MuseumsForward

Hands-on learning in focus: understanding environmental programming for teenagers in museums

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Abstract

Despite museums playing a critical role in environmental education, there remains a lack of prolonged, meaningful, environmental programming for teens across North America. This gap raises the question of how the handful of institutions running these programs are managing. This case study was carried out to understand how museums engage teenagers in prolonged, meaningful, environmental programming using hands-on learning practices. Data were collected through semi-structured interviews with 3 staff members from different museums across North America. The results suggest that A) Museums leverage their space, technology and collections as integral components of their programming; B) Effective engagement includes interactions between teens, their peers, and their communities; C) Recruiting participants is a significant hurdle in program implementation. This research solely explores programming from adult perspectives and can be strengthened by including the viewpoints of teenagers, and by conducting extended studies to investigate the long-term effects of participation.

Keywords

Teens; Climate; Program; Museum; Hands-on;

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Introduction

In an era marked by extreme climate change, museums stand as vital institutions for fostering the public's general knowledge and urgency surrounding the subject. Unfortunately, the topic has not emerged as an explicit priority for many institutions, which is partly due to an unwillingness to engage audiences in topics perceived as being politicized. According to Hamilton and Christian-Ronning (2022), particularly science museums and centers, whether through their own self-censorship or intervention from donors, can be dissuaded from sharing accurate scientific information on anthropogenic climate change to avoid controversy. However, the museum community is working to change this. According to the American Alliance of Museums, the museum community does recognize environmental issues as climate action was listed on their federal policy agenda from the 2024 Museum Advocacy Day, urging Congress to fund green infrastructure, grants for climate change research, and public-facing projects such as exhibits, and programs (American Alliance of Museums, 2024).

Among the public audiences served by museums, teenagers stand out as a demographic with great potential for future environmental engagement and stewardship. Additionally, research shows that when youth are more aware of the changing climate it opens the door for deeper understanding and also allows them to better communicate with and influence the awareness of their communities (Zybina et al., 2023). Because they one of the first generations to bear the brunt of the climate crisis, research suggests that teens are a promising group to leading global action against climate change, and are uniquely positioned to be effective climate messengers as they are the first generation to be faced with discernible evidence demonstrating its impacts (Bandura & Cherry, 2020; Sander et al., 2023). This awareness can come from personal interests or formal schooling but can also stem from extracurriculars or informal education opportunities, many of which incorporate hands-on learning activities. This is where museums have the potential to use their positions as trusted science communicators to provide educational opportunities. Alas, outside of a small number of museums, research shows that there is a general shortage of environmental programming available to teens in museums (Papoulias, 2022). Because of this gap in programming, this research thesis stands to explore how science and natural history museums that are engaging teenagers in prolonged, meaningful, environmental programming use hands-on learning practices, in hopes of guiding future programming and expanding environmental education opportunities in the informal education field.

Museums as Climate Communicators

Outside of formal education, it has been suggested that museums are among the best places to engage the public with topics such as climate science and environmental advocacy. These institutions hold a unique position in society as trusted information sources and often serve as "safe spaces for unsafe ideas", which include highly politicized subjects such as climate change (Hamilton & Christian Ronning, 2020). Museums employ multiple modes of engagement with the public which allows for more immersive environments. These environments can then facilitate active roles for learners in which they have the opportunity to understand, interact with, and co-create educational narratives around climate change (Cameron et al., 2013).

Museums also play an important role in climate communication because of their partnerships and connections with their communities. According to the International Council of Museums, museums and communities are tightly linked even in the definition of the word "museum" as it includes "the participation of communities" within the very definition (International Council of Museums, 2022). The purpose of the modern museum is shifting as institutions are redefining their value to the community. Engagement is shifting away from the traditional way of providing learning opportunities, to inviting community members in to bring their own expertise and engage with local issues (Knutson, 2019). The spaces allow for dialogue, interactions, and storytelling which are much more meaningful and constructive than seminars or talks from scientists or other powerful figures (Cameron et al., 2013). The spaces also allow access for community members to interact with collections artifacts (including live and natural history items) and unique exhibitions which allows for deeper connections and more personal understandings of the crisis (Papoulias, 2022).

What does "Hands-on" mean?

Hands-on learning practices were popularized in the early 1900s by philosophers such as John Dewey, who believed that education is a social process in which students learn best when immersed in natural settings. (Dewey, 1938). These ideas are still being explored today as education continues to evolve and change. A 2016 study focused on the integration of hands-on learning in classrooms and laboratories found benefits of hands-on learning to include improving students' learning / logical thinking while also increasing interactions between educator and student (Handur et al., 2016). In addition to knowledge and skill-

based outcomes, hands-on learning is popular in informal education settings among students as well. A 2018 study focused on student perceptions of STEM learning in informal education environments reports students acknowledged the access they received to hands-on activities in authentic STEM settings was an important component of their informal learning experience. One participant noted, "It is hard for me to learn as fast as other people because I am more of a hands-on person. So, when there is a hands-on activity, I am really happy because I get [to] learn." (Roberts et al., 2018)

For the purpose of this research article, hands-on learning is described through three specific types of learning, each of which is centered around the concept of, "learning by doing". They are experience-based learning, field-based learning, and project-based learning.

Experience-based learning: An engaged learning process where students "learn by doing" and then reflect on the experience. The learning process is completed in four stages: concrete experience (engaging directly in an authentic experience), reflective observation (taking note of what happened and relating to past experiences or conceptual understandings), abstract conceptualization (distilling perceptions into abstract concepts), and active experimentation (using new skills to test new ideas) (Kolb, 2014).

Field-based learning: Learning is extended to a site outside of the classroom, exposing learners to a real-world setting. Learners gain knowledge through direct interaction with an environment that reflects taught concepts rather than learning through indirect presentations of the setting such as textbooks or lectures (Kaur Sidhu, 2014).

Project-based learning: Involves learners designing, developing, and constructing solutions to a problem. Typically, takes learners through the following steps: identifying a problem, devising a solution and path to solving the problem, designing and developing a prototype of the solution, testing and implementing the solution and, refining the solution based on feedback from experts, instructors, and/or peers (Krajcik & Blumenfeld, 2006).

Hands-on learning and teens

Recent research suggests a deeper, participatory approach to informal climate change education for teens as a way to directly provide resources to develop skills in responding to the social, ethical, and political aspects that surround climate change (Rousell & Cutter-Mackenzie-Knowles, 2020). According to Corner et al. (2015), "Young

people are more likely to understand, care, and act on climate change if they can engage with it directly and experientially, through some form of educational, outreach, or social activity". In general, teens care about authenticity from mentors, and about doing work that is impactful to them or their community, specifically in a group that they feel comfortable in (Maxson & Linzer, 2016). Peer groups are important in teen programming as peer relationships are highly influential for teens. Research shows that peer interaction can motivate students to engage in schoolwork and extracurricular activities (Juvonen et al., 2012). Studies suggest that climate literacy programs are more effective when young participants can apply their learnings in social practices while immersed in a supportive environment in which their peers exhibit similar positive behaviors (Payne, 2005; Satchwell, 2013).

Existing Environmental Programming for Teens

In general, participating in environmental programming benefits youth by increasing happiness, providing a sense of purpose, promoting feelings of belonging in their community, and positively influencing environmental stewardship (Barrera-Hernández, 2020; Nature-Based Youth, 2020). There has been a growth in organizations and initiatives focused on teens and climate change around the globe. In North America, Plant for Planet, This is Zero Hour, and Sunrise Movement, are all examples of climate organizations specifically created for Gen Z (those born between 1997 and 2012) (Organizations for Gen-Z, n.d.). Unfortunately, this wide range of programming does not translate to museums. A recent informal survey of the field revealed a surprising lack of programming centered on climate change in aquariums, zoos, and museums (namely natural history museums and science centers) throughout the U.S. The research states, "While climate change may be referred to in exhibits or in informal engagements on the public floor, there are very few visible educational programs that mention climate change in a meaningful way. If mentioned at all, climate issues were often tacked on at the end of the program like an afterthought." (Papoulias, 2022). Out of the museum programs that do exist, many are climate summits, symposiums, or one-time events that provide museums an initial path to connect with and empower teens to foster feelings of agency and provide opportunities for impact (Krestser & Chandler 2020). While these programs are valuable, they are short-term and lack the ability to engage participants over time. Longer term programming typically includes pathways for participants to develop relationships over time, and foster connections with their communities. The benefits of involving community in learning include empowering

students to be agents of change, challenge their previous assumptions and beliefs, allow them to build relationships with a diverse group of people, gain skills and knowledge for their future careers, and build new-found compassions (Donahue & Plaxton-Moore, 2018). A few programs operating across North America utilize a longer-term hands-on learning approach, giving teens more time to develop relationships and engage meaningfully with the community. An example of such a program is Youth Lead the Way, in which The Oregon Museum of Science and Industry hired 15 teens to form a Youth Advisory Research Board for participants to advise on projects, develop creative activities to communicate about climate impact and engage the public as climate impact educators. An evaluation of this three-year program showed evidence that it was successful at fostering collaboration and communication skills in youth. The evaluation showed that, "programs aimed at youth could scaffold and provide opportunities for them to apply research and communication skills into concrete projects and activities in ways that could be meaningful for youth and the public." (Herran et al., 2023). Furthermore, evaluation suggested that the program could support youth in developing a more nuanced approach to specific societal issues (such as climate change). Museums have great potential in providing these hands-on environmental program experiences for teens due to their access, funding, and connections with their communities. While only a small number of museums have undertaken this effort, it is important to have a deeper understanding of these efforts so they can be applied to the development of broader implementation.

Purpose & Research Questions

The purpose of this case study is to understand how science and natural history museums engage teenagers in prolonged, meaningful, environmental programming using hands-on learning practices.

1. What factors support the initiation of hands-on environmental programming for teens?
2. How are hands-on environmental programs for teens structured?
3. How is success within this type of programming defined?

Methods

This research was designed as a case study with cross-case analysis to reveal themes across multiple settings. Data was collected through interviews with museum staff who manage teen programs to provide integral findings.

Sampling

Case study sites were selected using purposive sampling, and were identified through general Google searches, Google Scholar, informalscience.org and, the researcher's professional connections. To identify museums that had programming that is relevant to the research, the following criteria were established by the researcher:

Age of participants 13-18

Frequency Meets more than 10 times over at least one month

Format Is in-person/hybrid and has a hands-on aspect (experience, project, or field-based learning)

Focus on conservation, climate, or environmental subjects

Longevity has engaged at least one cohort

Examples of programs that did not fit these criteria were teen climate summits as they are typically implemented over a single weekend, teen climate symposiums as they lack opportunities for long-term social connections / often do not include hands-on learning practices, and newer programming that has not been running long enough to provide sufficient data. After narrowing down sites using the above criteria, 21 museums in North America were approached by email. While seven of these museums agreed to be the subjects of this case study, four of the museums ultimately could not participate due to scheduling conflicts or other reasons. Data was collected from the following three sites.

Site 1: Manitoba Museum (MM)

Originally opened in 1970, the Manitoba Museum (previously known as the Manitoba Museum of Man and Nature) is Winnipeg's largest museum with a focus on science and history that is explored through nine immersive exhibits, various school programs, and professional learning opportunities. The Museum recognizes its responsibility to raise awareness and educate the public on topics such as natural history, climate change, environmental sustainability, and the current biodiversity crisis. In recent years, the museum has strengthened its stance on climate change and has incorporated new climate-themed programming and events.

Mika Pineda, Learning engagement producer for Youth Climate Action

Program: Youth Climate Alliance

The Youth Climate Alliance is a group of grade 9-12 students who work together to better understand climate change and its impacts. Through a series of workshops and training, the Youth Climate Alliance aims to host events "by and for" youth. The goal of the Youth Climate Alliance is to give youth an avenue to pursue climate change advocacy and have their voices heard (Manitoba Museum, n.d.). The program is currently in its second cohort.

Site 2: Science Museum of Minnesota (SMM)

The Science Museum of Minnesota was founded in 1907, and today impacts over one million people annually through museum trips, school visits, online experiences, traveling exhibitions, and Omnitheater movies. The museum's main vision is a world where everyone has the power to use science to make lives better. SMM has a strong stance on climate change which is noted on their website in the statement, "The Science Museum of Minnesota commits to being a resource on climate change and a hub for climate action. We will amplify collective solutions that ease the impacts of the climate crisis and that enable us all to imagine, design, and realize a better future."

Thulani Jwacu, Director of the Kitty Anderson Youth Science Center

Program: Kitty Anderson Youth Science Center

The KAYSC high school program provides paid out-of-school programming for underserved youth with the goals of building leadership skills, career readiness, and fostering confidence and appreciation of STEM. Topics are focused on biological sciences/ public health, technology, environmental sciences/ sustainability, and engineering. Youth on KAYSC teams develop community service-learning projects and lead hands-on STEM workshops/outreaches for younger youth in their communities (KAYSC, n.d.). The KAYSC opened and has been providing programming since 1996.

Site 3: Maine Maritime Museum (MMM)

The Maine Maritime Museum has been educating the public on the past, present, and future of Maine's waterways since 1962. The museum includes indoor exhibitions with galleries full of activities and an outdoor area which is a preserved shipyard for visitor exploration.

(Maine Maritime Museum, n.d.-a). Recently, the museum has opened a year-long exhibit titled *SeaChange: Darkness & Light in the Gulf of Maine*, which immerses visitors into rich Maine ecosystems in hopes of inviting reflection on the human impacts on our shared oceans. This exhibition has opened doors to new programming and educational opportunities on the environment and local climate change.

Katie Conroy, Education and Community Engagement Manager

Program: Green Teens

Green Teens runs each Spring and invites six high school students to work alongside museum professionals and community leaders to raise awareness on a local environmental issue. The teens learn professional skills in project and time management, collaboration, and creative problem-solving (Maine Maritime Museum, n.d.-b). Teen participants are paid a stipend for their time in the program. Currently, the program has completed one cohort.

Data Collection & Analysis

After confirmation to participate and before an interview, participants were asked to fill out a pre-interview questionnaire to give the researcher general information about their program. This questionnaire collected data confirming that the program uses hands-on learning and verifying that the program meets other criteria such as program length, format, and longevity. Programs were asked if they would be willing to participate in an optional teen questionnaire which was later removed from the study due to low enrollment.

Site	Program	Experience Based	Project Based	Field Based
MM	Youth Climate Alliance	x		
SMM	KAYSC		x	
MMM	Green Teens		x	x

40–60-minute interviews were conducted over a two-month period with museum staff that were currently overseeing programs that fit the program criteria. The meetings were conducted via a virtual meeting platform and were recorded and transcribed for later analysis. One participant met with the researcher before the interview to discuss their program's research and fit. In addition to the information provided by pre-interview questionnaires, the researcher used the

sites' websites and media pages as a primary source for program information. Following data collection all transcriptions were checked for accuracy, and minor edits were made to remove filler words and technological errors. Responses were then coded using emergent coding to reveal major themes between the three programs.

Results

What factors support the initiation of hands-on environmental programming for teens?

Sparked by prior organizational commitment

Across all three sites, the teen programs were not the first environmentally themed initiative that the museum had embarked on. However, each of the sites' prior work/interest in environmental content varied in depth and breadth of organizational commitment as described here. SMM described their efforts in taking a strong stance on the climate for some time. In discussing the museum's current stance the museum noted, "I know that we are making some pretty strong statements around climate change at the moment, and right now there's an initiative to inform and to kind of centralize the language around climate change across the museum." The museum's position regarding climate change has influenced its programming, leading to programs such as KAYSC that concentrate on environmental topics. MM described how the program came from an updated operational plan, stating "The museum is doing its best to include more climate-related and sustainability-related programming. It's something that's definitely a little bit newer for us, but with our operational planning and everything, it's now been included." As a maritime museum, MMM has historically focused on boats, but a recent effort shifted thinking, MMM reflects, "Recently, last year, we had an exhibit that specifically spoke to environmental advocacy climate change ocean awareness. And so, we've been alert, and after that, a lot more people are more comfortable with it.". This exhibit led to the museum being more open to environmental education, especially on the local front.

Source of funding

Interviews revealed funding to be found in numerous places and sources. All sites shared that the teen programs were not embedded in the organization's operational budget, instead seeking restricted, project-specific funding from other sources. These sources and

strategies differed across the sites. Youth Climate Alliance at Manitoba Museum is fully funded by the Canadian initiative Gen Action, an initiative that supports 30 science centers across Canada to deliver climate action programming to inspire the next generation of climate heroes (Gen Action, n.d.) The site described applying for and receiving the funding. For KAYSC, SMM shared “A large chunk of our funding comes from the Anderson Foundation, so we actually have a recurring operational budget from them. But it's not our only source of funding, we fundraise every year from different foundations and also we take advantage of any federal or state funding.". MMM does not have a dominant funding source and described applying for and securing a large grant through the Department of Education alongside a few small grants. The site also mentioned working with community partners that assist in compensating teen participants. Funding was noted to be one of MMM’s challenges in initiating Green Teens, as their first attempt at securing grant funding did not provide enough resources to get the program up and running. The site reflected, “I think that's probably the biggest factor as to why we started it this year and not the year before because we tried it the year before and we couldn't, we didn't have as much money into it.”

Requires active recruitment

Recruitment was noted across all sites to be challenging. Among all three sites, staff members note that they actively search for participants. As MM put it, “getting teens involved in special environmental stuff, is not the easiest. It's not a sports club.” Sites describe using multiple channels to get the word out about the program. Multiple strategies were described such as advertising on social media, reaching out to students through local high schools, connecting with parents, tabling at events, and partnering with local community organizations dedicated to teen program placement. In addition, MM mentioned the importance of the program lining up with academic calendars in the area. The site discussed a lull in their recent enrollment and deduced that it was likely due to the program’s schedule not lining up with the semester changes and breaks at local high schools.

SMM reported their preferred strategy as, "Ideally, we want to recruit from the middle school program into the high school program.”. Despite this pool of potential participants, the site shared, “Now that doesn't always happen that way, so we work closely with school partners, and community-based organizations that are youth-serving to recruit for our high school program.”. MM’s preferred strategy is a

combination of social media and outreach to teacher communities, "Social media is definitely a big thing, but a lot of students are participants who have said that they heard it from their teachers." MMM also experienced struggle in recruitment, mentioning it as an additional factor for why their program started a year later than it was initially planned, "We have to work to reach out to students in many different ways and many modalities.". Additionally, the site mentioned sports and other extracurriculars as another major obstacle.

Staff Support

For hands-on environmental programming for teens, staffing is generally reflected by the number of participants. For example, MM and MMM both described having a small number of participants (5-10) and therefore are managed by one staff member with the support of other education staff for events or activities. For larger programs such as SMM's KAYSC program which has multiple cohorts numbering from 30-60 students, a robust staff keeps the program functioning. This includes typical staff such as program managers, coordinators, cohort managers, and in this case, even the teens are considered staff members. Despite varying staff sizes, all interviewees note carrying responsibilities outside of their teen programs such as school field trips, middle school programming, camps, etc. When it comes to the background of the staff running these programs, experiences vary. One staff member describes having a background in environmental education, while others had backgrounds in science and general youth programming.

How are hands-on environmental programs for teens structured?

Museum space and resources

Museum space and resources are used in several ways across all interviewed sites. For example, sites detail the use of the museum as a base for their program meetings and events, and the space used for programming varies between programs. For example, SMM describes being fortunate enough to have their own building called the Kitty Anderson Youth Science Center with access to tools and technology for the teens to conduct project-based learning and a place for teen participants to hang out and get comfortable with access to a lounge and kitchen area. Sites with smaller programs such as MM do not have a dedicated building, but still use the museum as their primary place of

meeting and as the venue for their final event in which they invite the community to come learn and interact with their cohort's final project.

Aside from the physical space, programs also utilize the museum's technology and collections. In the Kitty Anderson Science Center at SMM, participants use technological resources such as computers, 3D printers, and other science equipment. For example, the most recent cohort used technology to test a nearby lake's core samples to learn more about fresh water resources in their area. From a museum collections standpoint, MMM recounts their past use of collections items in their programming as tools for learning. "Part of what we talk about is teaching stories and how an object can hold stories. So, we go into the actual museum and kind of talk about why things are on the walls and what their point is. But then also pull things from the collections that are not usually presented and use those objects to learn from."

Cohort model

All sites use a cohort (or crew) model and range from five to ten youths of multiple grade levels depending on the site. Some sites note that their cohort size was solely determined by the amount of funding the program was allotted, while others were simply attempting to gather however many teens wanted to participate. Across all sites, cohorts start the program together, and work towards a common goal throughout, whether to create a final project or to conduct fieldwork. One site described their reasoning for the cohort model as giving teens opportunities to interact with other students across grade levels, schools, and friend groups. Additionally, teens gain the ability to learn more about climate change and its impacts, while being able to communicate with like-minded individuals.

Across all sites, cohorts have regular meeting times that hold steady throughout the program.

Site	Cohort	Meeting Frequency	Meeting Length	Program Length
MM	5-10	Every other week (every week closer to the event)	1 ½ hours	2-3 months
SMM	6-12	Saturdays	4 hours	1 year
MMM	6	Tuesday &Thursday + one full Saturday	2 hours	4 weeks

Community Connections

Interview data reveals community to be an important resource for participating sites. Community organizations support the programs in numerous ways including financial support, educational resources, and social connections. Two sites report inviting community organizations to educate students on fieldwork and job responsibilities. At SMM, for instance, “community networks of support are made up of a university faculty from a couple of universities here. And they're contributing lessons. They're contributing information. They’re contributing space. They’re contributing just their time to come and talk about the field.” Organizations in surrounding areas also support the programs at SMM. Trane Technologies, a company that creates climate solutions for commercial buildings and works on climate mitigation, partnered with the program to introduce technological tools and language focused on climate solutions. The students recently took a field trip to the site where they learned about industry and different climate solutions. MMM reports a similar structure, describing working with local organizations such as the Maine Coast Fishermans Association, and Bigelow Science Labs for participants, “both to learn the topic and then also, again, to be exposed to different fields and stuff.”. MM did not report using their community resources as an educational tool but instead offered an event organized by the teens that was open for attendance. “Through the events that they host, they can see that they can engage people from the community, and it's very inspiring to see when they do their actual event. You will see other people like talking to them, and every time I would ask them for feedback at the end of the program, that's the one thing that they always say, that they enjoy presenting at the event.”.

Program topic

While all programs focus on STEM and environmental subject matter, the topics of projects and field-based work vary. This also extends to the selection process of the topic. For example, MM leaves the topic completely open to the teens, only suggesting a few ideas for inspiration. In the most recent cohort at MM, the teens base their project after Canada’s 2024 Earth Day theme, Planet Vs. Plastic and the teens built a large-scale board game themed around plastic use for a community event (Pineda, 2024). At MMM, teens pick from suggested topics that the program provides. “We give them the two options, and then give them information to narrow down that option, so it's still their choice.” The most recent cohort had the option between the warming of the Gulf of Maine and the working waterfront. The program then has

community members come to speak with the teens to provide information on both topics. At SMM, the topic is often selected by looking for community issues that have STEM-based solutions. “Typically, every year we'll find a group of people that are doing good stuff in the community where youth can go and leverage their growing STEM skills to contribute to community.”. An example of a past theme for KAYSC teens was food justice, in which they worked to increase access to healthy foods in their community through innovative tools and technology (KAYSC, 2016).

How is success within this type of programming defined?

Peer interactions

All sites describe peer interactions as an indicator of success, putting extra emphasis on them as a perceived benefit of the program. Through these interactions, teens can share ideas with those who share similar values, establish relationships outside of school, learn teamwork through projects and fieldwork, and struggle with one another. SMM notes that they intentionally provide a space that allows teens to grow on a personal level in a social environment that connects them to peers. In a report with a focus on youth development insights within the program, a main finding was that activities focused on connecting helped to strengthen bonds between participants. Many youth mention that the structure of the program helped them to get to know one another with one participant sharing, “I guess the KAYSC does a really good job of having you work with your coworkers and getting to know them.” (King, 2021).

At MMM, teens find commonalities that they may not have realized. Though they come from the same geographical area, they may have never interacted previously. "Some came from the same sports team and it's like this other person that they knew so, you just start talking and you realize you have these connections. One of them works at the ice cream place that people use? Oh!”. A measure of success for MM is for teens to realize that they are in the climate fight together. MM describes, “I think just by being surrounded by like-minded individuals; they feel empowered knowing that they're not alone.” The site also recounts a time in which a participant felt discouraged by her classmates throwing a banana into a recycling bin at school, narrating “she (the student) found it very sad that her peers at school don’t seem to care. So I think just having the program for them to meet and talk

even just like a few times in a given month. I think that's what really empowers them."

Adult engagement

Adults were a large part of the site's definitions of success for multiple reasons. MM mentions their teen participants experiencing feelings of frustration towards adults due to their perceived lack of care for the environment. The site details, "For a lot of the participants that I've had so far, one of their biggest feelings is the feeling that adults don't care about anything environmental." The site defined success in terms of adult engagement because they felt as if teens experience feelings of empowerment and accomplishment from interacting with adults in their community while presenting their final project. On the other hand, both SMM and MMM use adults who are already engaged in community or climate work to interact with teens as positive influences, creating more relationships between generations. Both programs use adults from the field to come and talk with students, thus creating connections between participants and a network of people who are willing to answer questions and talk about their work.

Outside of interacting with the public, sites also mention their own relationships with the teens, reporting that their relationships grew over the course of the program. MMM reflects on spending time with the students, and creating meaningful relationships, "I mean, the two of us were always there. We would joke with them. We could just have a conversation with them.". MM mentions a participant from a previous cohort returning to use their new connection for academic advancement, "I noticed one of them reached out recently, they asked for a reference for a scholarship.".

Development of science identity

All sites report feelings of success when a participant connects with their work and develops new skills. SMM reflects, "Some youth, especially the youth that we work with, may not have had positive experiences with STEM.". Because of this, it is important to the museum that they provide affirming interactions with the subject, and the staff has created a unique curriculum that seeks to build a sense of belonging in STEM, while also affirming cultural and identity backgrounds for participants. At SMM, a report on the KAYSC program assessing needs in equity-oriented informal STEM education detailed it as, "Adults wanted young people to also believe that they can actively participate in STEM through redefining and/or reclaiming societal

expectations, perceptions, and stereotypes associated with the backgrounds and identities they embody." (Her, 2021)

Other sites describe success when teens can see themselves making a difference. At MM, teens felt empowered when they felt as if they had a platform and were able to look back on their accomplishments. The site reflects, "Seeing the youth at the end of the program thinking hey, this is like what we created, and they look so proud of it is what I consider success.". At MMM, teens felt empowered when they walked away from the program with new skills and the realization of their worth outside the structure of school. MMM notes, "I think they were able to understand more of who they were." The site details sitting the teens down and discussing their new skills, detailing to the researcher, "You know, what they do matters, what they say matters, how they work together matters, right? And they realize oh yeah, I'm doing this for myself, and for others, and for a greater cause.".

Discussion

The purpose of this research was to explore how science and natural history museums engage teenagers in prolonged, meaningful, environmental programming using hands-on learning practices, with the intention of providing information for museums that are looking to expand their current teen engagement. Though research shows participation in such programming benefits both youth and promotes environmental stewardship (Barrera-Hernández, 2020; Nature-Based Youth, 2020), North American museums are lacking in providing such experiences (Papoulias, 2022). The following discussion will describe the main themes that emerged from this case study and begin to articulate avenues for future research.

According to Hamilton and Christian Ronning (2020), museums hold a unique position in society as trusted information sources and are essential institutions in discussing highly politicized subjects such as climate change. This idea emerged in this case study as programs discussed their use of unique museum resources such as communal space, technology, and collections to execute successful programming. Research shows that access to collections items and exhibits contribute to climate education (Papoulias, 2022), and in this case study, sites described using their collections and gallery space to connect students with the program curriculum. The museum as a physical space was also used as a meeting place for all sites, likely establishing a relationship between teens and the institution. The use of the museum resources in these programs further asserts that a) museums are essential

institutions in providing climate change education, and b) this type of programming can constructively make use of such resources.

A major benefit of these programs was the connections that participants made with peers and with their communities. Peer relationships are highly influential in a teenager's life, and research shows that peer interactions can motivate students in extracurricular activities (Juvonen et al., 2012). This was demonstrated in the site's definitions of success, in which all mentioned inner-cohort interactions to be an important part of their program. These peer relationships were reported to provide access to like-minded individuals, develop group work skills, and create new relationships across diverse age and school groups. This reported data fits with assertions found in previous studies suggesting that climate literacy programs are more effective when young participants can apply their learnings in social practices while immersed in a supportive environment with peers exhibiting similar positive behaviors (Payne, 2005; Satchwell, 2013).

On top of peer connections, community connections emerged as a major theme in the case study. According to Cameron et al. (2013), museums are spaces that allow for dialogue, interactions, and storytelling which provide meaningful and constructive ways of engaging with climate change. These programs implemented this idea by inviting participants to engage with their communities and have interactions in a multitude of ways. For example, programs reported looking into their community for issues that can be solved with STEM solutions, planning and executing events for the community to come to the museum and engage with climate change topics, and inviting members of the community into the program to establish relationships with their participants and serve as role models. These themes link with research showing that connections are important in teen programs because teens care about authentic work that is impactful to them or to their community (Maxson & Linzer, 2016).

This research was built upon the assertion by Corner et al. (2015) that, "young people are more likely to understand, care, and act on climate change if they can engage with it directly and experientially, through some form of educational, outreach, or social activity". The hands-on aspects of these programs were defined through three learning theories: experiential learning, project-based learning, and field-based learning, all of which have different definitions, but are loosely defined as "learning by doing" (Kolb, 2014; Krajcik & Blumenfeld, 2006; Kaur Sidhu, 2014). All three sites were identified to use a hands-on learning approach and reported similar results through utilizing hands-on learning practices, indicating that participation in these programs a) led

to the development of new skills and b) led to the development of teen/staff relationships. These outcomes connect with the general benefits of hands-on learning explored in Handur (2016), reporting, “benefits to hands-on learning include improving students learning / logical thinking while also increasing interactions between educator and student.”.

The main challenge in running hands-on environmental programming for teens that emerged among all sites was recruitment. Each site described similar instances of actively reaching out to their communities to find participants. Sites used many strategies including reaching out through schools, social media advertising, connecting with parents, and using community connections to fill their rosters. One of the main issues that emerged in the interviews was sports and other extracurricular activities in combination with the academic calendars of local high schools. It is however important to note that two of the programs explored in this case study (MM and MMM) are fairly new, having completed only one full cohort. This could be a reason for challenging recruitment and low enrollment as the sites are still working on getting the word out and creating a relationship with the community. SMM has an established program that has been running for decades, and while they still described actively recruiting, they also had a large pool of participants coming from their middle school programs. Therefore, one might infer that longer-standing programs are more visible in their communities and may have an easier time recruiting based on connections.

Implications

The main recommendation emerging out of this case study is for museums to use their status as trusted science communicators in their communities to provide meaningful environmental education opportunities through hands-on learning for teens. This research shows that hands-on environmental programming for teens in museums can be executed in many ways and is a real possibility for many institutions in North America. For museums interested in crafting their own program, this research recommends museums use their resources and community connections for financial backing and educational support. All participating sites described funding their programming through avenues such as grants, partnerships, and other forms of external funding, suggesting that this type of programming can be done without internal operational funding from the museum. It should however be noted that fundraising techniques vary by museum,

are time-consuming, and may require additional skill sets such as grant writing.

When it comes to recruitment (the most discussed challenge), museums have multiple courses of action. Social media is suggested as a starting point. Though many teens likely will not follow the institution, posts will often be seen by parents (whom MMM noted to be a valuable party in the process). Reaching out through local high schools in the form of tabling, fliers, and announcements is also viable. It is important when using this method to be sure that all schools represented in the area are considered. Lastly, reaching out to other organizations serving teens in the community can potentially offer candidates, alongside additional funding.

Future Research

Though this research provides an overview of the initiation, structure, and definitions of success for hands-on environmental programming for teens in museums, it is solely explored from an adult perspective. Initially, this case study was designed with an element focused on gathering teen perspectives to gather information from the demographic that these programs serve. Through the research process, the teen questionnaire was removed due to low enrollment, and definitions of success were speculated only from the staff's perspective. Future research would benefit from gathering teens' points of view so that definitions of success can be explored and analyzed from multiple angles.

In addition, a study aimed at understanding the long-term benefits of programming would add new measures of success indicating whether the programs were successful into the adolescents' adult years. All interviewed sites indicated that they do not keep records of participants post-program. One site mentioned their thoughts about collecting such data, "For me, that's what I'm starting to get curious about is like, what impact are we having in the long term?... Are they getting jobs within, you know, four or five years of graduating from high school? And/or do they end up going to college? And doing, you know, whatever they want to do in college? Or is there something else?"

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Appendix A
Informational Sheet

Graduate Thesis Study - University of Washington

Who:

McKenna Johnson - Graduate Student, Museology - University of Washington

Dr. Meena Selvakumar - Committee Chair, Museology - University of Washington

What:

A Graduate research study to understand how museums engage teens in hands on environmental programming.

Guiding Research Questions:

How do museums initiate hands-on environmental programming for teens?

How are hands-on environmental programs for teens structured?

How is success within this type of programming defined?

When:

February through March 2023

Entails:

40-60 minute recorded Zoom interview

Why?

This research seeks to understand how museums are engaging teens in hands-on environmental programming and will become richer with the participation of museums such as yours who are currently running such programming. The end goal is to contextualize best practices in this type of programming to inform the larger museum community for those interested in establishing similar programs.

Please contact me or my thesis chair if you have any questions. Thank you for your consideration.

McKenna Johnson

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Appendix B
Description of Consent Talking Points for Zoom Interviews

McKenna Johnson

Museology Graduate Program

Consent talking points will include the following:

- Data collectors name and affiliation
- Purpose of the study
- Participation is voluntary (there will be no consequences for opting not to participate)
- Participation will include a 40-60 minute Zoom interview that will be recorded
- Only the researcher will hear the recordings.
- Site names will be published however the subject has the option to not be directly named in the final product if they choose. Subjects may be quoted.
- Participants will introduce themselves before sharing any information.
- Name and phone number of a study contact person will be administered.

Appendix C
Instruments

Pre-Interview Questionnaire

The purpose of this case study is to understand how science and natural history museums engage teenagers in prolonged meaningful environmental programming using hands-on learning practices.

Below are definitions of specific types of hands-on learning. Each of these definitions is centered around the concept of "learning by doing".

Experience-based learning: An engaged learning process where students "learn by doing" and then reflect on the experience. The learning process is completed in four stages: concrete experience (engaging directly in an authentic experience), reflective observation (taking note of what happened and relating to past experiences or conceptual understandings), abstract conceptualization (distilling perceptions into abstract concepts), and active experimentation (using new skills to test new ideas).

Field-based learning: Learning is extended to a site outside of the classroom, exposing learners to a real-world setting. Learners gain knowledge through direct interaction with an environment that reflects taught concepts rather than learning through indirect presentations of the setting such as textbooks or lectures.

Project-based learning: Involves learners designing, developing, and constructing solutions to a problem. Typically, takes learners through the following steps: identifying a problem, devising a solution and path to solving the problem, designing and developing a prototype of the solution, testing and implementing the solution and, refining the solution based on feedback from experts, instructors, and/or peers.

1. Keeping the above definitions in mind, please provide the following information about your museum's teen program.

2. What is the name of your program?

3. How long has your program been running?

4. How many participants does your program currently have? Is this a consistent number or does it deviate based on circumstance?

5. Please name any significant community partners involved in your program, if any. Are these partners rotating or are they a core piece of the program?

6. What is the commitment level required of participants in your program? (how many meetings and how frequently, specific projects or tasks, etc.)

7. Does your program fit the description of any of the above-mentioned hands-on learning practices? If so, please indicate which (you may select more than one).
    - Experience-based learning
    - Field-based learning
    - Project-based learning
    - No, but I would consider it hands-on (reply in comments below)
    - None of the above

Additional comments:

(Q's 8-10 redacted when teen survey was removed)

As part of data collection for this study, the inclusion of teen program participants' perspectives is greatly valued. Would you be willing to distribute a questionnaire to your participants. The questionnaire has four open-ended and four close-ended questions and takes 10-15 minutes to complete. It is anonymous and optional for teen participants. Sites can choose to receive the raw, anonymized data.

8. Our site is willing to forward the teen questionnaire to the participants in my program.
    - Yes
    - No

9. Our site would like to receive raw, anonymized data from our site's teen participants.
    - Yes
    - No

10. Our site conducts its own evaluation of the programs and/or participants and we are willing to share relevant reports.
    - Yes, we collect data and can share reports
    - No, we do not collect data OR are not willing to share reports.

Interview Guide:

1. Please state your name and your job title.
2. What is your museum's general stance on climate/environmental advocacy?

3. Does the museum have a history with environmental action or advocacy in other programming, exhibits, events, etc.
4. What factors led you to start your program?
5. If it wasn't part of the museum's strategic plan, how did you pitch and get the institution on board?
6. How is your program funded?
7. What does staffing for your program look like?
8. What made you choose a hands-on program over other types of programming (such as weekend seminars, online classes etc.)?
9. How do you use your unique position as a museum as a resource in this programming?
10. Do you use collections items, museum space for meetings, etc.?
11. Please describe your recruitment and selection process.
12. Specifically, because this programming is for teens, what are some of the engagement strategies you use for this age group?
13. Describe some of the challenges you've faced in working on this program?
14. How do you believe teens are empowered through participating in this program?
15. In what way(s) is the program designed to help teens gain new skills?
16. How do teens give input or have a voice in the design or implementation of the program?
17. How would you describe success for your program?
18. What are your desired outcomes for participants?
19. Do you stay in contact with previous participants of the programs?
20. If yes, have participants continued to engage with environment/climate topics
21. Have participants leveraged this experience in any other specific ways?