



OPEN ACCESS

EDITED BY

Joseph Edward Michaelis,
University of Illinois Chicago, United States

REVIEWED BY

Haipeng Mi,
Tsinghua University, China
Cucuk Wawan Budiyanoto,
Sebelas Maret University, Indonesia

*CORRESPONDENCE

Paul N. Reimer
✉ paul@aimscenter.org

[†]These authors have contributed equally to this work and share first authorship

RECEIVED 16 February 2024

ACCEPTED 24 September 2024

PUBLISHED 08 October 2024

CITATION

Reimer PN and Moreno C (2024) Invitations to play: designing for family engagement through STEAM exhibits in community settings.
Front. Comput. Sci. 6:1387202.
doi: 10.3389/fcomp.2024.1387202

COPYRIGHT

© 2024 Reimer and Moreno. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Invitations to play: designing for family engagement through STEAM exhibits in community settings

Paul N. Reimer^{1*†} and Celeste Moreno^{2†}

¹AIMS Center for Math and Science Education, Fresno, CA, United States, ²Atlas Institute, University of Colorado, Boulder, Boulder, CO, United States

Intergenerational play between children and their family members provides a rich context that can inform family-centered interaction design. Despite research on the roles and perspectives in adult-child interactions, less is known about the design elements and features of voluntary interaction settings that provide opportunities for family members to collaborate and play in joint, balanced ways. To this end, we report the qualitative results of our design and implementation of three interactive STEAM exhibits installed in an early childhood education center over a six-month period. Our findings surface insights and tensions related to the design features' impact on supporting family engagement in STEAM exhibits, emergent aspects of family-centered play, and supports needed to implement family-centered STEAM exhibits. Other designers, such as those who design with new technologies or explore human-computer interactions, can learn from our process of iteration and adjustment based on family interactions.

KEYWORDS

constructionism in learning, exhibit design, family centered approaches, STEAM (enriched with arts), playful learning environment

1 Introduction

Intergenerational play between children, their families, and community members offers an especially rich context for children's learning and development. It surfaces adults' background—if tacit—domain knowledge and metacognitive skills (Davis et al., 2002), as well as children's self-efficacy, as young learners relate to family members as co-learners (Rogoff, 1990). Intergenerational play also aligns with the mixed age, mixed skill community contexts in which children have historically learned about their worlds (Vygotsky, 1978). Parents and other family members in informal learning environments are valuable teachers and co-learners of disciplinary skills and epistemic practices. When family members engage in informal STEAM learning with children, those children potentially learn more than content—they learn how to learn.

To further opportunities for family-centered and intergenerational STEAM play, our design and research team is developing interactive exhibits that are installed in childcare and early learning centers, libraries, and other community spaces. Each six-week exhibit is designed to promote exploration and discovery while offering opportunities for children and their family members to tinker, create, and share what they make with others. These design orientations are shaped by constructionist design for learning through making artifacts that are both personally meaningful and shareable (Papert, 1980). Constructionist design

approaches offer learners opportunities to pursue their interests and create in their own ways. These learning environments typically encourage learners to use a wide range of tools and materials while drawing on ideas and inspirations that emerge individually or collectively through various forms of interaction and collaboration (Lave and Wenger, 1991). Learning happens through trial and error, with learners taking up new concepts as they serve their goal-oriented work and immediately appreciating those concepts for their utility toward that work (Ainley et al., 2006).

While many constructionist learning environments take the form of makerspaces or other permanent settings, “pop-ups” or temporary interactive exhibits offer families opportunities to engage voluntarily on a come-and-go basis. The mobile and temporary nature of these experiences is well-suited to the everyday and often busy schedules of families with young children. However, prior work has identified the challenge of engaging participants in sustained activity in these types of temporary environments. For example, as Berland (2020) argues, “If a voluntary activity is unattractive or too frustrating too early, people will stop or leave. When people have left, nobody starts creating in the first place and, as such, nobody will create temporary communities around creating” (p. 208). Our work involves the design of interactions that evoke a sense of wonder and intrigue through which children and their family members can rapidly set and pursue personally meaningful goals.

Families in constructionist learning environments comprise members of different ages with varying levels of experience and expertise. As such, researchers have studied adult-child interactions with attention to children’s and parents’ contributions to the activity. Yip et al. (2017) proposed four dimensions of adult-child interactions: facilitation, relationship building, design-by-doing, and elaboration. They described each of these dimensions in terms of balanced and unbalanced partnership between adult and child, defining balanced as the “specific interactions in co-design that are equitable and lead to an equal amount of contributions from both adult and child” (Yip et al., 2017, p. 5). In the elaboration dimension, for example, a balanced partnership involves both adult and child elaborating on and mixing each other’s ideas. This kind of partnership seems well-suited to support children’s developing agency as well as family members’ evolving roles in interactions in children. Furthering this work, Yu et al. (2020) focused on the roles parents played during interactions with children, such as spectator and bystander, as well as co-play roles such as teacher and collaborator. Related to design for families, one design implication suggests activities that “balance different levels of difficulty while still making fun challenges for children of different ages” (p. 10).

Other scholars have focused on providing alternatives to the binary of child-centered education versus adult-centered education. Vossoughi et al. (2021) described their goal in a tinkering after school program as not to be in the middle of these two, but rather argue for redefining learning and teaching in ways that acknowledge a broader complexity of roles and relationships: “The role of elders also reminds us that joint activity does not only emerge between children and adults but also within and among young people and adults of different ages and forms of experience within community” (Vossoughi et al., 2021, p.7).

Recognizing that families are situated in the broader context of community, researchers have also examined ways to design experiences that encourage families to share their interactions with

others in their community (Roque, 2020). For example, in their efforts to support tinkering performances in museums, Lyons et al. (2015) reported: “A key design goal identified was the need to transform the tacit engineering practices of visitors into visible engineering performances, such that those performances could serve as ‘cultural tools’ for mediating the learning of other visitors” (Lyons et al., 2015, p. 49). Tzou and colleagues employed narrative-based design to encourage families to transform their stories into creative models that are shared with the broader community. This work focused on “centering the intergenerational engineering work and providing the impetus for deep agency with the technology” (Tzou et al., 2019, p. 72).

Despite research that illuminates the roles and perspectives in adult-child interactions, less is known about the design elements and features of a learning experience that provides opportunities for family members to collaborate in joint, balanced ways. Further research is also needed to understand the ways community contexts shape family interactions.

To this end, we report on our family-centered design efforts in a real world setting through three interactive exhibits installed in several early childhood education centers over a six-month period. Our findings provide insight into design considerations for child, family, and community engagement. Specifically, we focus on three research questions:

- 1 What design features or modifications support family engagement in STEAM interactive exhibits?
- 2 What aspects of family-centered play and learning emerge in these exhibits?
- 3 What resources, expertise, and supports are needed to implement these exhibits in community settings?

2 Method

2.1 Exhibit design team

A team including staff members from a nonprofit research and design center focused on STEAM learning in community contexts, two doctoral students working as design and research fellows with the center, and two undergraduate students working for the nonprofit organization led the development, implementation, and maintenance of the interactive STEAM exhibits. The center director (author) and one doctoral design and research fellow (author) led the analysis and research efforts.

2.2 Exhibit design

We developed and installed three interactive STEAM exhibits as seen in Figure 1: Wind Tubes (A), Light and Shadow (B), and Sensing Sand (C).

“Wind Tubes” is an adaptation of an experience originally designed by the Tinkering Studio at the Exploratorium (The Tinkering Studio, n.d.). This exhibit invites families to experiment with creating objects using an assortment of craft and recycled materials that take flight when placed in a wind tube—a fan angled upwards with a tall, clear plastic enclosure surrounding it to guide the airflow. The “Light and

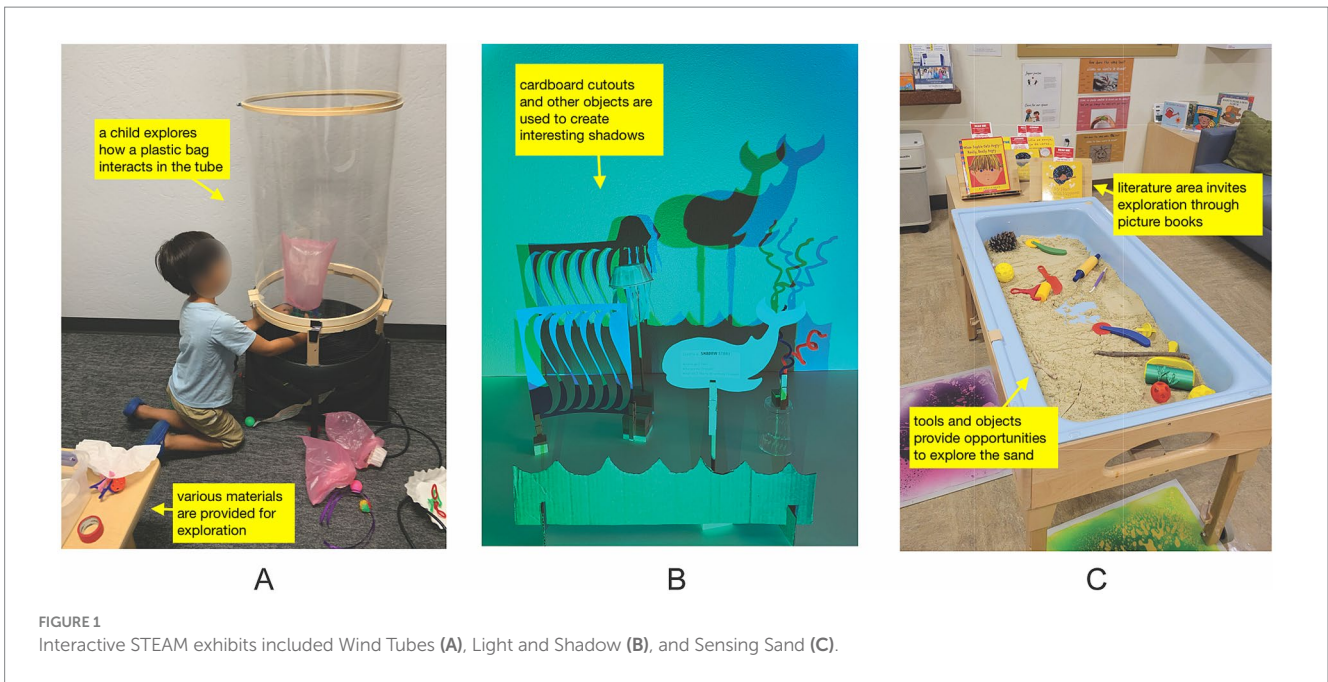


FIGURE 1 Interactive STEAM exhibits included Wind Tubes (A), Light and Shadow (B), and Sensing Sand (C).

TABLE 1 Interaction design criteria.

Personal interaction	Family interaction	Community interaction
Exhibits should be designed to:		
<ul style="list-style-type: none"> facilitate a diversity of goals, emergent possibilities, and generative activity connect to personal activities at home use familiar and diverse materials, a “pantry of ingredients” 	<ul style="list-style-type: none"> empower children to lead activity while caregivers co-learn with children shift roles of expert and novice encourage family member support of emerging goals and pursuits 	<ul style="list-style-type: none"> provide opportunities for communication and collaboration in real time with others make visible various goals and processes

Shadow” exhibit is likewise adapted from [The Tinkering Studio2 \(n.d.\)](#). This exhibit supports learners in exploring the phenomena and beauty of light and shadow by manipulating light sources and objects and observing the visual impact of these actions. The exhibit design team emphasized telling family stories and exploring narrative in our implementation of this exhibit. The “Sensing Sand” exhibit asks families to experiment with shaping and manipulating sand and to explore how sensory play can connect to socioemotional learning. For example, the exhibit encourages families to use the sand to help name and express their emotional states.

In addition to guiding pedagogies of constructionist, family-centered design previously described, we developed an emerging set of interaction criteria shown in [Table 1](#) to guide the design of these exhibits.

Each of these criteria categories is intentionally interwoven into the design and implementation of the exhibits. Based on prior work in the field, we approached designing for family interaction and engagement with attention to the individual and their interests or

roles, the dynamics of collaboration and engagement that emerge in family interactions, and the broader social and cultural or community context that families and individuals are situated within.

2.3 Exhibit context

We installed the STEAM exhibits at an early childhood center for roughly 6 weeks each across a period of 6 months. The center offers children ages 0–5 years and their families access to a host of co-located resources including daycare and preschool programs, social services and behavioral health, parent education, and workforce development. State subsidies and scholarships are provided to families on a needed basis to help with tuition costs. The center also offers observation areas and on-site training opportunities to learn about their approach to high-quality care and utilization of a blended-funding model.

This early childhood center was selected as the site for the exhibit design team’s first implementation of the STEAM exhibits as there is an established relationship between the two organizations. Earlier versions of exhibits like the Wind Tube were previously implemented at the center with enthusiastic feedback and engagement from community members. Additionally, the ultimate goal of creating these exhibits is to create comprehensive guides that support early childhood centers like this one in creating and installing their own STEAM exhibits. The implementation at this center will yield relevant insights that can support the development of these guides.

2.4 Observational data

We used a qualitative research approach to help inform the design and iteration of STEAM exhibits and future guides. This approach helped us to interpret and understand the experiences of participants, which included children ages 0–5 and their accompanying family

members. The exhibit design team collected observational data such as photos, videos, and field notes of families' interaction with the exhibits at the childcare center. Weekly exhibit design team meeting notes captured additional staff reflections on exhibit design and implementation. Although engagement in the exhibits is voluntary, takes place in a public setting, and families can request that no photos or observations be documented, for this report we have de-identified images and observations of participants.

Through collaborative conversations and thematic analysis of this observational data, the exhibit design team adjusted the exhibits to better align with the interaction design criteria. We share some of the emergent considerations, observations, and tensions that emerged from our analysis in the following section.

3 Results

Exhibit design team staff and childcare center staff reported diverse observations of how families engaged with the exhibits, ranging from children independently exploring the exhibits to multiple families co-playing and interacting with the exhibits. In this section, we further unpack these patterns of family engagement according to our research questions, noting how specific design features shaped families' experiences with the exhibits and highlighting what needs emerged during the implementation of the exhibits to facilitate family engagement.

3.1 Design features' impact on supporting family engagement in STEAM exhibits

Guided by our interaction design criteria, we curated exhibits to support multiple dimensions of interaction, from personal to family to community. Beginning with the personal, or individual, dimension, we found that diverse exhibit materials and open-ended prompts supported individuals, particularly children, in pursuing different explorations within the same exhibit. For example, observations from the Light and Shadow exhibit documented how one learner chose to explore cause and effect relationships, making shapes with their hands in front of the lights and observing the resulting shadow. Another learner explored storytelling, an exhibit design team member noting, "The lights died while (I was) playing with this student but the student kept playing. He moved the nature aspect of the exhibit to the side because he said that leaves and pinecones do not live in the ocean." Both observations illustrate how the curation of materials and prompts can influence how individuals engage with an exhibit.

To move from individual engagement toward family engagement, we implemented shared exhibit components that encouraged and supported a variety of collaboration patterns, such as joint activity between participants within the same family group or between participants from multiple family groups. For example, the original wind tube design created by the Tinkering Studio features a circular design that is open all around the base ([The Tinkering Studio1, n.d.](#)). We found this design allowed multiple participants to access and engage with the exhibit at once, supporting a variety of interaction configurations seen in [Figure 2](#) such as individual participation (A), multi-child participation (B), and intergenerational participation consisting of multiple adult caregivers and children (C).

Another way we designed to invite family engagement was through the intentional curation of materials. The families in this context often included very young children. Accordingly, the exhibit design team aspired to curate a set of materials that appealed to both young learners and adult caregivers. In particular, we observed that exhibit materials successfully supported children of various ages, such as siblings in a family, in co-playing with the exhibit in different ways. For example, a preschool-aged child was observed placing objects in the wind tube and watching as they flew out of the top. As this occurred, a toddler-aged child selected objects like paper streamers, threw them into the air, and watched as they fell to the ground. Both children used the provided materials to experiment, play, and explore phenomena according to their individual preferences.

While materials play important roles in supporting family engagement, they can also help attract families' interest initially and invite them to participate. Aesthetically interesting exhibit materials, such as flying objects in a wind tube or colorful lights, attracted children's attention and sparked their curiosity about the exhibits. For example, a design team member observing the Light and Shadow exhibit noted, "I heard multiple students say 'I want to play with the light!'...As a student passed by he said 'look at the pretty colors.'" Attracting interest can be especially helpful in voluntary environments where an exhibit may be competing with other family needs.

Finally, in attending to the community dimension of the interaction design criteria, the exhibit design team made a series of design decisions throughout the exhibits' implementation to foster connections to families' social and cultural communities. For example, as pictured in [Figure 3](#) the signage (A) and picture books (B) included with each exhibit were displayed in English and Spanish to reflect the language preferences and cultural identities of the families in this community.

Another exhibit element the design team explored to foster community-level collaborations was a "community creations" space in which wind tube flyers constructed by families could be left behind and displayed with the exhibit to inspire future participants or to offer starting points for future participants. The public setting of the exhibits, the weeks-long presence of each exhibit, and the multi-participant interaction structure afforded unique opportunities for families to explore ways to observe and remix others' ideas. However, with limited observational data about how community members engaged with these ideas, this tentative finding requires more investigation.

3.2 Emergent aspects of family-centered play in STEAM exhibits

Following our interaction design criteria, we aspired to support family members in taking on diverse roles within an exhibit experience; for example, having children guide the exploration while adult caregivers co-learned or co-played alongside children created opportunities for balanced partnerships. We found that the exhibits successfully supported children in directing their play experiences and taking on leadership roles. Several observations noted how children guided adult caregivers to the exhibits and immediately engaged with the exhibit activities. The extent to which adult caregivers participated in co-learning or co-play and the kinds of roles they took on varied.



FIGURE 2 A child plays with the Light and Shadow exhibit (A), a family consisting of one adult caregiver and multiple young children play with the Wind Tubes exhibit (B), multiple families consisting of two adult caregivers and several young children play with the Wind Tubes exhibit (C).

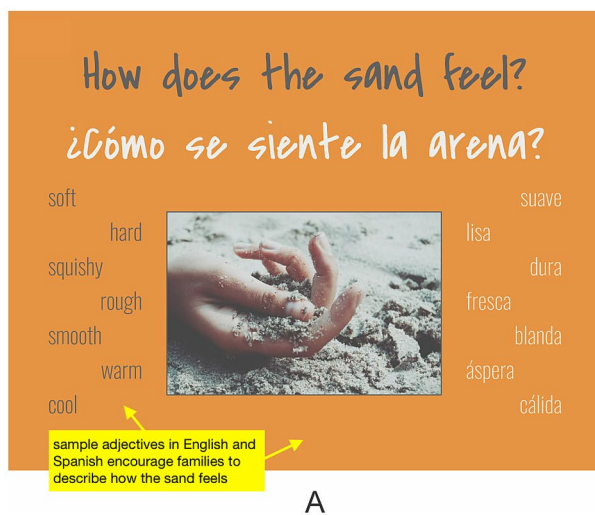


FIGURE 3 Exhibit signage for the Sensing Sand exhibit includes both Spanish and English text (A). Picture books to accompany the exhibit in both Spanish and English are displayed (B).

When adult caregivers engaged with the exhibits alongside children, they often took on supportive and facilitating roles—offering suggestions, asking questions, noting observations of the children’s play, or guiding children’s attention. For example, a staff observation of the Wind Tube activity illustrates an example of an adult caregiver offering suggestions, “[the] caregiver suggests objects to try; mom says ‘here try this one’ and hands child an object... [the child says] ‘Okay!’ and puts things in the tube.” In another Wind Tube interaction, a staff observer notes that the caregiver “points to objects in the [wind] tube, directs children’s attention to follow [the] flight path.” Additionally, we found that some adult caregivers selected specific elements of the exhibit to co-engage with. For example, in an interaction with the Sensing Sand exhibit, an adult caregiver was observed reading the books

accompanying the exhibit with his child but not engaging with the sand alongside his child.

While there were several recorded observations of adult caregivers playing with the exhibits alongside their children, the wide variety in patterns of adult caregiver engagement prompted the following reflection from the exhibit design team staff: “The nature of the exhibit promoting a child-centered approach [is] a positive but are there ways we could invite caregivers into co-play?” More iteration is needed to identify and understand the strategies that support adult caregivers in engaging in balanced co-play roles within the exhibits. Additionally, it is important to consider the role that this setting plays in caregivers’ abilities to engage with the exhibit. Several adult caregivers were occupied with concerns such as filling out paperwork or needing to get their children home for dinner or other family activities.

3.3 Supports needed to implement family-centered STEAM exhibits

The STEAM exhibits described here are designed as temporary “pop-up” experiences that ideally require little maintenance and upkeep from staff within the spaces they are implemented in. They are designed to invite family members to participate as facilitators of their exhibit experiences. However, in implementing these exhibits it became noticeable that some support from both the exhibit design team staff and the childcare center staff was helpful. The kinds of scaffolding that helped maintain the exhibits fell primarily into two categories: clean-up and activation.

Each exhibit included various loose parts, such as craft supplies for the Wind Tube and kinetic sand for the Sensing Sand exhibit. A small amount of clean-up in the form of tidying, curation, and organizing of materials daily and weekly was required to maintain the exhibit and create a welcoming environment.

Observation notes documented the role that staff can play in activating an exhibit experience. Child care center staff and exhibit design team staff invited families to engage with the exhibits through verbal invitations and modeling play and engagement with the exhibit. For example, one exhibit design team member described how they approached activating the exhibit, noting that “no students came to play [during their observation] but some watched me play as I made this masterpiece.” This observation suggests that staff members may play important roles in sparking families’ interest and engagement with the exhibit and that more work is needed to understand what conditions or qualities of an exhibit capture families’ interest and desire to engage.

4 Discussion

The results described above provide insights into families’ engagement with the interactive exhibits as well as the particular features and supports needed to implement family-centered STEAM exhibits. In particular, we summarized ways these exhibits fostered interactions for individuals, families, and broader communities. In this section, we elaborate these insights to discuss implications for future family-centered exhibit design. While targeting exhibits in childcare and other learning centers, these implications are also relevant to designing with various technologies in other learning or family settings.

First, our findings point to several ways the characteristics of a physical space and environment impact an interactive experience. The temporary and voluntary nature of our installations in a community education center presented challenges; we initially saw this environmental feature as constraining the family engagement we hoped to engender. For example, in contrast to a museum-type experience where families may spend 30 min dedicated to exploring an exhibit together, our interactive exhibits required families to incorporate moments of play into their daily routines. As seen in our observations, it can be quite challenging for families to take time to stop and engage: some rushed children off to appointments, others focused on completing paperwork or taking phone calls. To this point, we resonate with Berland’s (2020) conclusion: “Constructionist design has sometimes undervalued voluntary spaces because building anything quickly in transitory spaces is unlikely (at best), but there are

many benefits to improving how we approach the design of learning environments in these spaces” (p. 210).

While the environment we explored presented challenges for engagement, our findings underscore the need for interactive exhibits that support the “stepping in” and “stepping out” of family members. As seen in our observations, this flexibility in an experience can provide an engagement opportunity for children while a family member temporarily takes on other roles or tasks. Thoughtful family-centered design offers different roles and tasks for family members to take on that accommodate the flexibility needed in family-centered spaces like the early childcare space in this study. Such flexibility allows families to engage when they might not if the task demanded full attention. Design with new technologies can benefit from this approach in providing opportunities for family members to create or play in short bursts of time—to step in and out of activity—and in so doing, honor the time and space that families have to engage. Further research should explore the particular features that allow for this “stepping in” and “stepping out” across a variety of designs with technologies.

Second, we return to the theme of family-centered design and the complexity of goals that is present in any family activity. What does “family-centered” mean in relation to this multiplicity of goals? Our findings add to recent research that explores “how to balance child agency with adult constraint across a range of educational content and for different learners” (Weisberg et al., 2016, p. 180). We suggest that designers view adults’ and children’s goals not as competing, but rather take an investigative approach to explore how these goals propel family members’ activity, how they align with or diverge from others’ goals, and how they impact the nature of activity over time. If a designer’s goals are to actively engage both adults and children in collaborating or co-constructing, designs should invite adults into balanced (Yip et al., 2017) and co-play (Yu et al., 2020) oriented roles, with attention to the activating strategies that will invite adult caregivers into co-play or co-learning alongside children. For example, as we saw in our project, adults might benefit from explicit invitations to play or experiment. These invitations, as our findings suggest, can welcome new forms of interaction and challenge traditional views of adults-as-experts and children-as-novices. Accordingly, we suggest that designers keep in mind Roque’s assertion: “Parents can be as curious, insecure, and playful as their children” (Roque, 2023, p. 74).

5 Conclusion

In conclusion, our design research project has taken a step toward exploring the design elements and features of family-centered learning experiences that support intergenerational STEAM play at personal, family, and community levels. Future work needs to further examine the design features that invite family members of various ages and levels of expertise into co-play. Other designers, such as those who design with new technologies or explore human–computer interactions, can learn from our process of iteration and adjustment based on family interactions. Staying close to the participants—that is, carefully noticing and adjusting designs in response to family members’ interactions—ensures that designs will be more responsive to the multiplicity of roles, contexts, routines, and relationships that shape family and community interaction.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans because this project focused on the design and implementation of exhibits in the public space of an early learning center. No risk was involved, families could request that no photos or observations be documented, and only de-identified images and observations of participants are reported. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements because signage informed participants that photos and videos may be collected to inform the exhibit design and staff observers requested permission to collect photos/videos. Written informed consent was not practical given the nature of the exhibits and the verbal consent used to collect photos/videos *in situ*.

Author contributions

PR: Writing – original draft, Writing – review & editing. CM: Writing – original draft, Writing – review & editing.

References

- Ainley, J., Pratt, D., and Hansen, A. (2006). Connecting engagement and focus in pedagogic task design. *Br. Educ. Res. J.* 32, 23–38. doi: 10.1080/01411920500401971
- Berland, M. (2020). “Playful constructionism in museums, libraries, and other voluntary spaces: co-construction, co-facilitation, and co-dread” in *Designing constructionist futures*, eds. N. Holbert, M. Berland and Y. B. Kafai. (Cambridge, MA: The MIT Press), 205–212.
- Davis, L., Larkin, E., and Graves, S. B. (2002). Intergenerational learning through play. *Int. J. Early Child.* 34, 42–49. doi: 10.1007/BF03176766
- Lave, J., and Wenger, E. (1991). *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Lyons, L., Tissenbaum, M., Berland, M., Eyd, R., Wielgus, L., and Mechtley, A. (2015). Designing visible engineering: supporting tinkering performances in museums. *Proceedings of IDC 2015: The 14th international conference on interaction design and children*, 49–58.
- Papert, S. (1980). *Mindstorms: children, computers, and powerful ideas*. New York, NY: Basic Books, Inc.
- Rogoff, B. (1990). *Apprenticeship in thinking: cognitive development in social context*. New York: Oxford University Press.
- Roque, R. (2020). “Building projects, building relationships: designing for family learning” in *Designing constructionist futures*, eds. N. Holbert, M. Berland and Y. B. Kafai (Cambridge, MA: The MIT Press), 195–203.
- Roque, R. (2023). Imagining alternative visions of computing: photo-visuals of material, social, and emotional contexts from family creative learning. *Proceedings of IDC 2023-22nd annual ACM interaction design and children conference: rediscovering childhood*, 68–81.
- The Tinkering Studio1. (n.d.). Wind Tubes. Available at: <https://www.exploratorium.edu/tinkering/projects/wind-tubes> (Accessed February 14, 2024).
- The Tinkering Studio2. (n.d.). Light Play. Available at: <https://www.exploratorium.edu/tinkering/projects/light-play> (Accessed February 14, 2024).
- Tzou, C., Bell, P., Bang, M., Kuver, R., Twito, A., and Braun, A. (2019). “Building expansive family STEAM programming through participatory design research” in *Reconceptualizing libraries: Perspectives from the information and learning sciences*, eds. V. Lee and A. L. Phillips (Boca Raton, FL: Routledge), 72–93.
- Vossoughi, S., Davis, N. R., Jackson, A., Echevarria, R., Muñoz, A., and Escudé, M. (2021). Beyond the binary of adult versus child centered learning: pedagogies of joint activity in the context of making. *Cogn. Instr.* 39, 211–241. doi: 10.1080/07370008.2020.1860052
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Weisberg, D. S., Hirsh-Pasek, K., Golinkoff, R. M., Kittredge, A. K., and Klahr, D. (2016). Guided play: principles and practices. *Curr. Dir. Psychol. Sci.* 25, 177–182. doi: 10.1177/0963721416645512
- Yip, J. C., Sobel, K., Pitt, C., Lee, K. J., Chen, S., Nasu, K., et al. (2017). Examining adult-child interactions in intergenerational participatory design. *Conference on human factors in computing systems-proceedings*, 2017-May, 5742–5754.
- Yu, J., Bai, C., and Roque, R. (2020). Considering parents in coding kit design: understanding parents' perspectives and roles. *Conference on human factors in computing systems-proceedings*.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

We would like to acknowledge the playful and creative efforts of children and caregivers who interacted with the exhibits throughout their installation.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.