Improving STEM Museum Accessibility in Pennsylvania for Diverse Communities

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Executive Summary: A baseline of scientific literacy among the general population is crucial for laypersons to be able to understand and evaluate data-driven recommendations for addressing public health and environmental crises. While updated formal education standards can help improve knowledge gaps for upcoming generations, they do not reach beyond K-12 students. Informal science, technology, engineering, and mathematics (STEM) public learning spaces, including museums, can potentially have broader impacts; however, the benefits are limited by accessibility. Notably, there is a lack of policy regarding sociocultural barriers that may exclude underrepresented communities from science museums. The Pennsylvania Historical and Museum Commission (PHMC) has demonstrated a willingness to support museum research and resource development throughout Pennsylvania (PA). However, resource availability alone does not guarantee the capability to meet the needs of disadvantaged groups in STEM learning spaces. Thus, there is a need for policy to establish standards to make science museums both more accessible and culturally aware to effectively serve their purposes of public learning and engagement. We recommend that the PHMC requires museums to form diversity and inclusion committees to collect and implement community input about museum content and establishes a requirement for exhibit information to be available in multiple languages to increase visitor diversity and improve public learning outcomes.

I. Introduction and background

Contemporary issues of global wellbeing, including the COVID-19 pandemic and climate change, highlight the intensive need for general scientific literacy. Such literacy allows laypersons to understand the connections between data and behavior recommendations, as well as make informed decisions when information is not as highly publicized or simplified. Thus, a public well-versed in data-driven decision-making is likely to practice behaviors that promote wellbeing. Formal public education provides K-12 students with opportunities to learn science from an established curriculum. Informal education venues, however, can vary their curricula more broadly and can cater to people of all ages. For instance, science, technology, engineering, and mathematics (STEM) museums can encourage exploration play with exhibits and provide opportunities to directly interact with scientific experts and exercises (Marcus et al. 2018; Mujtaba et al. 2018).

Visiting science museums in middle and high school is correlated with higher science academic performance and self-efficacy (beliefs about one's own ability to succeed), even after accounting for factors including parental education and previous science performance (Suter 2014). Informal learning also allows students to make connections between STEM concepts and everyday life, grow excitement for STEM topics and careers, and establish a reference for future learning (National Research Council 2009, 62-64). For unmarried, childless young adults, a single visit to a science museum was correlated with a short-term increase of self-efficacy in science, and for females this effect persisted several months later (Gutwill 2018).

The manner in which scientific information is conveyed and the interactions between museum-goers impact the effectiveness of informal learning. For instance, parent-child conversational interactions and hands-on experiences at exhibits stimulate learning (Marcus et al. 2018), and children have better retention of information when parents read labels and facilitate information connections (National Research Council 2009, 150-151). Additionally, the types of questions or encouragements given to learners can predict the ways that they interact with and explore an exhibit (Willard et al. 2019). These effects suggest that instructions explaining how to think about and interact with exhibits could impact museum visitor learning.

Although science museums offer potentially broad-reaching benefits, finances, geography, inadequate communication for diverse groups, cultural differences, and fear of discrimination are potential barriers for museum visitation, museum learning, and public engagement for minority groups (Stern et al. 2022). As such, there are inequities in museum accessibility.

First, the majority of museum visitors are people of non-minority backgrounds e.g., white, middle-class people who live in urban regions (Dawson 2014). Second, gender disparities extant in STEM fields are reinforced at museums. When staff at over 70 STEM museums worldwide evaluated gender representation in their exhibits and other materials, they perceived 59% of depicted STEM professionals as male and only 38% as women (Association of Science and Technology Centers 2021). Third, regarding socioeconomic barriers, some museums charge for entry, and even museums with free admission can be expensive when considering transportation, food, and souvenirs (Dawson 2014). Last, people who have limited English capabilities experience language barriers that interfere with learning and may make them feel unwelcome at museums with exclusively English signage (Ibid).

Because science communication is more effective when community identities are respected and information presented in a culturally aware manner (Orthia et al. 2021), lack of multilingual or multicultural materials can limit museums' educational effectiveness.

II. Current progress for access to STEM learning in Pennsylvania

Efforts are currently being made to increase scientific literacy through formal K-12 education in Pennsylvania (PA). The Pennsylvania Department of Education has developed initiatives such as the STEM Coalition, a collection of stakeholders who discuss ways to improve equity in STEM learning (Pennsylvania Department of Education n.d., "STEM education in Pennsylvania"), and Pennsylvania Computer Science for All, a summit to teach educators how to provide computer science experiences to their students (Pennsylvania Department of Education n.d., Pennsylvania's CSForAll Summit"). In 2020, the State Board of Education also voted to adopt new sets of science and technology education standards, pending revisions. These standards, set to go into effect in a few years, include the study of climate change and sustainability (Wolfman-Arent 2020), demonstrating the state's interest in teaching students to understand impacts of societal behaviors. However, public school curricula are limited to K-12 students, while information in museums can reach wider demographics, highlighting the importance of making museums as accessible and informative as possible.

In 2019, the PHMC demonstrated an interest in improving museum accessibility by partnering with the PA Federation of Museums and Historical Organizations to help develop the Accessibility Excellence program. This program will publish a self-assessment toolkit for museums to evaluate their current state of accessibility and improve it accordingly (Fox 2019; PA Museums n.d., "Accessibility Excellence Sign-up Page - Pa Museums"; Angell 2021). The toolkit is expected to be released in 2022 and distributed through webinars, conferences, social media, and articles (Mid-Atlantic Association of Museums 2019). However, as there are no government policies requiring museums to use it (or similar tools) for self-evaluation and improvement, there is no guarantee about the extent of its future impacts. Mandating additional museum practices alongside such resources could better ensure that science museum accessibility improves.

III. Policy options

i. Option 1: Require museums to establish diversity and inclusion committees to self-assess and report accessibility progress.

Welcoming diverse communities requires museums to be aware of the kind of exhibits and resources that those communities desire. For example, communities may want to see more diverse representation in exhibits. In some science museums, depictions of women and racial minorities are limited mostly to subjects or patients of science, rather than in a scientist role (Dawson et al. 2020). Additionally, communities may wish to see acknowledgement of mistreatment of racial minorities throughout the history of science research and the lack of diversity of biomedical research subjects (Scharff et al. 2010; Jacewicz 2016).

We propose that the PHMC requires STEM museums to form diversity and inclusion committees that will collect community input through town halls, questionnaires, and/or surveys, and implement this feedback into museum exhibits. These committees should be composed of executive museum staff along with community members reflective of local demographics. The PHMC can allot funding to museums to support the hiring and work of the committee and in return, museums will submit annual reports detailing their progress. Community input has proven effective at the Boston Museum of Fine Arts, which invited community members to provide feedback about whether an exhibit reflected lived experiences prior to opening; subsequently the exhibit received thousands of visitors per week even during the COVID-19 pandemic (Solomon 2021).

Additionally, in recent years, diversity officers and committees have been established at other museums, including the Penn Museum (DiSanto n.d.) and the Florida Museum of Natural History (Florida Museum of Natural History 2022). Committees can also use pre-existing resources such as the Dialogue & Deliberation Toolkit (Association of Science and Technology Centers n.d.), the Gender Representation Toolkit (Association Of Science and Technology Centers 2021) the Broadening Participation Toolkit (Center for Advancement of Informal Science n.d.), and soon the Accessibility Excellence Toolkit (PA Museums n.d., "Accessibility Excellence Sign-up Page - Pa Museums") to identify areas for improvement.

Benefits

Exhibits that reflect diverse community input will have a broader appeal. Additionally, the requirement for museums to report their findings and progress to the PHMC will hold committees accountable for making meaningful changes.

Drawbacks

Community input will be limited to those who are able or willing to attend town halls or complete surveys, and thus may not represent desires of all community groups. PHMC budget constraints may also limit the financial support they can allot to STEM museums aside from pre-existing grant funds.

ii. Option 2: Establish a standard for remote learning materials for science museums.

Remote museum learning, including online classes, trivia nights, online escape rooms, virtual visits, video conferences, digitized collections, and mobile apps, result in increased interaction with more people and increase the likelihood of in-person museum visits (Ennes et al. 2021; Butcher et al. 2022). While many museums developed online learning programs in response to the COVID-19 lockdowns, barriers included a lack of tools and resources, limited funding, staffing limitations, and technology issues (Ennes 2021; Ennes and Lee 2021).

Digitizing even partial museum collections can cost hundreds of thousands of dollars; for example, Chicago's Museum of Science and Industry received a $225,000 grant to create a public database cataloging approximately one-fifth of its artifacts (The Associated Press 2020). The PHMC currently offers Cultural and Historical Support Grants for up to $65,000 per eligible museum, but with a total program cap of under $2 million (Pennsylvania Historical & Museum Commission n.d., "Cultural and Historical Support Grant Program"). Since PA has over 1,000 total museums (PA Museums n.d., "About"), the current PHMC grant budget is not sufficient to support widespread exhibit digitization, let alone in addition to other funded initiatives. Additionally, Historical & Archival Records Care Grants (up to $5,000 per organization) are only

applicable for digital preservation of historical records (Pennsylvania Historical & Museum Commission n.d., "Historical & Archival Records Care Grants").

We propose that the PHMC sets a minimal standard that museums must make public videos of guided exhibit tours or experiment demonstrations (where applicable) if digitizing collections is not feasible. The cost of this depends on museum size and whether the museum hires an external company or rents filming equipment to make the videos; camera rentals can be as low as a few hundred dollars per week (BorrowLenses n.d.). Alternatively, hiring an external service provider to develop image-based virtual exhibit tours can range from $750 to over $3000, depending on provider and exhibit size (360° Virtual Business Tours 2021; Invision Studio n.d.). To support this expansion of remote learning, the PHMC should either expand eligibility for the Historical & Archival Records Care Grants to include digitization of STEM learning materials or allocate part of their overall grant budget specifically for remote learning tool proposals.

Benefits

Requiring museums to provide publicly available videos of exhibit tours and demonstrations would ensure that content from all STEM museums in PA would be able to reach audiences who would be otherwise barred by cost and geography. Additionally, such resources would preserve information about exhibit materials even if the physical exhibits are removed.

Drawbacks

The current PHMC grant budget cannot support comprehensive digitization of museum collections across PA. Requiring only videos of tours and demonstrations limits opportunities for virtual exhibit exploration and discussions. Additionally, remote resources are limited to people with reliable internet access.

iii. Option 3: Require instructional materials in multiple languages to accompany science museum exhibits.

Individuals who are unfamiliar with museums and not comfortably fluent in the museum's primary language can be disoriented when visiting (Archer et al. 2016). Although the extent of the impact of multilingual exhibits alone is unclear, museums that commit to having exhibits with multiple languages often show awareness of other culturally important considerations (Renner et al. 2015). Such culturally aware museums report having diverse visitor profiles reflective of their local communities (Ibid). Yet, cultural competence may not be enough for effective learning.

Training or hands-on modeling can make people more comfortable with science material and with helping others learn (Raynal et al. 2022). We thus propose that the PHMC requires museums to provide instructional materials regarding how to interact with the exhibits to maximize learning in multiple languages based on the population demographics of the region around the museum. Museums could meet this standard in various ways, including translated signage displayed, digital tablets with choice of display language, or physical pamphlets/handouts. Technological options such as apps and QR codes have already been proven feasible at museums worldwide (Ward 2019).

Benefits

Having instructions for how to interact with exhibits can enhance learning for visitors of all ages and enable parents to teach their children even if they, themselves, are not familiar with the material. Multiple languages would allow non-English speakers to learn and feel welcome. Additionally, translating exhibits into common languages does not require constant maintenance, as the proper signage can be generated when each exhibit is put up and then kept for its duration.

Drawbacks

There may be visitors who are not fluent in any of the common languages displayed. Additionally, the more languages that are displayed, the less streamlined exhibit descriptions may be, especially for lower-tech options. Furthermore, translations would have to be reviewed to ensure they are accurate and clear, which would increase the cost.

IV. Policy recommendation

We recommend a combination of **Option 1: The PHMC should require museums to form diversity and inclusion committees to ensure exhibits reflect community input** and **Option 3: The PHMC**

should set a standard requiring multilingual educational materials to accompany exhibits. The combination of both policies would allow for more diverse communities to see the types of exhibits that are most meaningful and useful to them in a manner that will facilitate increased learning. Since facts in isolation are not enough to effectively impart why scientific information is important, it is imperative to provide a welcoming space for people from all backgrounds to learn science informally. Though the adoption of these policies will require financial and time investments, they will encourage more extensive and diverse interactions with STEM subjects in Pennsylvania. This can contribute to a more equally informed and scientifically competent public. Additionally, due to the availability of inclusion-oriented toolkits and the variety of multilingual display options, museums can balance financial and practical considerations. Furthermore, while this memo focuses on STEM museums, increasing public engagement and learning through these policies would be applicable to other public learning spaces as well.

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