Understanding science centre engagement in making personal connections

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Abstract

The paper highlights selected renowned science centre practices that used to encourage visitor participation and immersion. Visitors act as celebrants of science information in an edutainment context, motivated by a quest for social experiences. This study review multiple learning theories underpinning how visitors learn and how these theories impact science centre's exhibition design efforts. Using the recent experience of Science Centre Singapore, The Mind Museum, Philippines and Questacon, Australia as case-studies, the qualitative method provided a comparison of approaches across multiple institutions. The study discusses the responses in order to explore the extent to which the process occurs. Understanding how and why these institutions make certain exhibition design decisions will provide insight into how exhibitions might foster changes in visitor attitudes, knowledge, belief structures and curiosity. Such insights may be applicable to support informal learning and visitor diversity in other museums. The paper argues for making personal connections as primary themes that emerged from the rich and descriptive data. The themes represent central values and important recurring concepts which strike at the core of the exhibition design process. Visitors' create a more amorphous connection to science information through play and creativity. How does science centre nurture personal connections? How do they support quality visitor experience and informal learning intentions? Answers to these questions are the essence of this paper.

Keywords: Exhibition design; Informal learning; Science centre; Visitor experience

1. Introduction

The growth of science centres since the 1990s is closely related to the developments of the information society. Communicating science to the public via different media is to better serve scientific research and academic education in a society (Popli, 1999). The continuing world-wide trend is for a broadening of the subject range of science centres and an increasingly interdisciplinary approach to exhibition themes (Salmi, 2003). The varieties of exhibits spanning across disciplines are basically incubators of scientific knowledge and emphasises hands-on exploratory learning. Frank Oppenheimer has been quoted as the creator of the science centre pedagogy (Oppenheimer, 1968). His criticism of the passive pedagogy of science education derives implicitly from Dewey's ideas (Dewey, 1938). The same approach can be seen in contemporary developments in science centre pedagogy: The famous hands-on principle articulated by Oppenheimer is the basis of interaction principle in modern science centres. What Dewey and modern science centre pedagogy share is the accent on motivation, free will and the learner's own activity, stimulated but not forced.

The style of the exhibit presentation deeply affects the kinds of thinking engaged in by visitors (McManus, 1989). Studies conducted found that many families choose to visit museums because they anticipate that there will be fun and entertaining things for everyone in their group to see and do there (Moussouri, 2003). In most instances, families say that they come to the centre to learn something new, to enjoy themselves, and to spend quality time together (Borun, 2008). Recent studies in museum have examined various factors that can influence learning such as engaging visitors' emotions or connecting with visitors' prior knowledge and interests. The biggest challenge for science centre institutions is to strategically provide opportunities for cognitive and affective learning while simultaneously facilitating enjoyment and fun. Using the recent experience of Science Centre Singapore, The Mind Museum, Philippines and Questacon, Australia as case-studies, this paper examines the responses of the centre managements in

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order to explore the extent to which the process occurs. The nature of their roles at the respective Science Centres had resulted in a correspondingly wide-ranging mesh of findings. The theme making personal connections represent essential values and important recurring concepts which strike at the core of the exhibition design process.

2. Existing Discourse on Learning in a Museum

Museum is considered as a free to choose learning environment; that is, visitors largely come by their own choice and thus intrinsically motivated. They engage in the activities in a self-directed manner, and therefore, their methods of learning varied (Greenhill, 1999a). In describing the integration of intrinsic motivation into a theory of learning, Rice (2001) highlighted the task of museum educators is to move people into becoming learners. "…In the mission of moving people from a recreational agenda to a learning-centered agenda, there is no better motivator than a powerful aesthetic experience" Rice (2001, pp. 49). A theory of learning that integrates into it the function of motivation is ultimately one that can reconcile affective experiences with the construction of meaning. According to Perry (1992), requirements for an intrinsically motivating museum experience include the ability to instill curiosity, challenge, control, confidence, play and communication in the visitor's experience. To achieve intrinsic motivation, the learning theories underpinning how visitors learn and how these theories impact a museum's exhibition design efforts are further discussed.

Exhibition design is the process by which decisions are made regarding all the aspects that are related to how an exhibition will be installed and the impact it is intended to have. The design process includes exhibition arrangement, mode of presentation, media selection, and setting in relationship to: other media, the space, and the visitors. Design is a non-linear, "transactional process involving logic and intuition, in which the message to be communicated, the mode and the medium are played off against one another according to the individual values placed on them" (Miles, et al., 1982, p. 56).

Meaningful learning has two components. First, the content should be meaningful and motivating for the learners. Second, the learning process should be arranged pedagogically in a meaningful way according to the learners' age, prior knowledge and skills, and according to the logical structure of the topic being taught. The role of informal learning is increasing in modern societies - in countries, which are developing their societies by investing and creating opportunities for research, innovations and education (Salmi, 2010).

Behaviorism models are drawn from traditional classroom practices and have been used to design museum exhibits in the nineteenth and early twentieth century (Greenhill, 1999b). This led to authoritative, didactic displays, frequently arranged to illustrate conventional epistemological hierarchies and classifications (Hein & Alexander, 1998). Many educators are now realizing that this model may not be the best suited for learning within a museum (Hein, 1999).

Within the past three decades, other learning theories have become prevalent in exhibitions. Along with the change in theories, an alternative definition of learning itself has come into play. "Learning is now seen as an active participation of the learner with the environment…and therefore, (museums)become central to any educational effort when the focus shifts from the written word to learners' active participation through interaction with objects" (Hein, 1998, pp. 6). These newer theories include John Dewey's Experiential Learning theory, Constructivist theory by George Hein, the Contextual Model of Learning by John Falk and Lynn Dierking, and Howard Gardner's Multiple Intelligences theory.

2.1 Experiential Learning Theory

A working definition of Experiential Learning (Kolb, 1984) states learning is "the process whereby knowledge is created through the transformation of experience" (p. 38). From the experiential perspective, learning is an adaptive process through which knowledge and experience are continuously being recreated and transformed, both objectively and subjectively (Kolb, 1984). The underpinning concepts of contemporary museum exhibitions originated with the Experiential Learning theories of John Dewey (1938). In a museum setting, the implication is that visitors will take individual meaning from exhibitions based upon their individual previous experiences and their present experience in the museum. Dewey also acknowledged the continuity of personal experience; that one experience builds upon the previous. Within a museum, this implies that visitors' learning is not a static operation, and learning is an ongoing,

lifelong process. He also recognized the relationship between a learner's context and the way in which he learns. In a museum setting, this implies that the museum environment influences a visitor's learning significantly.

2.2 Constructivism

Constructivist theory is focused on activity and grounded on some of the basic premises of Experiential Learning theory. Constructivism is a learning theory in which learning is considered an "active process of constructing knowledge rather than acquiring knowledge;" and "is the activity in context," in which "the entire gestalt is integral to what is learned" (Duffy & Cunningham, 1996, p. 171).

Furthermore, visitors 'construct' their own knowledge from the meaning in the exhibit. This leads to a different focus when considering exhibit planning. "Constructivist educational theory argues that in any discussion of teaching and learning the focus needs to be on the learner, not on the subject to be learned. For museums, this translates that we need to focus on the visitor, not on the content of the museum" (Hein, 1999, pp. 78). A shift in emphasis, from the content of the exhibit to the visitor who is viewing the exhibit, is inherent in this theory.

2.3 Contextual Model of Learning

John Falk and Lynn Dierking, museum educators and experts on free-choice learning, proposed a model of learning specifically for use in free-choice learning environments. They state (2000, pp. 10-11):

> The Contextual Model involves three overlapping contexts: the personal, the sociocultural, and the physical. Learning is the process/product of the interactions between these three contexts…Learning, is ephemeral, always changing. Ultimately, then, learning can be viewed as the never-ending integration and interaction of these three contexts over time in order to make meaning.

This theory of learning accounts for far more in this context than any of the previous theories and is specifically aimed at museum type learning. Falk and Dierking (2000) acknowledge that there are numerous factors which influence learning within a museum, including: personal motivation and expectations; visitors' knowledge, interests, and beliefs; the visitor's ability to choose their learning; dynamics of the visitor's group (i.e. a family group); facilitated learning (i.e. docent interactions); pre-arrival orientation; design; and reinforcing events outside of the museum. The success of the museum learning is varied and based upon the successful implementation of these eight factors. For effective learning to take place within a museum, all eight of these factors should be considered when planning.

2.4 Multiple Intelligences Theory

Howard Gardner's Multiple Intelligences theory recognizes the different learning styles within visitors to museum exhibits. He proposes that:

> …There are at least seven different intelligences that manifest themselves [in people] in various configurations of differing degree. They are: (1) linguistic (out of which writers and poets are made); (2) logical mathematical, which traditionally leads to success in school, and of which scientists are made; (3) musical; (4) spatial (pilots, architects, chess players, and surgeons exhibit these skills); (5) bodily kinesthetic (in which the body serves as the agent for solving problems or fashioning products-dancers or mechanics exhibit this intelligence); (6) interpersonal (understanding other people, exhibited by salespeople and therapists); and (7) intrapersonal (understanding self) (Davis & Gardner, 1999).

He posits that museums, when considering educational opportunities, should cater to people of all intelligences, thus making exhibits more widely accessible to all types of learners (Davis & Gardner, 1999). These multiple intelligences are widely considered when planning for exhibition design.

3. Conceptual Framework

The earlier discussion of learning and educational theory examined the implications for the exhibition development process. Next, the paper discusses the methods used to encourage visitor's response and the effects on the visitor's participation and immersion. The attention on the theme, *making personal connections*, focuses around the concept of these science centres' need to establish a rich and cohesive experience. This theme also relates to reflecting the overall goals of the science centres and the nature of how and what the centre conveys to those who walk through its doors. The modern science centre must be able to present phenomena related to all academic research. Accordingly, the content is planned in an interdisciplinary way supported by a broad spectrum of temporary exhibition themes. Making personal connections as part of a science centre visit can heighten the impact of a visitor's experience. This paper addresses ways in which visitors discover personal connections with science centre exhibitions and how the centre can help foster these connections. The discussion related to this theme also presents how the management contributes to the creation of personal connections for visitors by targeting and understanding their audience.

4. Research Method

The research question that guided the investigation:

i. What are the methods used to encourage visitor into having a response?
ii. How does this effect visitor's participation and immersion?

The method of inquiry used was educational connoisseurship and criticism (hereafter referred to as educational criticism), an arts-based qualitative method of inquiry initiated by Elliot Eisner (1998; 2002) and used now by researchers worldwide (see for example Flinders, 1996; Barone, 2000; Uhrmacher & Mathews, 2005). Educational criticism requires that the researchers describe, interpret, evaluate, and discern themes, although the distinctions are "sharper on paper than in fact," Eisner points out (2002, p. 225). The descriptive aspect of educational criticism is intended to allow the reader to "participate vicariously" in the educational situation, which points to the use of literary vignettes that are presented here. Although the researcher's act of selecting what to include and what to leave out of a vignette are considered interpretive acts, interpretation also includes connecting the events to relevant literature and to ask what the situation means to those involved. Next, because "the point of educational criticism is to improve the educational process," the evaluation shows the educational significance of what has been described and interpreted (Eisner, 2002, p. 233). Thematic in educational criticism are "recurring messages that pervade the situation…a theme is like a pervasive quality" (Eisner, 1998, p. 104). They are, in short, lessons to be learned. Eisner points out that one learns from a single case all the time, whether by folktale, fictional or nonfictional stories.

Although attending to each aspect of educational criticism is a distinct part of the research process, the presentation of these aspects does not need to be sequential or artificially separated. Instead, the four aspects guide the inquiry process but do not limit the communication of the ideas and research findings.

The data collection process began with interviewing the Director of Exhibition from Science Centre Singapore, the Curator from The Mind Museum, Philippines, Head of Concepts and Education together with Design & Online Services Manager from Questacon, Australia and Principal Curator of Physical Sciences & IT at the Powerhouse Museum, Australia. Next, the author observed and recorded in photographs the scenography, exhibitions and activities in the galleries. The data collection process come to a concluding interview during which time the author asked the respective Directors and Curator to reflect upon the ways in which making personal connections themes actually emerged at the core of the exhibition design process. Next, following Eisner's ideas about "selecting a focus" and "building a plot" (see Eisner, 1998, pp.189-192), the researcher analyzed the data with pragmatic intent. That is, examined the data with an eye towards building a story.

The researcher provides several vignettes that illustrate portions of design ideas from the case studies; these vignettes in part serve as the response to the first research question inquiring on the methods used to encourage visitor into having a response. This will lead the researcher to interpret how this effect visitor participation and immersion in understanding level of engagement of the experiential settings. The researcher then draws out the dominant themes from the vignettes and discusses each in detail and in relation to other relevant literature. The researcher next describes

the planning process on how using the themes helped the curator meet his scientific intentions for the visitors. The study will conclude with a discussion on the significance of the paper and its applicability to other science centres.

5. The theme on making personal connections

The science centre implements a variety of means to promote personal connections for visitors on multiple levels through: the science content, the arrangement of the design elements and physical exhibition space, the exhibits on display, the marketing and consideration of visitors' interests and needs. Ultimately, visitors must draw connections for themselves by identifying science concepts from theme that relate to their own lives; they must make a connection by interacting with the exhibition space. As described by Curator Maria Isabel Garcia, the Mind Museum defines ideas relative to the institution's core purpose:

> The core purpose is to help people to make a connection to science. The personal realization is very important. Individuals feel connected to science... You're presenting things…that allow people to see how they're connected to science and I think you're doing things that allow people to realize that science is around us, it's not just a presentation of facts, and if you're feeling a personal connection to something, I think that implies…you're learning.

Garcia's comments emphasize the idea that visitors must make connections to the exhibitions that are derived from their own personal curiosity in order to be truly meaningful and real. But how can science centre find ways to encourage and sustain this connection for its visitors? The science centre strives to help people to be connected by drawing them in with a variety of visual elements, presenting objects, providing sensory experiences, and sharing a broad range of science concepts visitors may find recognizable or engaging. All the elements must interrelate -the exhibition design must support the theme and be tailored to a specific audience, explained John Richardson, Design and Online Services Manager of Questacon Technology Learning Centre (QTLC):

> Questacon as a building can also limit us physically on what we want to do, so we do try to modulate different experiences. You might find Q Lab in gallery 4, a place for interchange among the staff and the public. It's a very different kind of approach. Say, Wonderworks where you wonder around and play with the exhibits. It is an interaction within that space but in a smaller scale. In terms of working out all of the experiences from design perspectives, I guess we don't really get ask to comment on that. We just get ask to make work what the idea being presented either from exhibition concept perspectives or what the executives want. If it's too much of the same, although we do not decide on the variety of experiences, we throw ideas whether we can do this differently. Make it a 'different' feel so you can be having a different experience than the previous gallery that you visit to.

As Richardson suggested, space can be a limitation, therefore modulating different experiences is required. The way all elements interact impacts on how an exhibition will be received: from the selected content and focus, to how it is designed, and from who designs it to the audience for whom it is intended.

The following section explores several factors which contribute to promoting personal connections with science centre exhibitions.

6. Taking science home

A key goal for the science centre is to find ways for visitors to leave the centre feeling connected to science. However, fostering this connection is not always easy to do. Cindy Chambers, Head of Concepts and Education at QTLC suggested in describing the challenges to science exhibits:

> Museums are very important for social recreation education. As my boss often said ' I don't wake up in the morning and think I am going to the science centre to learn about science, they wake up and say I am going to the science centre because I want to share learning for fun, with my children or my guests in town'. So it creates an opportunities for visitors to have a social experience that is based on science. The way another saying is how you feel when you learn something is really important, so try to make it a little bit more accessible. I am doing science because it's really intriguing, makes me curious, I can laugh at you because you look silly in this exhibit… that's the perception going on behind it.

Chamber's quote emphasizes the fact that it can be difficult to reach people through science and have them feel connected with the material being presented. If science content is presented in a way that affords interactive and taps into some aspect related to visitor's curiosity, then that content can promote a connection and make science understanding more fun.

Getting through to visitors is about getting past the surface and striking a chord at a personal level. As John Richardson, Design and Online Services Manager went on to explain:

> Why Questacon is doing what it's doing – we want our visitors to pick up some inspirations so they become interested in science. Perhaps it's about translating a child who have no idea about science and get them into starting to think about science. It might be little steps at a time. So we start at a very early age, we look at adult also these days but traditionally its 8 to 14 years of age, the idea is like as they leave the building, if they're impressed in some way, they responded in appropriately and its quite an experience, that's a good outcome for us and that's the whole visitor experience that we want to happen, we hope they go through science as a career. That's the payoff. That's what we're trying to encourage. It's like to break down the barrier, because science – it can be terrified, it's too complicated, so we want to encourage to break down the barrier or the boundaries.

As proposed by Richardson, making the visitor experience themselves in the centre and understand about what they do is critical to unlocking an opportunity to encourage personal connections with the content. The 7 galleries address the ways Questacon can open people's mind to science by making them experience it and offering some aspect of understanding to take home.

6.1 Making science accessible

A crucial requirement for helping visitors to discover connections with science is to ensure the science centre and its contents to be accessible. Achieving this means the layout of the centre, the design of the exhibitions, and the format of the actual content all must be presented in a way that is approachable, relevant and easily understood by a range of audiences. The initial impression of the centre must be such that the visitors feel comfortable. The SCS tries to provide a welcoming environment and enough variety to offer something for all visitors. Daniel Tan, Director of Exhibition in Science Centre Singapore (SCS) commented:

> I think it's to be more accessible to all audiences. …What's nice about the size of this centre and the types of exhibitions, there seems to be something for everyone….through the Mind's Eye, the Waterworks, Planetarium …and the Halls, the atrium is setting a lovely theme for the centre in terms of welcoming and offering visitors many path and options of experiences.

As Tan's comments suggest, the overall array of experiences available is important in making visitors feel that they can explore, access, and learn from the exhibitions within.

Once gaining an initial sense of comfort, visitors must find the contents accessible on multiple levels as they continue to look more closely at the exhibitions. Every aspect of the exhibitions should support the content and contribute to the whole experience. Specific ways to encourage accessibility and making connections with content are evident in the following examples related to: exhibition flow, labels, scaffolding materials, and opportunities to interact. John Richardson, Design and Online Services Manager, described how the flow of an exhibition impacts the comfort and accessibility of the exhibition:

> In navigation, it's like the Guggenheim style museum, as one move from up along the ramp, and move down one gallery after another, along the drum. A number of years later, they change it, in reverse where we have to go up. Then about two years ago, they change it back to the original design to accommodate the public coming from the parking. The foyer ceremonial entrance is for the official and school trip. They turn the rear entry to a more accessible entry via open podium and café. It seemed to be working.

> The foyer level has been used in many ways. Access to the foyer is free but to get up into the exhibition, that's where you have to pay the ticket. You can get to the café, shop and look around the foyer without having to pay for the ticket to get in.

Cindy Chambers, Head of Concepts and Education at QTLC commented on accessibility and making connections with exhibitions content:

> In the foyer, we got quite a few ways that try to put a flavor to what you might find at the gallery so that a person who enters the gallery for the first time get a sense of it. There's a lot of movement, activities and this is what Questacon is all about.

These quotes from Richardson and Chambers support the idea that careful planning and providing wayfinding cues in the exhibition space minimize the physical, emotional, and cognitive efforts required by a visitor to navigate through the space. This off-loading of required resources allows the visitor to be able to direct more attention to the content, making it more accessible and easier to consume.

Another means to make exhibition content easier to understand is by providing interpretive labels that utilize layers or levels of information to support a well conceived, cohesive exhibit plan (Serrell, 1996). Writing clear labels of all types - title labels, introductory labels, section labels, object labels - play a vital role in telling the story underlying an exhibition and helping visitors connect with science. Maria Isabel Garcia, Curator at The Mind Museum, described how integral labels are to the accessibility of content:

> I think that in terms of content, no matter what the content is… we try to make it accessible. It has to be simple and inviting. We encourage our visitor to read the text. It's a reminder posted through our galleries.

As evidenced by Garcia, labels are important - both in terms of the information they convey and the way they are written. With regard to creating labels for an exhibition, length, type size, style, format, and vocabulary should be addressed relative to the targeted audience.

According to Cindy Chambers in terms of the experiential learning, the Questacon realized the need to offer additional support and assistance to encourage making connections through different styles of exhibits:

> There are different styles of exhibits that we would prefer as educational/learning experiences or the informal learning approach. The style of exhibit that we would prefer varies such as problem solving exhibit, information communication, exploring physical phenomena; open ended, play form, experimental style and quizzes. There are a lot of exhibit styles we can come up with, depending on whether that topic is important for that particular style of exhibit. Together, the Exhibition Project Team will try and pull them up together.

As suggested by Chambers, some connections may be preferable depending on the topics for different style of exhibits. For the more subtle connections, visitors may need a little variety and support to access the connections.

The WonderWorks gallery provides content in such a way that visitors have fun while exploring science. For example, building a life-sized distorted room provides immersive experience. Offering these types of tactile, sensory experiences makes science more readily accessible, since there are multiple levels on which to interact with the content. As commented by John Richardson:

> We do exhibits such as the Ames Room, the distorted room. We create that space to have an impact on them. We go that extra trouble, a lot more effort to get the full body experience. Yes, set work and space is the understanding for the exhibits. It allows one to enter and physically immerse in the room to understand the phenomena - rather than reading labels of a scale model.

Richardson's quote indicates that one key design objective for the gallery was to help visitors access the content. Instilling a sense of relevance can reinforce the creation of connections.

6.2 Providing relevance by drawing on personal and the social environment

Everyone has a preference - grounded in one's cultural value and own personal experiences. Incorporating exhibits, information, and issues within the science centre exhibitions that reflect on visitors' lives or social environment can help cultivate connections. The variety of issues and facts in the exhibition provides myriads of instances for visitors to find connections to their own lives. Ling Ling Chew, Assistant Manager, Research & Web Outreach at SCS described some visitors she observed making personal connections with the objects and exhibits:

> [People] find this personal connection in some facet of the exhibition… It can be random, it can be as simple as the chicken hatch and they're like, "…we used to watch this every time when we visit the place." I find that interesting. Walking through and overhearing, or when I see parents telling their kids stories about, "…when we grew up" looking at the gravity ball and kind of telling stories and how they were observing them back then, something like that.

As expressed by Chew, people get excited when they see things that remind them of objects or memories from their own lives. Seeing something familiar not only draws the visitor's attention, it also reinforces memories and makes the visitor more likely to share their memories and personal history with others - passing along a bit of connection. When visitors find themselves drawn in by something familiar they are also apt to look more closely at the other exhibition components and content, thereby connecting themselves even further with the place. Offering ways for visitors to relate to the exhibition content or context is important. Daniel Tan, Director of Exhibition described several examples of areas in *The Science Show* which pique visitor interest:

> I think that people have been very interested in The Mind's Eye area near the lobby. They remember the interaction and things like that or… certainly, in the *Lightning Science Show* they see action…I think that's the important thing that people can actually relate to what's in there. They do feel the intense… The fire thunderstorm section or when people see The Bugs Return… people really get excited … even if it's something that has been there before, repeat visitors are still able to find something that they can relate to.

As Tan suggests that presenting things people will recognize is an ideal way to entice visitors to look more closely at the theme exhibition. Familiarity offers the perfect hook for the centre to pose more detailed information and help visitors learn new things that will broaden both their knowledge and deepen their personal connection with the content and science wonders. Science show can play a powerful role in communicating science in the exhibition. The size, placement, and general science discovery of an action can effect into the initial impression. Sometimes the most important impact is tied directly to a personal connection a visitor already associates with. Maria Isabel Garcia, the Curator at The Mind Museum, described an example:

> I saw action happen in [*Universe*] gallery, with students who had explore the interactive exhibits and knew the rotatable link tunnel that's on display there, they go through it a few times…So it was the experience that they can really connect with …they really get involved, I think that has an impact on them.

As Garcia's comments indicates, a pre-existing personal experience with an object can lead to new exploration, as well as promote further involvement with the surrounding objects and other components on display in the exhibition.

Even if visitors do not have a personal connection with a specific object, they often find themselves drawn to certain exhibits based upon aspects related to their personal interests and experiences. They may see objects and be reminded of science fictions they had read from encyclopedia. People seek out connections based on their life and personal experiences, as explained by Matthew Connell, the Principal Curator of Physical Sciences and IT at the Powerhouse Museum:

> People seem to connect to [*Outerspace*] on this personal level… to be walking through the gallery and have a visitor stop you and say, "Do you have anything on the space shuttle or the zero gravity? The astronaut and such"… I think it's most effective and may not be apparent with how long they play with the interactive but they really are making that connection and taking it home with them.

As described by Connell, personal interests can prompt visitors to make connections. Helping visitors connect with exhibitions on a personal level can trigger questions; asking questions can lead to gathering new information; new information can result in having visitors leave the exhibition with a new personal connection with science. It's the immersive experience itself.

6.3 Creating new interest by engaging with the senses

Sometimes unearthing new discovery can pave the way to engaging with science, creating new interest, and introducing new ideas and connections. *Invent* at Hall G, described Daniel Tan, Director of Exhibition at SCS exemplifies an exhibition which provides visitors the opportunity to create new awareness and find new connections by building on familiar context:

> One of the things I think is important about [*Invent*] is that the exhibits have been on permanent display in our centre. We put them in a meaningful interpretation that allowed for a different way of seeing those same scenes. People who remember them from their last visit are able to come back and have a 'bazaar' experience with them. It would have been easy to just recreate that gallery and have it feel like the typical exhibition, but we didn't do that…we created something, I think, much richer than the usual display.

As Tan's comments suggest, the *Invent* and the scenes displayed within it carry a sense of layering message not just in terms of content, but because of being on display as a market stage. Visitors who come to the gallery for the first time would likely to remember the elaborate recreations of these 'streetwalk' events. The interpretive labels and interactive components placed alongside the multimedia encourage visitors to look more closely and see new details in the content presented before them. The interactive components challenge visitors to use more than their eyes to gain a deeper understanding of the issue depicted. Visitors have the opportunity to do something - to push buttons, to play music, to click the camera - to interact with the exhibition.

Interacting with an exhibition on multiple sensory levels can add depth to a visitor's experience. The technology's gallery, *How Things Work,* was designed and developed specifically with the intent to engage a full range of sensory experiences and elicit connections with science application, explained Maria Isabel Garcia, the Curator of the Mind Museum:

> We wanted this gallery to be interactive, whole body experiences so from the focus groups we landed on *How Things Work*. From that point, the objectives were - we wanted children to see science is all around them, that they're connected to science and that through these sensory experiences, they have a connection.

As indicated by Garcia, *How Things Work* engages visitors by providing the opportunity to *do* something related to science application—helping visitors connect with the concept. Garcia also noted how the hands-on nature and the varieties of exhibits stations contributed to the success of these exhibitions with school groups:

> They are having fun…I think [they are] surprised that this type of space is here; they're doing something other than looking. So, I feel the school group visits are highly successful. Children moved around and they're doing things. I think they're making connections. They're tracing the path of the exhibition, maybe they don't know the relation between each exhibit but we're contributing to their learning and understanding of it. When they do study this in school, they're going to have this little spark go off in their mind that they had done that here.

Garcia's statements propose that by having the opportunity to interact with the exhibitions students are creating foundations for future connections and learning. Likewise, being able to relate something from one's previous knowledge with something in the exhibition can result in the formation of new knowledge and understanding.

Interaction with an exhibition can lead to excitement, new knowledge and connections. People get excited when they feel like they are part of it, especially when it involves interacting with an actual object, explained Cindy Chambers, Head of Concepts and Education:

> *Excite@Q* was great because it makes you do every single aspect of it. People love that. They like to be part of it. They're experiencing the exhibits in a way and I think that is good. But then you have something like the freefall and 360', which people love because they can feel through it, that's a bonus. It's the very first freefall design to explain its connections to the psychological science. It lets them to actually experience a fright and excite feeling, biological feel, that's so integral to our mind and body. Experiencing the real stuff and having it being engaged in some way, is worthwhile.

As the comments from Chambers implied, if a visitor can feel a real piece of science - can be part of it - then the experience becomes more tangible, more personal and heightens the connection to the theory behind it. Getting beyond the surface of the exhibition - delving into the context and the concept that the exhibition reflects - is the important part of making a lasting personal connection with science. John Richardson conveyed some examples of exhibits and objects at the Questacon which attempt to engage visitors' senses and garner a deeper understanding and connection with the role of science in their lives:

> Trying to create a three-dimensional space that incorporates, like the children's gallery, fits in a role for all the senses to be thinking about science and the environment. So getting away from the pure, visual appreciation, the reading of content is a way to understand science. Trying to break that down a little bit, the *MiniQ* exhibit's the same way. Trying to create some experiences with science through objects like the water canals, the street smarts interactive, the construction even…where the power of science is not solely theoretical.

The examples shared by Richardson exemplify how the Questacon juxtaposes current objects and stories that relate to contemporary life - of science in the environment - bring a sense of relevance to the toddlers. Providing young visitors the opportunity to be directly involved with an exhibit and make a personal connection between the exhibit and their own lives can lay the groundwork for learning.

Learning can be difficult to access in an exhibition setting, since it is not a structured learning environment and because visitors may not recall their visit experiences or even realize what they have learned until long after their visit. Cindy Chambers described learning from an exhibition in this way:

> Science centre immersive exhibit play with your senses. So, sometimes the immersive that we have is an experience that will 'upset' your sense of balance a bit or it create a particular perception, a response. For science centre, an immersive has an impact on you. Immersive is – 'I am trying to change your senses' as the message.

As described by Chambers and echoed by interviewer of all respective science centres, learning is not necessarily the targeted goal of an exhibit, but it can be a byproduct of the experience. Rather than focusing on learning as an outcome, the Questacon strives to offer visitors stimulating experiences that will create personal connections which make enough of an impression to stay with visitors long after they leave the centre. In summary, the hope is that visitors will make personal connections during their hands-on experience and take home with them a bit of science.

The science centre encourages visitors to find connections by: making science accessible, providing relevance by drawing on personal engagement and experiences, and creating new memories by engaging with exhibits. Visitors are given an invitation to open their eyes to science and see connections to science and its concept. As stated by Maria Isabel Garcia, The Curator of the Mind Museum:

> This place is providing a lovely connections to the Bonifacio Art city… hoping when visitors leave, they're looking at the city in a different way. That we've provided them with fresh eyes to both art and science, as they move through the city, make new connections with artistic works outdoor and aesthetic theme of science indoor.

Helping visitors leave the centre with new connections, as Garcia described, relies upon knowing who its visitors are and understanding why they came. The centre needs to connect with visitors, which requires the centre to identify exactly with whom they are trying to connect.

Table 1: Summary of interviews based on theme coding

Maria Isabel Garcia Curator The Mind Museum		
Issue	Interpretation	*Theme*
Defines ideas relative to the institution's core purpose	Make connections derived from visitor own personal curiosity	*Making personal connections*

The impact of an interactive exhibits to visitors	A pre-existing personal experience with an object can lead to new exploration, as well as promote further involvement with the surrounding exhibition components	*Providing Relevance by Drawing on Personal connections and the Social Environment*
Exhibition as a space to engage sensory experiences and elicit connections with science application	How Things Work engages visitors by providing the opportunity to do something related to science application - helping visitors connect with the concept	*Creating Interest by Engaging with Sensory Experience*
Comments on how the hands-on nature and the varieties of exhibits stations contributed to the success of exhibitions with school groups	By having the opportunity to interact with the exhibitions students are creating foundations for future connections and learning	*Creating Interest by Engaging with Sensory Experience*
On Visitors invitation to science and see the connections through aesthetic space	Helping visitors leave the museum with new connections relies upon the museum knowing who its visitors are and understanding why they came	*Creating Interest by Engaging with Sensory Experience*
Cindy Chambers Head of Concepts and Education at Questacon Technology Learning Centre		
Issue	Interpretation	*Theme*
In describing social recreation education in science centre	If science content is presented that affords visitor's curiosity, it promote a connection and make science understanding more fun	*Taking Science Home*
On accessibility and making connections with exhibitions content	This off-loading of required resources allows the visitor to be able to direct more attention to the content, making it more accessible and easier to consume	*Making science accessible*
Describing experiential learning through different styles of exhibits	Some connections may be preferable depending on the topics for different style of exhibits. Visitors need a little variety and support to access the connections	*Making science accessible*
Comments on experiencing the exhibits	If a visitor can feel a real piece of science and be part of it then the experience becomes more tangible, more personal and heightens the connection to the theory behind it	*Creating Interest by Engaging with Sensory Experience*
Describing science centre immersive exhibits	Learning is not necessarily the targeted goal of an exhibit, but it can be a byproduct of the experience. The hope is that visitors will make personal connections during their hands-on experience and take home with them a bit of science	*Creating Interest by Engaging with Sensory Experience*
John Richardson Design and Online Services Manager at Questacon Technology Learning Centre		
Issue	Interpretation	*Theme*
On the interrelation of the exhibition design, theme and the visitor	Modulate different experiences is applied. The way all elements interact impacts how an exhibition will be received	*Making personal connections*
Comments on getting through to visitor at a personal level	Making the visitor experience themselves in the centre and understand about what they do is critical to unlocking an opportunity to encourage personal connections	*Taking science home*
Describing on how the flow of an exhibition impacts the comfort and accessibility of the exhibition	Careful planning and providing wayfinding cues in the exhibition space minimize the physical, emotional, and cognitive efforts required by a visitor to navigate through the space	*Making science accessible*

How tactile and sensory experiences makes science more readily accessible	One key design objective for the gallery was to help visitors access the content. Instilling a sense of relevance can reinforce the creation of connections	*Making science accessible*
Comments on getting beyond the surface of the exhibition - delving into the context and the concept that the exhibition reflects	Providing young visitors the opportunity to be directly involved with an exhibit and make a personal connection between the exhibit and their own lives can lay the groundwork for learning	*Creating Interest by Engaging with Sensory Experience*
Matthew Connell Principal Curator of Physical Sciences and IT at the Powerhouse Museum		
Issue	Interpretation	*Theme*
Comments on people seek out connections based on their life and personal experiences	Personal details can prompt visitors to make connections. Helping visitors connect with exhibitions on a personal level can trigger questions; asking questions can lead to gathering new information; new information can result in having visitors leave the exhibition with a new personal connection with science. It's the immersive experience itself	*Providing Relevance by Drawing on Personal connections and the Social Environment*
Daniel Tan Director of Exhibition at Science Centre Singapore		
Issue	Interpretation	*Theme*
On providing a welcoming environment and variety for visitors	The overall array of experiences available in the centre is important in making visitors feel they can explore, access and learn from the exhibitions within	*Making science accessible*
Describing several examples of areas which pique visitor interest	Familiarity allows the centre to pose more detailed information and help visitors learn new things and deepen their personal connection with the content and science wonders	*Providing Relevance by Drawing on Personal connections and the Social Environment*
Comments on an exhibition to create new awareness and find new connections by building on familiar context	The exhibition carries a sense of layering message not just in terms of content, but because of being on display as a market stage. Interacting with an exhibition on multiple sensory levels can add depth to a visitor's experience	*Creating Interest by Engaging with Sensory Experience*
Ling Ling Chew Assistant Manager, Research & Web Outreach at Science Centre Singapore		
Issue	Interpretation	*Theme*
On describing some visitors making personal connections with the objects and exhibits in the exhibitions	Familiarity reinforces memories and makes the visitor share along a bit of connection. They look more closely at the other exhibition components and content, thereby connecting themselves even further with the place	*Providing Relevance by Drawing on Personal connections and the Social Environment*

7. Conclusion

The theme, *making personal connections* focuses on the interactions visitors have with exhibitions and the connections people form with the exhibition content, as well as with one another, as a result of their experiences. The case studies offer multiple levels on which visitors can make connections with the varieties of subject range in addition to interdisciplinary approach to exhibition themes. The belief is to encourage visitors to take science home with them through making science accessible, providing relevance by drawing on personal as well as the social environment and creating new interest by engaging with the senses. Careful attention is given on how the exhibition design elements and physical space are combined and presented to create an appealing, inclusive, multi-layered visitor experience. The making of museum experience is important in nurturing intellectual and emotional benefits. Visitors choose their

preferred activities and design their own learning experiences. To support visitors, science centres aspire to an environment that combines learning with enjoyment. All educational endeavors are orchestrated to nurture creativity and there is a clear focus on meaning-making. Interview data analysis revealed that the exhibition design and development process is truly a process - one which involves people, ideas and components that must work together as a unified whole. Falk and Dierking (2000) suggested the importance of the "whole experience" for visitors through their Contextual Model of Learning in museums. The personal background of a visitor intersects with multiple contexts of the museum experience to impact the visitor (Falk & Dierking, 1992, 2000). The findings here support the idea that science centre practitioners have embrace ways to create a rich environment that support quality visitor experience.

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