Reframing Playful Participation in Museums: Identity, Collaboration, Inclusion, and Joy

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Our design of learning environments, such as museums, should match the expansiveness with which we think about the diversity of human learning. In contrast to schools or school-adjacent spaces, museums are often designed to elicit various forms of learning–including affective, embodied, cultural forms–through a variety of pathways for participation from the individuated to the collaborative (Allen, 2004). However, these design intentions are not always legible to a racially, culturally, and linguistically diverse group of visitors, many of whom may only visit the museum as part of a school visit or other "formal" educational activity or on limited occasions (Archer, et al, 2016). This runs up against the design imperatives of museums that frequently foreground experiences which assume visitors know or feel welcome to engage in the supported forms of participation – including traditional modes of science inquiry and/or collaboration (Feinstein & Meshoulam, 2014). More recently, there has been a move across museum studies, educational research, and the learning sciences to include the kinds of experiences that many learners find more inclusive of a broader range of prior knowledges and ways of knowing and doing: including games, toys, play, and theatre. In this symposium, we will explore how recent research reframes museum experiences towards greater inclusivity that scaffolds complex learning, joy, and play and may have implications for learning and identity. As such, we bring together scholars who are exploring new ways to design for, study, and engage museum visitors to respect different ways of knowing, different perspectives, and different backgrounds.

Major issues addressed by the symposium

Despite efforts – and even when museum visitorship is diverse – museum educators note that museums often focus on those visitors who already engage with the content (Falk & Dierking, 2000). Science museums, for example, often foreground science education perspectives that preferentially reach those students who already value traditional modes of science (Bang & Medin, 2010). Following in the tradition of Vossoughi, Escudé, Kong, & Hooper (2013), this symposium posits that new recent educational research that focuses on joy, fun, inclusion, and different ways of knowing can provide a new lens and a new angle on improving museum experiences by engaging kids in collaborative, playful experiences – affording new and diverse forms of access to understandings and knowledge.

Scope of presentations and significance of contributions

This symposium brings together a phenomenal cadre of interdisciplinary, collaborative, and international scholars – based in museums, universities, observational, and design(-based) research. This is intentional: we sought a diversity of expertise and perspectives. Across these backgrounds, we collectively focus on "play as an entry point." Where Booker's piece looks at co-construction as play, several of the others use games explicitly. Where Hladik et al. investigate reframing scientific practices as museum play with young children, several other papers interpret the learning tasks at a broad level. Where Lindgren et al. and Kumar et al. are explicit about fostering collaborative play, other papers engage individuals. In bringing together this group, this symposium will evoke a vibrant debate about the affordances and tensions of inclusion and play in museum spaces.

Format of symposium

The format for the symposium will be a relatively traditional structured poster session: for ~10 minutes, the chair will present the framing argument and one situating slide for each projects. This will be followed by ~45 minutes of "poster time" in which attendees will have an opportunity to talk with and look at each of the projects. A member from each team will then go up front, and for ~25 minutes, the discussion will lead a "targeted panel discussion" in which our discussant will ask questions of the panel, foster discussion among the panel, and offer comments about the projects. We will end with ~10 minutes of open questions from the floor.

Energize the exhibit floor!: Embodiment and play in an interactive museum experience about energy

Robb Lindgren, James Planey, and Kathryn Quigley

Free-choice movement and playful engagement are challenges, but also key resources, for designing effective museum learning experiences (Allen, 2004). In this paper we describe an exhibit that was designed in collaboration with staff at a museum on the U.S. West Coast to solicit visitors' whole-body movements as a way to build understanding about energy. *energIze* is a two-player game targeted at upper-primary school visitors that has them acting out transformations of energy as a means to overcoming a series of obstacles within an outpost on a fictional remote planet. We briefly describe the design rational based on principles of embodied learning (Abrahamson & Lindgren, 2014) and some preliminary observations we made of visitors using *energIze* on-site at the museum.

energIze: Rationale and design objectives

Developing an understanding of energy that transcends a particular science discipline can be challenging for children (Driver, Rushworth, Squires, & Wood-Robinson, 2013). For young learners especially, it can be difficult to see energy as a singular construct as it moves within a system, undergoing transformations (e.g., from kinetic to potential). *energIze* was designed to let museum visitors roleplay these transformations in a playful way while maintaining a persistent representation of energy. Figure 1 shows visitors working together to control a robot avatar that is faced with various obstacles requiring different types of energy. Using the body as an anchor for representations of an abstract concept such as energy is key tenet of embodied learning (Lindgren & Johnson-Glenberg, 2013). Previous research on technology-enhanced embodied learning has investigated collaborative interactions (e.g., Enyedy, Danish, Delacruz, & Kumar, 2012) and museum contexts (e.g., Price, Sakr, & Jewitt, 2016), but *energIze* is unique in its explicit focus on bolstering crosscutting ideas through multiplayer embodiment within a playful narrative.

Figure 1. Visitors using their bodies to collect solar energy (left) and exert mechanical energy (center and right).

Preliminary observations and implications

To understand how visitors were using *energIze* and how it was potentially influencing shared ideas about energy, we developed both observation and software logging protocols. Our field observations were time-stamped to allow for cross-reference with the software logs and they tracked a learner's interaction with *energIze* in terms of

"episodes", noting their gestures, verbal utterances, and other events of interest. Software logs were able to record more precise metrics such as game objectives achieved, time, and the intensity of the gestures that were performed by a particular visitor. In an initial data collection period using these protocols that spanned two days and over a hundred unique sessions, we observed visitors engaging for relatively long durations, were frequently laughing and playfully experimenting with the interface, and often invoking energy terms when talking about their gameplay (e.g., "our moving propelled us forward and brought us energy" or "I had to use my arms and legs to get energy to get further in the level"). energIze was successful in the sense that visitors showed very little hesitation walking up to the exhibit and using their bodies to engage with the tasks. Further analysis of the interaction data has the potential to inform whether these experiences enabled a more robust understanding of energy and possibly influenced visitors' attitudes toward science.

The pack: Playfully eliciting epistemic computational thinking by embodying computation in a simulated world

Leilah Lyons, Wren Thompson, Elham Beheshti, and Stephen Uzzo

There are a wide variety of playful strategies for engaging children in a more embodied way in Computational Thinking (CT), from computer-free approaches like CS Unplugged, to programming activities that involve manipulating physical blocks (Wyeth, 2008; Horn, 2009) or virtual blocks on-screen (Resnick et al., 2009). Arguably, physical versus virtual embodiment provides different affordances for CT– "computational thinking is not monolithic and . . . thinking with the computer-as-tool can be affected by how it is contextualized and constrained" (Berland & Wilensky, 2015). Immersive virtual environments like first-person computer games can influence what is salient to the learner in terms of the context, processes, and effects of computation. We argue that control over contextual relevance is very useful for preparing learners for Computational Thinking in STEM (CTS), which covers how computation is used within the context of STEM practices (Weintrop et al., 2016).

Immersing players in "The Pack"

The Pack is a game that engages learners in an embodied computational world to influence their perceptions of computational operations. It immerses learners in a simulated environment wherein they "befriend'' creatures that embody different types of programmatic functionality, adding them to their "pack" (see Figure 1). Creatures each perform a specific function that can be combined sequentially in a stack to form reusable algorithms that when released back "into the wild," transform the ecosystem by digging trenches to reroute water, building up ridges, and finding and collecting resources. Changes to the ecosystem in turn reveal new types of creatures and present new challenges requiring more sophisticated algorithms. The game represents an extended metaphor for the epistemic practices of programmers working in STEM fields, who often grow their computational skillsets in response to emerging demands, and whose expanded skillsets in turn help them perceive new problems to solve.

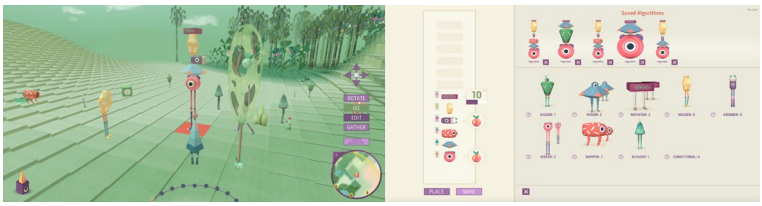

Figure 1. Screenshot of the player instantiating an algorithm in the game world (left) after assembling it in the algorithm-construction screen (right).

Preliminary results

This study was conducted as solo think-aloud interviews with 38 children ranging in age from 9 to 15 years old who were recruited off the floor museum through the use of a sign while visiting a museum with their families.

The response was universally positive, with many players continuing engagement beyond the targeted 15 minute session time. Those participants who played long enough (about 5-10 minutes) were often able to recognize when creatures became situationally relevant (e.g., when the player encountered fruit that grew on trees too high to pick). The fact that the game mixes algorithm-design and algorithm-execution did not seem to overly confuse players, but participants occasionally forgot that after they left the algorithm design screen it mattered where they placed the algorithms in the world (resulting in outcomes like misplaced holes). This is actually an interesting mistake, from a CT perspective, as it helps emphasize that even a properly designed algorithm can misbehave if given the wrong input. Some players didn't care what the creatures were for, at least not initially –

they just wanted to find and befriend them all. But in order to do so, they had to master using a number of the creatures, so they ended up learning creature functions along the way, showing that players could still learn the intended content even if they entered the experience with different motivations.

We are entering an era of supporting CT-S in primary education, without really knowing which aspects can carry over from early experiences to "real" applications of CT in STEM. Much like engagement with Scratch helped young learners transition more smoothly to actual programming (Armoni, Meerbaum-Salant, & Ben-Ari, 2015) the hope is that early experiences with open-ended, playfully-embodied CT-S experiences like The Pack might make future engagement with CT-S, where computation is embedded in the epistemology of the STEM work, more productive for learners.

Positioning and scaffolding learners in science museums: Views from a research practice partnership

Stephanie Kay Hladik, Basak Helvaci Ozacar, Marie-Claire Shanahan, and Pratim Sengupta

While research on families interacting with science exhibits has revealed the complexity of these interactions (Dierking & Falk, 1994; Falk & Dierking, 2000; Andre, Durksen, and Volman, 2017), design-based researchers suggest that learning in such settings can be supported through careful design of the learning environment (e.g., scaffolding and new forms of human computer interactions) (Horn, 2018), as well as facilitation within and across settings (Anderson et al, 2000). Our recent work on public computing (Author, 2017; Author et al., 2019) expands the call for supporting authenticity in visitors' engagement with computational science in informal spaces. We positioned public computing as a new form of open-ended learning environments in which visitors can directly access, modify and create complex and authentic scientific work, originally authored by scientists and professionals, through interacting with open source computing platforms (rather than using block-based languages), alongside archived and live facilitation (Author, 2017). In this poster, we seek to identify how, through a multi-year research practice partnership (RPP) (Penuel, 2019), we have iteratively designed a public computing exhibit such that it can position learners productively in public computing - especially those learners who may not be typically framed as taking part in computing due to factors such as age. We also present the emergent design of scaffolds to better position these learners and engage them in authentic computing work.

Methods, data and analysis

Over a period of eight months, we collected the following forms of data: a) field notes of researchers who participated as both facilitators and observers of visitors' interactions, b) video recordings of visitors' and facilitators' (both the museum staff and researchers') interactions with the visualization, code and other elements of the exhibit, and c) interviews with facilitators (museum staff) about their experiences with the exhibit. Visitor interactions ranged in length from a few minutes to nearly an hour. These video clips, along with statements concerning the designed blocks from field notes, were coded inductively using thematic analysis (Miles & Huberman, 1994) and constant comparison (Glaser & Strauss, 1967).

Results and significance

Our analysis reveals two key elements of our experience of positioning and scaffolding in public computing: 1) reframing "who" the learners are through facilitation - e.g., a toddler (~1 year old) was positioned as a "programmer" through facilitators' encouragement, and subsequently, the toddler's gestures and verbalizations were interpretively translated by the parents into computer code; and 2) how to scaffold visitors' interactions with the code and their reasoning about the relevant phenomenon through designing material supports (physical blocks) for computational action. Both these forms of positioning and scaffolding arose out of the RPP: for example, after observing visitor interactions over a year, the museum staff (exhibit designers and facilitators) proposed the design of physical blocks that would embody written explanations of key programming commands, which our research team then developed further in partnership with them. Our findings suggest that by focusing on scaffolds and patterns of interaction among visitors and museum staff, we may be able to re-position visitors productively in relationship to public computing in science museums.

The joy and struggles of collaborative museum gaming

Vishesh Kumar, Leilah Lyons, Maxine McKinney De Royston, and Matthew Berland

This study presents findings from a digital museum exhibit – Rainbow Agents – a collaborative computer science game-exhibit at the New York Hall of Science and the Lawrence Hall of Science. Rainbow Agents is designed to

facilitate a plurality of collaborative interactions while maintaining player agency in choosing from a diverse set of in-game goals. We describe two cases that illustrate how different forms of collaborations in the museum game environment afforded the pursuit of different kinds of goals, and affective experiences as reported by the visitors. We then discuss the value of designing for a variety of goal-directed activities in game-like activities, and a spectrum of collaborations that can be accessed by visitors depending on their context and preferences.

Balancing shared experiences with individual goals via design

Museums provide a unique social setting for learners to engage with content (Falk & Dierking, 2000), but interactive exhibit designers struggle with how to support multiple simultaneous users who often have different individual goals (Allen & Gutwill, 2004). Criticisms include how too many controls lead to parallel play (Kreijns, et al, 2003), while too few controls lead to competition over control (Marshall, et al, 2009). Exhibit designers have tried to distribute control in a variety of ways: allowing visitors to productively interfere with one another's actions (Falcão & Price, 2009; D'Angelo et al., 2015), aggregating visitor actions to produce uniquely emergent outcomes (Lyons et al., 2014), or making visitor actions more readily inspectable (Lyons et al., 2015; Yoon et al., 2013). Much of this work positions specific collaborative behaviors as purposeful and undervalues other forms of social engagement (Tissenbaum et al., 2017), whereas games often embrace a wider array of social interactions (Ventrice, 2009). As both a game and an exhibit, we designed Rainbow Agents to expressively afford engagement with complex concepts in individual, asynchronously collaborative, as well as synchronous & interactively collaborative ways. In RA, players can place animals onto a shared virtual garden. These animals can be programmed to plant seeds and water them, in order to grow a variety of plants. Gameplay interacts with resource constraints and emergent effects. The players engage with each other through the garden and use computational discourse to work together.

Preliminary results

In the first case, Jessica (all names pseudonymous) – an African-American high-school girl – split up from her school friend group and intently engaged with the withering plants that an earlier player had left behind on the garden by herself. Entering the game space with earlier players' artifacts still present allowed for an instance of "asynchronous collaboration": Jessica continued and appropriated the work left behind by another player. Jessica engaged in around 10 minutes of intense gameplay, despite repeated calls to leave from her classmates. She played with two of the complex animals (i.e. programming interfaces), and persisted until all three of the plants she had chosen to care for died. In a short after-play survey, she reported finding the exhibit frustrating for how punishing it was. This case presented how asynchronous and non-interactive collaboration (with just one way communication and no dialogue), set the player up for a specific goal choice (managing plant survival) and a sense of frustration for failing at this goal, despite her deep engagement and how it involved rich productive learning (visible in increasing competency with programming the animals). In the second case, Lexi[1], also a female African-American high schooler, attended the exhibit with her family. They began the game with an empty garden and thus, began experimenting with the animal programming interface before engaging meaningfully with the shared garden space. Over the course of their engagement, their goals shifted, from trying to understand the programming screen's mechanics to the small-scale challenge of trying to unlock treasure boxes, to the large-scale challenge of trying to establish and sustain a very large garden. Lexi was the primary player, with her sister sometimes trading places with her brother. Throughout, the siblings alternated between periods of individual focus, narrating their understandings, playfully competing, and negotiating how they could coordinate actions. While they had a "slower start" than Jessica, taking longer to master the different agents in the game, they reported more satisfaction with the experience.

Synthesizing these cases, we see that the design of RA supported flexible engagement, with this flexibility, learner goal-setting became much more socially-dictated than content-oriented. Jessica began with a goal she assumed from a prior visitor, and perceived all of her work mastering the agents to attain that goal as almost superfluous challenges. Whereas Lexi and her siblings were able to gradually ratchet up the complexity of the goals they set for themselves, they used each other as barometers of achievement, and thus felt more accomplished. These cases illuminate how frustration, an integral component of many good games and a driver of learning and achievement (Gee, 2003), can conflict with the cultural expectation of museum exhibits providing "aha!" moments which feel affirming, and successful, even if they may not be very educational (Gutwill, 2008). This work suggests that more work needs to be done to help visitors select more proximal goals, and thus have more satisfying play experiences, at flexible exhibits. This work is an initial foray into seeing the power and limitations of designing collaboration-centered games for museums – while leveraging the power of games coupled with the joy of working and learning with strangers or acquaintances provides for engaging learning experiences, it can also undermine cultural expectations of attaining easily achievable goals, particularly in the

lack of social support. Future work intends to deepen our understanding of how these differential experiences can be identified through visitor behavior and play data; and be supported by feedback to players or facilitators to enrich their gameplay.

Escaping the exhibit: Designing an escape room inspired computational thinking learning experience at the computer history museum

Anthony Pellicone, Derek Hansen, Elizabeth Bonsignore, Kari Kraus, June Ahn, and Kathryn Kaczmarek-Frew

Computational thinking has grown increasingly prevalent as a construct for designing formal and informal learning that aims to attract diverse learners to the realms of coding, engineering, and computation. In the computational thinking framework, there is an emphasis on the ways of thinking that facilitate and elucidate the processes of computation: for example the ways that algorithms can be used to solve problems, or the means of breaking down a complex problem into simpler logical steps (Wing, 2006). A major contribution of Computational Thinking (CT) as a framework to conceptualize computer science education is that it prioritizes the idea that CT is not the limited domain of computer scientists and engineers, but instead is a system of thought that is open to everyone, and broadly applicable across various realms of life and society (NRC, 2010). Likewise, there has been a related movement over the last decade for increasing recognition of the ways that computation relates to and intersects with the arts and the humanities, with benefits being found in helping students to cross disciplinary boundaries in their learning (Ghanbari, 2015; Maeda, 2013; National Academies of Sciences, 2018).

It is with the above in mind that we designed an educational alternate reality game called *The Tessera*. *The Tessera* presented players with a variety of CT challenges and activities across a number of platforms, including a digital game, online community platforms, social media accounts, and (as we report on in this panel) an interactive exhibit at The Computer History Museum called *The Tessera: Ghostly Tracks*. Both *The Tessera* and *Ghostly Tracks* were designed to tap into the rich and often understudied history of computation - specifically the diverse group of innovators and thinkers who pioneered many important foundational aspects of computation, such as Ada Lovelace's work on the Analytical Engine, Grace Hopper's role in creating machine-independent programming languages, and Jean Bartik's work on the original ENIAC system. *Ghostly Tracks* was designed to draw players through the personal stories of six figures from the history of computing, building on the design of the Computer History Museum's History of Computation exhibit as a space of informal, experiential learning (Roschelle, 1997). We used Escape the Room games as a framework, where groups of individuals come together to cooperatively solve puzzles with one another while following a place-based narrative (Nicholson, 2015). However, instead of "escape" being the central goal of our game, we instead used a locked crate (containing a lead-in to our digital ARG) to motivate players' sense of discovery, with each of the six groups needing to uncover an unique combination to one of six locks.

We discuss preliminary results from a three-month administration of *Ghostly Tracks*, which reached a racially and socio-economically diverse group of middle school students. We begin with a description of the design process of *Ghostly Tracks*, and how it fit into the larger ARG project, along with the attendant ARG ethos of This is Not a Game (Bonsignore et al., 2012), and the efforts that we took to make our puzzles and narratives appealing to groups traditionally underrepresented in computer science fields. We discuss some interesting design constraints of this project, such as tying into an existing fiction within our larger ARG, the necessity of building the game experience on top of a related but independent and already existing exhibit, and our efforts to create puzzles that were able to be quickly apprehended by large groups of students, but still provide adequate challenge and fun in terms of interactions. We then examine preliminary findings of both qualitative and quantitative analysis of a pre- and post-survey instrument administered to our players. We conclude with broader design considerations around designing museum experiences that adopt the design principles of escape room games; creating collaborative puzzles that allow for meaningful participation within large groups; and in structuring scaffolds and technological aids that are useful and appropriate for museum contexts and for diverse groups of chaperones and learners.

Designing learning environments as sites of co-construction

Angela Booker

In this presentation, I consider the design of learning environments across scales of relationship—pairs and small groups, communities, organizations, and institutions—as this has implications for equity as a collective and distributed sensemaking process. These scales of relationship organize, even dictate, where co-construction can happen or is expected to happen, and where it is negated, limited, or meaningfully delayed. The cases presented

here are youth-focused and ask, where and when are there opportunities for young people to discover the meaning(s) of their presence in a learning environment and the potential for their invited and open participation in that environment? These concerns are mapped to design intentions by incorporating listening strategies that respect combinations of young people's knowledge, socio-historical experiences, and intrinsic awareness of what are vital conditions for their individual and collective growth.

Two learning environments with shared learning goals and intentions but different social positions and resources are presented: (1) a community technology center in a small and frequently stereotyped community serving Black, Latinx, and Tongan families through an art and technology children's program, and (2) a children's art and technology museum serving families and tourists in a world-renowned city, that has a charge to be both cutting edge and accessible to marginalized communities. These two learning environments were geographically and institutionally organized communities with particular histories of practice, freedom or constraint of movement, and that relied upon relationships that were familial, cultural, neighborhood-specific, and influenced by institutional structures. Across these environments, I examine how the design intentions foreground the relational and ethical work necessary for acts of invitation, mutual respect, and co-construction and seek to understand what these learning spaces communicate, who they invite to participate, who they respect and when, and who they surveil.

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