Family Learning in Museums: The PISEC Perspective

Philadelphia-Camden Informal Science Education Collaborative (PISEC)

Authors: Minda Borun, Jennifer Dritsas, Julie I. Johnson, Nancy E. Peter, Kathleen F. Wagner, Kathleen Fadigan, Arlene Jangaard, Estelle Stroup, Angela Wenger

Editors: Jennifer Dritsas, Minda Borun, Julie I. Johnson

Designer: Anne Marie Ryan
PISEC project team

The Philadelphia-Camden Informal Science Education Collaborative (PISEC)

Principal Investigator: Minda Borun, The Franklin Institute

Project Directors: Nancy E. Peter, Academy of Natural Sciences
                   Julie I. Johnson, New Jersey State Aquarium
                   Kathleen F. Wagner, The Philadelphia Zoo

Project Coordinator: Jennifer Dritsas, The Franklin Institute

PISEC Team Members: Kathleen Fadigan, Academy of Natural Sciences
                     Ann Marie Ferry, Estelle Stroup, Angela Wenger,
                     New Jersey State Aquarium
                     Sharyn Horowitz, Arlene Jangaard,
                     The Philadelphia Zoo
                     Caren Garfield, The Franklin Institute

Statistician & Data Analyst: Margaret Chambers, Ph.D.

Chief Advisor: Christine Massey, Ph.D., University of Pennsylvania

Additional Advisors: Stephen Bitgood, Ph.D., Jacksonville State University
                     Deborah Perry, Ph.D., Selinda Research Associates
                     Elaine Simon, Ph.D., University of Pennsylvania
                     Portia Sperr, University of the Arts

Additional Data Collectors: Lori Davis, Cynthia Gosling, Lisa Levinson,
                            Jennifer Pusey, Nicole Schaller, Inger Severson

Copyright 1998
Philadelphia/Camden Informal Science Education Collaborative (PISEC), The Franklin Institute

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher.

Published by PISEC
c/o The Franklin Institute
222 North 20th Street
Philadelphia, PA 19103
Acknowledgements

We are very grateful for the support received from our institutions, with particular thanks to:

The Academy of Natural Sciences
Paul Hanle, Ph.D., President and CEO
Phelen Reed Fretz, Ph.D., Vice President for Public Programs

The Franklin Institute
Dennis Wint, Ph.D., President and CEO
Carol Parssinen, Ph.D., Vice President, Center for Innovation in Science Learning

The New Jersey State Aquarium
Michael I. Crowther, President and CEO
Judith L. Wellington, Ph.D., President, New Jersey Aquarium Foundation

The Philadelphia Zoo
Alexander L. “Pete” Hoskins, President and CEO

In addition, we appreciate the insights, encouragement, and assistance of:

Joel Bloom, President Emeritus, The Franklin Institute

Barbara Butler, Ph.D., Informal Science Education Program Officer, National Science Foundation

Betsy Leebruun, Ph.D., Video Consultant, Professor and Chairperson, Department of Broadcasting, Telecommunications & Mass Media, Temple University

and Ann Cleghorn, Kathryn Coriell, Janet Ruth Falon, Nadina Henley, Jane Horwitz, James McGonigle, Christine Riviello, and Laurie Smith.

The PISEC Family Learning Project is supported by grant #ESI-9355504 from the National Science Foundation and matching funds from The Pew Charitable Trusts. Any opinions, findings, conclusions or recommendations expressed herein are those of the authors and do not necessarily reflect the views of the National Science Foundation or The Pew Charitable Trusts.
# Table of contents

## Introduction

The *Family Learning Project*: An Overview  
1

## Phase One

- Reviewing the Literature  
  
- Selecting Test Exhibits  
  
- Creating an Operational Definition of “Family”  
  
- Developing a Quantitative Measure of  
  Learning Behaviors  
  
- Developing a Qualitative Measure of Learning  
  
- Collecting, Transcribing, and Analyzing the Data  
  
- Identifying Behavioral Learning Indicators:  
  - Comparing the Qualitative Measure to the Quantitative  
  
- Conclusion: Families are Learning in Science Museums  
  5

## Phase Two

- Back to the Books  
  
- Focus Groups as a Research Tool  
  
- Seven Characteristics of Successful Family Exhibits  
  
- Enhancing the Test Exhibits with Family-Learning Components  
  
- How To Do It: Four Steps to Effective Exhibits for Families  
  
- The Academy of Natural Sciences  
  
- The Franklin Institute  
  
- The New Jersey State Aquarium  
  
- The Philadelphia Zoo  
  
- Testing with Diverse Audiences  
  
- Conclusion: Designing Family-Friendly Exhibits  
  20
Phase Three

Collecting the Data

Analyzing the Results: Assessing the Impact of Enhanced Exhibits

Conclusion: Family Learning can be Enhanced through Exhibits

Conclusion

The Last Word: What’s Significant about the PISEC Family Learning Project

References

Appendix

A1 - Learning Level Criteria for Test Exhibits

A2 - Demographic Questionnaire

A3 - Phase 1: Behavior Coding Sheet

A4 - Template for Assessing the Family-Friendliness of Exhibits

A5 - The Franklin Institute’s Behavioral Checklist and Interview

A6 - Phase 3: Behavior Coding Sheet

Resources

PISEC Products

Service Providers

Where to Find Literature on Family Learning

Photography Credits
Families learn about the world by discussing new experiences, asking questions, and sharing memories. Museums can stimulate families to use the learning strategies they have developed through their close association and shared history. But, how can family learning in museums be measured and identified? What attributes of museum exhibits encourage family learning?

To seek answers to these important questions, the Academy of Natural Sciences, The Franklin Institute Science Museum, the New Jersey State Aquarium, and the Philadelphia Zoo formed the Philadelphia-Camden Informal Science Education Collaborative (PISEC) and embarked on the Family Learning Project. This handbook summarizes the results of a three-phase investigation into family learning in museums.

The handbook is intended for two primary audiences: museum practitioners and visitor behavior researchers.

Museum Practitioners can:
- Use PISEC's list of seven characteristics of family-friendly exhibits (p. 23) to guide new exhibit development.
• Evaluate current exhibits to assess how well they embody the seven characteristics of family-friendly exhibits, using the template on page 62.
• Develop exhibits or exhibit add-ons to encourage family interaction using suggestions from PISEC’s development of four family learning components (p. 27-42).

Researchers can:
• Use PISEC’s method of recorded narration (p. 12) to accurately capture the behavior and conversation of family groups.
• Use PISEC’s five performance indicators (p. 18) of learning behavior to evaluate the effectiveness of family-oriented exhibits.
• Adopt PISEC’s Learning Level schema (p. 15) to assess family conversations at exhibits.
• Use PISEC’s definitions to describe and track the fluidity of family groupings (p. 48).

The Visitors’ Voice
The thoughts and feelings of museum visitors are reflected in quotes from parents and other adult caregivers who participated in PISEC’s focus groups. Italicized quotes appear in the margins throughout this book. In their own words, visitors describe museums as environments where adults and children learn together, develop lifelong interests, and build shared memories.

Museum practitioners are responsible for providing excellent programs for all audiences. For science museums, the majority of the audience visits in family groups (Borun & Dunbar, 1980; Doering, 1992; Korn, 1996). The Family Learning Project has been a rich experience for the participating museums. It is hoped that what PISEC has discovered about how to study, create and evaluate exhibits to foster family learning will help other museums create better learning environments for families.

The Family Learning Project: An Overview
Defining Family Learning
Learning is often viewed as a change in a person’s knowledge, skills, and beliefs. In physiological terms, learning is a change in
nerve pathways (the neural net). However, learning also has a social dimension. It can be heightened and shaped by input from family or group members. Each family brings its unique culture - shared knowledge, values and experiences - to a museum visit. The museum in turn enriches the family culture through immediate and potential learning experiences. Family members can share the associations stimulated by exhibits immediately, or even long after the museum visit.

Family conversations at exhibits tend to involve associations and comparisons to past events and information (Hilke, 1987). For example, a visitor viewing birds at the New Jersey State Aquarium commented, “I’ve seen tons of killdeer (shore birds) down on Strathmere Beach.”

This social definition of learning was a guiding premise for the Family Learning Project, which assessed connections to prior knowledge shared with other family members as well as the acquisition of information about exhibit content. The goal of the project was to study learning in family groups and then create exhibits that would facilitate and enhance social learning.

Phases of the Family Learning Project
The Family Learning Project had three phases, each a response to a research question:

- **Phase 1 - What is family learning and how can it be measured?**
  Phase 1 was a research study to establish behavioral indicators for family science learning. Visitors’ behavior was studied at a test exhibit at each of the four PISEC museums.

- **Phase 2 - Do specific exhibit characteristics facilitate family learning?**
  This phase involved the development and evaluation of four exhibit modifications or family learning components based on a list of seven characteristics of family-friendly exhibits.

- **Phase 3 - Do exhibits that have the seven characteristics of family-friendly exhibits produce measurable increases in family learning?**
  The final part of the project was a research study comparing the frequency of learning behaviors for families that used the
enhanced test exhibits (treatment group) to families that used the original test exhibits (control group).

A detailed description of each phase follows.

**Research vs. Evaluation: What’s the Difference?**

To understand the Family Learning Project, it is necessary to understand the difference between research and evaluation. Phases 1 and 3 of the Family Learning Project were research studies; Phase 2 was exhibit development and evaluation. Bitgood and Shettel (1997) point out that while research and evaluation may employ common methods of data collection such as observation and interview, they differ in several ways. The following chart illustrates these differences:

<table>
<thead>
<tr>
<th></th>
<th>Research</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Focus</strong></td>
<td>Answers broad questions about visitor behavior to elicit generalizable principles</td>
<td>Answers project or museum-specific questions</td>
</tr>
<tr>
<td><strong>Standard of Proof</strong></td>
<td>Formal standards requiring large sample sizes, detailed statistical analysis, and small margins of error</td>
<td>Flexible standards allowing smaller sample sizes and less stringent statistical analysis</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>Frequently more quantitative</td>
<td>Frequently more qualitative</td>
</tr>
<tr>
<td><strong>Dissemination</strong></td>
<td>Results are widely disseminated for review and replication</td>
<td>Results are usually shared within a museum or project since they tend to be site-specific</td>
</tr>
</tbody>
</table>

(adapted from Bitgood and Shettel, 1997)
Phase one

What is family learning and how can it be measured? Are families learning in science museums? If so, can learning be measured by studying visitors’ behavior?

Reviewing the Literature

Before embarking on a research study, it is important to conduct a literature review so that the new study can extend and not repeat prior work. To share this resource with the museum field, the PISEC group published a literature review (Borun, Cleghorn, & Garfield, 1995).

There had been several prior reviews of the literature on family behavior in museums (Dierking, 1989; Dierking & Falk, 1994; Kropf, 1989; McManus, 1994). The research covered in these reviews had focused on two areas: 1) general family behavior in informal settings; and 2) the nature of family learning (Dierking & Falk, 1994). Visitor studies professionals had long discussed what constitutes museum-based learning (Dierking and Falk, 1994; Falk and Dierking, 1992) but prior to the PISEC study no researcher had attempted to correlate observable behavior in the museum with a direct measure of learning.

PISEC’s literature review summarized the answers to five basic questions related to family learning in museums:

1. Why study families? Families comprise more than half the visitors to the nation’s museums (Dierking, 1989). Because of the number and variety of family visitors, museum practitioners need a better understanding of this large portion of their audience.
2. **Which families visit museums?** One predictor of museum visits was documented in a 1978 survey conducted by the National Research Center of the Arts. The study found that the more often people were taken to museums as children, the more likely they were to visit as adults. The same study indicated that the higher the adults’ level of education, the more likely the family was to visit museums (cited in Wolins, 1989).

3. **How do families behave in museums?** Hilke and Balling (1985) found that the family is a “highly responsive and flexible learning system that adapts well to museum environments (p. 2).” McManus (1987, 1988) found that groups with children had longer conversations and lingered at the exhibits longer than “childless” groups. Bitgood (1993), Diamond (1981), Gottfried (1979), and Rosenfeld (1981) also documented similar differences between adult/child and all-adult groups. Families are groups of learners of mixed ages and backgrounds that attach great importance to social interaction (Hood, 1989; Laetsch, Diamond, Gottfried, & Rosenfeld, 1980).

4. **How do families learn?** Social interaction can enhance cognitive processes (Blud, 1990). Laetsch et al. (1980) pointed out that sharing information at an exhibit helps visitors make connections to related phenomena. Hilke and Balling (1985) found that 66% of family behavior at an exhibit was about acquiring or transferring information and an additional 5% was about relating this information to past or future experiences of other family members. Further, Dierking (1987) found that interactive exhibits that allow for touching and manipulating stimulate higher levels of attention-focusing behaviors such as questioning and explaining, which are frequently associated with learning.

5. **How have previous researchers measured family learning?** Observers of museum-based learning have most often taken a descriptive and exploratory rather than experimental
approach. They have examined the verbal and physical behavior of members of family groups (e.g., Diamond, 1981; Dierking, 1987; Hilke & Balling, 1985; McManus, 1987, 1988; Taylor, 1986). Many researchers have inferred that learning is taking place when people are engaged in activities generally associated with learning such as: asking and answering questions, talking about an exhibit, pointing to exhibit components, reading label text, engaging in hands-on activities, and even just looking intently at an exhibit. PISEC decided to test this inference, to find out whether families that appear to be learning, are actually learning.

Selecting Test Exhibits

PISEC team members identified one “test exhibit” at each museum. Exhibits were selected that seemed to have family appeal and variation in format (immersion, exhibit program, glass case, and interactive):

Shark Tooth Dig at the Academy of Natural Sciences

_Shark Tooth Dig_ allows visitors to participate in a fossil dig. Adults and children use sifters to search for fossilized sharks’ teeth in a simulated streambed filled with gravel. When a tooth is found, visitors can follow a dichotomous key (a sorting system) to sort sharks’ teeth by significant characteristics (e.g. straight or bent) and determine the identity of the shark species. Successful “fossil
hunters” receive a certificate with their name on it. The exhibit is designed to create an understanding of fossils and enable visitors to use a key to identify them.

**Sand Pendulum at The Franklin Institute**

The *Sand Pendulum* features a Y-shaped, compound pendulum that supports a funnel into which visitors can pour sand. When a finger is held under the hole in the funnel and the pendulum is released, the falling sand makes a design that traces the complex swing of the pendulum. Observant visitors, or label readers, can learn that the compound pendulum swings from two different places, creating the pretzel-like sand pattern. The goal of the *Sand Pendulum* is to help visitors understand how the swing of a compound pendulum makes a special kind of pattern.

**Barrier Beach at the New Jersey State Aquarium**

We watch to see what's going to interact with what. My son loves it!

---

1 A compound pendulum has multiple parts or “arms,” and is constructed in such a way that one section swings perpendicular to another and at a different rate.
Barrier Beach was a living diorama of a New Jersey barrier island. Its 4’ x 24’ clear acrylic front afforded an unobstructed underwater view to small children, visitors who use wheelchairs, and crouching adults. Living features included shorebirds, fish, horseshoe crabs, sea stars, seaweed, and beach plants. The exhibit’s goal was to increase visitors’ understanding of the flora and fauna on local barrier islands and the islands’ importance to land stabilization and wildlife.

Naked Mole Rats at the Philadelphia Zoo

Naked Mole-Rats is a simulated, cross-sectional view of an underground colony set into a wall about 10-feet wide. Visitors can peer through windows into tunnels where approximately 30 live naked mole rats run, fight, dig, sleep, and eat. Above the tunnels, a diorama depicts the African Plains, the naked mole rats’ home. An elephant foot and trunk, dung and dung beetle, and an entry to the mole rats’ tunnels add context. Another small diorama shows naked mole rats defending their colony against a predatory snake. The exhibit’s goal is to enable visitors to learn about naked mole rats, observe their behavior, and notice that they, like some other social animals, live in organized groups.

1 The past tense is used here because between Phases 1 and 2, Barrier Beach was transformed into Carribean Beach (see page 8).
Creating an Operational Definition of “Family”

One of the first steps in research is identifying the subjects. Since PISEC was studying families, it was necessary to decide what kinds of visitor groups would be counted as families. PISEC’s definition of a family was a multigenerational visiting unit of no more than six members, with at least one child between 5 and 10 years of age and one adult, age 19 or older.

While this definition excluded groups of cousins or siblings (not multigenerational), it was broad enough to include many other kinds of family groups:
- traditional nuclear families: parents and their children
- single parents with children
- extended families including grandparents, aunts, uncles, cousins, nieces, and nephews

Unrelated people (i.e. friends, baby-sitters) accompanying the family on their visit were counted and observed as part of the family group. The size limit was dictated by the fact that it is difficult for one data collector to attend to more than six people at once.

Developing a Quantitative Measure of Learning Behaviors

Identifying the Behaviors to Observe

Based on previous studies (Bitgood, 1993; Diamond, 1981; Dierking, 1987; Hilke & Balling, 1985), a list of behaviors thought to be associated with learning was formulated. This list of behaviors provided a language for coding observations of family behavior:
- Approach/withdraw from the exhibit
- Engage in hands-on activity (interactives only)
- Call someone over
- Point at the exhibit
- Climb on the exhibit
- Read text aloud
- Read text silently
- Comment on the exhibit or explain how to use it
- Ask a question
- Answer a question
- Express “like” verbally
- Express “dislike” verbally

The connection between these observable behaviors and a direct measure of learning had not yet been established.

Phase One 10

Nuclear families included step-parents with step-children.
Testing an Observation Method
Research methods were tested and refined through a 100-family pilot study. Data collectors observed 25 randomly selected families at each of the four museums. A family had to spend at least 30 seconds at the exhibit to be included in the sample. During the pilot phase, data collection strategies were modified until a method was created to accurately capture the behavior of family groups.

What Didn’t Work
- **Coding live action at the exhibit.** Initially, data collectors coded their observations of families directly onto a coding sheet, but it proved too difficult to write and observe at the same time.
- **Placing a stationary microphone on the test exhibit.** This method did not allow data collectors to accurately identify who was talking, and background noise obscured family conversations.
- **Placing a lapel microphone on a data collector.** Background noise and inability to identify the speaker continued to be problems.
- **Narrating behavior and repeating conversation into a hand-held directional microphone.** Data collectors were able to accurately capture behaviors and conversation, and identify speakers, but the microphone was too obvious to visitors.

A Note on Ethics
A sign was posted at each test exhibit to notify visitors of the research activity so that those who did not want to be recorded could avoid the area. For example:

```
FAMILY LEARNING STUDY
AUDIO AND VIDEO TAPING FROM
10:00 AM TO 2:00 PM
```

Families were identified only by numbers. If visitors who had been observed declined to be interviewed, the data on their family was discarded.
What Worked
Data collectors narrated family conversation and behaviors into a small microcassette recorder easily hidden in the palm of the hand. Using the recorder, they could stand within inches of visitors, repeat their conversations, and describe behavior without being noticed. As a further refinement, families were videotaped by a stationary camera mounted on or near the test exhibit. Researchers used a remote control to start and stop the camera.

Coding Manual
When testing a methodology, a record of procedures is essential. PISEC recorded this information in a detailed coding manual that defined terms, demographic categories, and rules of data collection. The coding manual served both as a record of research methods and the primary training tool for data collectors. As new questions arose and were answered by the team, the manual was updated.

Recruiting and Training Data Collectors
Good data collectors share many qualities with secret agents; they must be attentive, patient, quick-witted, and unobtrusive. Data collection is both physically and mentally rigorous. Anyone stepping up to the task needs good hearing and eyesight, and should be prepared to stand quietly for long periods of time.
The use of multiple data collectors necessitated paying close attention to the issue of reliability. Data collectors observing and coding the same family should not differ in their procedures. To build reliability, the project coordinator cross-checked all data; if persistent discrepancies emerged, training sessions were held to foster convergence among coders.

**Developing a Qualitative Measure of Learning**

Are families really learning in museums? Can learning be inferred if learning behavior is observed? To answer these questions, PISEC recorded the behavior of family members, and then measured how much the group had learned. The project was interested in studying more than the acquisition of exhibit-based information; it was also hoped that connections to prior knowledge shared with other family members while at an exhibit would be captured.

It may seem that it would be simplest to measure learning by just giving families a traditional cognitive test. But should this test be given to the family as a group or to individual family members? It was agreed individual tests of exhibit content would be time-consuming and age-dependent, and would fail to reflect the group’s experience. Moreover, individual family members might concentrate on different aspects of an exhibit. A family experience at an exhibit has both more and less learning potential than a structured test reveals. More, because vivid and meaningful connections to prior experience would not appear on the test; and less, because the family may attend to only part of the exhibit (not necessarily the part being tested). Thus, it was felt that a family might not score well on a test of exhibit content. To test this hypothesis, the New Jersey State Aquarium staff developed a cognitive test for *Barrier Beach*. The test had three questions drawn from the exhibit’s goals:

1. Which animals and plants belong on a New Jersey beach?
2. Why are beaches important?
3. How do birds and other animals use the beach?

The test combined game-like elements and questions. Staff gave visitors a diagram of *Barrier Beach*. Pictures of the animals and plants found on a beach were shown in a legend at the bottom. The youngest school-age child in the family was told to draw lines.
reflecting the family's decisions on placement of animals/plants on the diagram. When staff asked the follow-up questions, the youngest person in the family was asked for a response first, followed by the next oldest, up to the adult(s). This test was given to 20 families who had seen the exhibit, and also to a control group of 20 families who had not seen the exhibit.

Families had difficulty placing the appropriate animals and plants on the diagram. In fact, families who had not viewed the exhibit scored higher than families who had seen the exhibit. Thus, this presumably objective test of content was not validated as a measure of exhibit learning.¹ The notion of a quiz was abandoned and it was decided that the assessment of what a family had "learned" from an exhibit would be determined by analyzing family conversations and responses to an open-ended interview. This qualitative measure of learning would also take into account the rich background of prior knowledge and experience that families bring to their museum visits.

**Constructing Learning Levels**

How should the transcripts of family conversations and interviews be analyzed? Based on the literature and team discussions, three learning levels were defined. These levels reflect increasing richness of detail and complexity in both the group's understanding of exhibit-based information and their connections to prior knowledge.

¹A valid test is one that measures what it is intended to measure.
Learning Levels

**ONE**
Identifying

- One word statements
- Few associations to exhibit content
- Connections to content miss the point of the exhibit

**TWO**
Describing

- Correct connections to visible exhibit characteristics
- Connections to personal experience based on visible exhibit characteristics, not concepts

**THREE**
Interpreting and Applying

- Correct statement of concepts behind exhibits
- Connection to personal experience based on exhibit concepts

Although these learning levels seem to echo “Bloom’s Taxonomy” (see Bloom, 1969), there are important differences. The levels above include associations and personal connections which are the essence of museum learning. From this general outline of learning levels a template was made for scoring families’ learning levels at the four test exhibits (see A1 in Appendix).

Collecting, Transcribing, and Analyzing the Data

**Collecting the Data**

Data collectors observed 129 families, recording all instances of the behaviors listed on page 10. With the exception of “hands-on activity,” the behaviors were counted as many times as they occurred. Since hands-on activity continues over time, a new instance of this behavior was counted after every 15 seconds of continuous activity. Audio and video taping began when the first qualified family (i.e., having at least one child who appeared to be five to ten years old) entered a pre-determined location in the exhibit area. Recording continued until the last member of the family withdrew from the exhibit. If a family realized they were being observed, the observation ended and was deleted from the sample.

As the family was leaving the test exhibit, the data collector requested a brief interview and, with permission, tape recorded the
proceedings. She then determined whether the group met the
definition of family by asking and recording the age and
relationship of group members. Next, the data collector facilitated
a group discussion of the family’s reactions to and perceptions of
the exhibit. Questioning began with the youngest child and all
family members were asked to contribute; this method was used so
that no one would dominate the session or speak for others.
Families were asked a series of open-ended questions:

What do you think this exhibit is trying to show? e.g. visitor
answers “naked mole rats”
Prompt: e.g., What about naked mole rats? Could you tell
me some more?
Why do you think the Zoo put the naked mole rat
exhibit here?

What comes to mind when you see this exhibit?
Prompt: Was there something that especially interested you?
Did you see/find out something that you did not
know before?
Did this exhibit make you remember anything
in particular?

After the interview, the data collector asked an adult family
member to answer questions about previous family visits to the
museum and exhibit, museum-visiting habits, and ethnic
identification. (see A2 in Appendix)

Transcribing, Tabulating and Analyzing the Data
Data collectors transcribed their recordings of narrated family
conversations, behaviors, and interviews. They then tabulated on a
coding sheet (see A3 in Appendix) the number and sequence of
behaviors, and the initiator and recipient of each behavior.
Videotapes served as a back-up to clarify the information on the
audiotapes. Only exhibit-related verbal and physical behaviors
were coded; procedural conversation (concerning food, visit
planning and other logistics) was excluded. The project statistician
entered the coded data into FoxPro, a relational data base, and
used StatView for statistical analysis. This level of detailed coding
and transcribing was labor-intensive but yielded a great deal of information about how family members were interacting with one another and the test exhibits.

Coding for Learning Level
Two members of the project team who had not been involved in data collection coded for learning level. Both the transcripts of family conversations and open-ended interviews were coded. A third person coded all disagreements; two out of three votes carried. The coders scored the transcripts sentence by sentence. Since PI Sec was concerned with group learning rather than individual learning, the highest level achieved by any member of the group became the overall family score. This sample transcript of a Level Three family at the Academy of Natural Sciences illustrates the coding method (see A1 in Appendix):

FATHER     Is it straight? It’s curved. It tells you what kind they are too. LEVEL 3
DAUGHTER  Oh I found one tooth. LEVEL 2
SON        Holly found one all by herself Dad. LEVEL 1
DAUGHTER  Daddy look.
FATHER     Found one? All right, there, put it back over, Holly.
SON        I found three. LEVEL 2
            Father reads label silently.
FATHER     Holly, your tooth is called a snaggletooth shark.
            Now bring it back in there, so somebody else can find it. LEVEL 3

Prior knowledge and knowledge gained from viewing the exhibit were not distinguished. If a family member shared information at the exhibit, the exhibit was a catalyst, thus, the resulting discussion was considered to be exhibit-based learning.

Identifying Behavioral Learning Indicators: Comparing the Qualitative Measure to the Quantitative
Most families scored at Levels One or Two (42% and 46% respectively), indicating low to moderate learning. This represents learning of concrete, visible exhibit information. Twelve percent of the families scored at Level Three, involving interpretation and application of exhibit content.
The Performance Indicators
Learning level was compared to frequency of the observed behaviors. Only five of the coded behaviors actually distinguished between successive learning levels. The average frequency of these five behaviors increased significantly from one Learning Level to the next (one and two, or two and three):

- ask a question
- answer a question
- comment on the exhibit or explain how to use the exhibit
- read text aloud
- read text silently

These five behaviors were called *performance indicators*. However, they did not all perform in the same way. “Ask,” “answer,” and “comment or explain” distinguished between Level One and Level Two. Only “read aloud” and “read silently” distinguished between Level Two and Level Three. This was undoubtedly because the main message of the test exhibits was carried by their text. Visitors had to read to get the big idea. In exhibits designed to convey concepts experientially, it may be possible to reach Level Three by observation and interaction.

When all five behaviors were considered as a group, they distinguished between Level One and Level Two and between Level Two and Level Three (Borun, Chambers, & Cleghorn, 1996). *Since the five behaviors had a significant relationship to Learning Levels, they were considered to be learning indicators; that is, if these behaviors were seen, it could be inferred that learning was taking place.* This finding supports previous studies that were based on the assumption that observable learning behaviors indicate learning (Diamond, 1981; Dierking, 1987; Hilke & Balling, 1985; McManus, 1987, 1988; Taylor, 1986).

“Hands-on activity” was also significantly related to Learning Level. However, since only two of the test exhibits were interactive, “hands-on” could not be used as a learning indicator in all cases. Additionally, it was felt that PISEC’s time-dependent measure of “hands-on activity” was too different from the other

If you can enhance learning through hands-on activities, they are very involved.
measures to warrant inclusion as a performance indicator. However, the data suggest that hands-on activity should be considered a performance indicator for interactive exhibits.

What about the other behaviors?
Many of the behaviors assumed by previous researchers to be associated with museum learning did not show a relationship to Learning Level in this study. Behaviors that were not systematically related to Learning Level were:
- Calling someone over
- Pointing at the exhibit
- Climbing on the exhibit
- Expressing “like” verbally
- Expressing “dislike” verbally
- Approaching/withdrawing from the exhibit

Time And Demographics
In addition to the observed behaviors, time spent at the exhibit and demographic factors were also compared to Learning Level to see if these variables were associated with differences in learning. Time spent at the exhibit turned out to be directly related to Learning Level; families with higher-level scores spent significantly more time at the exhibits. On the other hand, none of the demographic characteristics measured varied directly with Learning Level.

Conclusion: Families are Learning in Science Museums
Phase 1 of the PISEC Family Learning Project documented a relationship between Learning Levels and observable behaviors. On the basis of coding family conversations and interviews for Learning Level, it was found that families do learn from exhibits, and that the level of learning is associated with specific observable behaviors—the performance indicators. Grouping these behaviors as performance indicators distinguishes between all three levels and provides a useful measure of exhibit learning. Family learning can be identified and measured by counting the frequency of the five performance indicators. This is the measure that was used later in Phase 3 to test the effectiveness of exhibit modifications designed to increase active family learning. But, first these exhibit modifications had to be developed and evaluated.
Phase two

Are there specific exhibit characteristics that facilitate family learning?

Once family learning had been defined and a method of measurement developed, PISEC sought in Phase 2 to apply its research to practice by developing exhibits that would facilitate family learning. To do this, it was necessary to identify the exhibit characteristics responsible for successful family learning, and clarify what makes an exhibit attractive and engaging for families.

Back to the Books

PISEC returned to its library of family-learning literature and looked to see what other researchers said about specific exhibit characteristics that facilitate family learning. Some researchers discussed these characteristics (Benton, 1979; Bitgood, 1993; Blud, 1990; Butler & Sussman, 1989; Diamond, Smith, & Bond, 1988; Dierking, 1987; Dierking, 1989; Hilke, 1987; Hilke & Balling, 1985; Hood, 1989; Kropf, 1989; McManus, 1994; Spires, 1989) suggesting that interactive exhibits with clearly presented content and opportunities for cooperation encourage family learning. Effective labels for families present information in chunks and are suitable for readers of different literacy levels. Family learning is inhibited at exhibits that cannot accommodate groups, are physically inaccessible to children, or present content in difficult-to-read labels. These characteristics will be discussed in greater detail on page 23.

Focus Groups as a Research Tool

To find out what visitors had to say about the question of effective exhibits, a set of four focus groups was conducted. Focus groups encourage group interaction and in-depth discussion, revealing
feelings, attitudes and perceptions (Krueger, 1988). Groups usually consist of seven to ten people, who are unfamiliar with one another, but share certain characteristics. Individuals are recruited to participate in a dialogue led by a trained interviewer.

PISEC data collectors recruited a pool of qualified focus group participants by approaching visitors at the test exhibits who, based on their family conversations and behavior, appeared to be good learners. All participants were parents or adult caregivers from groups that fit the definition of a “family” (See page 10 for family definition).

A market-research firm was hired to provide a trained facilitator to conduct the focus groups. The groups met in a specialized facility where the project team could sit behind a two-way mirror and observe and hear the discussion. A two-hour focus group was held with visitors from each of the four PISEC museums. The sessions were videotaped for later reference (See order form under RESOURCES page 65).

What Was Learned
Focus group participants discussed museums and other leisure activities. Participants’ comments about family learning in museums are applicable beyond the PISEC institutions.

Attitude toward visiting museums - Participants said they enjoyed visiting museums and viewed them as a valuable family activity. They cited educational benefits and used expressions such as “building shared memories” to describe museum visits. Most focus group conversation about museum-based learning was general, but some parents identified specific evidence of their children’s learning.

Planning museum visits - Both adults and children influence the decision to visit a museum. Families tend not to plan an agenda for the visit, but they do have favorite exhibits that they go to every time in addition to new or temporary exhibits. Parents usually allow their children’s interests and attention spans to guide the visit.

I buy my son a toy and he plays with it for about 15 minutes and that’s it. But, after we went to the museum, the next week at library hour, he wanted a book about the body. I think that was from going through the heart [exhibit]. Then he wanted a book about weather. It really made an impression on him. Even two months later things are really still sticking with him from that visit.

Somewhere walking through Disney World my son said, “It’s just like at The Franklin Institute, the building moved and the pendulum didn’t.” I thought “Hey, we did something. It wasn’t all wasted. He got it!”

They develop favorites. We always have to go to the optical illusions.
We talk conservation all the time. I take them from awareness to action. Awareness is where it starts at the Zoo. We’ve taken it to action at home and in their schools by adopting natural grasslands and things like that.

I feel that part of being a parent is exposing kids to things other than what they learn in school. Learning is a process that takes place in everything that you do and learning is fun.

People learn best by using all of their senses.

Respondents’ views of museum exhibits - According to PISEC focus groups, good exhibits are: self-explanatory, labeled with simple large type, not crowded, interactive, multi-sensory, friendly, and inviting. Respondents also appreciate museum staff who are knowledgeable, friendly, and helpful, but not intimidating. They felt strongly that the presence of staff and volunteers improved a museum visit.

Parents’ strategies to involve children - Motivated parents develop strategies to engage their children’s interest in museum exhibits. Parents report asking questions about exhibits, pointing out elements of an exhibit, relating exhibits to a child’s prior experiences, conveying their own excitement, talking with museum staff, relating museum topics to school work, and continuing the discussion about concepts on the trip home.

Parents’ suggestions - Participants offered recommendations for museum practitioners including:
- Designating specific exhibits for certain ages so parents know what will appeal to their children.
- Giving parents suggestions for discussing exhibits with their children.
- Explaining exhibits clearly for parents who do not have a science background so they can “translate” for their children.
- Providing a simplified written guide to the museum for parents, including information on best times to visit, ideal length of a visit, tips for dealing with bored children, and other orientation information.
- Developing family-learning tours on different themes for various ages and interests.
- Creating color-coded maps with photographs and explanations of exhibits.

Conclusions
Focus groups helped shape the thinking of the PISEC project team and enhanced its understanding of what makes an effective and appealing exhibit. Groups encouraged dialogue, allowed
participants to respond to sample materials and objects, and helped to identify areas for further investigation.

As a research tool, it's important to remember that focus groups do not yield quantitative data. Opinions expressed by group members may not represent the museum audience as a whole. If focus groups are used, time and money should be invested in developing a good interview guide and selecting an experienced moderator. Staff from a variety of museum departments should be invited to observe the groups. Hearing visitors’ comments about programs and exhibits is a powerful experience.

**Seven Characteristics of Successful Family Exhibits**

Information from the literature review, focus groups, and Phase 1 observations resulted in a list of seven characteristics of family-friendly exhibits (Borun & Dritsas, 1997):

- **Multi-sided** - family can cluster around exhibit
- **Multi-user** - interaction allows for several sets of hands (or bodies)
- **Accessible** - comfortably used by children and adults
- **Multi-outcome** - observation and interaction are sufficiently complex to foster group discussion
- **Multi-modal** - appeals to different learning styles and levels of knowledge
- **Readable** - text is arranged in easily-understood segments
- **Relevant** - provides cognitive links to visitors’ existing knowledge and experience.

These seven characteristics, though seemingly obvious, rarely are present in any one science museum exhibit. A walk-through survey in June, 1997, of more than 250 interactive displays at The Franklin Institute Science Museum revealed that only 6% incorporate all seven characteristics. The list of seven characteristics can be used to assess the family-friendliness of exhibits. It’s important to remember, however, that these criteria are not meant to replace exhibit characteristics related to specific cognitive and affective objectives, but rather are an additional set of exhibit criteria (See
A4 in the Appendix for a template for assessing the family-friendliness of existing or planned exhibits).

**Enhancing the Test Exhibits with Family Learning Components**

Exhibit-based learning involves both exhibit variables and visitor variables. Exhibit variables include the physical aspects of exhibits, as well as content, labels, and location. Visitor variables include demographic characteristics, previous knowledge and experience, and frequency of museum visits. Since the visitor variables could not be altered, PISEC hoped to measurably increase family learning by modifying exhibits on the basis of the seven characteristics.

To be clear about what was being measured, the test exhibit had to be held constant and it was necessary to add a new component that would account for any observed changes in visitor behavior. Exhibit enhancements or “family learning components” were developed which took the form of either kits or interactive stations. The new family learning components were integrated into the original test exhibits so that they functioned as one experience.

While designing for families, it was important to remember that museums also serve school groups. Activities designed to facilitate inquiry-learning for families tend to have small, (re)movable parts that may not withstand use by school groups. Developing separate learning components for families provided one solution to this persistent dilemma.

The Academy of Natural Sciences and New Jersey State Aquarium created portable kits to be distributed only on weekends and school holidays when families are most numerous. The Franklin Institute’s solution was a flexible station whose top can be folded down when school group visitation is high. The exhibit remains on the museum floor, serving as a countertop in its folded state. The fourth component, developed by the Philadelphia Zoo, was designed to withstand school-group use.

**How to Do It: Four Steps to Effective Exhibits for Families**

Step One - Front-end Evaluation

*Study the target audience. Who are they? What are their*
interests and preferences? What knowledge and experience do they bring to the museum visit?

In museums, early planning research (front-end evaluation) uncovers visitors’ baseline knowledge and preconceptions about a topic to be treated in an exhibit or program (Borun, Massey, & Lutter, 1993). For PISEC, the transcripts of 129 family conversations and interviews from the Phase 1 research served as front-end study for understanding the ideas, questions, problems, and interests that visitors were bringing to the test exhibits.

Step Two - Goals and Objectives

Decide what impact the exhibit should have.

Since PISEC’s ultimate goal was to foster family learning, the desired outcome was that the family-learning components would increase the incidence of the performance indicators defined in Phase 1. Phase 1 data also revealed that families with higher-level scores spent significantly more time at the exhibits. Thus, it was hoped that families would stay longer, allowing more opportunity for learning through conversation, exhibit interaction, and reading.

Observations of Phase 1 families and transcripts of their conversations revealed how well each test exhibit was working:
- Were visitors using the exhibits correctly?
- Did they seem to understand the main messages?
- Did the exhibits incorporate the seven characteristics of successful family learning?

Plans for the family-learning components built on the test exhibit’s strengths, addressed weaknesses, sought to make content more accessible to families, and applied the seven characteristics to exhibit design. New goals were set that described the understanding and insights a family should possess after using an enhanced test exhibit. These goals were translated into behavioral objectives that could be assessed by observing and interviewing visitors.

Step Three - Review

Study the museum literature and investigate museum exhibits to see how the seven characteristics of family-friendly exhibits have been used successfully.
The project team met with colleagues at other institutions that were working on exhibits and programs for families and assessed its own museums' exhibits to better understand how the seven characteristics could be incorporated into exhibit design.

Step Four - Formative Evaluation

Create a prototype, and then test it. Are visitors doing what is expected? Do they get it? If not, revise the prototype and test it again.

Development of the family-learning components started with brainstorming. The teams translated ideas into mock-ups or prototypes of each component. Early prototypes were composed of simple pictures on poster board, and handwritten text or laser-printed labels; later prototypes were more elaborate but still made of inexpensive materials. Testing low-cost prototypes ensures that the more costly permanent versions will be effective.

PISEC development teams used a range of formative-evaluation techniques, both quantitative and qualitative, to try out the prototypes in conjunction with the test exhibits. Methods included: timing families, noting their behaviors on checklists, and watching to see if visitors were engaged with and able to use the prototypes correctly. If family-learning components involved several activities, evaluators watched to see if they were all effective and appealing. They also talked to visitors to determine
whether they understood the exhibit and content goals, asking open-ended questions such as: “What do you think this exhibit is trying to show?” and “How would you make it better?” They asked affective questions as well: “Do you like this exhibit? Why or why not?” Team members observed and questioned families, making sure to include both children and adults.

The power of evaluation became evident as visitors’ encounters with prototypes provided valuable feedback about what worked and what did not. Developers modified each prototype based on this feedback; modifications ranged from quick label revisions to discarding an ineffective prototype design and starting over with an entirely new idea. This process continued until the prototypes met their goals. Once the components seemed to be working effectively, they were fabricated in permanent form and installed at the test exhibits for visitor use.

The sections that follow describe how each PISEC museum tested and modified its family-learning component to achieve specific learning objectives. Even though the four museums have very different settings, the needs and learning attributes of families guided exhibit development. A chart illustrating how the seven characteristics of family-friendly exhibits were incorporated into exhibit design follows the description of each museum’s family learning component.

**The Academy of Natural Sciences**

**Was The Test Exhibit Working?**

The goals of *Shark Tooth Dig* are to create an understanding of fossils (particularly of the sharks’ teeth found in a nearby New Jersey streambed) and to enable visitors to correctly use a dichotomous key (sorting system) to identify fossilized sharks’ teeth. Phase 1 data suggested that these goals were not being achieved. The majority of visitors thought that the teeth they were finding were reproductions, not real fossils. In addition, many did not seem to realize that the exhibit is modeled after an actual streambed in New Jersey named *Big Brook* where fossilized sharks’ teeth have been found. Also, since there were pictures of the sharks’ teeth at the end of the dichotomous key, visitors
skipped the process of sorting by characteristics and identified the teeth by simply matching them to the pictures.

Learning Objectives
The Academy’s development team wanted to design a component that would enhance visitors’ understanding of fossils and clear up their misconceptions about Shark Tooth Dig. It was hoped that visitors using the component would:
- demonstrate an understanding of the story of Big Brook
- sort fossilized sharks’ teeth by visible characteristics
- be able to match a living organism to its fossilized remains

It seemed that an activity kit would be suitable for the environment of Shark Tooth Dig and a viable means of achieving these objectives. The kit consisted of three simple activities that could be completed in one visit.

Evaluation
Formative evaluation revealed both anticipated and unexpected results:

Story Wheel
This activity explains fossilization through the story of the Big Brook streambed in New Jersey.

The area was once covered by a shark-inhabited sea. Visitors could read the Big Brook story by rotating a wheel counterclockwise; however they tended to turn the wheel clockwise, reading the story backwards. Developers reversed the sequence of the story panels and added the words “Turn Here.” Once these modifications were made, turning the wheel promoted family interaction; adults read the story aloud to children. Colorful illustrations engaged children and non-readers.

Shark Finder
This was a sorting activity, but it did not show pictures of the actual shark teeth. The initial prototype used circles and squares to portray tooth characteristics, but visitors had difficulty comparing the illustrated characteristics to the actual fossils. The team made the illustrations more tooth-like, while maintaining a generic look.
Testing and revision continued until visitors could work through the key.

Matching Puzzle
The third activity asked visitors to pair magnetic puzzle pieces depicting living organisms and their fossilized counterparts. Many visitors mistakenly tried to assemble the puzzle pairs into one giant puzzle. Developers altered the instructions until visitors understood the activity.

Printing important procedural words in bold, such as “match,” “find,” and “sift” helped visitors understand what to do. The final version of the kit opens like a book with the story wheel and the title “Big Brook” on the outside.
Originally, several copies of the kit were placed on a shelf for visitors to borrow, but people did not feel comfortable helping themselves. Signs such as “Take One!” did not prompt appropriate action. Distribution by museum staff proved more effective. Also, positioning the staff person near the Shark Tooth Dig helped visitors understand that the kit was a supplement to the exhibit.

Adults and children were able to correctly identify sharks’ teeth and complete the matching puzzle. Overall, families using the kit were more engaged in activity and discussion, and spent more time at the exhibit. Since the completion of the project, the kits have been made a permanent feature of Shark Tooth Dig and are routinely made available to families.

<table>
<thead>
<tr>
<th>Seven Characteristics of Family-Friendly Exhibits</th>
<th>Academy of Natural Sciences-Big Brook Activity Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-sided</strong></td>
<td>Kit can be accessed from any direction.</td>
</tr>
<tr>
<td>Family can cluster around the exhibit</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-user</strong></td>
<td>A puzzle, magnifying glass, sorting key (requiring interaction with the exhibit), and story wheel can simultaneously engage multiple family members.</td>
</tr>
<tr>
<td>Interaction allows for several sets of hands or bodies</td>
<td></td>
</tr>
<tr>
<td><strong>Accessible</strong></td>
<td>Kit can be used in any space in the exhibit area; large puzzle pieces are suitable for adults and children.</td>
</tr>
<tr>
<td>Comfortably used by children and adults</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-outcome</strong></td>
<td>Multiple activities provide opportunities for extended conversation and engagement.</td>
</tr>
<tr>
<td>Observation and interactions are sufficiently complex to foster group discussion</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-modal</strong></td>
<td>Finding and identifying teeth requires handling and examination. The storybook engages reader. The puzzle can be completed by reading or matching graphics.</td>
</tr>
<tr>
<td>Appeals to different learning styles and levels of knowledge</td>
<td></td>
</tr>
<tr>
<td><strong>Readable</strong></td>
<td>Text and graphics are segmented. Key words are capitalized and highlighted in bold.</td>
</tr>
<tr>
<td>Text is arranged in easily-understood segments</td>
<td></td>
</tr>
<tr>
<td><strong>Relevant</strong></td>
<td>Story wheel tells the story of Big Brook, a streambed in nearby New Jersey.</td>
</tr>
<tr>
<td>Provides cognitive links to visitors’ existing knowledge and experience</td>
<td></td>
</tr>
</tbody>
</table>
The Franklin Institute

Was the Test Exhibit Working?
Despite its popularity, the Sand Pendulum was not meeting its instructional goals. From observations conducted during Phase 1, it was clear that visitors focused on the sand pattern and not the Y-shaped pendulum that produced the pattern. Few people realized that the pretzel-shaped pattern resulted from two different motions made by the compound pendulum. The explanation offered on the label was not inviting to families. The team thought the content would become more accessible if families could learn by experimenting with the key variables.

Learning Objectives
The Franklin Institute team's goal was to increase family learning at the test exhibit by adding an experiment station that would encourage inquiry learning through investigation, comparison, and discovery. It was hoped visitors using the component would:
- notice and be able to describe the pendulums as Y-shaped
- experiment with multiple pendulums
- compare the Y-shaped pendulums and observe that different-shaped compound pendulums produce different patterns.

Evaluation
Unlike the original exhibit where the pendulum's structure hung from the ceiling, the new experiment station put the pendulums at eye level for observation and experimentation. The first prototype had a single pendulum suspended from a wooden frame. Visitors were supposed to choose from several different Y-shaped chains,

When he [my son] gets to do an actual experiment, it sparks his interest in learning more about that subject.
systematically hang each on a set of hooks, attach a funnel to the bottom of the chain, fill the funnel with sand, swing, and create patterns. During the first minutes of testing it was apparent that what seemed clear to the developers was unintelligible to visitors. Visitors didn’t know what to do with the chains. Multiple chains were draped across the device and attached to every available hook, resembling a spider web more than a compound pendulum. Additional directions and rewording of the label made little difference. It was too difficult and time-consuming for visitors to figure out what the experiment was about, let alone to systematically try each chain.

Another prototype presented visitors with a slide that they could move up and down the pendulum chain, varying the length of the parts of the pendulum to change the resulting sand patterns. The slide also proved a confusing entry point for experimentation. Few visitors moved the slide and those who did failed to systematically compare the patterns. Most visitors were satisfied with making just one pattern and did not explore different outcomes.

As prototype testing continued, some design mandates became evident. Most important, the starting point of the experimental process had to be easy and obvious. Similarly, operating the interactive had to be simple and fool-proof. When the experiment was too complicated or the device malfunctioned, visitors became frustrated and withdrew from the exhibit.
Discovering the limitations of the single-station designs, the team was propelled to an alternative idea: a multi-outcome experiment station with three mini-pendulums, each tracing a different pattern. The new device was about twice the width of the previous prototypes. Its wide front and open sides could accommodate family groups. It actually looked appropriate for a group as opposed to the smaller prototypes that looked like stations for single users.

Applying the seven characteristics to the experiment station required a creative compromise. Visitors did not read text placed on the side of the exhibit. The text had to be placed directly in front of them for significant numbers to read it. This meant adding a back panel and eliminating rear access. However, the sides were kept open to maintain as much access as possible.

The multi-station design was an instant success, but a few label revisions were necessary. A behavioral checklist and interview (see A5 in Appendix) helped evaluators compare visitors’ responses to different versions of the label. Early versions which opened with content explanations, did not spark interest or prompt families to systematically experiment. The final version of the label poses a challenge as a question that can only be answered by trying all three pendulums.

Family members often read the label aloud. More than 50% of families noticed the Y-shapes and could explain that changes in the Y result in different patterns. The new device is fabricated in
materials similar to the original test exhibit. Together, they serve as interpretive companions, helping families understand how a compound pendulum can create complex patterns.

<table>
<thead>
<tr>
<th>Seven Characteristics of Family-Friendly Exhibits</th>
<th>Franklin Institute - Sand Pendulum Experiment Station</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-sided</strong>&lt;br&gt;Family can cluster around the exhibit</td>
<td>Three open sides and long front (6'4'') accommodate groups.</td>
</tr>
<tr>
<td><strong>Multi-user</strong>&lt;br&gt;Interaction allows for several sets of hands or bodies</td>
<td>Three pendulums can be operated simultaneously; has opportunities for cooperation (e.g. one person holds a funnel while another fills it with sand).</td>
</tr>
<tr>
<td><strong>Accessible</strong>&lt;br&gt;Comfortably used by children and adults</td>
<td>Height of working surface (32'') is comfortable for children and adults.</td>
</tr>
<tr>
<td><strong>Multi-outcome</strong>&lt;br&gt;Observation and interactions are sufficiently complex to foster group discussion</td>
<td>Experiment takes several minutes to complete; three different pendulums and patterns foster repeat experimentation.</td>
</tr>
<tr>
<td><strong>Multi-modal</strong>&lt;br&gt;Appeals to different learning styles and levels of knowledge</td>
<td>Visitors can figure out main ideas through hands-on activity, reading and/or observation.</td>
</tr>
<tr>
<td><strong>Readable</strong>&lt;br&gt;Text is arranged in easily-understood segments</td>
<td>Label is simple (fewer than 50 words) divided into segments.</td>
</tr>
<tr>
<td>** Relevant**&lt;br&gt;Provides cognitive links to visitors' existing knowledge and experience</td>
<td>Pendulums make familiar shapes: a fish, pretzel, and oval.</td>
</tr>
</tbody>
</table>
The New Jersey State Aquarium
Was The Test Exhibit Working?
As mentioned previously, between Phase 1 and Phase 2, Barrier Beach was transformed into Caribbean Beach. While the interpretive focus changed, the general physical aspects of the exhibit remained the same. Like Barrier Beach, Caribbean Beach is a diorama with living creatures, but now it depicts a tropical beach inhabited by animals native to the Caribbean (live shore birds, brightly colored fish, and crustaceans) and is filled with lush foliage. The exhibit represents three habitats: aquatic, terrestrial, and arboreal. Overhead panels feature photographs, names, and the eating habits of Caribbean Beach’s inhabitants. The new exhibit’s intended goal was to increase visitors’ understanding of how animals in the three different habitats use their environments.

Caribbean Beach, although aesthetically pleasing and large enough to accommodate families, was limited as a vehicle for family learning. Families seemed to enjoy looking at the fish and birds but had little opportunity to develop a deeper understanding of them. It was a mostly observational experience with few graphics.

Learning Objectives
Since Caribbean Beach contains no hands-on elements, the Aquarium’s development team thought it was important to create an interactive family learning component that would focus attention on the fish and birds in the exhibit and provide opportunities to learn more about them.
The team decided an activity kit would work. It was hoped that visitors using the kit would:
- demonstrate an understanding that animals at the beach occupy one of three habitats: water, land, or trees
- be able to describe types of camouflage
- recognize that animals’ bodies provide information about how they move

Evaluation
The team developed a kit with three activities, dealing with habitat, camouflage and locomotion.

Postcard from the Beach

Visitors used self-inking stamps to print pictures of fish, birds, and invertebrates in their correct habitats on a line drawing of *Caribbean Beach*. Kit directions encouraged families to study the exhibit to determine where the animal stamps should be placed on the “postcard.” Although this activity was immediately popular, evaluation prompted the following adjustments: 1) increasing the contrast in the illustration to clearly distinguish the land from the water; 2) including instructions for how to use the stamps; and 3) adding names and pictures of the animals on the stamps.

*Magnetic Puzzle*
Families assembled puzzle pieces - representing fish heads, bodies, and tails - into complete fish on a magnetic board. Printed clues
helped visitors match the correct pieces. Problems encountered during evaluation included:
- Families rarely read the directions because there was too much text and it was not eye-catching.
- People did not realize that the fish pieces could be moved.
- The magnetic board was too weak to hold the pieces.
- Similarly colored pieces caused erroneous matching.
The Aquarium team revised the design and modified text until these problems were solved.

_Camouflage Book_
This eight-page book featured acetate overlays that hid animals within their habitats. Families read riddles to deduce the identity of the camouflaged animals. Unfortunately, visitors rarely noticed the book because it was hidden under a wooden panel. Substituting a transparent plastic panel and adding the words "Open Here" solved this problem. Animals' names were initially omitted from the text to encourage families to read exhibit labels. But families wanted to know the animals' names as they read the book, so the names were added.

The three activities fit into an attache-size wooden box with a handle. Visitors were confused because the kit's exterior lacked directions. Adding the words "Family Activity Kit - Open Me at the Beach" to the lid of the kit helped greatly. Developers attached a "luggage tag" to the kit's handle with instructions on how to open and use the kit and added colorful stickers to enliven its exterior. Side supports held the lid upright during use.

As at the Academy of Natural Sciences, families were hesitant to take a kit from a cart and use it, even when signs encouraged use. To solve this problem, Aquarium staff and volunteers were assigned to encourage families to take a kit. As a final improvement, developers supplied folding stools so that visitors did not have to sit on the floor to use the kit (although many did anyway).

The final version of the kit stimulated in-depth observation of the animals. The hands-on activities engaged adults and children, and encouraged them to talk about the exhibit. Visitor conversations
ranged from simple identification to discussions about camouflage and habitat. Several copies of the kit were made and they are now a regular offering at *Caribbean Beach*.

<table>
<thead>
<tr>
<th>Seven Characteristics of Family-Friendly Exhibits</th>
<th>Aquarium - Family Activity Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-sided</strong></td>
<td>Kit can be accessed from any direction.</td>
</tr>
<tr>
<td>Family can cluster around the exhibit</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-user</strong></td>
<td>Three different activities can be carried out by several family members at once. Some family members can work on activities while others look for animals in the exhibit.</td>
</tr>
<tr>
<td>Interaction allows for several sets of hands or bodies</td>
<td></td>
</tr>
<tr>
<td><strong>Accessible</strong></td>
<td>Portable kit can be used on the floor or on folding stools provided by the museum. Activities feature chunky pieces easily grasped by small hands.</td>
</tr>
<tr>
<td>Comfortably used by children and adults</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-outcome</strong></td>
<td>Three related but independent activities with multiple parts require sustained exhibit observation, communication, and teamwork. Take-home materials stimulate further involvement.</td>
</tr>
<tr>
<td>Observation and interactions are sufficiently complex to foster group discussion</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-modal</strong></td>
<td>Activities require varied skills for successful completion: manual dexterity, observation skills, deductive reasoning, reading skills.</td>
</tr>
<tr>
<td>Appeals to different learning styles and levels of knowledge</td>
<td></td>
</tr>
<tr>
<td><strong>Readable</strong></td>
<td>Text is segmented and supplemented by illustrations.</td>
</tr>
<tr>
<td>Text is arranged in easily-understood segments</td>
<td></td>
</tr>
<tr>
<td><strong>Relevant</strong></td>
<td>Rubber stamps and puzzles are familiar objects for families. Kit is designed to look like a suitcase.</td>
</tr>
<tr>
<td>Provides cognitive links to visitors' existing knowledge and experience</td>
<td></td>
</tr>
</tbody>
</table>
The Philadelphia Zoo

Was The Test Exhibit Working?
The goal of the *Naked Mole Rats* exhibit is to enable visitors to learn about these animals, observe their behaviors, and notice that they, like other social animals, live in organized groups. By looking at the exhibit, families learned that naked mole rats are native to Africa, live underground, move through tunnels, and are preyed upon by snakes. But visitors rarely read the information about social structure and behavior on the small, black-and-white label. Also, visitors had fundamental misconceptions about the animals, including identifying the adult mole rats as babies because of their small size and pink, wrinkled, seemingly hairless skin.

Learning Objectives
The Zoo's development team wanted to increase visitors' knowledge about naked mole rats and to clear up common misconceptions. It was hoped that visitors using the family learning component would:
- show increased attention to the naked mole rats
- demonstrate an accurate understanding of mole rats' physical characteristics
- be able to discuss specific social behaviors.

Evaluation
Formative evaluation proved a powerful tool for eliminating two ineffective approaches that did not attract or interest family visitors. By discovering this early in the testing process, a third, more effective component was developed before significant funds had been invested in the final product.

Approach #1 - Live Actors
The team's first idea was to use live actors to perform or model good learning behaviors (*Koran, Koran, Foster, & Dierking, 1988*). The team developed a script that included key facts about the naked mole rats. The actors - mother, father and a child - performed the script in front of the exhibit, pretending to be casual visitors. However, it soon became clear that using live actors was problematic. Visitors interacted with the actors, preventing them from performing the script. The actors, especially
the child, tired quickly. The team decided to bring down the curtain on live performances.

**Approach #2 - The Video**

Next, the team tried showing a video of the family of actors portraying good family learning. The video was located in a kiosk near the exhibit. Despite trials with different locations and text, visitors ignored the video. Most watched it for less than 10 seconds. When the video kiosk was placed in front of an adjacent exhibit, visitors climbed behind it to look at those animals.

![Image of children looking at video kiosk]

The evaluators determined that people wanted to see animals, not watch TV. Using video to model learning behaviors at the Zoo was a dead end.

**Approach #3 - Family-Friendly Graphics**

The Zoo needed a family-learning component that would enhance animal viewing, not compete for visitors' attention. Further, since one of the problems with the zoo's test exhibit was ineffective labeling, it was hoped that an interactive graphic would stimulate directed looking and family conversation.

The team decided to focus on what is most striking about naked mole rats: their unusual appearance and seemingly bizarre behaviors. Staff tested text to determine the ten facts visitors found most interesting. Then the team created a series of cardboard prototypes and watched people's reactions. When facts were
displayed statically people ignored them, even if the text was large, clear, and inviting. Visitors responded positively when an *action* (such as lifting laminated sheets) was required. But operating the interactive had to be simple; as at The Franklin Institute, visitors were frustrated when there were too many steps to perform or they could not understand the directions.

To attract visitors to the new graphic, developers went 3-D, building a cardboard prototype consisting of a low box with a maze of tunnels drawn on its top surface. Ten cards were inserted

through slots in the top of the box. Each card had a picture of a mole rat on top and one fact that visitors could read by pulling the card upwards out of the box (a stop prevented the cards from being detached). Evaluators added a title, “Ten Weird Facts about Naked Mole Rats,” and instructions to “Lift and Look!” They found that people began to use the mock-up even though it was rather crude, plain, and small.Doubling the size of the title panel and making the word “weird” bright yellow increased usage dramatically.

The final version was a free-standing graphic station. A step provided easy access to the pull-up cards for smaller visitors. Most visitors to the exhibit used the new interactive graphic station. As hoped, they read the labels, called out the facts to other family members, recalled facts read at the interactive while looking at the naked mole rats, and even corrected one another when the naked mole rats were mistakenly called babies.
<table>
<thead>
<tr>
<th>Seven Characteristics of Family-Friendly Exhibits</th>
<th>Zoo - Interactive Graphic Station</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-sided</strong></td>
<td>Three open sides and a square shape facilitate clustering.</td>
</tr>
<tr>
<td>Family can cluster around the exhibit</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-user</strong></td>
<td>Ten different pull-up cards offer activities for many people. More than one card can be raised at a time.</td>
</tr>
<tr>
<td>Interaction allows for several sets of hands</td>
<td></td>
</tr>
<tr>
<td>or bodies</td>
<td></td>
</tr>
<tr>
<td><strong>Accessible</strong></td>
<td>Cards are at different levels. Station has a built-in step for young children.</td>
</tr>
<tr>
<td>Comfortably used by children and adults</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-outcome</strong></td>
<td>Each card lists a different fun fact along with a humorous cartoon. Cards stimulate in-depth examination of the exhibit.</td>
</tr>
<tr>
<td>Observation and interactions are sufficiently complex to foster group discussion</td>
<td></td>
</tr>
<tr>
<td><strong>Multi-modal</strong></td>
<td>Brief fun facts appeal to readers of all ages. Illustrations relate the facts to younger children and non-readers. Cards provide suggestions for directed looking.</td>
</tr>
<tr>
<td>Appeals to different learning styles and</td>
<td></td>
</tr>
<tr>
<td>levels of knowledge</td>
<td></td>
</tr>
<tr>
<td><strong>Readable</strong></td>
<td>Station has short, direct labels (12-30 words each). Text is engaging when read aloud. Cartoons attract children.</td>
</tr>
<tr>
<td>Text is arranged in easily-understood</td>
<td></td>
</tr>
<tr>
<td>segments</td>
<td></td>
</tr>
<tr>
<td><strong>Relevant</strong></td>
<td>Text relates naked mole rat activities to human behavior.</td>
</tr>
<tr>
<td>Provides cognitive links to visitors' existing knowledge and experience</td>
<td></td>
</tr>
</tbody>
</table>
Testing with Diverse Audiences
One of the shared goals of the Family Learning Project and PISEC's partner program, Community Connections, was to help museums appeal to families from diverse backgrounds. For this reason, it was important to include these families in the test audiences for the family learning components.

The Community Connections project was an outreach program involving African-American and Latino families, many of whom were not regular museum-goers before becoming involved with PISEC. The response of the Community Connections families to the family learning components was much like that of traditional museum audiences. Evaluation ensured that the prototypes could be successful with communities that are currently underrepresented in museums.

Evaluation Tips
- Become familiar with the target audience through front-end evaluation, checking assumptions about visitors' prior knowledge.
- Test exhibits, including graphics. Don't prejudge how people will react to a display or device.
- Use simple, inexpensive materials for prototypes.
- Ensure broad appeal by testing prototypes with adults and children from diverse backgrounds.
- Learn from hits and misses. Failures can be as enlightening as success.
Conclusion: Designing Family-Friendly Exhibits

There are specific exhibit characteristics that facilitate family learning. The list of seven characteristics of successful family exhibits received preliminary validation when these characteristics were incorporated into exhibits that visitors could use and enjoy. Based on observation and interviews, it was determined that adding the family learning components to the test exhibits created more effective exhibits. Families used the enhanced exhibits appropriately, worked together, and grasped the main ideas.

The Phase 2 evaluation, while an effective method for developing exhibits for the audience in specific museums, was not sufficient to yield generalizable results. Further validation of the seven characteristics took place during Phase 3, a formal research study. This phase - described in the next section - provides a comparative, cross-institutional measure of the impact of the enhanced exhibits on family behavior.
Phase three

Do the seven characteristics of family-friendly exhibits produce measurable increases in family learning?

To answer this question PISEC compared the frequency of learning behaviors for families using the enhanced test exhibits (treatment group) to families using the original test exhibits (control group). This comparison allowed measurement of the impact of the enhanced exhibits. For a more complete discussion of the Phase 3 research see Borun, et al., 1997.

Collecting the Data

In this phase of research, data collectors observed and coded only the five behaviors that were performance indicators for learning. These indicators were: ask a question, answer a question, comment on/explain the exhibit, read silently, and read aloud. The coding sheet and manual were modified appropriately. With the reduced list of behaviors, videotaping was no longer necessary.
As in Phase 1, data collectors unobtrusively narrated family behavior and conversation into a hand-held microcassette recorder. Data collection began when the first family member crossed a predetermined location in the exhibit area and continued until the last member of the family withdrew from the exhibit. At that point, the data collector asked an adult family member to describe the age and relationship of family members and to answer questions about previous family visits to the museum and exhibit, prior knowledge of exhibit content, frequency of museum visiting, and ethnic identification. Later, data collectors transcribed the audio tapes and coded for performance-indicator behaviors (See A6 in Appendix).

To refine the Phase 1 methodology, an additional aspect of visitor behavior was observed. During the earlier work, it had become evident that families did not always approach and withdraw from exhibits as an intact group. Rather, the family members who were present at the exhibit at any one time varied as people came and went. To capture this fluidity, data collectors recorded the time of the approach and withdrawal of every family member to determine the total time (in seconds) each was present at the exhibit (See A6 in Appendix).

Using these revised methods, data collectors observed 200 families (50 per museum) at the original test exhibit at each of the four sites. Following this control group observation, PISEC installed the family-learning components (developed in Phase 2) at the test exhibits, and then observed a treatment group of 200 families (50 per museum) to measure the impact of the enhanced exhibits.

**Analyzing the Results: Assessing the Impact of Enhanced Exhibits**

The 200 treatment-group families who used the enhanced exhibits demonstrated significantly higher numbers of performance indicators than the control-group families who used only the original test exhibits (Borun, Chambers, Dritsas, & Johnson, 1997).
## Frequency of Performance Indicators

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>Academy of Natural Sciences</th>
<th>Franklin Institute</th>
<th>New Jersey State Aquarium</th>
<th>Philadelphia Zoo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treatment</td>
<td>Control</td>
<td>Treatment</td>
</tr>
<tr>
<td>Answer a question</td>
<td>1.6</td>
<td>2.6</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Ask a question</td>
<td>3.1</td>
<td>5.7‡</td>
<td>1.7</td>
<td>3.0‡</td>
</tr>
<tr>
<td>Comment/explain</td>
<td>5.6</td>
<td>11.9‡</td>
<td>7.9</td>
<td>18.4‡</td>
</tr>
<tr>
<td>Read Silently</td>
<td>1.2</td>
<td>1.8</td>
<td>1.9</td>
<td>3.3‡</td>
</tr>
<tr>
<td>Read Aloud</td>
<td>0.8</td>
<td>2.3‡</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Average</td>
<td>12.3</td>
<td>24.3‡</td>
<td>12.9</td>
<td>26.5‡</td>
</tr>
<tr>
<td>All Indicators</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance Indicators</th>
<th>All Museums</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Treatment</td>
</tr>
<tr>
<td>Answer a question</td>
<td>1.1</td>
<td>1.6‡</td>
</tr>
<tr>
<td>Ask a question</td>
<td>2.7</td>
<td>4.3‡</td>
</tr>
<tr>
<td>Comment/explain</td>
<td>8.5</td>
<td>41.4‡</td>
</tr>
<tr>
<td>Read Silently</td>
<td>1.2</td>
<td>2.6‡</td>
</tr>
<tr>
<td>Read Aloud</td>
<td>0.6</td>
<td>2.1‡</td>
</tr>
<tr>
<td>Average</td>
<td>14.0</td>
<td>25.0‡</td>
</tr>
<tr>
<td>All Indicators</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Numbers given are average performance indicators per family

† significant at p<.008 (2-factor ANOVAs, museum and control/treatment)
‡ p<.003 (unpaired t-tests)
†† p<.05 (unpaired t-tests)
‡‡ p<.0001 (unpaired t-tests)

At all the museums, the frequency of performance indicators significantly increased from control to treatment for both the individual indicators and for the total of five indicator behaviors (although not every individual indicator increased significantly at each museum).

### Learning Level and Frequency of Performance Indicators

**PISEC succeeded in decreasing the number of families who were operating at a lower level of learning and increased the number of families engaged in active family learning.** In Phase 3, treatment-group families had an average of 25.0 performance indicators, which is comparable to Phase 1 Level Three (22.3).

However, the average number of performance indicators associated with Learning Levels in Phase 1 has limited utility as a norm since
there was a large standard deviation in Levels Two and Three. While it cannot be concluded that the majority of Phase 3 treatment families were responding at the highest Learning Level, it can definitely be said that there was a significant decrease in the percentage of families at Level One, implying a corresponding increase in Levels Two and Three.

The Dynamics of Family Groups
During Phase 3 research, several words and phrases were used to describe changes in family configurations at an exhibit:

- **Grouping**: the combination of family members that is present at an exhibit at the same time
- **Shift**: the change in groupings as family members approach and withdraw from an exhibit
- **Minutes per person**: the total time spent by one person at an exhibit
- **Family time**: the sum of minutes per person/number of people in family
- **Elapsed time**: the time between the arrival of the first family member and the departure of the last member
- **Fluidity**: the movement of family members to and from an exhibit. Fluidity is measured by the number of shifts during a family's elapsed time at an exhibit.

**Time and Frequency of Performance Indicators**
To capture the dynamic nature of family groupings, the time that each family member spent at the exhibit was recorded; this time might be continuous or in separate segments. **Family time** was calculated by averaging the individual totals, giving the mean amount of time family members spent at the exhibit. Computing family time resulted in a number that was usually lower than elapsed time, but gave a more accurate picture of how long most of the family members spent at the exhibit. For example, in a family of three with a mother who spent two minutes at the exhibit, a son who spent three minutes, and a daughter who spent six minutes, the **elapsed time** would be six minutes, but the **family time** would be four minutes. Family time reflects the fact that not all family members are present for an entire exhibit encounter.
Just as performance indicators increased from control to treatment group, *family time also showed significant increases*. Serrell (1997) argues that a good exhibit slows the pace of visitors, so that they make more stops and spend more time at exhibit elements. While Serrell is discussing whole exhibitions, a similar situation seems to apply to individual displays. In Phase 1 of the PISEC study, it was found that elapsed time at the exhibit was directly related to Learning Level. In Phase 3, it was observed that *treatment-group families spent significantly more time at the exhibits than did those in the control group.*

**Demographic Factors and Frequency of Performance Indicators**
Most of the demographic characteristics that were measured in the study did not influence the frequency of performance indicators. The exceptions were gender and generation. In both the control and treatment groups, adults had significantly more performance indicators than children, and adult females had significantly higher performance indicators than adult males, boys or girls. The latter suggests that adult females are learning leaders, who facilitate the family’s learning experience.

**Ethnicity and Performance Indicators**
Members of PISEC’s *Community Connections* program (who were primarily African-American and Latino) had tested prototypes of the Phase 2 family learning components. The effects of ethnicity were also checked in the Phase 3 sample. While some of the groups in the sample were too small for data to be statistically significant, increases were observed in performance indicators from control to treatment in all ethnic groups. In other words, the enhanced exhibits appeared to be successful with all groups.

**Impact of Differences in Type of Museum, Exhibit, and Enhancement**
The similarities in the behavior of families at the four museums suggests that the seven characteristics of successful family learning exhibits may apply to other museums. Indeed, the similarities in the data from the four museums far outweigh the differences. There were instances in which one museum was significantly higher or lower than the other three for a particular indicator.
But, these differences were limited and site specific (see Borun, Chambers, Dritsas, & Johnson, 1997).

**Conclusion: Family Learning can be Enhanced through Exhibits**

In summary, the Family Learning Project Phase 3 research demonstrates that exhibits designed to facilitate Family Learning can create a substantial and measurable increase in learning behaviors.

Despite differences in type of collection, test exhibit, and exhibit enhancement at the PISEC museums, all four enhanced exhibits produced significant increases in performance indicators and family time. The four exhibit enhancements or “Family Learning components” were based on the seven characteristics of successful family-learning exhibits. Thus, using the seven characteristics as a guide to exhibit development proved an effective strategy for increasing active family learning in four different science museums. These findings, which emerged from a comparison of four different types of science museums, are intended to be generalizable to other aquariums, zoos, science, and natural history museums.
Conclusion

The Last Word: What’s Significant about the PISEC Family Learning Project

Looking back over all three phases, the Family Learning Project differs from previous museum learning research in several ways:

- PISEC developed a new method for observing families. While visitor researchers have observed and coded group behavior, PISEC was innovative in narrating behavior and conversation into a microcassette recorder. This technique enabled description of the activity of a family group, identifying each of the speakers, capturing changes in group composition, and recording both behavior and conversation.

- PISEC investigated the relationship between a quantitative and a qualitative measure of learning. Most studies have observed learning-related behaviors or used a cognitive test to measure learning, but in its Phase 1 research, PISEC assessed learning in two ways. The first measure was quantitative and indirect, based on observable behaviors; the second measure was a direct qualitative assessment of learning based on the content of family conversations and interviews.

- PISEC identified five performance indicators - behaviors that indicate learning is taking place. These behaviors were associated with high Learning Levels as measured by direct assessment of learning.

- PISEC contributed a set of concepts and definitions to visitor-studies theory for measuring the ebb and flow of people at an exhibit. Family groups at exhibits are fluid - they tend to split and recombine. It is important to keep this dynamic in mind when studying family learning.
• The *Family Learning Project* identified a set of seven exhibit characteristics that facilitate successful family learning. Science-museum exhibits were originally derived from school lab experiments, which, like most school-based instruction, was aimed at the individual student. When thinking about exhibit-based learning, it's important to consider the social context of a museum visit, particularly the family visit. It is hoped that the seven characteristics will inform museum practice as well as visitor studies.

• PISEC's *Family Learning Project* combined theory and application. Previous projects have been research investigations or specific applications but not both. The PISEC project tested its research findings by applying them to the development of four family learning components to make existing exhibits more family-friendly. The modified exhibits were tested by measuring their effectiveness using the performance indicators formulated in the initial research. Thus, both theory and application were tested and validated. By working at four different sites, PISEC has produced results that are presumably generalizable.

• PISEC focused on the family audience, the natural unit for science museum visitors. This group perspective allowed for a consideration of the dynamics of social learning as well as individual cognitive and associative gains. More work is needed in this area to have a deeper understanding of the dimensions and possibilities of museum-based learning.

Through in-depth study, PISEC found that families are learning in science museums and that this learning can be enhanced and extended through thoughtful exhibit design. Also, through collaborative research, PISEC found similarities in how families learn in a natural science museum, a science center, a zoo, and an aquarium. By following a set of design criteria, it is possible to create exhibits that are effective for a wide range of family groups.
Even though families are a primary audience for science museums, many exhibits are designed for individual users and do not encourage group interaction. But the groups are there, and they have come to the museum with an agenda that is part social and part educational (Hilke & Balling, 1985). The social aspect comes naturally; it's the museum's job to make the educational experience easy, pleasant, and rewarding.
References


# Appendix

**Learning Level Criteria for Test Exhibits**
The italicized quotes illustrate how we scored visitors’ statements.

<table>
<thead>
<tr>
<th>ONE</th>
<th>Natural Sciences Shark Tooth Dig</th>
<th>Franklin Institute Sand Pendulum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying</td>
<td>• Identifies simple activity (sifting sand) &quot;Hey, come here, hold this and sift through it&quot;</td>
<td>• Identifies simple activity (swinging pendulum and making designs) &quot;I made a design&quot;</td>
</tr>
<tr>
<td></td>
<td>• Names pattern(s) (pretzel, heart, etc.) &quot;We’re doing a pretzel picture&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TWO</th>
<th>Describing</th>
<th>Connects to other situations of making designs especially pendulum designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counts, but does not identify or classify &quot;I found five teeth&quot;</td>
<td>• Connects to other situations of finding things</td>
<td></td>
</tr>
<tr>
<td>Connects to other situations involving digging for fossils &quot;In Norristown Public Library paleontology class we found a lot of animal teeth.&quot;</td>
<td>• Notices that pattern can change if pendulum swings from different starting points &quot;...when you switch the direction of the pendulum it's the same basic pattern, but it's squished.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THREE</th>
<th>Interpreting and Applying</th>
<th>Attempts to explain why patterns are made: 2 points of attachment, 2 parts of pendulum, 2 speeds of swing, multiple directions of swing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discusses systems of classification &quot;I think it's supposed to show you what kind of teeth there are for different sharks.&quot;</td>
<td>• Assigns to categories based on diagnostic features “you say ‘Is it straight?’ and if it’s straight you look at these. Right? And answer all the questions. If it’s bent, you answer these questions and it’s one of those teeth. O.K.?&quot;</td>
<td></td>
</tr>
<tr>
<td>Sorts and identifies “I found 2 mako shark teeth”</td>
<td>• Association to other pendulums and how they work (clocks, etc.) “It reminded me of something I’ve seen here - the thing that knocks over all the chips...by the steps.”</td>
<td></td>
</tr>
</tbody>
</table>
## Learning Level Criteria for Test Exhibits cont’d

<table>
<thead>
<tr>
<th>ONE</th>
<th>Aquarium Barrier Beach</th>
<th>Zoo Naked Mole Rats (NMR)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Identifying</strong></td>
<td>• Names “beach” or collective grouping (“fish,” “birds”) “Oh, there’s a fish over here, over here, over here.”</td>
<td>• Names “naked mole rats”</td>
</tr>
<tr>
<td></td>
<td>• Recalls general experiences “Went to Florida”</td>
<td>• Points out obvious physical attributes (hairless, big teeth) “Look at those teeth.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Recalls general experiences “Went to another zoo”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TWO</th>
<th>Describing</th>
<th>Describing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Describing</strong></td>
<td>• Describes specific animal or plant species and their attributes “Look at that. Did you see the noses? They’re sort of pointy. Did you see the pointy nose? Did you see the pointy little one?”</td>
<td>• Describes animal behaviors (eating, climbing, living underground)</td>
</tr>
<tr>
<td></td>
<td>• Describes experiences involving these species or similar species “Look Sam, do you see it? Just like at the seashore. See the seashells?”</td>
<td>• Notices other animals (snake, elephant) “It reminds me of other animals that live underground.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relates NMR to other species that look similar (mouse, mole)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Describes experiences involving these or similar species</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THREE</th>
<th>Interpreting and Applying</th>
<th>Makes observations about behavior of the group: describes NMRs as social species.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interpreting and Applying</strong></td>
<td>• Explains how different species support, compete or adapt “...how the fish and how the birds and the fish together make a habitat and how the habitat is formed.”</td>
<td>• Compares NMR group behavior to that of other social species (e.g. ants) “The lifestyle...they’re a colony, like the bees you learned about last night.”</td>
</tr>
<tr>
<td></td>
<td>• Explains how the shore protects the land, dunes protect the beach, beach supports animals</td>
<td></td>
</tr>
</tbody>
</table>
Demographic Questionnaire

I. PRIOR VISITS
   A. Is this visit: _______ 1st _______ Repeat
   B. Have you seen this exhibit before (TFI add: in the last 3 years)?
      ___ yes ___ no

II. PRIOR KNOWLEDGE OF EXHIBIT CONTENT
   How would you rate your family's knowledge of, or experience with:
   A. ____________________ ? ___ a lot (4) ___ some (3)
      ___ not much (2) ___ none (1)
      (fill in appropriate topic from below)
   B. ____________________ ? ___ a lot (4) ___ some (3)
      ___ not much (2) ___ none (1)
      (ANS & Zoo only)

ANS  TFI  NjSA  Zoo
A. sharks  A. pendulums  A. beaches  A. animals that live in social groups
B. fossils

III. MUSEUM BACKGROUND
   A. How often do you attend museums/zoos/aquariums in a year?
      ___ Once a year or less ___ 4-5 times a year
      ___ 2-3 times a year ___ More than 5 times a year

IV. ETHNIC GROUP
   A. Please look at the back of my clipboard and tell me the number of the group
      with which you most identify: Check all that apply and record family role.

      ___ 1. Black or African-American __________________________
      ___ 2. Latino/Latina __________________________
      ___ 3. Asian or Pacific Islander __________________________
      ___ 4. Native American __________________________
      ___ 5. White __________________________
      ___ 6. Mixed ethnicity or other (please fill in) __________________________

   B. Do all the members of your family visiting with you today identify
      with this group? ___ yes ___ no

   C. If no, then which group(s) do the other family members most identify
      with? (indicate above)
### Phase 1: Behavior Coding Sheet

<table>
<thead>
<tr>
<th>Interactions (actor receiver)</th>
<th>&gt;</th>
<th>&gt;</th>
<th>&gt;</th>
<th>&gt;</th>
<th>&gt;</th>
<th>&gt;</th>
<th>&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Logistics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Call someone over</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point at exhibit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Withdraw</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climb on/through</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Conversation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal observation/explain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ask question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Answer question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Express like</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Express dislike</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Use Graphics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read label/picture silent (2 sec.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read label aloud</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Continuous Behavior</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hands-on</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Observe Only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-exhibit, Behavior Only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Group #: _____  Observer: _____  Date: _____
Site: ANS _____ TFI _____ NJSA _____ ZOO _____  Exhibit: ____________
Time Start: _____  End: _____  Total Time (seconds): _____

### FAMILY COMPOSITION
Scout: _____

<table>
<thead>
<tr>
<th>Gender/Generation</th>
<th>Age</th>
<th>Family Role</th>
<th>Physical ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Template for Assessing the Family-Friendliness of Exhibits

<table>
<thead>
<tr>
<th>Seven Characteristics of Family-Friendly Exhibits</th>
<th>Exhibit Name:</th>
<th>Fill in Comments Below</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multi-sided</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family can cluster around the exhibit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multi-user</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction allows for several sets of hands or bodies</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accessible</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfortably used by children and adults</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multi-outcome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation and interactions are sufficiently complex to foster group discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Multi-modal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appeals to different learning styles and levels of knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Readable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Text is arranged in easily-understood segments</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Relevant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides cognitive links to visitors' existing knowledge and experience</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Franklin Institute's Behavioral Checklist and Interview

This behavioral checklist and interview helped evaluators compare visitors' responses to different versions of the label.

START TIME: __________
END TIME: __________
TOTAL TIME (sec): __________
FAMILY NUMBER: __________

<table>
<thead>
<tr>
<th>USE</th>
<th>FAMILY INTERACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Red Pendulum</td>
<td>6. Adults and Children Use</td>
</tr>
<tr>
<td>2. Blue Pendulum</td>
<td>7. Only children</td>
</tr>
<tr>
<td>3. Green Pendulum</td>
<td>8. Only adults</td>
</tr>
<tr>
<td>4. Use Sand Pendulum #1</td>
<td>9. Read Label: Yes ____ No ____</td>
</tr>
<tr>
<td>5. Use Sand Pendulum #2</td>
<td>10. Who reads?</td>
</tr>
<tr>
<td></td>
<td>11. Adults &amp; children discuss</td>
</tr>
<tr>
<td></td>
<td>12. Use silently</td>
</tr>
<tr>
<td></td>
<td>13. Compare Patterns: Yes ____ No ____</td>
</tr>
<tr>
<td></td>
<td>14. Compare Chains: Yes ____ No ____</td>
</tr>
<tr>
<td></td>
<td>15. Discuss &quot;Why&quot;: Yes ____ No ____</td>
</tr>
</tbody>
</table>

16. Can you tell me in your own words, what this exhibit is about?

17. What do you think is different about each pendulum?

18. What do you think makes each pendulum make a different pattern?
   If "Y", is there anything else you notice about the pendulums?

19. Which face best shows your feelings about this exhibit?

   Love It  Like It  It's OK  Don't Like It  Hate It

20. If you liked this exhibit, what did you like about it?

21. Was there anything you did not like?

22. Is there anything that would make it work better for a family group?
Phase 3: Behavior Coding Sheet

### Family Members

<table>
<thead>
<tr>
<th>Conversation</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal observation/explain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ask question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Answer question</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Use Graphics

<table>
<thead>
<tr>
<th>Use Graphics</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Read label silently (2 sec)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read label aloud</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Exhibit Only (no PI’s)*

### Non-participant

Group #: Observer: Date:  
Site: ANS TFI NJSA ZOO Exhibit:  

**FAMILY SIZE RECORD**

<table>
<thead>
<tr>
<th># of Participants</th>
<th>Family Members</th>
<th>Start Time</th>
<th>End Time</th>
<th>Lapsed Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Time (seconds)  

**FAMILY COMPOSITION**

Scout:  

<table>
<thead>
<tr>
<th>Gender/Generation</th>
<th>Age</th>
<th>Family Role</th>
<th>Physical ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Used to indicate a family member who observed the exhibit and did not interact with other members.
Resources

PISEC Products

Book:
Collected papers by well-known museum leaders on Family Learning and related topics.

Video:
PISEC has created a video featuring “Building Shared Memories” and “Community Connections,” selections from eight focus groups held in connection with the PISEC projects. To receive a copy of the video, reproduce this order form and mail to the address below.

Name ___________________________ Title ___________________________
Institution ________________________________________________________
Address __________________________________________________________
Phone number __________________ Fax number ________________________

Mail to:
Angela Wenger
New Jersey State Aquarium
One Riverside Drive
Camden, NJ 08103-1060
609-365-3300, ext. 382

Video $6.00
S&H $2.00
Total Cost $8.00

Total Enclosed $_____

Service Providers
Mindy Goldberg Associates, Inc.
Market Research Consultants
13 Hidden Acres Drive
Voorhees, NJ 08043
Phone: 609-772-9005
Steven Goldblatt Photography
32 South Strawberry Street
Philadelphia, PA 19106
Phone: 215-925-3825

The Learning Collection
An Education Resource Company: Museum Kits,
Exhibit Development & Design, Curriculums
1269B South Westtown Road
West Chester, PA 19382-8525
Phone: 610-399-8323

Where to Find Literature on Family Learning

Curator
American Museum of Natural History
Central Park West at 79th Street
New York, NY 10024
212-769-5433

Journal of Museum Education
Museum Education Roundtable
621 Pennsylvania Avenue, SE
Washington, DC 20003
202-547-8378; merorg@erols.com

Visitor Studies Today!
Visitor Studies Association
Department of Psychology
Colorado State University
Fort Collins, CO 80523-1876
970-491-4352

Science Education
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158
212-850-6645; SUBINFO@wiley.com

Resources 66