A Bug’s-Eye View: Examining the Impact of The Bug Squad Exhibit at a Local Children’s Museum

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Cover Page Footnote
I would like to thank the families for participating and contributing to this research. I would also like to thank Professor Amber Simpson for her continued support and guidance throughout this process. Additionally, to The Discovery Center staff and Executive Director, Brenda Meyers, and my research partners Abby Hamel, Eva He, and Joseph Darrell without whom this research would not have been possible.
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Abstract

To be sustained and prosper as a business, children museums must appease the children while also retaining their caregivers. In this way, it is important to consider the interactive exhibits chosen for children that will spark play, creativity, engagement, and development. Hands-on playing is vital in the development of a child, as it promotes their ability to progress socially, emotionally, and cognitively. Specifically, The Bug Squad at the Discovery Center in Binghamton, NY targeted this need to play directly, as its combination of hands-on learning and activities gauged the attention of the children throughout the museum. The purpose of this mixed-methods research study was to understand the level of engagement throughout the various elements within the museum’s exhibit and how this level of engagement prompted these elements to remain permanent. Data was collected through observation of children’s engagement and a short, five question survey to understand the parent’s point of view. We hypothesize that the elements that expand beyond their main purpose and promote creativity and socialization will attract more engagement. These potential findings can contribute to the sustainability and retention rate of other Children Museums with the implementation of, The Bug Squad.

Keywords: children’s museum, engagement, creativity, interaction, play, learn, motor skills
Introduction

In an age of educational institutions, children's museums have proven to demonstrate dynamic spaces for children to wonder, explore, foster creativity, and facilitate learning experiences through engaging in play (Alexander et al., 2017). There is a larger focus on creating design elements that promote expository and interactive play rather than curating historical pieces for display. This unique approach distinguishes children's museums apart from other museums and appeals to a specific audience: caregivers and children. It is widely recognized that hands-on playing is crucial in the development of a child, as it fosters their social, emotional, and cognitive abilities (Ginsburg, 2007). Children's museums give us insight into how valued play is in children’s upbringing and promoting learning in communities.

As noted by Ginsburg (2007), hands-on play is vital for children’s ability to develop socially and cognitively. By synthesizing current literature and identifying gaps, a comprehensive understanding of factors that influence children’s engagement in exhibits can be used to design elements that not only serve as effective educational resources but also provide enjoyment for caregivers and children. In this research study, researchers further utilized the various factors and design elements from prior literature to understand how a traveling exhibit, The Bug Squad, hosted in the Discovery Center provided an opportunity for children, ages 2-12, to interact and engage with the new exhibit, and how this influenced a caregiver’s decision to return.

Literature Review

Studies that were chosen were full-text and published between 2000 and 2023, and since the Discovery Center believes in learning through play, the purpose of the chosen research had to
focus on play with learning occurring as a byproduct. Additionally, it is important to collect both sides to an experience as there are dynamics between children and their caregivers in a museum environment. When choosing studies, research that involved or related to children between the ages of 2 to 8 and museums that incorporated multiple types of exhibits that aim to incite play through multiple means were also considered as vital inclusion. The methods the studies used were not considered in the inclusion and exclusion criteria. Instead, there was a more general purpose to focus on the conclusion the researchers made as it related to their purpose of conducting it, and how the sum of the studies overlapped to build a full picture of a child’s experience in a museum. The library returned 650 results. The 14 articles selected from the previously mentioned criteria were grouped together based on two characteristics: children's engagement and caregiver’s perspective. Children's engagement included research that focused on play, learning, or both of children; these distinctions created subcategories: promoting play and promoting learning. Two articles were extracted as a result of this process due to their irrelevance and poor overlap with the other 12 articles. In some cases, there was an experimental design involved followed by a survey or interview as demonstrated in the research conducted by Franse et al., (2020). In addition, most studies that chose to conduct interviews or surveys after the initial observation period were to collect data from caregivers as demonstrated in Eardley et al., (2018).

**Children’s Engagement**

Researchers who focused on children in their studies found that play and learning experiences are enhanced when there is increased parent involvement, prior knowledge, and open-endedness from the museum exhibit elements (Letourneau et al., 2017; Piscitelli & Penfold,
A commonality between the research is that through observation, it was found that museums have opportunities to create exhibits that encourage children to “learn through play” as it naturally occurs through exploration and open-ended experiences (Letourneau et al., 2017). For studies that did not focus on how the children learned, they still admitted that “exhibit design features differentially encourage child and parent engagement, which in turn may translate to learning” (Caporaso et al., 2022, p. 210). Thus, increasing the engagement children experience during meaningful play would promote the development of the child’s creativity, recognition, and understanding of their environment (Brown et al, 2019; Letourneau et al., 2017).

Exhibits that showed open-endedness, value creativity, and included multisensory aspects showed an increase in children's engagement, which in turn increased their ability to learn (Brown et al, 2019; Eardley et al., 2018; Piscitelli & Penfold, 2015). In a study conducted by Tougu et al. (2017), it was found that when museums incorporated open-endedness it was found that “more spatial play experience was associated with better family problem solving success”. Examples of incorporating open-ended elements into exhibits include creating environments that incorporate physical aspects such as building blocks and going beyond visual content with interactions (Eardley et al., 2018; Piscitelli & Penfold, 2015).

Beyond creating an open-ended educational environment, results showed that when children and caregivers have prior knowledge about the goals of the exhibit and are given some direction, play and learning increase (Piscitelli & Penfold, 2015; Tougu et al. 2017). To build off Tougu et al. (2017) study, if the spatial play was shown alongside a demonstration there was “better success by the children problem solving alone” (p. 10). Furthermore, in the study conducted by Piscitelli & Penfold (2015), it was found that if children were shown how to play
various activities in the Light Playspace it promoted reinforcement during their individual exploratory play. Overall, if children are given guidance by the staff or their caregivers, there is an increase in their ability to play with learning outcomes. If caregivers prompt their children, interact in play with them, and use number talk, it showed an increase in a child’s ability to play and learn (Braham et al., 2018; Franse et al., 2020; Shine & Acosta, 2000). For example, in the study conducted by Braham et al. (2018), it was found that children had an increase in their Spontaneous Focus on Number (SFON) scores (an exam that tracks focus and learning) when parents used number talk while playing in the grocery store. However, there was no measure of how long these results lasted after parent-guided play.

One study also argued that museums that demonstrate inclusion in children’s culture promoted creativity and should create exhibits based on these elements “rather than imposing an adult agenda of learning and didacticism” (Yates et al., 2022, p. 74). Collectively, these studies show that when it comes to creating an exhibit it is important to focus on how it will increase children's engagement, and parental involvement, and to incorporate demonstrations as these will increase a child’s ability to naturally learn through play.

**Caregiver Perspective**

Caregivers bring children to museums to find enjoyment, promote learning, and typically engage with their children (Brown et al, 2019). In a study conducted by Shine and Acosta (2000), it was found that caregivers are more likely to pretend to play with their children and show support when they feel there is a sense of privacy in a museum. Otherwise, caregivers are more likely to stand back and observe not because they want children to experience things on their own but rather because they are self-conscious (Letourneau et al., 2017). This has implications
for how museums should value an adult’s perspective and make exhibits inviting to them in addition to children. Furthermore, caregivers need direction and pre-knowledge to interact with their children effectively as shown in a study conducted by Franse et al. (2020) in which it was found that caregivers with pre-knowledge stayed at the exhibit for longer. Without pre-knowledge parents were found to quickly move on from an activity more quickly and feel more uncertain on how to be more involved (Franse et al., 2020; Letourneau et al., 2017).

When it comes to determining which museum a family will visit, it was found that caregivers value the opinion of the child “in all of the four decision roles – initiator, information gatherer, evaluator, and decision maker” (Wu et al., 2010, p. 723). It is important to leave a long-lasting impression on a child after their visit as such impressions are a driving force behind returning from a caregiver's perspective as they can judge their own satisfaction from engaging with the museum (Wu et al., 2010). This can be enhanced by promoting parent-child interaction as the benefits that were mentioned in the previous section enhance play and learning. Thus, museums should also cater to the needs of caregivers by providing direction and privacy so that more meaningful play and interaction can occur.

Discussion

Examining results from the literature review collectively showed that there was a persistent dynamic between caregivers and children’s learning in a museum through play (Brown et al, 2019; Letourneau et al., 2017; Piscitelli & Penfold, 2015; Tougu et al., 2017). Trends in the research show that incorporating spaces that feel safe, promote creativity, cultural heritage, familiarity, and are open-ended in nature promotes spatial play in children and learning (Eardley et al., 2018; Piscitelli & Penfold, 2015; Yates et al., 2022). In addition to providing children the
ability to interact with their imaginative play, caregivers giving children prompts, participating in pretend play, and providing direction also reaps benefits in a child’s overall experience (Brown et al., 2019; Piscitelli & Penfold, 2015; Shine & Acosta 2000). It is crucial to design exhibits with both adults and children in mind. Adults should feel a sense of privacy when interacting with their children and children should have the opportunity to go beyond the exhibit design through their creativity. Furthermore, by providing direction to both caregivers and children about the exhibit and the activities that may be performed, both caregiver-child interactions and engagement will increase (Franse et al., 2020; Tougu et al., 2017). Museums should consider articulating how play reinforces learning both in cognitive and social domains and use words familiar to caregivers that prompt them to use language associated with learning (Letourneau et al., 2017). Finally, it is important to recognize the role of museums since if designed well, an environment that encourages a sense of belonging can be created among children and caregivers who behave as a “third teacher” (Piscitelli & Penfold, 2015).

Research Study Overview

Research conducted in the Discovery Center focused on one travel exhibit, The Bug Squad. The data was collected by four undergraduate Binghamton University students in the Source Project under the supervision of Amber Simpson and Brenda Meyers over three months. The focus of the research revolves around two research questions: How do children, ages 2-12, at a local children’s museum interact and engage with the new exhibit, The Bug Squad?; How does this influence the parent’s decision to return?
**Location**

The Discovery Center of the Southern Tier was established in 1984 with the foundational belief that “play is an essential part of learning and exploration of the world leads children to self-discovery” (The Discovery Center of the Southern Tier, n.d.). With over 30 exhibits and an interactive garden, The Discovery Center is the only hands-on museum in Binghamton, New York. In an attempt to maintain interest and momentum, the current executive director, Brenda Meyers, agreed to implement a traveling exhibit called *The Bug Squad*. *The Bug Squad*, produced by the Omaha Children’s Museum, was installed in February 2023 and was open to the public until April 30th, 2023. Through this exhibit, the museum aimed to develop curiosity about bugs like butterflies, bees, ants, and more in a hands-on learning environment. The Bug Squad is composed of eight different stations of play-and-learn activities, each represented by an interactive animatronic bug. The following elements were in the exhibit:

- **Ant Colony Climber**: A jungle gym with a slide and tunnel represented by an ant named ABBI. This element showcases the environment of ants through jungle gym elements.

- **Chrysalis Spinner**: A freestanding spinner represented by a butterfly named Mariposa. This element reflects the transformation of caterpillars into butterflies and flight.

- **Drone Cockpit**: A joystick-controlled POV visual game represented by a dragonfly named Malcolm. This element demonstrates how bugs fly through the air in various environments.

- **Honey Headquarters**: A building block station represented by a bee named Miss Belle. This element incorporates hexagonal-shaped building blocks to mimic honeycomb.

- **Giant Jumps**: A single-person trampoline represented by a grasshopper named
Domonic. This element imitates the jumps of grasshoppers.

- **Lumineer’s Lair:** A glow-in-the-dark drawing station represented by a firefly named Phoebe. This element utilizes flashlights to draw on a blank wall to mimic firefly illumination.

- **Pollinator Power:** A pulley cannon ball represented by Miss Belle. This element alludes to pollination occurring by shooting yellow balls out of a cannon.

- **Wing Pattern Maker:** A projected butterfly silhouette represented by Mariposa. This element lets children use translucent colorful slabs to change the pattern of the projected butterfly.

In addition, the animatronic bugs are prompted to talk and share facts about their species when movement around them is sensed. They are also accompanied by a sign with written information about their superpowers and characteristics. Moreover, the exhibit also incorporated a large hive that children can enter and watch a documentary about bees or climb a staircase into a treehouse. This element is not part of *The Bug Squad* and was built prior to the installation of the exhibit. Furthermore, there is a pre-installed mini theater with puppets and a ball pit located around the hive. Observations focused on the eight elements of *The Bug Squad* and a research notice was placed by the entrance to notify families observation is actively taken in the exhibit on their children’s experiences.

**Methods**

*Authors Positionality*

As an undergraduate researcher in the field of psychology and other related fields, I have chosen to study children's and parents' experiences in Children's Museums to further understand
the dynamic roles that influence engagement and the decision to return. I acknowledge that this research was conducted under the supervision of a Binghamton professor; however, no external influences were pressuring for certain outcomes of the study.

**Data Source and Analysis**

A convergent parallel mixed methods approach was used to conduct this research (Moeller et al., 2016). The qualitative aspect included structured observation, meaning that there was a set of defined characteristics to pay attention to established before observations occurred. The general procedure included taking handwritten descriptions of each child, how long children stayed at each element, the engagement level shown in each observation, interactions occurring between children and caregivers, and interactions between the children and the element itself. The observations occurred on Saturdays from 10 am to 11:45 am, which were noted as the busiest hours. The four researchers spread themselves out and were assigned two elements to take observations on during that time span. Observations were taken on two separate occasions in total and researchers rotated their position to take observations on four unique elements in total. This way, two elements would have been observed by two different researchers. Before coming to the location to take observations, the researchers discussed examples of the kind of observations they may encounter and would note. There was an agreement to code each child based on their clothing, gender, or other notable trait. Furthermore, observations that pertained to facial expressions, physical actions, and comments made by the children would be recorded without assumption of their feelings. This method was agreed on before the observation to lessen bias or misjudgment from the researcher, given that each researcher worked independently of the other when observing their assigned elements.
The quantitative aspect focused on caregivers and included a six-question survey consisting of four multiple-choice questions and two open-ended questions. The multiple-choice questions were scale-type questions that asked caregivers to provide perspective on their child’s or children’s perception of the exhibit and their opinion of it as well. The scale ranged from 1 to 4, with 1 associated with negative feelings and 4 representing positive feelings. The open-ended questions directly asked which element their child/children most enjoyed and to note the gender and age of their child/children. The survey was voluntary, located at the entrance to the exhibit, and provided to caregivers while the exhibit was open to the public.

Descriptive coding was used by each researcher to summarize their observation notes and open-ended questions (Saldaña, 2015). Descriptive coding is the utilization of short words and phrases that are found repeatedly and allocated into patterns and themes. The following descriptive codes and their summary is listed below:

- **Short time span:** observed child spend only seconds engaging with an element
• Long time span: observed child spend more than 30 seconds with an element
• Gross Motor: observed child climb, jump, tug, spin, or display other motor skills with elements
• Enthusiasm: observed child smile, laugh, and/or show excitement
• Return: observe the child return to an element after leaving it
• Creativity: observe the child use element beyond its purpose or use imaginative play
• Interaction: observe the child encourage other children or caregivers to play with them

From the descriptive codes, each researcher looked over their observations and the observations of another researcher, who examined the same elements during another observational session, to determine patterns by finding commonalities, overlap, and prevalence. Such patterns included children spending more time with elements while displaying gross motor skills, children spending a short amount of time at an element while depicting a lack of enthusiasm, and children interacting with other children and caregivers while displaying creativity. Creative and gross motor elements had more engagement. Two themes were formed from the identified patterns:

• Gross motor skills and creativity increase time spent at an element
• Familiarity is a factor in time spent at an element

The themes condense the identified patterns, for example, it was observed that children spent more time at the Pollinator Power and Ant Colony Climber as they exhibited motor skills such as tugging the pulley, going down the slide, and crawling in the tunnel. These themes will be further elaborated on in the next section.
Over the two months of collecting surveys, over 65 surveys were completed by a caregiver. The results of the survey were entered into a Google Sheet. From there, the total number of fours, threes, twos, and ones were counted with Sheet commands for each multiple-choice question. The open-ended questions used the same aforementioned descriptive coding in addition to grouping responses that described similar elements from the exhibit to determine which were most popular.

Results

Results from the survey indicated that caregivers and children highly enjoyed *The Bug Squad*. To the question, “Do you believe your child/children enjoyed this new exhibit?”, 100% of the respondents indicated that their child/children either liked or loved the exhibit. Additionally, some respondents also stated that there were “So many learning opportunities! They loved the bugs moving & all of the science!” and “My child absolutely loves the bug squad. This is the only room he cares to play in. Would love for it to stay”.

To the question, “How likely are you and your children to return to the Bug Squad?”, 43 (66.2%) caregivers responded that they would definitely return, 15 (23.1%) stated they most likely would, and 6 (9.2%) indicated that they might return. Only 1 respondent said that they were likely not to return and did not expand on the open-ended questions. To the question, “How likely would you and your child/children recommend this exhibit to be permanent?”, 44 (67.7%) of caregivers strongly recommended this exhibit to become permanent, 13 (20.0%) would like this exhibit to become permanent, 5 (7.7%) were indifferent to this exhibit becoming permanent, and 3 (4.6%) indicated that they don’t suggest this exhibit to become permanent. Moreover, some caregivers stated in the open-ended responses “This is like my new favorite room” and
disappointment with the animatronics through responses such as “The animatronics were disappointing. If there was a button to activate at will, it would be perfect! But we stood in front of them + they did nothing + bored the lads”.

Results from observations revealed that children are quick to move between various elements of the exhibit and show indifference towards less engaging elements. For example, it was observed that children and caregivers moved on quickly from the *Lumineer’s Lair* and some expressed confusion about the activity as one child said, “I am not sure how this works” and a parent responded “Me too”, followed by a gesture to move on. This example demonstrates an unfamiliarity towards the element and a lack of engagement with it as well. Similar observations were made at the element *Wing Pattern Maker* as caregivers and children expressed confusion in an attempt to protect their creation and spent a short amount of time at the element.

Additionally, it was observed that children spent little time in the element, *Drone Cockpit*. Observations included children moving on quickly after aimlessly moving the joystick and smashing buttons alongside confusion by caregivers. It was observed that children moved on quickly from elements that lacked interaction and had creative limitations. This was observed at the element, *Giant Jumps*. This element only allowed one child to jump up and down.

Figure 3: Children drawing in the *Lumineer’s Lair*
Moreover, there was no creative play noted in the observations in this activity. Consistently, it was observed that children spent less than 20 seconds jumping until they ran off to another element. Similarly, at the element *Chrysalis Spinner*, which involved spinning on a freestanding spinner, it was observed that children spent a short amount of time at the element and were limited to only spinning.

However, elements that incorporated gross motor skills and did not have creative limitations were observed to have high enthusiasm and long-term engagement. This was observed most in the elements *Honey Headquarters* and *Pollinator Power* as these elements were placed close to one another and used in play in conjunction with one another. The Power Pollinator involved loading cannonballs into the cannon and then launching them by pulling a
rope. The Honey Headquarters involved building with hexagonal-shaped blocks. Although they are two separate elements, children exhibited play by creating games by combining the two elements.

It was observed that caregivers and children interacted with each other to build a hexagonal wall, preceded by the caregivers encouraging their child/children to launch the cannons into the wall. Excitement was shown through cheers and clapping when the wall was destroyed. Additionally, interaction between the children and caregivers was observed when caregivers held a basket in an attempt to catch the balls launched by children. In contrast to the Giant Jumps element, these two elements did not exhibit creative limitations, and different families were observed to come up with similar games that promoted play and extended the time spent at the elements. Similar observations were also noted from observing play in the element, Ant Colony Climber. Play in this element included children climbing through tunnels, caregivers following them through tunnels, children going down the slide, and caregivers encouraging their child/children to repeat these actions.

Figure 5: Photo on the left depicts a child launching cannons into a wall of hexagonal blocks and a basket. Photo on the right depicts another child pulling on the rope to launch cannonballs into a wall of hexagonal blocks. Elements.


**Discussion**

Qualitative Data revealed that children are quick to move between various elements of the exhibit and show indifference towards limiting elements while results from the survey indicated that *The Bug Squad* is highly enjoyed by both children and caregivers.

The observation data depicts that children show extended engagement through play and creativity with elements such as the Pollinator, an element that was shown to be used beyond its purpose and in conjunction with the Honey Headquarters. This aligns with the conclusions drawn by Eardley et al. (2018) and Piscitelli and Penfold (2015). In contrast, elements such as the *Mantis Camo* and *Drone Cockpit*, which were limited to their functions resulted in aimless and short-lived engagement among the children. There were also many scenarios in which caregivers encouraged their children to engage longer with the elements by either participating with them, explaining the activity, or simply asking them to. Moreover, children displayed prolonged engagement, and parents interacted more with their children with activities that were familiar to them and straightforward to them, as shown through the long-term engagement in *Pollinator Power* in contrast to the short-term engagement observed in *Drone Cockpit*. This reinforces the conclusions made by Piscitelli and Penfold (2015) and Franse et al. (2020) in which they found that creating familiarity through demonstrations or pre-knowledge promoted exploratory play and prolonged engagement. In addition, although not included in our initial curiosity, girls showed more engagement with the *Wing Pattern Maker* than boys, which sparks curiosity for future research into how specific aspects prompt more engagement with a certain gender.

The survey showed that both caregivers and children loved the exhibit and are likely to return to The Discovery Center for it. Specifically, caregivers noticed that their children enjoyed
elements that involve gross motor skills such as climbing, jumping, and running. Most dislikes referred to the animatronic bugs themselves as they went off with motion, which resulted in multiple animatronics talking at the same time, repetitively. It is also important to note that the surveys could be biased because they were voluntary to fill out and visitors may have chosen to complete one if they either really loved or really disliked the exhibit.

**Conclusion**

Results demonstrate that elements that promote gross motor skills and creativity aroused engagement from children in the exhibit, *The Bug Squad*. Elements that lacked these qualities received brief interest from children. Additionally, a caregiver’s decision to return is related to the enjoyment expressed by their children either directly or through their own observations of their child’s play. Therefore, children’s museums should focus on implementing exhibits that are instinctual in nature and incorporate motor skills to encourage elongated play and satisfaction among children and their caregivers. Designers of museum exhibits for children should be thoughtful in their selection and consider incorporating pulleys, slides, building blocks, and removable objects such as balls to promote gross motor skills and utilize familiarity. Moreover, intrinsic, or familiar elements may parallel real-world environments, such as grocery stores or construction sites. These elements have the potential of creating immense play that captivates children’s interest and provide more opportunities for parents to join as they would also be familiar with such components. No conclusion can be made regarding cultural significance on promoting spatial play and learning. It is important to note that these results are made from observational research conducted in the museum twice, with each session lasting roughly an hour and a half, by only four researchers. Consequently, there was limited exposure to interactions,
certain interactions may have been missed, and the entire scope of a typical museum day was not examined.
References


Introduction

The importance of museums as spaces for learning and engagement has been highlighted in various studies. 


The Discovery Center of the Southern Tier. (n.d.). *About us.* Retrieved from https://thediscoverycenter.org/