TEAM BEAM:

ECONOMIZING CHILDREN'S BEE-HAVIORAL DEVELOPMENT

by

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ii. Abstract

This research paper uses behavioral economics to design a children's play installation that facilitates soft skill development. By reviewing existing literature from Education, Early Development and Behavioral Economics, my installation supports improvements in collaborative behaviours within child-child and parent-child relationships. Literature across research disciplines explains how early soft skill achievement influences life course outcomes at school, work, home and in personal relationships.

The installation's user difficulty, material composition, colouring and incentives nudge children aged 2–4 toward making emotionally beneficial decisions. Because it is designed for a museum setting, the assumed expectations of installation users, other visitors and the host museum are acknowledged in the design. The installation's assumed effectiveness, specific location and accessibility features are produced from personal work experiences at the Royal Ontario Museum, interviews with field professionals, attention to parents' agency, existing literature focused on inclusive, play-based spaces and an iterative creative process based on design thinking methodology.

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1. Introduction

People learn by playing and this is especially true for children (Nijhof et al., 2018). Play helps to develop behavioral traits and transferrable skills that benefit individuals long after they begin Kindergarten. According to Oxford, “play” refers to taking part in organized activity for enjoyment rather than practical purposes; the definition also highlights role*play* where people may organize themselves relative to social roles like teacher, doctor or parent/baby (Lexico, 2020). Notably, the former definition refers to an individual’s motivation to play: someone may play for enjoyment, but play’s benefits (i.e. relationship-building, exercise, self-knowledge through experience) have practical developmental purposes and can occur non-consciously. These purposes are most relevant to children given their newly developing physical and cognitive skills (Milteer et al., 2011, p.2).

My Major Research Paper acknowledges play’s benefits by presenting a play installation design focused on developing children’s soft skills. It does this by “nudging” children aged 2–4 toward collaborative behaviours. Aesthetically, the design and its associated themes promote mainstream biodiversity concerns as described by the Canadian government (Government of Canada). Its proposed location in the Royal Ontario Museum’s Patrick and Barbara Keenan Family Gallery of Hands-on Biodiversity (further referred to as the Hands-on Gallery) wholesomely connects the installation’s play requirements, behavioral benefits and cultural relevance. The relationships between users, between users and the installation, and between users and their personal soft skill improvements are communicative in nature and support further consideration of how we materially and immaterially design children’s play.

Certainly, the benefits that a child finds in play-based spaces are relative to play design: this includes an installation's material composition and surrounding material environment, as well as mainstream cultural, political and economic beliefs influencing designers' and users' perceptions of play. Contextualizing this space, and then placing a theoretical prototype within it, requires considering how a museum's installation differs from public parks, forests, malls or any other environment where kids may be inclined to play.

There are few sources applying behavioral economics to installation design, less who do so with soft skills in mind and nearly none who do so in a museum setting. This leaves opportunity to innovate via conjoined ideas grounded in established design thinking practices. I learned about these practices during our first semester, studying and trying them with professor Dushan Milic's guidance. During this iterative design process, I frequently reconsidered why I was designing the installation and how it could consistently achieve beneficial outcomes for users. Following the design thinking framework depicted in Figure 3, I worked through its first four stages (the fifth unobtainable given COVID-19 restrictions), returned to the first and continued, improving my design along the way. This process led to gathering more, relevant information and seeking differences between what I want for the design and what it can be relative to my MRP's goals.

The installation is called Team Beam. This is how it works: a box, called the Honey Hive, holds three interesting, bee-related artifacts which children can see and touch under LED lights (Figures 1–2). But one user cannot fully explore the artifacts alone, because the lights are off unless someone is holding down their switches, which are activated by pressing the installation's buttons. Its buttons are too far away for one person to hold while looking into the Honey Hive. The wooden platform upon which the buttons and Honey Hive sit is bolted to the wall. Behavioral nudging occurs via the distance between the Honey Hive and the buttons—since people holding the buttons cannot see into the Honey Hive, they will need to work for someone else's enjoyable experience without fully experiencing it themselves. They are nudged toward collaboration. For parents holding the button down during a parent-child use, the parents may find most joy from watching the child enjoy themselves. For children though, child-child or parent-child collaboration will promote soft skill development through turn-taking, verbal communication and multitasking. This play design supports behaviours beneficial for children, parents and wider society.

1.1 Benefits of Research

I believe my research addresses modern educational concerns through an innovative design. Firstly, as students' classroom content consumption moves digitally, non-digital experiences must evolve to maintain interest; secondly, learning at the ROM is supposed to be enjoyable and will engage students in material and immaterial ways that classrooms do not; thirdly, children using Team Beam will likely learn something new, have fun and collaborate with their parents/guardians accompanying them at the ROM.

Research applying behavioral economics to play design as a means of facilitating soft skills is absent from academic literature. We know from works such as Neil Bendle and Philip Chen's (2016) *Behavioral Economics for Kids* that modern behavioral science is distillable into straightforward transactions that everyone takes part in. Adults may consider their decisions to be more complicated than children's, but both parties are influenced by biases such as endowment effect, sunk cost, framing and trust. "We humans usually do not decide as rationally as we think," says Gerhard Fehr, CEO of FehrAdvice & Partners AG, in the book's introduction. "We humans behave like kids most of the time" (Bendle & Chen, 2013, p.4).

By recognizing that young children make decisions similarly to adults, adult designers can improve youth learning by strategically disrupting, or intervening in, mainstream play design using proven behavioral concepts. Researchers from New York University and ideas42, a non-profit play design and consulting firm, use behavioral economics to explain how nudging parents toward particular programming decisions can improve the life course trajectories of them and their children (Gennetian et al., 2016, p. 8). They add that this is particularly true in institutional contexts. Team Beam's institution is the ROM and its endearing artifacts, alight in the otherwise dark Honey Hive, nudge children toward collaboration. Team Beam's emotional benefits are partially psychological, but using the installation is also physically beneficial. Given that healthy early development requires crafting fine motor skills, practicing coordinated button pushing and using a magnifying glass will support this physical development (Miller et al., 2020; Lubans, 2010).

The opportunity for parents to partake in using the installation with a child is important. The literature shows that healthy parent-child relationships are crucial to children's short- and long-term successes. And while parents' approaches to supporting their children's development via play vary based on sociocultural context, play's underlying necessity in a child's mental and physical growth remains consistent throughout human societies (Roopnarine & Davidson, 2015). By opening my design to both parent-child and child-child interactions, its educational stakeholders— such as paying parents, teachers on field trips, the ROM, the ROM's funding bodies and myself— hoping for a positive museum experience will be satisfied.

2. Theoretical orientation

Many researchers and organizations publish resources applying educational theory to play design. Among them is Playground Ideas' (2020), a playground building non-profit that offers DIY project tips and custom design support. Their website details its Global Play Alliance, a “coalition of play advocates” seeking to create play in resource-short communities (PI, 2020). The “Using Behavioral Economics to Create Playable Cities” report produced led by Tantia et al. (2014) and in collaboration with ideas42 and KaBOOM! Media, has a similar focus: it describes the vital developmental importance of play and then uses a behavioral economics model to practically consider play promotion (p. 3–4). The report acknowledges barriers or “behavioral bottlenecks to play” that educational campaigns commonly encounter. These challenges include unclear feedback responses, play’s uncertain timeliness and reinforcing individual’s play agency (pp.4–5). Tantia et al.’s insights are valuable because they approach play promotion from a similar theoretical position to mine, considering the varying factors influencing any one person’s decision-making. Though, whereas the authors describe designing urban spaces and programming to support children’s ongoing needs, I designed a play installation. This encourages me to value behavioral economics as a foundational theoretical position for my design.

Specifically, the behavioral concept informing my design is “nudging.” Nudge theory was popularized by Cass Sunstein and Richard Thaler in their 2008 book *Nudge: Improving Decisions About Health, Wealth and Happiness.* Thaler says nudging individuals means presenting them with choices that they would make if fully informed, unaffected by temptation (Thaler, 2018). I believe children fully informed on long-term collaborative benefits would consistently choose collaboration. The authors highlight concerns associated with future decision-makers identifying a system’s nudges and making adjustments that present decision-makers do not; this concern appears unlikely to effect the ongoing experiences of child-aged visitors to the ROM. In addition, a critical feature of nudging is that people can still make the lesser-preferred choice: in relation to my design, this requirement is met by allowing users to explore the Honey Hive whether it is lit or dim.

2.1 Design thinking

Ryerson University professor Dushan Milic introduced our MPC cohort to design thinking during last semester's course, PC8006 Advanced Editing and Document Design (Ryerson, 2020). According to its calendar description, this course draws from cognitive psychological theory and usability experts to help students make informed editorial and design decisions. It says these decisions are suited for varied messages, audiences and purposes. I found both those descriptors to be accurate. When applying our lessons, Dushan consistently suggested we refer to design thinking's iterative approach; Figure 3 provides a diagrammed example of design thinking's process: Empathize, Define, Ideate, Prototype and Test (Milic, 2019). Each stage relies on designer's considering the stages before it, challenging preconceived notions concerning what a finished product can look like. Through this process, our cohort worked to eliminate previous designs despite any fondness of them. Or in other words, "Kill [our] darlings," as professor Milic said.

Notably, the arrows on Figure 3 point back to stage one from stage five. This reinforces professor Milic's encouragement toward treating design iteratively. Design thinking's approach, one which views repeated failure as positive, is necessary if pursuing design iteratively. In an article titled "Design thinking for social innovation" for the *Stanford Social Innovation Review*, Tim Brown and Jocelyn Wyatt (2020) describe design thinking as a modern conception, one that is "inherently optimistic, constructive, and experiential" and "[addressing] the needs of the people who will consume a product or service and the infrastructure that enables it." The authors relate design thinking to a young Indian woman's plight for clean drinking water: despite living within walking distance to a community water treatment centre, the centre's cultural and physical requirements limit the woman and her family from capitalizing on its availability. The authors believe an improved treatment centre design would focus more on accessibility and cultural relevance than on functionality and look. They say this design process might include more, diverse feedback (relating to stage one Empathize) to challenge designers' ideas about the community centre's utility.

Researchers studying collective sentiments toward various design iterations found that later iterations were viewed more favourably than early iterations. Professors Lixiu Yu and Jeffrey V. Nickerson (2011) challenged people to draw a chair on a sketch system they programmed (p. 1393). The 1047 participants were divided into groups, the first sketching their chairs on a blank canvas with later groups getting to see earlier groups' sketches for inspiration. The sketches that later groups saw were based on collectively evaluating previous groups' illustrations using a Likert Scale (p. 1396). The authors state that later groups' chairs were substantially more creative than earlier groups'. Further, they explain the system benefited later participants because these users inherited images which could then be modified, whereas earlier sketchers drew inspiration from a blank canvas. The authors define this combination process through two forces: conformity and augmentation (p. 1398). Conformity moved designers to incorporate earlier chairs' features and augmentation moved them to modify existing features or add features not present. Upon a similar theoretical foundation, I built my design through constant consideration of stakeholders' theoretical expectations and my ideal outcomes using the design thinking framework.

2.2 Environment

The ROM's child oriented areas, including the CIBC Discovery Gallery and ROM Makerspace, are designed to allow for sensory exploration: touching collections, speaking loudly with peers and moving quickly by running or crawling are actions welcomed in these spaces. These areas are established to promote active behaviours because similar behaviours are generally unwelcomed among other exhibitions like *Florals: Desire and Design* and the Eaton Gallery of Rome. I believe this is partly because children and adults are in different stages of cognitive maturation, thus leading to differences in either party's perception of an enjoyable experience (museum or otherwise). In the *Winnie the Pooh: Exploring a Classic* exhibition, children discover a wondrous Hundred Acre Wood complete with activities and play structures. Though, these child-oriented spaces are somewhat separate from areas that parents might be culturally interested in: for example, the exhibition offers a fascinating timeline of author A. A. Milne's rough drafts, a Winnie-the-Pooh historical timeline and a large projection of the famous bear's Heritage Minute.

My design looks to incorporate child-child and child-parent co-exploration by requiring it. Referencing the Winnie-the-Pooh exhibition, it is possible that an adult will adore exploring Eeyore's tent and that a child will find fixation in a well-crafted Heritage Minute. Applying this flexibility to Team Beam, it is also possible that children and/or adults would find new ways to collaborate without my design's structure by choosing free play. These possibilities are acknowledged as potentially beneficial to an individual's emotional development and my design does not seek to replace them. Instead, Team Beam adds a fresh element to the museum play space. Users certainly incur a leisure time cost via forced collaboration, but enjoying bee artifacts and sharpening soft skills are worthy pay-offs. I believe that nudging children toward academically established, positive behaviours can be more worthwhile than hoping they reach these behaviours through less structured, semi-collaborative play environments.

Organizationally, the ROM ((ii), 2020) already presents similar play structure through their ROMKids Junior program; described as an "eight-week sensory adventure," children aged 2–4 are joined by their parents and ROM instructors to promote learning through exploration. I want to bring this program's expected developmental benefits to the ROM's everyday gallery spaces. While my installation cannot provide an individual with the dense learning experience that ROMKids Junior can, innovating toward soft skill development is comfortably assumed to be beneficial if all stakeholders are satisfied. The museum's areas designed for play include its Discover Gallery, which promotes ROM collections and research, and the ROM Makerspace. These areas do not directly promote sensory exploration for all public visitors like the Hands-On Gallery does, so the latter seems an appropriate location for my installation. Figure 4 provides a look into the Hands-On Gallery. My proposed installation will go out of frame to the bottom right, above the stairs.

The ROM's highly structured environment (from cost and physical restrictions to social expectations) limits participation in comparison to public play settings. But it allows for increased attention to particular design aspects, recognizing that children will likely be accompanied by parents who expect their dollars and time to be rewarded with thoughtful, learning-based experiences. It is also assumed that parents are unlikely to find these experiences publicly, hence paying to enter the ROM. For some ROM features like special collections and internal architecture, the benefit to entering versus remaining outside is clear: the sensory experiences these things provide cannot be replicated outside the ROM. For instance, the museum's four Nisga'a and Haida crest poles fit among its stairwells because the building was built around them (Kenter, 2017). These beautiful, historic poles cannot be personally viewed unless people pay admission, enter on free admission nights or sneak-in. This element to the museum differs from public collections or architecture, such as the TD Gallery at Toronto's Reference Library or the Scadding Cabin on Canadian National Exhibition grounds. Therefore, my design utilises environmental context, assumed compensation for payment and the ROM's forward-thinking mission to present an idea that satisfies each stakeholder.

2.3 Personal experiences

Time spent in learning-based roles, both among children and adults, helped form my perceptions of good and bad play design. It also helped me consider how children and adults might work together and be collectively satisfied with my installation. I allowed myself to be guided by these experiences as I considered the literature while iterating my design.

Over this summer, I learned about interdisciplinary learning through my job as a Communications Specialist at Ryerson's Science Discovery Zone. The SDZ (2020) is a pre-seed incubator promoting critical thought, collaboration and personal improvement through events, lab resources and personalized guidance. A foundational mission of the SDZ is presenting varied perspectives on similar ideas or topics, as demonstrated by our June event, *Curiosity Series: How will our interactions with space change?* Panelists included three Ryerson faculty members teaching History of Science, Occupational Health and Health Services respectively, and a faculty member from Ryerson's Design Fabrication Zone (Conley, 2020). Among the memorable insights were a professor discussing the 1918 Toronto Transit Commission's approach to managing Spanish Flu transmission and another professor describing how the community organizations they oversee recently pivoted to virtual support. At first read, these insights might seem unrelated. But in the event's interdisciplinary context, these ideas and others allowed listeners to appreciate the larger social context and relations where these insights are based. SDZ events like these helped me separate my design from personal biases when considering Team Beam's foundational concepts and goals.

Further, by discussing personally unexplored topics with new people individually and in virtual groups, I better recognize similarities in how people ask questions and arrive at conclusions. For example, when beginning this design I was deeply interested in learning from social and neurological perspectives; now, I more clearly see practical outcomes from my design as they relate to users and stakeholders. This professional education pushed me to continue iterating my design by considering more perspectives and lessening my personal perception of what a useful design might look like.

During my undergraduate degree, I volunteered with multiple organizations involved with childhood education, including the London Public Library System, Investing in Children and Growing Chefs. I was also an early education intern at London Bridge Preschool last summer. My time in these roles (and especially so in the preschool internship) were formative; time spent working with children produced first-hand knowledge of how educational organizations operate and how I can positively or negatively support a child based on my decision-making.

Mindful of these experiences and my ongoing Master of Professional Communication education, I take an interdisciplinary, self-guided approach to how my design can fulfill each stakeholder's theoretical expectations in a museum setting.

3. Literature review

Currently, associations between soft skills, behavioral economics and play design are largely unmade in individual research papers. But literature discussing soft skills, behavioral economics, early development and other fields that study behaviour each view play as critical to sophisticated cognitive maturation. The literature also widely discusses soft skills relationships to life course outcomes.

3.1 Soft skills

Soft skills, like hard skills such as reading, writing and computer programming, must be learned and practiced to grow competencies. Therefore, children's environments have an integral role in whether children are learning and practicing these skills. The Urban Child Institute (2020) explains that brain development from conception to age three is initially informed by genetics— a child's brain holds most of its adult neurons and twice times as many of its adult synapses (neuron communication pathways)— but environmental factors influence how the brain is wired. These early years are therefore particularly responsive to external inputs. "Genes provide a blueprint for the brain, but a child's environment and experiences carry out the construction," the Institute writes.

When defining soft skills in their article, "Behavioral economics of education," researchers Koch et al. (2014) write, "Soft skills encompass personality traits, goals, motivations, and preferences that are valued in the labor market, in school, and in many other domains" (p. 2). The authors detail the historical economic perspectives on education, relate described concepts to behavioral economics and incorporate studied variables (such as gender or class) that may influence academic outcomes. Children who develop highly regarded soft skills, such as self-control, patience and generosity, are better suited for future educational success when compared to their peers with lesser soft skill competencies (Koch et al., 2014).

Carlos Valiente et al. (2011) encourage behavioral insights about academic achievement to be considered with reference to children's emotional states. In one passage, the authors focus on effortful control. Quoting Mary Rothbart (Temperment, 2012, p. 15), the authors say effortful control is "efficiency of executive attention, including the ability to inhibit a dominant response and/or to activate a subdominant response, to plan, and to detect errors." In a classroom setting, differing abilities to activate these subdominant responses may be observed through soft skill capacities like self-regulation, multitasking or patience. Valiente et al. acknowledge the vast literature associating effort control with achievement. Yet, they state current research is inattentive (excluding anxiety studies) to how exactly emotions may positively or negatively affect student decision-making in educational contexts. The authors point to challenges in discerning emotionality from effortful control as one reason why this area may be understudied. Among the findings they highlight, the authors connect low- and medium-activated positive emotions (i.e. relaxedness, enthusiasm, joy) to heightened motivation, which in turn improves achievement (p. 130). This is likely because these positive emotions heighten cognitive processing and awareness. Regina Milteer et al. (2012) similarly relate higher cognitive processes to positive emotional development and improved life course outcomes.

Given that life course probabilities begin quantifying during early development, some researchers view behavioral intervention as a valuable asset for improving children's life course outcomes. Gennetian et al. (2016, p. 6) discuss interventions in public program frameworks to maximize potential use for families who desire them. They view behavioral economics as a "promising guiding perspective" when building socioeconomic models that address early childhood inequities in cognitive load (p. 9), self-control (p. 10) and experiences with poverty (pp. 9–10). Similarly, Britto et al. (2017, p. 1) analyzed early developmental interventions' potential with reference to the UN Sustainable Development Goals. They highlight lifelong benefits that accompany positive childhood experiences with acquiring language, growing cognitive skills and developing socioemotional competencies (p. 91). The authors write, "Opportunities for stimulation, responsive parent–child interactions, child-directed and focused enrichment, early learning, and positive parenting are crucial for children's development" (p. 94). These periods of receptiveness occur in early years, which is why the authors support intervention before age five. Britto et al. say intervening to address malnutrition, family violence, maternal stress and other widespread global issues through large-scale policy changes in learning programmes and social safety nets can vastly improve an individual's life course trends (pp. 96–97).

These researchers also indicate that views on potential interventions, such as through play — of varying type conducted in safe, nurturing environments— differ across cultures. Therefore, whether adults support behavioral intervention and what form that intervention takes will vary too. This is true for methods beyond play, including those through class curriculums, disciplinary methods and public policy changes. Focusing on play, Roopnarine and Davidson (2015) write, "The field of play research needs to further tease out what culture brings to the parent-child equation" (p. 229). They say that playful interactions between parents and children support parent-child attachment bonds, timely language development and appropriate social adjustment (p. 231). Despite these established findings, cultural differences in perceptions of play remain. The authors point to overarching differences in communities' behavioral frameworks, including between individualism-collectivism and socialized expectations; for example, researcher Kağitcibaşi found Turkish families living in urban environments adapted to encourage autonomy and interdependence in departure from universally applying individualism and collectivism during child-rearing (p. 230). In further play research, Roopnarine and Davidson support more carefully considering external variables to a family's play structure and socioeconomic factors which may supersede parent-child relationships in developmental effect (pp. 243–244).

3.2 Choice

There is also a growing literature relating behavioral economics to education, as exemplified by Bendle and Chen (2013). The authors use decision-making examples to explain concepts such as hyperbolic discounting (p. 11), trust (p. 17) and fairness (p. 19). These examples are useful because the plain speak is clear and the situations relate well to theoretical conflicts— like those among children or between parent and child— that my research investigates. Gennetian et al. (2016) analyze behavioral economics in the context of early childhood development, illustrating the critical importance that sophisticated decision-making plays in promoting life course opportunity (p. 1). Further, the authors focus on quality of early environments and quality of parenting practices as "two primary avenues of improving children's developmental trajectories" (p. 5).

Assumptions underlying behavioral economics, including those in psychology, neurology and economics, focus on the likelihood that certain decisions are made over others. Behavioral approaches to encouraging particular choices, such as delay-of-gratification, are shown to alter how individuals (and particularly children) make decisions (Koch et. al, 2014, p. 9). One 1980 longitudinal study from K.H. Rubin and L.R. Krasnor found that "parallel play," or unoccupied individual play, diminished once the children studied began preschool (p. 278). They state this change is perhaps minimally related to physical maturation: instead, children choose sociable activities over solo play once they are familiar with new peers and materials (p. 281). Their findings, though from the 1980s, point to environmental factors influencing children's play-based decisions during key developmental years. Forty years later, considering environmental factors is still a necessary design step when theorizing how someone might behave when prompted with particular choices.

Team Beam requires at least two people use interpersonal skills in tandem to achieve success. But not everyone has these skills already and many children will not be exposed to my game or other meaningful play programming. Failure, whether in playing my design or on grander scales, can be detrimental to a child's development if they lack encouragement. The flip-side of soft skill development is that some children will fail at using my installation, whether because they are bored, or do not understand or cannot find a collaborative partner. Thus the economic trade-off in structured play risk/rewards are acknowledged.

3.3 Bodies at play

Studies from multiple disciplines advance a foundational belief regarding early development: children need to play. They do so differently based on community contexts and these contexts are consistently revisited by researchers given their fluid states (Fleer 2009, p. 2). Professor Mary Fleer describes cultural-historical perspectives on play with reference to early childhood development in *Play and Learning in Early Childhood Settings*. In reviewing the existing literature, Fleer highlights cultural variations in community views toward social play (p. 2). These variations include the number of children playing and play frequency. Similarly, Roopnarine and Davidson (2015) write, "Previous reviews of parent-child play have articulated the importance of parental beliefs in the structuring of cognitive and social activities for young children" (p. 234). Play's varying community contexts lead to different perspectives regarding playtime's utility.

With attention to user experience, playground organizations like the DIY supporting Playground Ideas considers flow, difficulty, spacing, materials and colour in their designs (Moreno, 2020). Playground Ideas helps home builders design playgrounds with play outcomes in mind; active play, sensory play and creative play are among the archetypes they suggest. Russ & Wallace (2013) discuss the cognitive benefits associated with pretend play and creative processes. Particular cognitive abilities, such as divergent thinking, insight and cognitive flexibility, seemingly occur in both pretend play and creativity (p. 137). The researchers state that pretend play is a vehicle, "Enabl[ing] the expression of many cognitive abilities and affective processes important in creativity" (p. 138). Via symbolic behaviour, children view themselves and/or external objects as taking on a different role. The authors say that over time, this play style can help children organize narratives, grow their capacities for divergent thinking and develop their abilities to transform objects (p. 138).

4. Methodology

My installation was formed through cross-disciplinary research, qualitative interviews and an iterative design process. I used behavioral economics as an anchor for considering how the average person might behave in play situations. Factors influencing behavior and environment cannot be entirely controlled for in this scenario. But by grounding my design on theoretical averages driven by behavioral economics, its functionality is plausible when thoroughly analyzing disciplinary topics (like environment's effect on users) that may relate to my installation's user experience.

Academic institutions widely practice design thinking as an acceptable tool for innovating dated models. The Stanford d.school's Design Thinking Bootcamp—a program for rapidly learning about design thinking over a four-day practicum— provides small groups with realistic business challenges from where participants use design thinking to problem solve. HEC Paris (2020) offers an online specialization called Managing Innovation & Design Thinking. And as mentioned in Theoretical Orientation, Ryerson teaches design thinking throughout its undergraduate and graduate programs and within its Zone Learning ecosystem. I believe that design thinking's widespread appeal, even among culturally diverse communities, reinforces its value as a primary creative tool.

4.1 Research Questions

How can cross-disciplinary study lead to innovative design?

By identifying the option to economically nudge children toward positive behaviors, I then considered what innovation might look like. For some, an old forest might house endless opportunities for innovative play; for others, they might see playing in a forest as a lazy way to engage modern children. While I disagree with the latter, I accept that cultural differences in people's perceptions will lead to conflicts in opinion. In attempts to cut-out bias, I channelled my work through behavioral economics and interdisciplinary study. I was unsure whether or not there was an outcome which the average person would find innovative and favourable. But through research and experience, topics like environment (an awareness of and materially) and cognition regularly cropped up. This pushed me to understand how topics like these can cross disciplines and how my design can capitalize on widely held values in presenting a functional design.

What constitutes play?

Unlike early 17th century England, modern Canadian society is open to casual recreation in many forms (The editors, 2020). But how people play and how they feel about diverging from traditional play styles may vary relative to time and place. To address play, my research focuses on its physical nature and behavioral outcomes. It is acknowledged that other focuses— such as through sociohistorical analyses, wider inspections of design engineering or quantitative data sets regarding behavioral trends— will likely change my design. This leads me to consider my researched areas as deeply and effectively as possible, allowing my design to work relative to the disciplines it incorporates.

How might user behaviour respond to changes in the design's material composition?

Play's materiality is both aesthetically and pragmatically essential: as I change the physical environment and its conditions (for example, by using buttons rather than knobs) the children's theoretical responses will change too. This approach requires considering the probabilities involved with children and parents' decision-making relative to design features. For example, if I turn the Honey Hive 45° clockwise from its current spacing, then users at Station A can partially see into the box and respond to what users at Station B might be looking at— but this might lessen Station A users' incentive to turn-take with the Station B user, because simply viewing into the lighted box (while still pushing the buttons) might satisfy their interest in the installation.

How might my perceptions of play relate to other stakeholders' perceptions of play?

Despite my interest in this subject and belief in my design, I would not be a regular user. My perceptions of the installation's benefits are based on personal experience and research. They are not based on being a child or direct engagement with children and parents in a play setting.

With these facts in mind, I intended to widely vary my research and approach the literature with an awareness of my own biases. I take comfort in knowing that children and parents are human and their behaviours often fall within known archetypes. From this perspective, I moved forward in the literature hoping to ground my ideas in generalizable focus points (like “museum visitors want to enjoy themselves” and “collaboration is healthy”).

4.2 Interviews

To gather qualitative information relating to my project, I conducted two informal interviews: one with Earthscape Play architect Nathan and another with ROM educator Julie. My purpose in both interviews was to learn from their experiences and perspectives. We discussed their roles, views on learning, design approaches and the relationship between their roles and their employer’s organizational missions. Both parties say they are comfortable with being named in my paper.

My first interview was with Nathan. A term the playground architect uses when referring to professional creations is “place making.” By this, Nathan means capturing the essence of a community in his design, while also reflecting the community back at itself. To exemplify this concept, he cites the Fort Collins Sugar Beet Playground. Nathan says this playground is built on a sugar beet production plant’s property in a community with an economy driven by the sugar beet industry. With cultural context like this in mind, he tries to bring community stories alive from their new playground creations. For playing children, Nathan sees their experiences as complicated and unable to always fall neatly into cognitive or physical developmental categories. He explains this thought by citing a hugely successful bison skull playground in Bozeman, Montana: it is a morality questioning display that children gladly run a mock in and upon, raising fascinating interpretations of children’s relationship to death.

Nathan's design process, like professor Milic's and now mine, is iterative. Referencing one prototype's formation, Nathan says, "I did lots and lots and lots of bad sketches until I came up with a good one." He says that design work is hard like other work; great outcomes do not arrive easily.

My second interview was with ROM educator Julie. Julie says the ROM is actively conducting a Learning revamp with increased attention on digital tools and these tools' educational potential. In her role, Julie says she has adjusted her educational process to incorporate the students' curiosities organically; rather than telling children what to know, she approaches class with a topic and allows her students' initial questions to guide the lesson. Traditionally these classes have been "object-based": Julie explains how the ROM capitalizes on its vast collections to inspire unstructured creativity, such as in the Makerspace, based on the day's object-based lessons.

With COVID–19 likely to complicate fall programming, Julie sees an opportunity to continue ongoing development during social distancing. "We are currently in a shift as to how we approach building lessons," the ROM educator explains. The museum's move toward digital learning is accelerating as the ROM adjusts its spaces with public health in mind. Socially, Julie notes that increased digital learning can bring more children into the ROM's learning environment without requiring physical transportation.

Now, after interviewing Julie, working at the ROM as a Communications intern and studying play environments, I understand why the ROM views educational engagement as crucial to its learning goals and overall organizational success. And from speaking with Nathan, I better understand how play design and client-driven ambitions might combine, and what this combination means for a design professional. I believe continued progress in learning development and play design prompts targeted innovation with users' behavioral needs in mind.

4.3 Iterative design process

From programming to playgrounds to pirates, my notebook saw many variations of my installation's current state. By using design thinking processes to create my installation, its key features remained while lesser needed components faded away.

I feel design thinking's requirement to move from Prototyping back to Empathizing is an egotistically difficult but rewarding aspect to its process. Schnädelbach et al. (2004) describe how their experiences using an iterative approach to designing a location-aware device highlight the value of prototyping. I found prototyping to be a critical stage in my design's development as well. Though my prototypes never reached 3D, drawing them on paper among relevant written passages and mini-sketches helped me visualize whether this design was practical. Rather than being bogged down on the installation's materiality or aesthetic, my installation developed both among (in the notebook) and through (in my mind) relevant information. Certainly, a large portion of this information came via targeted academic studies over the last few months. But some useful information arrived by being more attentive to functional design in my material and immaterial environments. For instance, an immense breakthrough for me was recognizing that I do not need to completely understand my design's physics for it to plausibly work. I was considering my installation's mechanics too deeply. The breakthrough arrived while looking out at High Park's Grenadier Pond: water flowed, swans ruffled and lily pads sat. I marvelled at nature's beauty and functionality without needing to know the water's chemical composition or any other minute scientific details. From this conceptual point, I began considering how I can use forces already present in nature within a structured play environment.

I began considering water flow and irrigation, but Google searches for “pool pump” and flow speeds followed. Soon, I felt like I was writing for a Master of Chemistry rather than Communication. But then I had two bright ideas: light! And bees! Both are remarkable and deserve our attention from cultural and scientific perspectives. I maintained key features of earlier prototypes, like a vision blockade to incentivize turn-taking, but the entire design shifted as I reconsidered the structural pros and cons of using light rather than water. Around this time I conducted my interviews. I learned from two knowledgeable, experienced individuals that helped me pragmatize my work; basing my design off studies and personal experience was valuable, but allowing others to share relevant perspectives helped get my idea from concept to creation.

Through interdisciplinary research and a design thinking process, I identified generalizations about behaviour, environments and children’s needs which were then strategically applied when creating my design.

Below is a demonstration of how design thinking improved an earlier design iteration:

Float Boat

- Empathize: Before settling on Team Beam’s design, I tried to harness water via an installation called Float Boat. I know from working at preschool, my own childhood and mainstream children’s content that pirates are a popular source for child-aged enjoyment. I feel strongly that children’s content should inspire positive behavioral development. And from my studies and personal experiences, I understand thoughtfully designed play’s human benefits.

- Define: To fulfill stakeholder interests in an energy efficient, soft skill developing, pirate-oriented way, I turned to water. Like many children's authors, I thought pirates would be a useful thematic starting point for teaching. I felt pirates would be seen kindly by parents who may spend their money on pirate-themed goods already. The ROM's needs would be fulfilled because pirates are historic and remain culturally relevant. If using Float Boat appeared enjoyable, and if it could support soft skill development, then its oft-paying users and the ROM would be satisfied.
- Ideate: My plan was to have a boat sitting in an empty tank with a water vat to its left and a water vat to its right. If two users pushed buttons, placed on the floor, simultaneously, then doors on each vat were lifted and water entered the tank. Placing these buttons on a ramp-accessible platform met my design's physical accessibility needs. As water entered, the boat floated above a seaweed vision blockade, revealing itself to users for exploration.
- Prototype: I liked my Float Boat's aesthetic. Its room for themed decoration was plentiful, with the floor buttons shown as X's on a faux treasure map and the floating boat an item ripe for imaginative details. Before realizing how particular my water levels needed to be in either vat (i.e. each vat needed twice the necessary amount of water to float the boat because water stopped flowing into the main vat as the overall water level evened out) the process seemed to fulfill MRP goals while presenting an enjoyable experience.

Team Beam

- Empathize: The pirates were a poor fit for a gallery focused on biodiversity. I liked the pirate idea so much that I did not confirm where exactly it would go among the ROM's play areas. Additionally, realizing how finicky Float Boat was to run efficiently over many uses, I saw wide potential for stakeholder dissatisfaction. I believed my MRP's overall goals were worthwhile, but I rethought how achieving them could look.

- Define: I knew my next design would fall within the parameters of an efficient system that pushed users to collaborate. I also knew it needed to be physically accessible. But my appreciation for pirates was supplementary to these desires. Instead, I refocused my attention toward electricity rather than water and bees rather than pirates.
- Ideate: An initial Float Boat run seemed workable, but wait— how do I get the water back into the vats? This is the question that led me down too technical a path when considering my design's construction. Instead, I leaned on electricity's comfort with flowing against gravity. Team Beam's circuits only rely on its switch to complete/incomplete the current, whereas Float Boat relied on excessive force and particular measurements to work properly.
- Prototype: It took study and many sketches to iterate Float Boat, and more of each to arrive at Team Beam. I believe this updated prototype distilled Float Boat's advantages into a clearer, more intellectually accessible way: collaboration=light on, independent use=light off. The reward for collaborative play is immediately recognized by the activated lights, whereas Float Boat's reward was slow and disrupted if users stopped playing mid-float. Further, Team Beam's material construction is simpler than Float Boat's and therefore more defendable as a realistic museum installation.

In the future, I hope this design or an iteration can be installed at the ROM so user metrics may be observed and the design's value will be better understood. The ROM and other innovative, robust organizations gather varied information and consult widely in hopes their investments pay off via engagement. For my installation, this information may be gathered by observing target users playing with a rudimentary prototype in the Hands-On Gallery; perhaps this early prototype would only present one button connected to one light in one small Honey Hive on a simple wooden play platform. There is also an opportunity that my design (whether as concept or physically prototyped) can be evaluated through an exclusive, members only event featuring other visitor draws like Makerspace activities and exhibition tours. Ideal user metrics would be developed in collaboration with the ROM and in relation to the museum's current expectations for activity engagement. Combined with an adherence to design thinking processes, my prototype would continue changing to better meet user needs.

5. Design and discussion

Team Beam rewards users for displaying soft skills. By pushing its biodiversity-promoting pairings simultaneous to another person viewing the collection's artifacts, the lights activate and the dim Honey Hive becomes bright. This visual stimulation is meant to excite and intrigue young children, as well as spur enjoyment in the parents/guardians who are watching or using the installation with them. Users are free to touch the artifacts whether other users play with them or not. But to see the artifacts under light and then more closely inspect them with a magnifying glass or hands, turn-taking between two individuals is required. Collaboration is shown to be a critical soft skill given the collaborative nature that workplaces, schools, homes and others spaces demand in achieving goals and building relationships with others (Koch, 2014). Teaching children that working with others may lead to rewards can promote collaborative behaviour in its users.

Each user relies on their partner pushing the correct buttons. This is because the installation uses distance to keep Station A users from seeing into the Honey Hive. This is a key feature to my design and one which older children might find disinteresting. This is because an older child may recognize that they need to push a certain button relative to what their partner appears to be looking at. For example, if a Station A user sees a Station B user looking at the crystallized honey, then they may immediately push its corresponding button without requiring the Station B user to verbally direct them. But based on my experiences as an early education intern in the London Bridge Childcare network, young children may not immediately do the same; the multitude of colours, the installation's newness and museum environment's potential obscurity are plenty to disorientate a small child.

5.1 Materials

Team Beam uses three separate electrical circuits. Each circuit contains one switch (THD (ii), 2020), two batteries (Rona (ii), 2020), one battery holder (Kidder, 2020) and one light (THD (iii), 2020) with wiring (THD, 2020) connecting them; Figure 5 demonstrates the circuit's basic design. A charger is an additional cost to promote environmental sustainability (Rona, 2020). By running each circuit from a switch at Station A to a light in the Honey Hive at Station B, users at Station A can active lights for users in Station B. The lights are covered by a reclaimed metal cage with a wooden bee toy, a jar of honey (closed) and a real honeycomb sitting beneath them. The general structure, including play counter, wiring container and Honey Hive are made from reclaimed wood. The buttons above the switches will be reclaimed plastic. The structure's back will be bolted against the wall, allowing individuals to physically access the installation without chairs or table legs in the way.

I will use momentary switches because once someone stops pushing a button down, I want it to return to its neutral off state (SparkFun, n.d.). If I use a maintained switch, such as those found in many living rooms, then someone can push a button at Station A and leave to Station B without needing to stay at Station A. This defeats the purpose of requiring collaboration and turn-taking, so keeping at least one person at Station A is necessary. The person at Station A cannot clearly see into the Honey Hive. Again, this may be physically and socially dividing for two collaborating users in an experiential sense, but it is crucial that the Station A user sacrifices this experience for the Station B user. Hopefully the Station B user returns the favour for the Station A user if the Station A user desires a turn too. Notably, there are three buttons— or one more than the average person has arms. This is important because it demands that two people make ongoing decisions about which lights they want kept on. It also offers an opportunity for a third person to enter the fray, pushing the remaining button (if a person at Station A is already pressing two of three) and further positively complicating the social exchange between users.

The design uses image coordinated buttons for one user to push while another user capitalizes on their newfound lighted Honey Hive. This idea is inspired by another colour-coded installation in the biodiversity inspiring series, *Zoboomafoo*. Figure 6 displays the TV show's (2016) aesthetically appealing blue buttons with corresponding foods. Similarly, my installation will catch people's attention via these colours despite the Honey Hive being dim until lit. My installation's colours will hopefully direct users toward pushing the buttons despite the box being left dim (and therefore unappealing). I expect the buttons to be very satisfying to push. Perhaps, only being able to push two at a time will become a challenge in itself if they are satisfying enough. It is difficult to project this without prototypes, but from my experiences working at preschool, a button to push with external consequences for when/if it is pushed will be a draw for children aged 2–4.

My installation's physical design is environmentally sustainable, connecting to the ROM's ongoing sustainability initiatives and saving money while doing so. Currently, the museum partners with Fleming College to offer an Environmental Visual Communication graduate certificate (Fleming College, 2020), provides a free virtual Burgess Shale gallery in collaboration with Parks Canada (ROM (iv), 2011) and actively promotes environmental awareness through its permanent exhibition *Life in Crisis: Schad Gallery of Biodiversity* (ROM, 2020). The Honey Hive's lights are 120-watt light emitting diodes (THD (iii), 2020). LEDs are considered the most energy efficient bulbs on the market. According to the U.S. Department of Energy, LEDs last longer, are more durable and use 75 percent less energy than traditional incandescent light sources (DoE, n.d.). Because the switch is momentary, the design only uses power while users are actively pushing the buttons; a small amount considering the ROM's limited operating hours and LED lights' lengthy durations. The battery packs each use three rechargeable batteries, costing more than non-rechargeable batteries but saving energy and money over time.

5.2 Nudging

The design's obscured view from Stations A to inside of the Honey Hive is important because it nudges users toward a collaborative effort if they want the installation's full sensory experience. For older children and adults, it might be obvious which buttons to push based on where the other user is trying to look. Yet if users are child-child or parent-child (with child using button and parent using magnifying glass), then giving direction and correctly acting on that direction (by hitting the corresponding button) is an interaction fraught with potential for failure: What if a child ventures away from Station A while their partner observes artifacts? What if a child gets to use the magnifying glass and no longer agrees to be the button pusher? What if a child disregards their partner's directions and hits the wrong button, purposefully or otherwise? These questions point to the inherent uncertainty in assuming behavioral outcomes, which becomes especially pertinent concerning young children.

Using behavioral economics to nudge children toward incentivized decisions helps negate this uncertainty. By appreciating children's interest in learning and parents' interest in having them learn, as well as the environmental context of a hands-on biodiversity gallery, my design operates in a space where nudging toward viewing bee-based items is sensible. I believe this installation would be less likely to achieve soft skill development if installed in a church or grocery store. This is not because children and parents avoid either location or because parents do not want children learning lessons in these spaces. The environmental expectations in these spaces and others may not favourably welcome a collaborative activity bent toward biodiversity education.

Additionally, children aged 2–4 are developing fine motor skills that may be tested by button pushing and wielding a magnifying glass (Miller et al., 2020; Lubans, 2010). Although these are minor actions, Goodway and Branta (2002) highlight movements like these as building blocks for advancement toward more complicated movements and sport-specific skills (p. 36). They differentiate factors influencing motor skills into two categories: organism and environment. Organism refers to the learner and environment refers to external sources of stimulation effecting the learner's decisions (pp. 36–37). From this perspective, Team Beam presents low-risk motor skill practice with attention to learner needs and environmental context.

The reward in this situation will need to be a worthwhile one to expect children and parents to consistently play along with my installation's expectations. To this, I believe that visually and physically exploring the Honey Hive is a beneficial outcome for all stakeholders. Bringing my installation to such a workable position will require creating and testing my installation in a real-life environment. I will need to enlist a woodworker to craft my design (ideally with reclaimed wood) and a contractor to install it. I will have incentive to find someone to do this efficiently with reusable materials because stakeholders will expect it. I will also take a deep look at available public and private funding avenues if I produce a testable prototype.

6. Limitations

Notably, this design is only accessible to people who are visiting the ROM. Apart from allowing free admission every third Monday evening each month from 5:30–8:30 p.m., the museum charges Adult tickets $23 and Senior tickets $18 (and while although infants get in free, it is unlikely they will arrive alone) (ROM, (iii), 2020). This cost barrier, as well as the ROM's 5:30 p.m. closing time on its other open days, leaves some children likely unable to partake in using my installation. Reasons for this stem from socioeconomic differences between groups living in the Toronto area. This is unfortunate when valuing equitable short- and long-term resource distribution as mainstream Canadian society, and I as well, do. It is also motivation to consider how a successful installation may precede a successful free, public installation.

To exemplify how socioeconomic status (SES) affects decision-making, we can look toward Toronto wealth distribution by geography. University of Toronto professor J. David Hulchanski's report *The Three Cities Within Toronto* captures how wealth concentrated centrally as lower-income residents concentrated in the city's northeast and northwest. Hulchanski showcases upward, neutral and downward socioeconomic trends among three areas of Toronto, showing how this distribution emerged from 1970–2005 (Figure 7). Of course, this inequity leads to numerous uneven outcomes outside early development and education— seen recently through the staunch difference in neighbourhood susceptibility to COVID–19 infection (City of Toronto, 2020) — but this paper reflects educational and institutional inaccessibility which many Toronto families face.

A dark irony is that these families may house children who require more behavioral intervention than their higher-SES peers who more frequently attend pay-to-use spaces like museums (Milteer et al., 2012). This point highlights my design's limitation as a public good in its current environmental iteration. Researchers Regina Milteer et al. (2012) indicate children in poverty face myriad barriers to play ranging from unsafe play areas to limited social programming (p. 205). They state these children miss "gaining the maximum benefit" from their play experiences, and this point relates to my installation's limited use (p. 204). Children from Toronto's northeast and northwest may desire improved play spaces and more attention from designers such as myself, but this design does not adequately address their concerns.

Another limitation is the installation's entirely theoretical premise. There was an early opportunity to begin a formal, in-person research study, but COVID-19 closures kept this from transpiring. I hoped to host a Play Day where children and their parents would partake in activities of various structure in a museum setting and then give feedback. Lacking formal, personal research study means the installation's perceived developmental value may be less (or more) fruitful than theorized. I believe referencing behavioral economics strengthens the likelihood that my design will work, but it is unknown without further testing.

Additionally, variables involved with play are extremely difficult to control for. One cannot know exactly what someone else is thinking, even if observing seemingly obvious actions. For example, classic behavioral perspective relies on making assumptions based on individuals' observable actions, which may reflect known behavioral patterns (Lumen, n.d.); but if we see someone grab an orange from the produce section and assume that person wants an orange, this assumption is always subjective. Given this, I cannot know exactly what a child or parent is thinking, even if seeming to benefit from my design via their observed vocal and bodily communication. Similar to classical theory, reciprocal determinists believe that actions are reciprocally shared between environment, behavioral expectations and individuals: environment influences behavior, behavior influences environment, and each influence individuals who also influence them (APA, 2020). If this is the case, then producing a concrete concept of why an actor behaves in a particular way at a particular time is perhaps impossible without knowing users and their environments' entire physical make-up (Koch, 2012). The American Psychological Association further connects this concept to social learning theory. Because people, such as a child beginning at a new school, rely on observation to learn behavioral expectations and strategies, the social contexts of a learning space will affect that individual's learning (Lumen, n.d.).

7. Conclusion

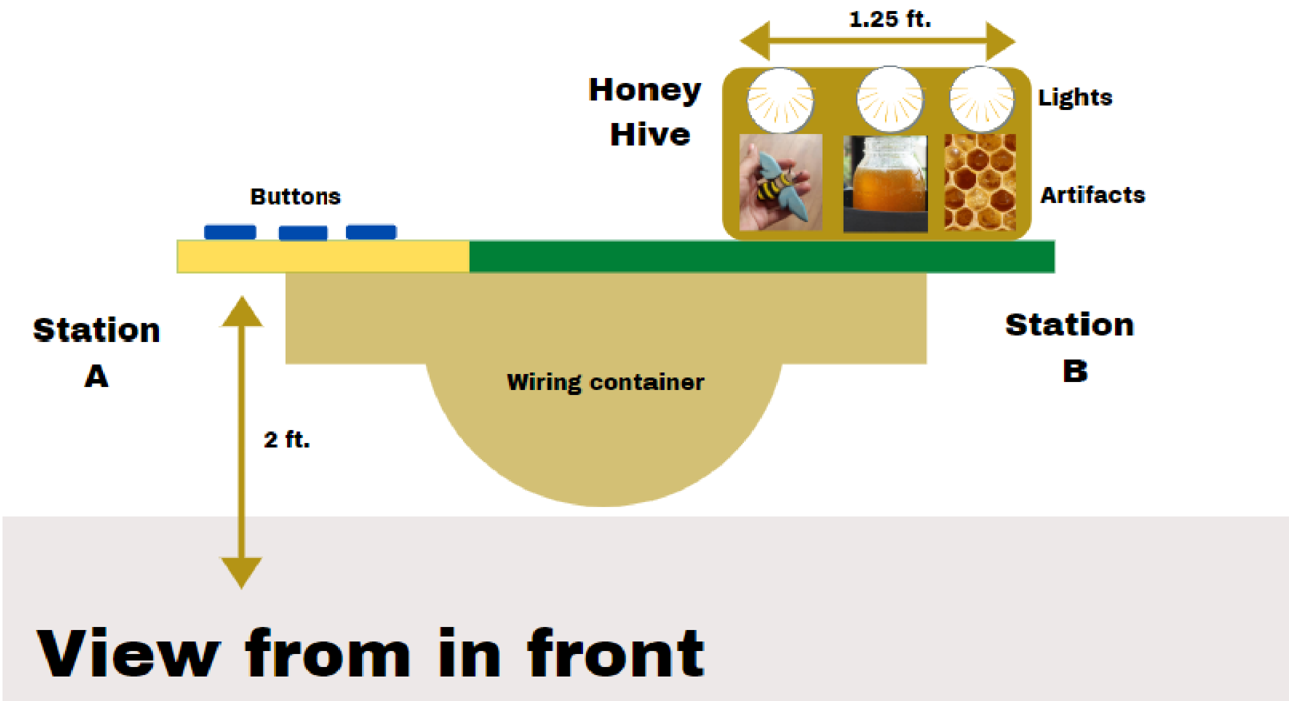
Views of play design and its perceived benefits will vary based on individual beliefs, yet there are clear ways to incentivize choices that support healthy behaviours. By applying behavioral economics' nudge theory to a play installation's design, children may be led to decisions that many disciplines identify as beneficial. These decisions involve sharpening soft skills such as collaboration, multitasking and turn-taking. Children with these skills are shown to achieve socioeconomically higher levels than their peers without (Koch, 2014). It is crucial that public organizations and parents acknowledge the short- and long-term benefits associated with growing these skills. If research on soft skills benefits is widely available and cross-disciplinary, then incorporating this information into current educational practices will serve individuals and their respective societies.

The design is highly structured in a time when mainstream Canadian organizations like the Canadian Public Health Association (2020) tout unstructured play as a critical component to children's wellbeing. I hold this belief and feel that unstructured play must be incorporated into learning programs within and without the public sphere. But I also believe carefully building innovations like mine into a free play environment, such as the ROM's Hands-On Gallery, can positively disrupt children and parents' expectations for that space. Every stakeholder committed to children benefiting from their experiences at public museums can support an installation that children will enjoy and learn from.

Through personal experiences, interviews, interdisciplinary research and a design thinking approach, my installation incorporates environmental and individual behavioral contexts. Consultations with my supervisor and continued ideation moved an iterative process forward. I hope this MRP will inspire others to continue innovating in early education.

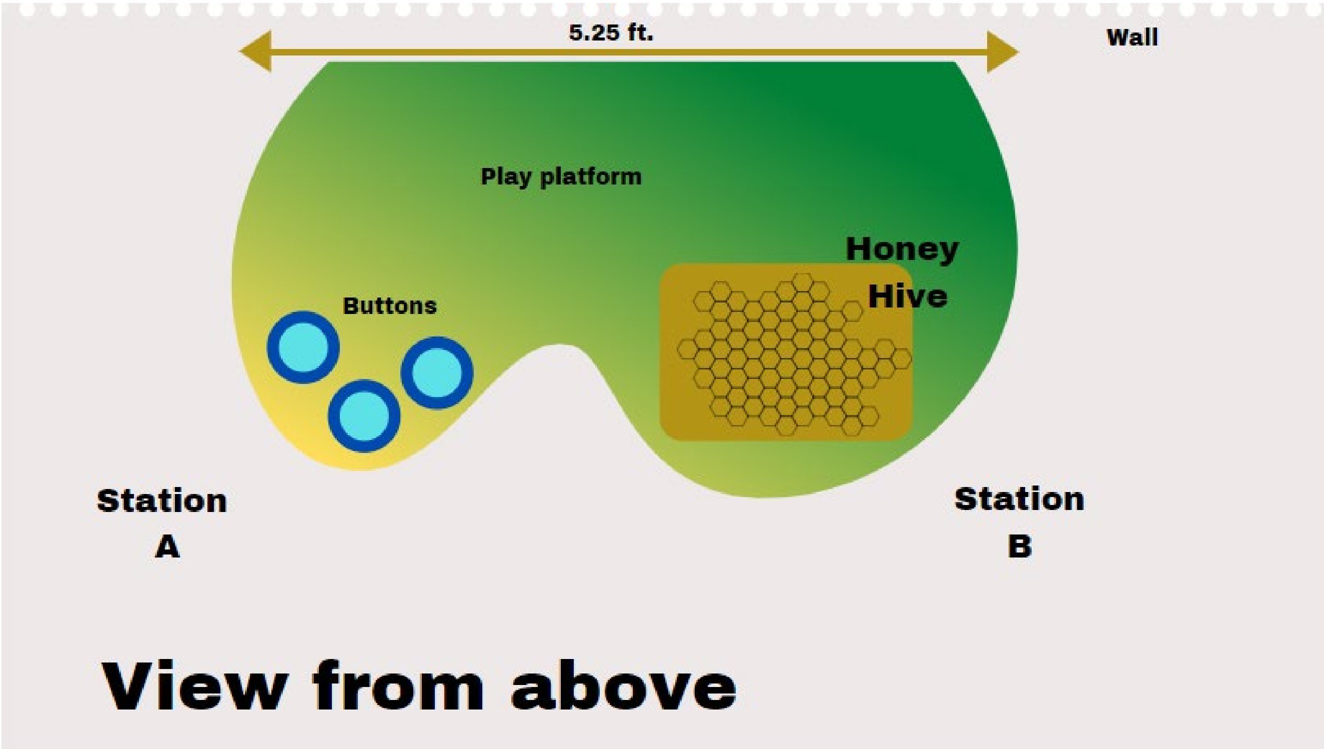
8. Figures

Figure 1



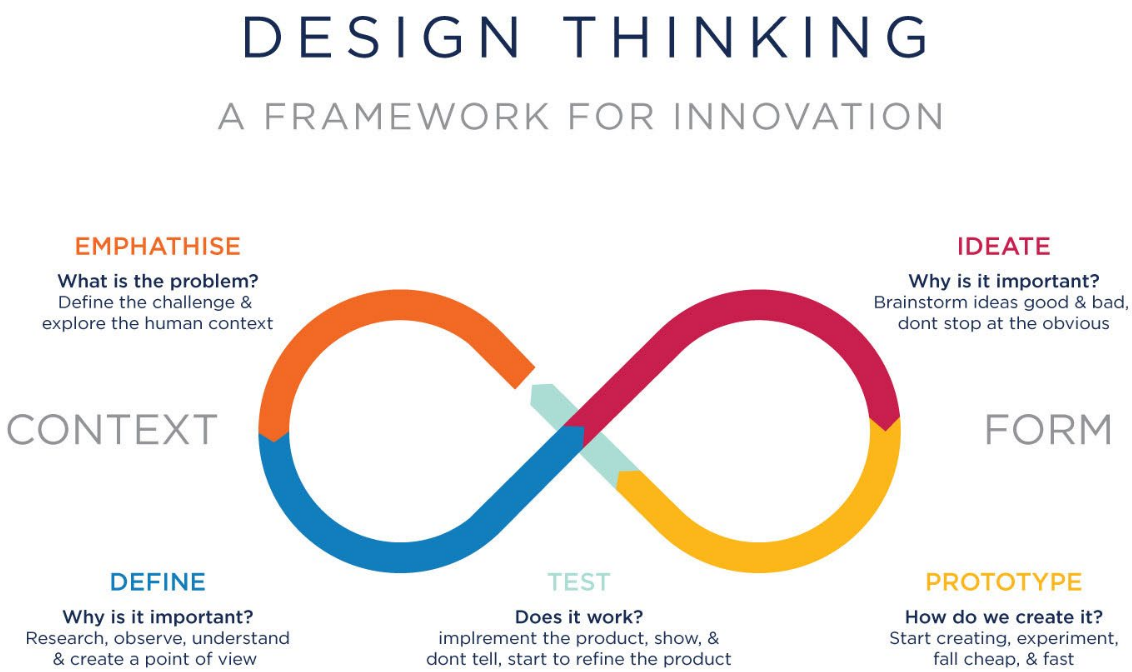
Note: this design was created on Canva.com.

Figure 2



Note: this design was created on Canva.com.

Figure 3



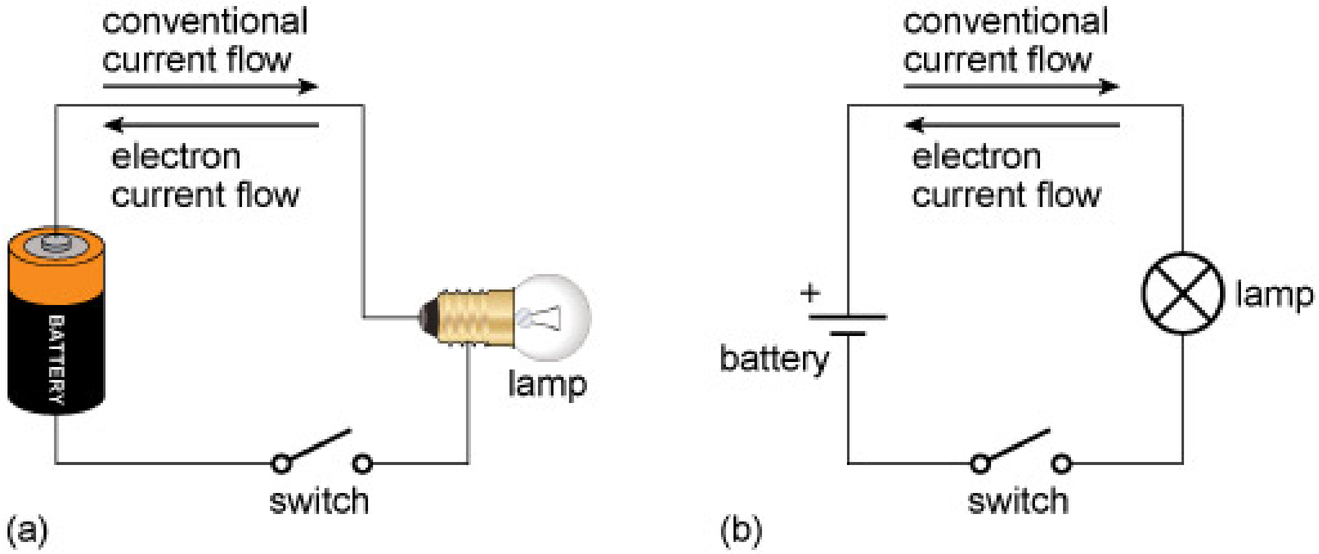
From "UX Design Processes", UX Beginner. (https://www.uxbeginner.com/ux-design-processes/).

Figure 4

From “ROM Keenan Family Gallery of Hands-On Biodiversity”, YouTube.

(https://www.youtube.com/watch?v=7WBLWxpxsNc)

Figure 5



From "An introduction to electronics", OpenLearn. (https://www.open.edu/openlearn/science-maths-technology/introduction-electronics/content-section-2.1).

Figure 6

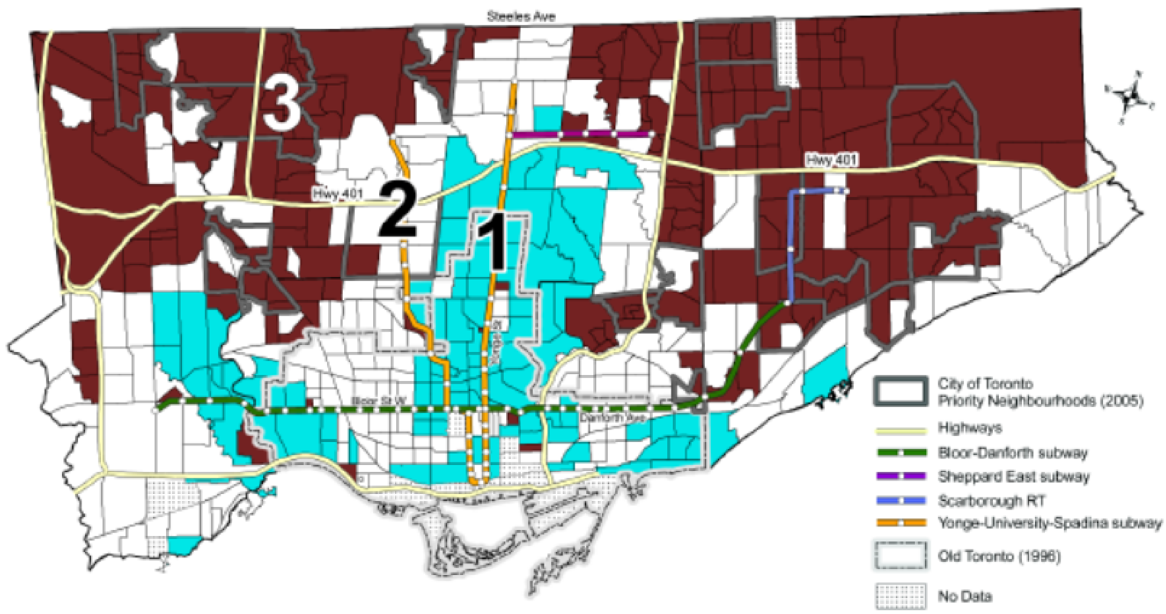
From “Zoboomafoo 118 - Feeling Good (Full Episode)”, Zoboomafoo.

(https://www.youtube.com/watch?v=uhh0Mh5hZL0.)

Figure 7

MAP 1: CHANGE IN AVERAGE INDIVIDUAL INCOME, CITY OF TORONTO, RELATIVE TO THE TORONTO CMA, 1970-2005

Average individual income from all sources, 15 years and over, census tracts



Change in the Census Tract Average Individual Income as a Percentage of the Toronto CMA Average, 1970-2005

City #1
Increase of 20% or More
100 Census Tracts, 20% of City

City #2
Increase or Decrease
is Less than 20%
208 Census Tracts, 40% of City

City #3
Decrease of 20% or More
206 Census Tracts, 40% of City

Note: Census Tract 2001 boundaries shown. Census Tracts with no income data for 1970 or 2005 are excluded from the analysis. There were 527 total census tracts in 2001

2 The Three Cities Within Toronto

From "The Three Cities Within Toronto," by J. David Hulchanski, 2007, University of Toronto, p.2.

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