Design Strategies in Science Centre

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Abstract. This study presents semiotics semantics theory as a possible standard for exploring the interrelations amid learning and the design of informal learning environments. The theoretical notions of classification (Bernstein, 1996), formality (Halliday, 1996), and framing (Bernstein, 1996) were sourced to explain the approach in selected exhibition galleries in Petrosains. Studies on the relationships between signs and symbols and what they represent, especially the relations between form and their reference in the physical world or the world of ideas, have been performed. Applying the semiotics semantics theory to the science centre settings has significant ability for expanding awareness of the role that exhibition plays in the visitor experience, and apprising the design strategies. The findings suggest that the representational modes do promote an investigative learning of science in pedagogical functioning.

Keywords: informal learning setting, science centre, semiotic semantics theory, visitor experience

1. Introduction
Science centre makes science accessible to a broad range of people in engaging and enjoyable ways. Given the current climate in formal educational institutions, the need to promote and sustain informal learning environments, is even more critical. Research into relation of exhibition design and learning processes is important to understand the conditions that facilitate an enjoyable and productive learning experience (Packer, 2006). Informal learning environment offers broad, reflective, and immersive learning experiences that cannot be gained from a textbook or a classroom lesson.

2. Case Study Background
Operating since 1999, Petrosains – The Discovery Centre, is known as a high-tech educational centre dominantly exhibiting the discovery of oil and gas industry. The main objective is to enhance and create interest for the public in knowing more about petroleum science and technology. The interactive discovery centre is compacted with fun-filled activities, arranged according to the same concept as the walk-through museum which exhibits a collection of science-related elements starting from the space system to the fossils industry. The visitors are welcomed in a well-arranged and systematic route which consists of about 19 interactive showcases. For the purpose of this study, six selected exhibitions have been identified. Refer to Appendix 1.

3. Literature Review
A learning theory that combines into the motivation value is eventually the one that produces affective experiences with the construction of meaning. Affective experiences are an essential part of learning,
reasoning, and social performance (Norman, 2004). Affect is identified as a key feature of the visitor experience (Roppola, 2012). Furthermore, this affective dimension was firmly connected to a motivation of seeking “richness of experience” comprising both entertainment and educational motivations from a museum visit (Moreno Gil & Ritchie, 2009). This suggests a possible link between affective responses and ‘Learning for Fun’ experiences as described by Packer (2006). Constructive affect aids vision and ingenuity, while appealing objects (which produce constructive affect in the user) are easier to use (Norman, 2004). This indicates that design as able to inspire constructive affect, and hence, better cultivate an attitude that is contributing to discovery, exploration, and learning. Further research into relation of exhibition design and learning processes is significant to value the settings that assist an enjoyable and productive learning experience (Packer, 2006). There is a need to understand the interrelations between learning and the design of learning environments. This is important because the gap between deeper interpretive contemplation of science phenomena and the experiential pleasure of science exhibits influence visitor interests and future visits.

4. Research Methodology
Enhancing visitor experiences study approach typically depend on full insights about setting and visitor behaviours. These understandings are basic to increase designers’ responsiveness. Visitor behaviours were not discussed in particular, as the subjects of inquiry are process based. A purposeful sampling strategy was implemented in the selection of Petrosains, in efforts to provide an “information-rich” case from which the most could be learned (Merriam, 1998; Patton, 1990). Petrosains was chosen as the case study on the criteria of quality standard exhibition design as well as offering integration of a variety of new exhibits within its exhibition environment. Likewise, the selection was based on several specific criteria (Merriam, 1998) or attributes: size and location, quality of exhibitions, variety of exhibition elements, and the range of exhibitions present in the science centre which implements an assortment of informal learning strategies and provides multi-sensory opportunities for visitors.

5. Strategy of photography-based data collection
Data collection methods for this study included photographic analysis of the science centre’s environment. The procedures begin when 20 applied arts students participated as respondents. Analysis through observation study and photography-based data collection was done during a visit from Petrosains in March 2018. Based on the limitation of time and budget factors, the analysis on degree of linearity, two-dimensional, sound, and graphic text were excluded. Only functions on three dimensional representational systems and lighting were analyzed, being totally conscious of the necessity to extend the studies to accommodate other representational modes. Photography-based data collection method is particularly strong in three aspects: capturing contextual information, reviving memory, and facilitating reflection (Rose, 2007). The photographs also refresh the respondents of exhibitions physical context, thus, prevent the loss of important information. Therefore, photographic medium is an appropriate method for this research. The data collection focused on capturing contextual data of architectural style, general interior atmospherics, space layout, and design as well as individual exhibits and displays. As photos were taken to facilitate reflection, rich contextual information allows the respondents to document what had been seen. An analytical strategy (Koulaidis et.al., 2002) based on cognitive effects of the exhibits’ design in a science centre was used. The theoretical notions of classification (Bernstein, 1996), formality (Halliday, 1996), and framing (Bernstein, 1996) were sourced to explain the approach in which the exhibits support a visitor to the knowledge implication and to analyze data for identifying the multiplicity of representational modes.

6. Analytical Template
The types of concerns for the representational modes was preliminarily analyzed by organizing information into the analytical template with four components of representational system, classification, formality, and framing. The photographic data of six galleries in Petrosains were organised according to the analytical template before thematic analysis was performed to understand the representational
modes in physical context of the science centre. Data from analytical template of the photographic medium were systematically coded to identify:

i. The types of epistemological relationships between knowledge categories.

ii. The degree of abstraction, elaboration, and specialization.

iii. The influence over the interaction established by the exhibits.

iv. The social interfaces in the setting of science centre.

7. Findings on Three-Dimensional Representations

The site analysis and observations of six selected galleries in Petrosains suggest a variety of common references to the every-day realm of the visitors and this is mostly made by producing examples of the way the specialized scientific knowledge attains applications that transform our everyday lives.

7.1 Classification Modulation

The content specialization promoted by the three-dimensional representations is determined by the form and the function of each representation. According to Bernstein (1996), this determines the epistemological relationship between knowledge categories of specialized 'techno-scientific knowledge' and the 'everyday knowledge'.

a. Form

Observations on six selected galleries in Petrosains suggest a balance of conventional, hybrid, and realistic representations. The three-dimensional representations promote balance of strong and weak levels of classifications in their form. For example, the model exhibits are realistic and most of them can be manipulated by the visitors. This can be seen mostly at the Oil Platform as shown in figure 1. The uniforms of the oil rig’s workers were even provided. Petrosains exhibits the realistic model of F1 car for the visitors as shown in figure 2.

![Figure 1](image1.png)

![Figure 2](image2.png)

b. Function

The three-dimensional representations are more metaphorical as shown in Appendix 1. It signifies connotations over what they literally represent. These weak classifications highlight that there are many references to the every-day realm of the visitors. Findings indicate science centre as a ‘learning-oriented entertainment experience’ consistent with what was suggested by Moscardo (1999) where an interpretative involvement create a ‘mindful’ visitor. This mindfulness can be created by interpretive practices that encourage control, interaction, and activity, as well as introducing novelty, piquing the visitors’ personal interests, and properly orienting them to the interpretive subject. The five selected galleries represent weak classifications, an enlightened and unconventional method on science learning, without the densities of the specific, and weak theoretical techno-scientific conventional representative systems. Findings indicate science centre as a ‘learning-oriented entertainment experience’ consistent with what was suggested by Bitgood (2002) where “visitor attention spans are affected by how much physical and mental effort they have to put in to stay on an exhibit”.


7.2 Framing in 3-dimensional representations
The framing (Bernstein, 1996) in 3-dimensional representations is used to measure the tendency of how the relations between the visitors and the exhibits is happening and how affective they are. The findings of strong and weak framing are reinforced by the power relationships and visitors' involvement in the three-dimensional representations.

a. Power relationships
Three-dimensional representations add to the decree of the interpersonal/affective relationships between the visitors and the exhibits. The element that contributes to the formulation of the power (hierarchical) relationships between the exhibits and the visitors is the exhibits’ size and the vertical angle of view. A three-dimensional representation that is large in size, can be viewed from a high and oblique angle and which cannot be touched, tends to create a feeling of diminishment and alienation to the visitor and promotes strong framing as shown in Figure 3 and 4.

The majority of the exhibits are the human-like size exhibits, which can be viewed at an eye-level and which can be manipulated by a visitor. This tends to create a feeling of familiarity and call for involvement and promotes weak framing.

b. Visitors' involvement
The three-dimensional representations promote weak framing in its visitors' involvement. The representations are mostly where visitor can manipulate the exhibit. The analysis from all the three-dimensional representations lead to the conclusion that the visitors are allowed a great deal of independence in accessing the exhibits and are also treated as socially equal partners who are highly motivated to get involved with them. The three-dimensional representations also promote a combination of strong and weak framing in different parts of the exhibitions.

8. Findings on Lighting Representation
Lighting is an intangible medium but it has an enormous influence on both the perception of physical space and upon the emotional response of those who enter these environments. These issues are addressed with a strong sense of aesthetics, functionality, and quality of light to ensure quality visitor experience.

8.1 Formality Modulation
The findings of high and low formality (Halliday, 1996) are reinforced by degree of colour realism, colour differentiation, and degree of directionality.

a. Degree of colours realism
The low levels of formality were observed in four out of six galleries. As far as their degree of colours realism is concerned, the lighting has made more galleries categorized as realistic colours.
There are fewer galleries which are categorized as unrealistic colours as in Speed and Dark Ride galleries.

b. Colour differentiation
Whereas with respect to their colour differentiation, a balanced gallery has one or two colours as shown in Figure 5. The use of blue and yellow lighting in colours leads to high formality at Speed gallery.

c. Degree of directionality
As with respect to their degree of directionality, there are more galleries which utilized focused light beam. In conclusion, high levels of formality are characterized in the majority of exhibitions.

8.2 Framing Modulation
The intensity of illumination of an exhibit in relation to the corresponding intensity of the surrounding exhibits represents a significance in deciding the level of framing. The observation suggests that four out of six galleries are more intensely illuminated with respect to their surroundings and there is an implied hint to the visitor to draw his/her attention. In this way, lighting increases the visitor’s control and, hence, leads to strong framing.

9. Conclusion
This research identifies the sources that generate visitor responses, known as the representational modes in the exhibitions. The reason essential to the constructing of the experience is in its matter and the sources employed by the designers. The degree of abstraction, elaboration, and specialization reinforced by the form and function of the three-dimensional representations suggest majority weak classification. The specialized character of the scientific facts can nonetheless be stated in codes of low formality. Lighting has an enormous influence on both the perception of physical space and upon the emotional response of those who enter these environments. These issues are addressed with a strong sense of aesthetics, functionality, and quality of light to ensure quality visitor experience. The low levels of formality characterize lighting in its degree of colours realism and degree of directionality. Whereas with respect to their colour differentiation, majority of the galleries have high formality. The lighting promotes strong levels of framing as majority of the galleries have intense lighting. The generated sense of independence and control over the intended knowledge can display the analytical, lively, and exploratory character of science. The study supports the potential of semiotic semantics in representational modes as a design tool for advancement in informal learning environments.

10. Research contribution
Practical insights are among these research contributions. This study offered a viewpoint for deliberating design in the informal learning setting. The concept of transformational experience (Kolb, 1984) in the design of exhibition context is acknowledged. This research analyzed the representational characteristics in science centres to facilitate understanding the relation between types of science centre offerings,
design highlights, and visitor experiences. Regarding the research method, this research uses photography-based methods in researching about science centre offerings and its design emphases. The photographic medium research method captures the structure of symbolic and experiential offers. This method further explains science centre representational expressive modes. Photographic medium captures the details visually and yields physical evidence of science centre exhibition environments. This finding confirmed that the sites attract and focus the visitors’ attention effectively. It is demonstrated that science centre exhibition environment is designed for affective experiences. Science centre creates positive attitudes and lets visitors learn for fun.

Acknowledgement
The authors wish to thank the International Islamic University Malaysia and the Ministry of Higher Education for funding this project in RIGS17-086-0661.

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Appendix 1
Analysis on Three dimensional-representations and Lighting

| Science Centre         | Three dimensional-representations | Lighting | Framing (strong/weak) | Power relationships | Degree of colours | Colour differentiation | Intensity of lighting to the surroundings | Intensity of lighting everywhere |
|------------------------|-----------------------------------|----------|-----------------------|--------------------|-------------------|-----------------------|------------------------------------------|-------------------------------|
|                        | Classifications (strong/weak)     | Framing (strong/weak) | Formality (high/low) | visitors' involvement | Degree of realism | Colour differentiation |                            |                                |
| Petrosains             | Form                              | Function  | Framing               | Visitor can only see the exhibit | Unrealistic colours | Realistic colours |                            |                                |
|                        | Conventional representation       | Realistic representation | Classificational, Analytical, Narrative | Visitor can manipulate the exhibit | Realistic colours | Unrealistic colours |                            |                                |
| Dark Ride              | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| The Known Universe     | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| Sparkz                 | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| Oil Platform           | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| Speed                  | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| Molecule Cafe          | *                                 | *         | *                     | *                   | *                 | *                     | *                          | *                              |
| TOTAL                  | 4                                 | 4         | 1                     | 5                   | 3                 | 3                     | 4                          | 2                              |

Classifications (strong/weak):
- Strong
- Weak

Framing (strong/weak):
- Strong
- Weak

Formality (high/low):
- High
- Low

Power relationships:
- Visitor can only see the exhibit
- Visitor can manipulate the exhibit

Degree of colours:
- Unrealistic colours
- Realistic colours

Colour differentiation:
- Unrealistic colours
- Realistic colours

Intensity of lighting to the surroundings:
- Focused light beams
- Diffuse lighting

Intensity of lighting everywhere:
- Uniform lighting everywhere