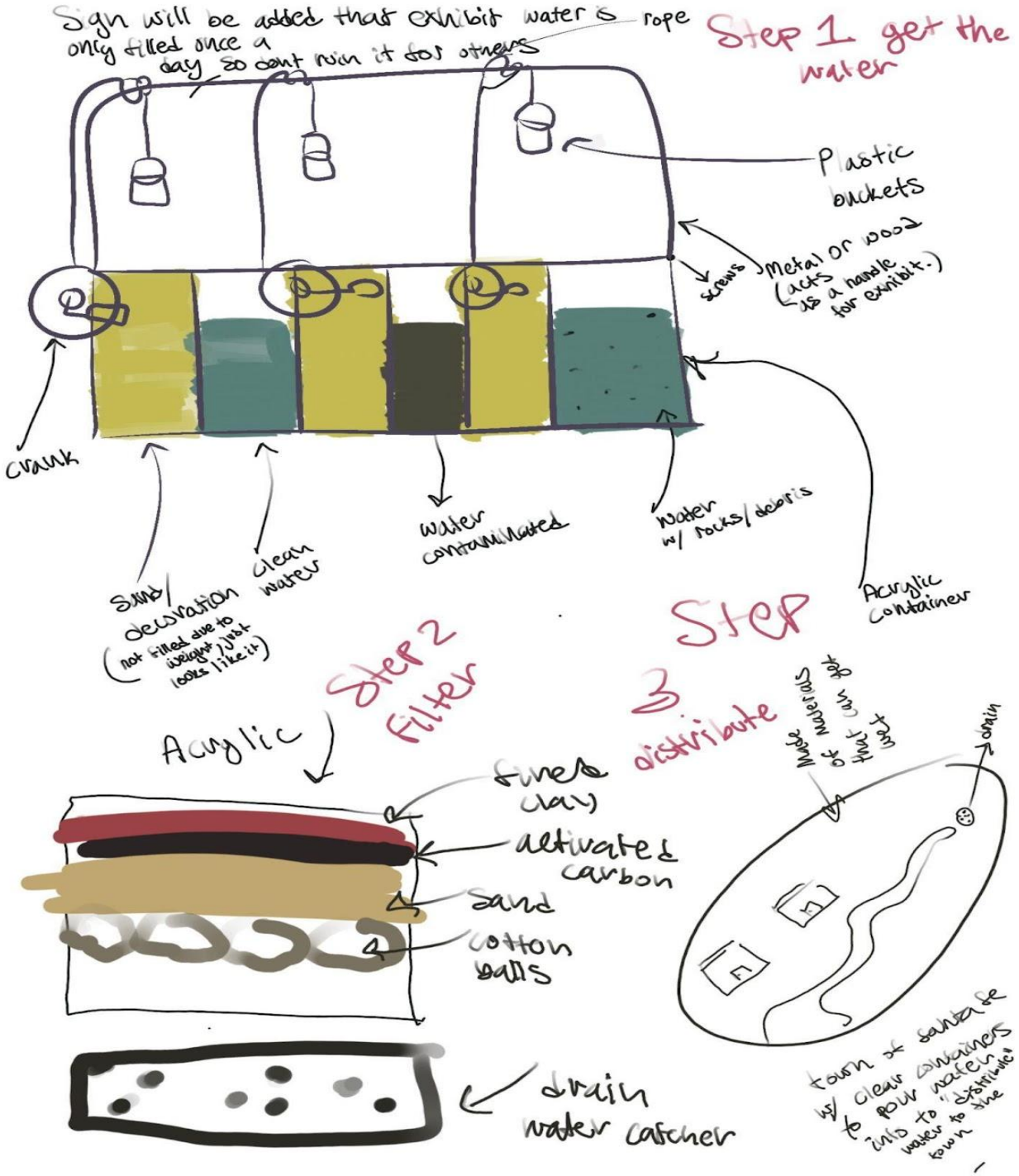
Inquiry Based Questions

1. What happened to the dirty water as it passed through the filter?
2. Try adding a new layer of sand or gravel from your local area to make a new layer on top of the cotton. Did the water come out cleaner than before?
3. How do you feel about the filtered water after doing the experiment? Which water would you rather drink, the one at the beginning of the experiment or the water at the end?
4. Why do you think water filtration is important?
5. If you were stuck in nature, what could you use to re-create this experiment?
6. This filter helped remove tiny particles from the water. How do you think you can remove germs and bacteria?

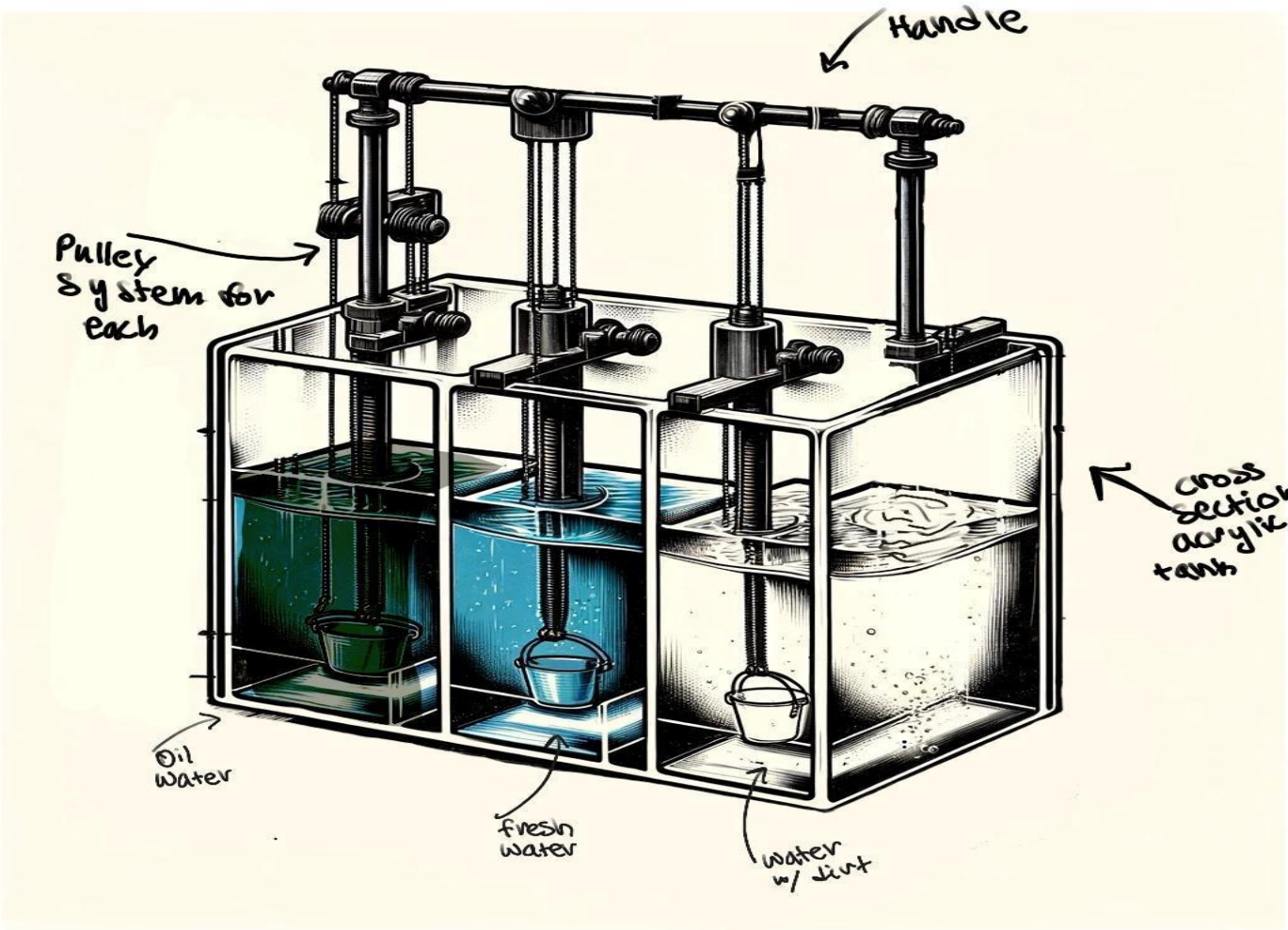
Answers

1. As the dirty water passed through the filter, it became cleaner. The filter removed tiny particles, making the water safer to drink.
2. Yes! The water that came out of the filter was much cleaner than the water we poured into the filter. It showed us how effective filtration is when removing little rocks and dust from the water. The more layers we add, the cleaner the water will be!
3. Even though the water is considered clean, there are even more steps to check and see if the water is free of germs and bacteria. The water at the end of the experiment has gone through the filter and is much cleaner to drink, but you can not drink any water in this experiment!
4. Filtration is important for clean drinking water because it helps remove harmful things like dirt, sand, and chemicals. It shows how the water we drink is safe and healthy, protecting our health and bodies.
5. Find a grown-up or friend and go outside to test this experiment yourself!
6. You can remove germs and bacteria by heating the water up, like boiling the water on the stove!

Appendix I: Initial Prototype Design



Appendix J: Refined Prototype Diagram



Appendix K: Signage for Prototype

Appendix L: Prototype Instructions

Background

History of groundwater

- **Native Americans and Early Settlers:** Native American tribes, like the Pueblo people, and early settlers used groundwater for everything. They dug wells by hand and used this water for drinking, cooking, and growing crops.
- **Growing Cities and Farms:** As more people came to live in New Mexico, they needed more water. They built bigger wells and used machines to get more groundwater. This helped cities and farms to grow.
- **Learning and Adapting:** Over time, people in New Mexico learned that they have to be careful with how much groundwater they use. They found out that if they use too much, it can cause problems like making it harder to get water in the future.
- **Today's Efforts:** Now, people in New Mexico work together to use groundwater wisely. They make rules about how much water can be used and find ways to save water. This helps make sure there is enough water for everyone, for drinking, for animals, and for growing food.

General information

- **What is Groundwater?** Groundwater is the water that is found under the ground in the soil and in between rocks. It's like hidden water that we can't see because it's under the earth.
- **How Do We Get Groundwater?** People dig wells deep into the ground to reach this water. They use pumps to bring it up to the surface so we can use it.
- **Why is Groundwater Important?** Groundwater is very important because it helps give us water to drink, to grow our food, and for other things like washing and cooking. In many places, especially where it doesn't rain much, groundwater is a main source of water.
- **Taking Care of Groundwater:** It's important to keep groundwater clean and not waste it. We need to make sure we don't put harmful things into the ground, like litter or chemicals, because they can make the groundwater dirty.

- **Groundwater in New Mexico:** The document talks a lot about groundwater in New Mexico. In New Mexico, groundwater is very important because there isn't a lot of rain. People there use it for their homes, farms, and animals.
- **Being Careful with Groundwater:** Sometimes, if we use too much groundwater, it can run out or get lower in the ground. This makes it harder to get and can also cause problems like making the ground sink in some places.
- **Working Together to Protect Groundwater:** People in New Mexico, like in other places, work together to make sure there's enough groundwater for everyone, now and in the future. They make rules to use it wisely and keep it clean.

Presentation

Instructor Guide for the "Well, Well, Well" Exhibit: Engaging Elementary Students with Water Education

Overview of the Exhibit:

The "Well, Well, Well" exhibit is a dynamic, interactive display designed to educate elementary school students about the origins, treatment, and distribution of water in New Mexico. This hands-on experience is structured to foster engagement and learning through direct interaction. The exhibit "Well, Well, Well" is intended for an elementary school audience. It highlights where water in New Mexico comes from along with how we can treat it and distribute the water. The Well is currently made of acrylic glass-like a fish tank with three subsections in the tank, one hold colored water, one holding clean water, and one holding debris and organisms. Each subsection has its own bucket with a pulley attachment for children to pull water out of each tank. The clean water is meant to be the one pulled up to distribute to the "town"-the enviroscape. The two subsections with contaminated water are meant to be poured into the water filters suspended to the side of the tank, these have airline tubes attached to the filters that will put the water into the clean subsection ready to be distributed. A big point to make clear is once the water in the exhibit is gone then it is gone, so it is important to find ways to distribute it correctly. The filters are made of liter bottles with layers of cotton on the bottom, charcoal, dirt, and another layer of charcoal.

Exhibit Components:

1. **Tri-Sectional Acrylic Tank:** The centerpiece is a large, clear acrylic tank, divided into three sections. Each section represents different water states:
    - Colored water symbolizes contaminated sources.

    - Clear water represents clean, usable water.
    - Water with debris and organisms illustrates natural water bodies.
2. **Interactive Pulley System:** Each tank section has an associated bucket with a pulley system. This setup enables students to physically draw water from each section, enhancing their tactile and visual learning experience.

Educational Goals and Activities:

1. **Clean Water Distribution:** Instruct students to use the pulley system to draw clean water for distribution to the model town, named "EnviroScape." This activity simulates real-world water distribution challenges and promotes understanding of resource management.
2. **Water Filtration Process:** The contaminated water sections are designed to be filtered through DIY filters, made from liter bottles with layers of cotton, charcoal, and soil. These filters demonstrate basic water purification techniques. Encourage students to observe the filtration process, noting the before and after states of the water.
3. **Conservation Message:** Emphasize the finite nature of the exhibit's water supply. This aspect of the exhibit is crucial for teaching water conservation. Explain to students that once the water is used up, it cannot be replenished, mirroring real-world water scarcity issues.

Facilitation Tips:

- Encourage Inquiry: Prompt students with questions about the water cycle, water treatment, and conservation.
- Supervise Interaction: Ensure that students safely use the pulley system and engage appropriately with the exhibit.
- Facilitate Learning: Use the exhibit as a springboard to discuss broader topics, such as the importance of water conservation and the science behind water treatment.
- Print out school bus graphics, a school bus is typically 10 feet tall. Water in Santa Fe can be found as deep as 600 feet but typically stays around 45 or 100 ft depending on the area.
- The team recommends changing the cotton balls, dirty, and charcoal every week.

SOURCES FOR ADDITIONAL INFORMATION:

- EPA, Water Cycle and Water Conservation, https://uttoncenter.unm.edu/assets/docs/publications/water-matters-2015/06_Groundwater.pdf
- https://waterdata.usgs.gov/nm/nwis/rt