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"This Is Exactly the Type of Activity the Museum Should Be Doing All the Time": Exploring an Interactive Museum Exhibit Through Activity Theory

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Abstract

Recent research suggests that the use of natural history collections in museum education can be beneficial for science engagement and public education. This study expands on this extant research through an exploration of a natural history Live Lab exhibit, in which museum faculty, staff, and volunteers prepared paleontological specimens for collection while engaging the public in science education in an interactive exhibit space. Using a framework of activity theory, a mixed-methods survey was distributed to individuals who participated in the Live Lab to explore the interactions of the subjects, objects, tools, outcomes, rules, and labor division in the Live Lab. Twenty-two (n = 22) individuals responded, and their quantitative and qualitative responses to this survey were openly coded and analyzed. This analysis revealed that participants valued engaging the public with paleontology, believed both themselves and the public benefited from the exhibit, and expressed enthusiasm for future interactive and collections-based exhibits. Conversely, some participants also experienced challenges with the physical Live Lab space, feelings of unpreparedness, and hesitations about personal skills when engaging in public outreach. As such, a future Live Lab or similar collections-based exhibits are recommended alongside greater preparation and training for those staffing the exhibit.

Keywords: science education, public engagement, activity theory, collections, interactive exhibit, science communication

Introduction

Natural history collections have historically acted as resources used in academic research, museum exhibits, and public education (Astrin & Schubert, 2017). Collections provide valuable insight into complex biological, environmental, societal, and health concerns impacting modern and past populations, as well as promote discovery and curiosity for upcoming generations of science, technology, engineering, and mathematics (STEM) professionals (Bakker et al., 2020; Powers et al., 2014). Due to recently increased interest in using collections for educational purposes, teaching collections are often curated from larger natural history collections for

undergraduate and graduate students studying the diversity of the natural world across a spatiotemporal landscape (Hiller et al., 2017; Cook et al., 2014). This interest has also led to the digitization of many natural history collections, making databases of interactive, digital materials accessible to larger audiences (Hiller et al., 2017; Cook et al., 2014). These audiences include K-12 educators and classrooms, whose use of web-based collections provides unique, hands-on STEM learning experiences for K-12 students (Powers et al., 2014). Collectively, these experiences have benefits for students, educators, and scientists; students and educators can explore curriculum through specimen-based learning, and scientists can gain new perspectives on their work when facilitating science education with the public (Powers et al., 2014).

Despite teaching collections, even those that are digitized, being accessible to K-12 and higher education students, there remains a disconnect in the engagement of the public with specimen-based science education using natural history collections (Norris, 2017). Furthermore, recent research has evaluated natural history collections as educational tools in formal settings (i.e., classrooms and schools), yet their educational role in informal settings, such as museums, remains less explored. This exploratory study examined a natural history museum in the Southeast United States which attempted to overcome both barriers. The museum did this by establishing an interactive temporary exhibit known as the 'Live Lab', in which a fossil preparation lab was set up in an exhibit space and opened to the public to engage museum guests in an immersive specimen-based learning environment. Those who participated in the Live Lab had the opportunity to work with fossils recovered from a nearby archaeological site while simultaneously engaging the guests in science communication and outreach.

Conceptual Framework

Activity theory was chosen as a conceptual framework to evaluate and analyze the Live Lab for its holistic approach to reviewing an activity as a system of interconnected, individual parts (Park et al., 2013). Using the framework, the Live Lab was analyzed as an educational activity, from which collections-based science education and public engagement within a museum space were explored.

As an evaluative framework commonly used in psychology, activity theory provides a method by which an activity is analyzed by examining the different components of the activity,

their interactions with one another, and the consequent production of the activity (Engeström, 2000). According to Park et al. (2013), the framework defines six distinct elements of an activity:

(1) Subject: the participants of the activity;

(2) Object: the goal(s) the subjects pursued;

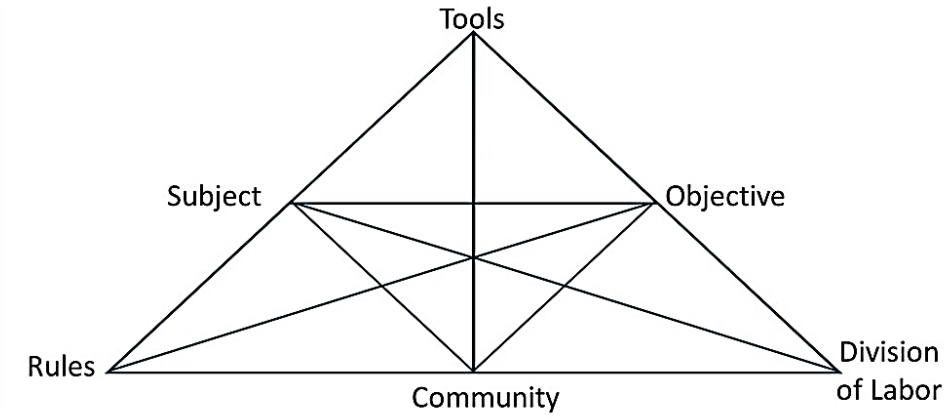
(3) Community: everyone whose role impacted the activity;

(4) Rules: informal and formal customs, norms, and/or rules subjects were expected to follow;

(5) Division of labor: the way tasks were distributed;

(6) Tools: physical or social resources used by subjects to work towards the object.

Under the framework, the different elements come together to produce the activity (represented in Figure 1 as a network of triangles). By analyzing each element independently as well as interactively, one can gain a comprehensive understanding of the activity. This structure and holistic approach is conducive to the multifaceted nature of an educational activity such as the Live Lab.



Source: Adapted from Engestrom (2000, p. 962) and (Park et al., 2013, p. 792)

Figure 1. Activity Theory Triangle

For the purposes of this study, the six elements were defined as follows:

(1) Subject: the participants that worked in the Live Lab;

(2) Object: the goal of the Live Lab was to increase meaningful science engagement experiences with the public through collections-based education;

(3) Community: everyone that needed to work together to achieve the object;

(4) Rules: informal and formal customs, norms, and/or rules subjects were expected to follow in the Live Lab;

(5) Division of labor: how responsibilities, communications, and roles were distributed amongst the participants;

(6) Tools: the physical and social resources used by participants to achieve the object.

Methods

A mixed-methods approach was used to evaluate the various elements of the Live Lab using activity theory. The participants included anyone who worked in the Live Lab whose responsibilities included working with the fossils and engaging with the public. A survey was designed using activity theory to collect both quantitative and qualitative data about participants' experiences with the interactive exhibit through a series of close-ended and open-ended questions. The survey, administered through Qualtrics, was sent to fifty-eight (n = 58) faculty members, staff, volunteers, and students who indicated they participated in the Live Lab through email. Of those emailed, twenty-three (n = 23) responded for a response rate of approximately 39.7%. However, one (n = 1) respondent indicated they did not participate in the Live Lab on the survey, so only twenty-two (n = 22) of the responses were analyzed.

The quantitative and qualitative responses were openly coded to examine trends and patterns in the data within the activity theory framework. A codebook was inductively developed for the responses to the open-ended questions, which was then used by two researchers to code the open-ended responses. The coded data was analyzed for emerging themes and categorized into the respective elements of activity theory they correlated to. This study was determined to be exempt by the University's IRB.

Results

The results provided below are broken down into the six elements of activity theory based on the researchers' analysis and categorization of the survey data.

Subject

Of the twenty-two (n = 22) participants whose responses were analyzed, 73% (n = 16) were volunteers, 14% (n = 3) were graduate students, 9% (n = 2) were museum faculty, and 4% (n = 1) were undergraduate students. Of the participants, 68% (n = 15) had previously participated in public education and outreach, while 32% (n = 7) indicated no prior outreach experience. All participants who were not volunteers (i.e., faculty members, graduate students, and the undergraduate student) had engaged in public education and outreach before they worked in the Live Lab.

Object

Only a few participants agreed that, in general, the public understood the value of paleontology (n = 3) and natural history collections (n = 2) before engaging with the Live Lab. One participant also expressed they were "surprised by the number of local students who were unaware that paleontology was a career option, that there were volunteer opportunities, and that [our university] did paleontology work."

However, many (n = 9) participants agreed that the public benefitted from talking to them in the Live Lab and learned more about the museum, paleontology, and natural history collections after engaging with the exhibit. Participants also reported that they were surprised by how many museum guests demonstrated an interest in the exhibit by asking questions (n=2), how excited the public was to see participants working with the fossils (n=4), and how well received the exhibit was by both school groups and families (n=2).

Community

To achieve the goal of the exhibit, the museum, participants in the Live Lab, and the public needed to work together. The museum was responsible for overseeing the logistic details of the lab (i.e., scheduling, orientation materials, task distribution); the participants were expected to work with the fossils and facilitate science communication with museum guests; and the public

was responsible for engaging with the exhibit and the participants working in it. The combination of these roles produced the activity (i.e., the Live Lab) and contributed to efforts to facilitate collections-based science education and engagement in the exhibit space.

Rules

There were no specified formal or informal rules, customs, or norms regarding expectations or responsibilities in the Live Lab outlined in the survey responses. There were, however, emerging themes in participants' motivations for working in the Live Lab; personal interest (n = 15) and a value of science engagement (n = 14) were among the most popular motivations, producing an informal norm that informed participation in the Live Lab. Additional motivations included a desire to continue ongoing volunteer activities (n = 9), a perceived value in sharing research with the public (n = 7), and enjoyment of public engagement (n = 6).

Division of Labor

Participants fulfilled several roles in the Live Lab. These included (1) engaging in communication with children, adults, and intergenerational groups and (2) demonstrating how they worked in the exhibit for museum guests. Only two (n = 2) respondents reported not engaging with the public at all when working in the Live Lab space. Other results indicate that some of the staff, faculty, volunteers, and students participated in science communication and education more than others due to preferences in engagement frequency or perceived personality-driven characteristics like introversion/extroversion. This led to some ambiguity in the delegation of responsibilities and tasks, but one (n=1) participant stated this was resolved throughout their time in the Live Lab.

When asked whether the communication and supervision surrounding the Live Lab were sufficient to support their responsibilities, 87% of the 15 participants who responded to the question (n = 13) agreed the communication and supervision were adequate. One of the remaining two respondents requested more supervision from museum faculty and graduate students, while the other expressed frustrations with other participants "judg[ing] me a little on how I talked about the material."

Tools

The tools participants required for engagement included (1) physical tools, (2) preparation for engagement, and (3) communications support.

physical tools.

Physical tools include any spaces or materials participants interacted with to prepare the paleontological specimens and engage in science communication. Given that the Live Lab was an active lab environment, some participants encountered negative experiences with the exhibit space such as noise produced by loud tools, insufficient lab infrastructure, and lighting issues that presented challenges with communication and engagement. Additionally, many participants suggested that more educational tools be provided to them in the Live Lab for both them and the public to engage with. These suggestions included hands-on interactive models, activities, and demonstrative tools, all of which were suggested to help explain scientific concepts, keep museum guests engaged, and support participants during outreach.

preparation for engagement.

Some participants also reported that they did not feel adequately prepared for engagement before working in the Live Lab due to concerns with learning the content, a lack of orientation and support materials, and hesitations with personal communication skills. While 56% of the 18 participants that responded (n=10) agreed that they had enough background knowledge to talk with museum guests about the work they were doing, others suggested that reference materials provided by the museum would have been helpful. Suggestions included frequently asked questions (FAQ) sheets for reference, handouts with paleontological information, and visual aids for participants to use in the exhibit when answering questions and communicating with the public about scientific topics.

communications support.

Support for outreach and science communication was an essential component of the tools involved in the Live Lab. Participants indicated varying levels of comfort with communication and public engagement in the exhibit (see Table 1).

Table 1. Participant Communication and Public Engagement Comfortability

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am comfortable engaging with museum visitors with my work.	0	1	6	11	0
I have the skills needed to communicate effectively with museum visitors while in the Live Lab.	0	1	6	10	0
I have the skills needed to engage audiences of different age groups.	0	1	9	8	0
I have the skills needed to engage audiences of varying education levels.	0	1	9	8	0
I have the skills needed to engage audiences of different cultural backgrounds.	0	3	9	6	0

There were also mixed perceptions of potential communications training before engagement in the exhibit. Of the eighteen (n = 18) respondents, 39% (n = 7) strongly disagreed or disagreed, 39% (n = 7) were neutral, and 22% (n = 4) agreed that they would have benefited from some training about how to talk with museum guests about the paleontology lab. Of those respondents, 50% (n = 9) disagreed, 17% (n = 3) were neutral, and 33% (n = 6) agreed that they would be interested in professional learning opportunities on how to effectively engage museum visitors in the work they did in the exhibit.

Final Thoughts

Following their participation in the exhibit, thirteen (n = 13) participants agreed they benefited from working in the Live Lab, twelve (n = 12) participants agreed that they would recommend participation in the Live Lab to others, and eleven (n = 11) expressed interest in participating in another Live Lab in the future. One participant even stated, “This is exactly the type of activity the museum should be doing all the time,” and another suggested, “Let’s do it again!”

Discussion

This study explored a natural history museum’s incorporation of collections-based science education into an interactive exhibit through the lens of activity theory. An important aspect of an analysis of the exhibit is an understanding of the role of the participants (i.e., ‘subjects’ under the activity theory framework) in the production of the Live Lab. As most surveyed participants were volunteers, motivations for participation were an essential component of subject engagement with both their work in the Live Lab and their communication with the public.

These motivations included personal interest, a value of science engagement, and a perceived lack of public awareness of paleontology and natural history collections, which prompted most participants to work in the Live Lab. Therefore, a desire to contribute to science education serves as an informal norm that informs participant engagement with the exhibit and the public. It can therefore be argued that a desire to contribute, regardless of professional background, is an essential component of a successful educational activity like the Live Lab, for such can impact subject behavior and consequent public experiences in an exhibit space.

The combination of the subjects' enthusiasm with perceived enthusiasm from the public illustrates that the ultimate goal (i.e., the 'object' under the activity theory framework) of the Live Lab to increase meaningful science engagement experiences with the public through collections-based education was mostly achieved. Participants' desire to participate in future interactive exhibits coupled with reportedly high levels of public engagement with the Live Lab might also indicate general interest in the interactive exhibit design used. It is therefore recommended that similar interactive exhibits be established at the museum to continue fostering public science education through collections-based engagement. Given this premise, future research opportunities exist that might explore the public's perception of interactive exhibits for a more comprehensive analysis of the Live Lab model from all aspects of the activity's community.

Other results from this study present an opportunity for improvement before the development and facilitation of other Live Labs at the museum. After considering that most participants were volunteers who did not have a background in paleontology or collections work, and only about half the participants agreed they were confident in their background knowledge when engaging with guests, it might have been beneficial for the museum to provide volunteers and other interested participants with supplemental information about paleontology, natural history collections, or the museum. This could take the form of physical reference materials for use in the exhibit or orientation supplies provided before participants engage with the public to establish a supplementary knowledge base for those who do not work with collections regularly. Physical tools like those suggested by participants (i.e., demonstrative tools, hands-on activities) may also allow future participants in Live Lab exhibits to provide guests with more in-depth,

interactive explanations of scientific concepts or processes that can promote enhanced understandings of science amongst the public.

Enhanced communication support may also be beneficial for some participants in future interactive exhibit spaces. A majority of participants reported self-confidence in their abilities to engage and communicate with museum guests, as well as disinterest in holistic communications training. However there was less self-confidence reported when engaging with guests of varying age groups, education levels, and cultural backgrounds. Targeted communications training is therefore suggested for future Live Labs to ensure all participants can engage diverse groups in culturally responsive and sustaining science education while in interactive exhibit spaces. It is also important to consider that some participants may gravitate more toward a communicative role in the exhibit while others might prefer to do more independent work with the collections. These differences can help inform the division of labor suggestions from the museum, as task allocation can be determined by participants' strengths and motivations. Regardless, the opportunity for public engagement still exists for all participants in the exhibit space, so specified science communication training, delegated tasks, and supplemental materials should be provided by the museum to ensure all participants feel supported before engaging with the public.

Conclusion

Natural history collections are powerful educational tools for public engagement in science education. This study explored a natural history museum's interactive Live Lab exhibit that used paleontological collections to facilitate engagement between exhibit participants and the public. Activity theory was used as a conceptual framework to evaluate the subject, object, tools, division of labor, community, and rules of the Live Lab, which provided a detailed analysis of the independent elements that interacted to produce the Live Lab as an educational activity. Participants cited personal interest and a desire to contribute to science education as primary motivations for their involvement with the Live Lab and encouraged similar interactive exhibit spaces in the future. There are, however, areas of improvement for exhibits that follow the Live Lab model to ensure participants are supported during engagement with the public, particularly with supportive and preparatory materials, specific task distribution, and targeted science

communication training. Future interactive, collections-based exhibits are consequently recommended along with greater support provided by the museum to participants.

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