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Construction of Knowledge in Non-Formal Settings

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ABSTRACT *The study focused around two exhibits in the Discovery Room, which is an interactive science center for children, located inside the American Museum of Natural History in New York City. The purpose was to examine several factors, from those identified in the literature, that seem to contribute to science learning in non-formal settings. Thus, the present study investigated the extent to which the presentation and content of the exhibits, several characteristics of the visitors (family units), children's inquiries about the exhibits and staff interactions with visitors contribute to achieving science learning objectives. A variety of qualitative and quantitative data, from observations, interviews, and questionnaires, were collected during eight 40-minute periods from children, parents or guardians, and staff members. The findings indicated that the exhibit presentation is an important factor affecting science learning in the museum setting, because it determines the degree of children's engagement in an activity. The study also concluded that children and parents prefer to be actively engaged- mentally and physically- with the exhibits. Several patterns of children's questioning during their interactions or involvement with the exhibits were identified. These patterns constitute clear indicators of the learning outcomes supported by a specific informal setting. The results of the study corroborate with research evidence indicating that educational experiences in a museum setting better facilitate the process of knowledge construction and recall of information in comparison with the decontextualized learning in formal settings.*

KEY WORDS: *science learning, non-formal setting, museums*

Introduction

The learner is no longer considered to passively absorb scientific knowledge. Humans, children in particular, are naturally inquisitive and they constantly seek to satisfy their curiosity by asking questions and by using their senses to expand their knowledge. Scientific inquiry is a derivative of this belief, and refers to combining knowledge, imagination, reasoning, and process skills to actively develop science understanding (Carlson & Maxa, 1997). As Piaget suggested, knowledge is constructed through our interaction with our surroundings (Gardner, 1994). Constructivism, a theory rooted in cognitive psychology, suggests that our knowledge is actively constructed in challenging learning environments and through engagement in authentic tasks (Woolfolk, 2000), so that it is internalized and adapted by the learner. Consequently, inquiry-based approaches in science education are gradually gaining more attention as effective practices of promoting scientific knowledge and higher-order reasoning skills to student populations.

Often, the traditional formal instruction does not promote authentic inquiry, since the classroom setting is a substitute for the real world, where authentic inquiry is implemented (Chinn & Malhotra, 2002). Research (Anderson, Piscitelli,

Everett & Weier, 2002) has documented that nonformal settings, museums in particular, are powerful intermediaries between children's prior knowledge and experiences, memory and enjoyability, and provide the context in which scientific knowledge will be embedded into children's pre-existing schemata.

The purpose of this study was to examine children's involvement in activities that usually promote science learning in non-formal settings. According to Falk (2002), learning from museums is a complex phenomenon, which is, nonetheless, subject to analysis and predictive description. Learning outcomes are influenced by predictable and unpredictable factors, which could be interrelated. Therefore, in this preliminary study, four variables were selected and examined: exhibit presentation and content, characteristics of family units, children's inquiries about the exhibits, and staff interactions with visitors. The setting selected to examine these factors was the Discovery Room (DR), which is an interactive science center located in the American Museum of Natural History (AMNH) in New York City.

Literature Review

Learning is acquired both in formal and non-formal settings. Contemporary theories of cognitive science are shifting their attention towards the learner as an important component of instruction and learning. Gardner's Theory of Multiple Intelligences, theories of cognitive development, and inquiry-based learning provide a broad theoretical framework of how to teach science effectively. Therefore, science teaching is becoming more child-centered and inquiry-based, and it does not necessarily have to take place inside the traditional classroom setting.

Falk and Dierking (1992) support that science learning in museums occurs in a social context, which is a major factor affecting learning outcomes, since part of the visitors' attention is focused on the people with which they arrive or on other people already in the museum. In the case of hands-on inquiries in the museum, the social context is a major factor affecting the museum experience.

Contextualizing knowledge, as a way to promote effective learning, is also supported by Anderson et al., (2002):

> *"Museum experiences embedded within children's familiar experiences and contexts are powerful mediators of memory, enjoyability, and learning in these settings. [...] exhibits and programmatic museum experiences, which provide context and links with children's prior knowledge and past familiar experiences, seem to be more readily recalled, have greater impact, and are more educationally effective in a range of dimensions than exhibits and experiences, which are decontextualized in nature" (p. 16).*

The shift towards inquiry-based educational approaches, which encourage children's learning through direct observations and manipulation of the materials, is evident throughout the educational system. According to the National Science Standards (1996), science is an active process and, therefore, engaging in *"hands-on"* activities is not sufficient. Rather, students should be engaged in *"minds-on"* activities, where they are challenged to combine understandings of scientific knowledge with thinking and reasoning skills. Chin et al. (1997) support that students should be involved in tasks that are similar to authentic science in order to

be familiarized with scientific reasoning.

The term ***"nonformal education"*** refers to an approach that considers the process of acquiring knowledge as so important as the knowledge itself (Domroese & Sterling, 1999). Nonformal science approaches endorse learning outside the classroom setting with leadership of an adult and have an interdisciplinary nature indicating that science knowledge is intertwined with a variety of subject areas (Carlson et al., 1997). Thus, nonformal approaches mainly focus on problem solving, where learning is self-initiated and self-paced, and, therefore, nonformal education is sensitive to individual learner needs. Science museums allow for freedom of action (Sandifier, 1997), and, at the same time, they constitute a setting where authentic scientific inquiry is practiced. The science museum setting is dynamic and multidimensional, and, therefore, offers opportunities for implementing cognitive theories to promote scientific literacy. Interactive exhibits, in particular, do not simply require physical manipulation but minds-on engagement as well.

According to Schauble and Bartlett (1997), museums usually attract visitors that are in a "leisure time" frame of mind. Museums have a wealth of materials, resources, and activities that can satisfy a variety of interests, level of engagement, and backgrounds. However, this wealth of resources often serves as a barrier to visitors' involvement in activities beyond "gazing" the exhibits. Therefore, exhibits should be organized in ways that provoke reflection over various concepts, and they should engage visitors in "systematic study and exploration." This translates into a challenging exhibit presentation and carefully designed activities, which should allow a high degree of initiative on behalf of the visitor. The same concepts should reappear several times throughout a museum designed for children, although the contexts in which they reappear could seem different to the visitor in order to promote gradual construction of knowledge. Learning in science museums could also be promoted through extended play and first hand interaction with materials, bearing always in mind that not all non-formal settings are appropriate learning environments for all children.

As Rivkin (2000) suggests, the setting and the activities have to be carefully designed in order to encompass a developmentally appropriate learning environment. Sandifier (2003) conducted a research study in order to identify the characteristic of interactive exhibits, which are most effective in attracting and suspending visitor attention at a science museum. He concluded that technological novelty and open-endedness are the most educationally effective and influential characteristics of an exhibit presentation.

The important role of facilitating learners during their activities in science museums is stressed throughout the literature (Falk, 1997; Schauble, 1997). Thus, museum staff should be aware of the way children think and learn. In the Discovery Room (DR), for example, staff members function as facilitators, fulfilling their immediate role without directly interfering in other kinds of interactions that children are engaged in. Falk (1997) also pointed out the importance of explicit labeling of any exhibit clusters on the development of visitors' factual and procedural knowledge, and suggested that labels facilitate learning because they function as conceptual organizers of knowledge.

Methodology

Setting of the study

The setting selected for this study was the Discovery Room (DR), a special section of the American Museum of Natural History (AMNH), designed for multi-sensory, object-based inquiry for all ages. It is comprised of eight sections that are situated on a ground floor and a mezzanine, where children can be involved in activities concerning biodiversity, anthropology, paleontology, seismology, microscopy, or astronomy. The DR is focused on experiential learning through direct interaction with real specimens. It also serves as a referral to several exhibitions in the museum and as a resource room for parents and educators.

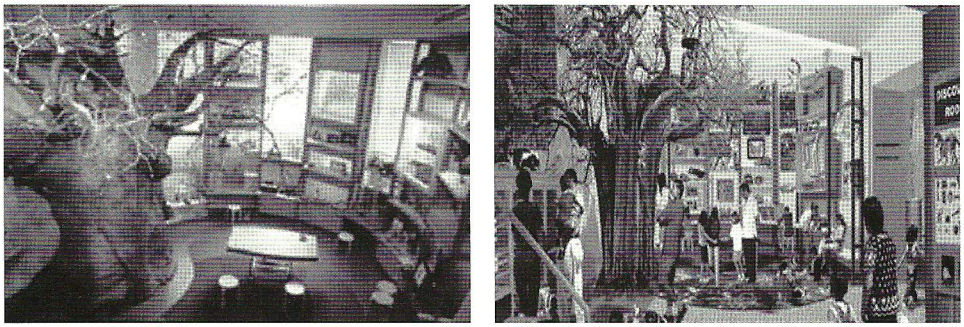
For the purposes of the study, we restricted the collection of data around two exhibits. The first exhibit was a real-size **African Baobab Tree,** which is located in the ***Biodiversity Section*** on the lower level of the facility. The key concepts to which it refers are biodiversity, conservation, and the scientific method. Children are called upon observing, recognizing, and categorizing the animals, or evidence of animals around the tree, through various activities. The activity we focused on was a treasure hunt around the tree that was supported by a worksheet. The tree and everything it contains can be observed from the ground floor or from the mezzanine. There are books concerning the tree and the wildlife surrounding it all over this section, which can be used during visitors' interactions. Moreover, visitors can enter a camping tent located next to the tree and observe a yellow–billed Hornbill nesting study that is particularly popular among children of 5-8 years of age, who are very curious to see what there is inside the tent.

Paleontology is another section in the DR where the concepts of fossils and fossilization, evolution, and the scientific process are addressed. The second structured activity that we examined was the reconstruction of a ***Prestosuchus fossil.*** Children choose the right bones and place them to the right position on the skeleton. This includes observational skills and symmetric matching. Because of the size of the skeleton, its reconstruction often becomes a cooperative activity, where children often present their arguments as to how the puzzle can be constructed. Figure 1 presents pictures from the exhibits selected for this study.

Sample

The sample included 24 family units, who visited the DR between the months of March and April, 2002. A family unit is a group of adult(s) and child(ren) who entered the DR together and had a family relationship between them. Household employees, such as caretakers, who were assigned to take children to the DR, were not included in the sample, since some of them did not speak English, or followed instructions not to talk to strangers.

According to the admission rules of the DR, each child has to be accompanied by one or more adults. There is a limit of 7 children per adult, with a 40-minute time limit for visitors to be in the facility. Data collection took place during eight 40-minute periods, during weekdays and weekends. According to the Discovery Room Visitors Survey (Cora Group, 1995), there are no significant differences in visitors' characteristics.



Aspects of the Baobab Tree Exhibit, from the first floor, and from the mezzanine.

The Prestosuchus Puzzle

Figure 1: Pictures of the selected exhibits for this study

Data Sources

Four kinds of data were collected. Field observations of family "engaging in activities" around the two exhibits, interviews with one adult from each family unit that we concentrated on, interviews with staff members, and information from the DR Guestbook. The term "engaging in activities" around the exhibits, for the subjects who interacted with the baobab tree, refers to those who used the related worksheet for more than two minutes. Subjects who returned to the treasure hunt more than once during the session were not counted twice. For the prestosuchus puzzle, the term "engaging in activities" refers to subjects who physically interacted with the exhibit for more than two minutes.

Three data collection instruments were designed and used for the purpose of the study. An observation protocol, an interview questionnaire for the adult, and

an interview questionnaire for staff members.

- The observation protocol was designed to standardize observations and contained two parts. The first part was a check list that was designed to collect quantifiable data, such as number and gender of people in the family unit, frequency of interactions between children and adults, feedback provided, etc. The second part included a blank space to record any other kinds of observable behavior, such as questions generated or conversations during the engagement period.
- The questionnaire for the adult in the family unit also included two parts. The first part was designed to collect demographic data of the family unit. The second part included open-ended questions regarding the family unit's experience in the DR.
- The questionnaire for staff members consisted of open-ended questions regarding the way staff members address the educational goals of the facility.

Validity and objectivity precautions were taken both for the design of the data collection instruments and during sample selection. Data analysis was multifaceted to accommodate for both qualitative and quantitative data.

Findings

Characteristics of Family Units

Table 1 presents demographic information of the sample and frequencies of their visits to the AMNH and to the DR during six months before the survey. For the sample we observed, the ratio of children per adult averaged 1:1, with the average age of children being 5. Accompanying adults were equally of both genders, in agreement with the results of the Cora Group Survey on the DR (1995). Most adults were between 30 and 50 years old. Most children observed (16 out of 26) were boys (62%), whereas girls were 10 out of 26 (38%). Furthermore, 24 out of 26 adults (92.3%) were parents, while for the remaining 2 family units (7.69%), the adult was a grandparent.

Fifteen out of 24 family units observed (62.50%) live in New York City, 3(12.50%) in New York State, outside New York City, 5(20.83%) in other states, and 1 (4.17%) overseas. As for the frequencies of visits to the AMNH and to the DR, 13 out of 24 family units (54%) visited the AMNH 2-5 times during six months before the survey, whereas 14 out of 24 family units (50%) were first-time visitors to the DR. This shows that most of the DR visitors are frequent AMNH visitors.

Four patterns emerged as to what the interviewed parents described what their child likes about each exhibit. Thus, the main reason why children like the ***Baobab Tree Treasure Hunt*** was exhibit presentation. Children love the idea of being actively involved in a treasure hunt. Additionally, the exhibit contains plenty of hiding places to play. This pattern was found in 5 out of 12 cases (41.66%). Three adults (25%) supported the idea that children liked the activity because it takes the form of a game. Moreover, four adults (33.33%) insisted that their children liked the activity because they had the opportunity to be active learners, to touch and feel the specimens, and to closely observe animals that they do not see frequently in their everyday lives.

The most popular reason why children like the ***Prestosuchus Puzzle***, according to their parents' ideas, was that the activity promotes active learning. This reason was mentioned by 5 out of 12 adults (41.6%). Besides, 4 adults (33%) believed that children like the fact that the activity is a puzzle. Evidently, adults were more aware of the educational goals of this exhibit rather than of the goals of the treasure hunt.

Patterns also emerged regarding adults' estimates on learning outcomes occurring through children's engagements with the exhibits. Two out of 12 adults (16.66%) stated that children gained both content knowledge and skills by being engaged in the treasure hunt. In addition, 5 out of 12 adults (41.66%) expressed the idea that children acquired content knowledge, whereas 2 out of 12 (16.66%) that children acquired only skills. Three out of 12 adults (25%) were not sure about what children were learning by being engaged with the Baobab Tree Exhibit.

For the puzzle activity, 5 out of 12 adults (41.66%) stated that children acquired both knowledge and skills, 3 out of 12 (25%) stated that their child gained only content knowledge, and 3 (25%) that children developed only skills. Finally, one of the adults (8.33%) did not have any insight as to what children were learning through this exhibit. Twenty-five out of 26 interviewed adults (96.5%) stated that they visited other similar places with the child they accompanied, such as parks, science and art museums, some pursued even interactive museums.

All subjects interviewed stated that they had in mind to return to the DR for various reasons, which included the child learning in an amusing way, the fact that the DR is a safe and engaging environment, the opportunity provided to acquire hands-on experiences in science, stimulation of interest about science, development of positive attitudes towards the environment, and development of social skills. Table 2 presents percentages for those reasons.

Table 2
Reasons Why Family Units Plan to Come Back

Reasons	N	%
Child is having fun	17	40.48
Child is learning	11	26.19
Safe, engaging environment	1	2.38
Hands-on experience in science	6	14.29
Stimulates interest	3	7.14
Development of positive attitudes towards the environment	2	4.76
An experience the child will remember	1	2.38
Development of social skills	1	2.30

The Role of the Staff

The staff did not directly intervene with the work conducted within the family units. As stated by the director of the DR, staff members do not teach, but they rather give prompts for discussion and investigation, and they encourage conver-

sations, which could continue at home. At the Baobab Tree Exhibit, facilitators provide visitors with the necessary equipment for the activities, they give clues, and they encourage children to observe interactions between the animals. For the older children, facilitators often provide feedback by conducting a short "quiz" after completing the activity.

At the Prestosuchus exhibit, facilitators provide clues according to children's cognitive level. They indicate that a methodology needs to be followed to solve the puzzle. They also encourage children to be engaged in comparative anatomy by simulating the fossil skeleton to the human body. Finally, facilitators try to replace labels around this exhibit, since, as mentioned before, their positioning is problematic for their use.

As shown in Table 1, 18 out of 24 family units (75%) interacted 0-1 times with staff members. None of the subjects interacted more than five times with the staff, which might suggest that staff members avoid guiding the procedure. Staff members intervene in the learning procedure only when family units request them to, or when there is a problem regarding the physical positioning of the exhibits.

Exhibit Presentation and Content

Several patterns emerged regarding the effects of exhibit presentation and content of learning outcomes. The amount of time spent doing each activity was also an indicator of the effectiveness of exhibit presentation and, therefore, data of this nature will be presented in this part of the study. The main focus at the Baobab Tree exhibit was the Treasure Hunt and the related worksheet. However, observational and spelling skills were also addressed through this exhibit.

In 6 out of 12 family units (50%), the use of the mezzanine to observe the tree was suggested by the child. The video session inside a simulation of a hornbill's nest, located inside a tent next to the tree, was attended by 10 out of 12 family units (91,66%). Children referred to the tent as a hiding place in 7 out of 12 family units. The treasure hunt is a highly individualized activity, since each child has its own worksheet and equipment. Therefore, there were not many child-to-child interactions during this activity. This was also evident by the questions generated by children that will be presented later.

Alternatively, the Prestosuchus Puzzle encourages visitors to make connections between the bones of a fossil and the human body. In 8 out of the 12 subjects (66,66%), these connections were conducted. In 3 of these cases, the accompanying adult initiated the connections, in 3 other cases a staff member initiated them, and in 2 cases the child initiated them. This exhibit has also been serving well its goal as a referral to other exhibits in the museum. For example, in 58.3% of the observed family units (8 out of 12 family units studied at this exhibit), someone in the family unit suggested visiting the Paleontology Exhibition of the AMNH.

However, only 4 of the 12 family units (33,33%) were aware that the specimen was not a dinosaur but an ancient crocodile, which indicates that they did not read the labels surrounding the exhibit. Nonetheless, children were very enthusiastic in reconstructing the Prestosuchus Puzzle, which could be partly attributed to the fact that the activity is a puzzle, a game most children like.

Table 1
Overview of Research Findings

Unit#	Number of children	Gender of children[a]	Number of Adults	Gender of adults[a]	Relationship to children[b]	Aver. Age of adults	Age of child	Where they live[c]	Visits to AMNH	Visits to the DR	Why children like the Baobab Tree[d]	Why children like the fossil puzzle[d]	Learning at Baobab Tree[e]	Learning at fossil puzzle[e]	Time spent at Baobab Tree (minutes)	Time spent at fossil puzzle (minutes)
1	1	M	1	F	M	30-50	5	1	2-5	2-5	EP	-	CK	-	5-10	-
2	2	F&M	1	F	M	30-50	5 & 6	3	0-1	0-1	NS	-	CK	-	5-10	-
3	1	M	1	F	M	30-50	10	2	0-1	0-1	EP	-	NS	-	10-15	-
4	1	M	1	F	M	30-50	4	3	2-5	2-5	EP	-	NS	-	Less than 5	-
5	1	M	1	F	M	20-30	3	1	2-5	2-5	EP	-	CK	-	10-15	-
6	1	M	1	F	M	30-50	4	3	2-5	0-1	NS	-	SO	-	5-10	-
7	1	M	1	F	M	20-30	2	1	2-5	2-5	GF	-	SO	-	10-15	-
8	1	M	1	M	F	30-50	5	1	0-1	0-1	GF	-	CK	-	Less than 5	-
9	1	F	1	M	GF	More than 50	6	2	More than 5	2-5	GF	-	NS	-	10-15	-
10	1	M	1	F	M	30-50	4	1	2-5	0-1	EP	-	KS	-	10-15	-
11	1	F	1	F	M	30-50	5	1	0-1	0-1	NS	-	CK	-	5-10	-
12	1	M	2	F	M&GM	30-50& More than 50	8 & 5	4	0-1	0-1	NS	-	KS & KS	-	5-10	-
13	1	F	1	F	M	30-50	9	1	2-5	2-5	-	GF	-	SO	-	More than 15
14	2	F	1	F	M	30-50	5	1	2-5	2-5	-	AL	-	KS	-	5-10
15	1	M&M	1	F	M	30-50	6&5	3	0-1	0-1	-	GF	-	KS	-	5-10
16	1	M	1	M	F	30-50	6	1	2-5	2-5	-	GF	-	KS	-	Less than 5
17	1	F	1	F	M	30-50	5	1	2-5	2-5	-	AL	-	CK	-	10-15
18	1	F	1	F	M	30-50	4	1	0-1	0-1	-	EP	-	KS	-	5-10
19	1	F	1	F	M	30-50	4	2	2-5	2-5	-	EP	-	CK	-	10-15
20	1	M	1	F	M	30-50	5	1	0-1	0-1	-	AL	-	NS	-	5-10
21	1	F	1	M	F	30-50	4	1	2-5	0-1	-	AL	-	SO	-	5-10
22	1	F	1	F	M	30-50	3	1	0-1	0-1	-	AL	-	CK	-	5-10
23	1	M	1	M	F	30-50	7	1	2-5	0-1	-	GF	-	KS	-	5-10
24	1	M	1	F	M	30-50	8	3	0-1	0-1	-	AL	-	SO	-	5-10

a:M=Male F=Female
b:F=Father M=Mother GF=Grandfather GM=Grandmother
c:1=New York City 2=New York State 3=Out of State 4=Overseas
d:EP=Exhibit Presentation GF=Activities Take The Form of a Game AL=Active Learning NS=Not Sure
e:KS=Knowledge and Skills CK=Content Knowledge Only SO=Skills Only NS=Not Sure

Time spent at each exhibit was used as an indicator of the effectiveness of exhibit presentation and content. Most visitors spend 5-15 minutes on the Treasure Hunt, with 41,66% spending 5-10 minutes (5 out of 12 subjects) and 41,66% (5 out if 12 subjects) spending 10-15 minutes. Most subjects (8 out of 12 or 66.66%) spent 5-10 minutes reconstructing the Prestosuchus Puzzle. Two of the subjects (16,66%) spent 10-15 minutes, and one of them (8,33%) spent more than 15 on the activity.

Therefore, we concluded that visitors spent more time doing the Prestosuchus puzzle, since 91.65% spent more than five minutes doing the activity, whereas only 83.32% of the sample spent more than 5 minutes on the treasure hunt and nobody spent more than fifteen minutes.

Children's Inquiries During Engagement

During their engagement with the exhibits, children generated various questions, which were grouped in five categories according to their nature and content, with some being generated by most children, and others being unique. The categories that emerged include content knowledge, problem-solving strategies, references to other exhibits inside the museum, and feelings and emotions.

Inquiries During Reconstructions of The Prestosuchus Puzzle. During their engagements with the Prestosuchus puzzle, children generated more questions than they did during their engagements with the treasure hunt. The first category of questions that emerged concerned content knowledge, which expanded beyond the field of Paleontology (e.g., Is this a rib?) The second group of questions concerned problem solving strategies. These strategies were both reasoning strategies and general skills (e.g., Can you show me how to do the puzzle? How do we use the numbers on the bones?) The third category of questions addressed connections to the human body (e.g., What would that bone be on us?). Finally, the fourth category of questions generated referred to feelings and emotions. Younger children, who often personified the fossil, mostly generated these questions (e.g., Why is the dinosaur crying? How is the dinosaur feeling?). The final category of questions concerned referrals to the rest of the museum. There were children who repeatedly asked the adults that accompanied them to take them to the paleontology exhibition of the AMNH right after the completion of this activity (e.g., Can we go see the dinosaurs upstairs?).

Discussion

This study focused around two exhibits in the Discovery Room, an interactive science center for children located inside the American Museum of Natural History, and examined several factors, from those identified in the literature, that seem to contribute towards science learning in nonformal settings. Thus, the selected factors were the exhibit presentation and content, characteristics of the family units, children's inquiries about the exhibits, and staff interactions with visitors.

The findings seem to indicate that the exhibit presentation was an important factor affecting science learning in the museum setting, because it determined the degree of children's engagement in an activity. Visitors preferred being engaged in activities that promote physical and mental autonomy. Therefore, the Prestosuchus

Puzzle was a more popular activity. The fossil was reconstructed and personified by family units without any direct guidance. The Prestosuchus fossil was presented like a puzzle, and children were fascinated to realize that it was applicable in a real-world situation, outside the school or the home setting.

Although the Baobab Tree Treasure Hunt was also a stimulating activity, it was not as popular as the Prestosuchus Puzzle. The lower tendency to be engaged in this activity might be attributed to the fact that during the treasure hunt, the human factor was absent. Children observed knowledge that was already "out there," but without being actually involved in constructing it. They just accumulated more declarative knowledge and skills. Visitors usually prefer to be engaged in activities that encourage creativity and autonomy in learning (Rennie, Feher, Dierking, & Falk, 2003).

Several patterns of children's inquiries about the exhibits seemed to be important indicators of the achieved learning and indicate various ways that staff members in the museum should behave. Exhibits with an attractive presentation made visitors easily aware of the expected learning outcomes and promoted an adequate understanding of the educational goals of an activity. Consequently, visitors generated a broader spectrum of questions. Children's inquiries, during reconstruction of the Prestosuchus puzzle, were not limited to science, but also addressed vocabulary acquisition, feelings and emotions, and attitudes towards science.

Moreover, most children who were included in the sample were boys, which tends to support the conclusion that there exist gender stereotypes in science learning and that there has been under-representation of certain groups, such as females in science (Hughes, 2000). The sample of the study was, however, small and cannot be considered as genuinely random, and the generalizability of the results is questionable. Falk and Dierking (1992) stated that the people who visit museums are self-selected, and random sampling is usually selected from that self-selected population. The mainstream visitors at the DR tend to be white middle class families living in New York City.

Patterns were also identified regarding parents' conceptions on what children like about or learn from each activity. Parents' conceptions are important to the educational outcomes of the DR and contribute towards the formation of an initial state or mentality that visitors may have when they return to the DR. This initial state can be altered each time they return to the museum, and each time they acquire deeper understanding of the encountered topics. According to Falk (2002),

> *"[...] the underlying model of learning (in the museum setting)[...] better accommodates the idiosyncratic and highly personalized nature of free-choice learning. Such a model assumes, [...] that initial states are important (for instance, prior interest and knowledge levels, agenda for the visit, expectations, etc.), but these initial states set learning off on very different tracks. [...] initial states are not stable, but change over time through interactions with both predictable and unpredictable events. Thus, outcomes though still at some level predictable, are much more complex and much more influenced by interactions between variables.*
>
> *Translated into a concrete museum visit, the model assumes an initial state, comprised of variables like prior knowledge and interest, motivation, age, prior expe-*

> *rience, group composition, etc. [...], which strongly influence the initial course of the visit. The visitor is then affected by a whole series of additional learning mediators, e.g., advance organizers, good and bad exhibits, presence or absence of orientation, etc., which further dictate the course of the visitor experience". (p. 15)*

Interactions with staff members were also a major factor affecting science learning in the DR setting. Staff members usually facilitate, but they do not get directly involved in the learning process. As a result, family units have the opportunity to be more independent in their learning activities, to explore and construct knowledge by themselves rather than passively absorb information.

Anderson et al. (2002) demonstrated that the theory of constructivism could be successfully implemented in the museum setting for young visitors. They supported that educational experiences taking place inside the museum can be more easily recalled and are more educationally effective than learning which is decontextualized in nature, such as learning taking place in formal settings. DR visitors plan to return to the facility, because it provides an attractive and well-designed learning context that encourages connections between the knowledge they acquire and their everyday lives.

More research is needed to examine the effectiveness of the same factors over a longer period of time and with a larger and representative sample, so that the results are more valid and generalizable. Children's inquiries during their interactions with the exhibits could be also further investigated, because they might reveal aspects of children's cognitive development and learning in nonformal settings.

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