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ABSTRACT

This research examines some of the factors that influence the learning process in an informal science education setting such as the Explora Science Center. Goals of the study include the completion of a qualitative as well as quantitative study on adult learning in an informal, hands on setting, observing and determining the learner characteristics which are crucial to the learning experience, and determining the multicultural use factors in a culturally diverse community. Statistical information on who visits which exhibits for what period of time is included. Age and gender are represented in the data displays and findings indicate that there are age and ethnic effects in adult visitor interaction with the exhibits. Numerous data tables are included to lend additional support to the research project. (Contains 29 references.) (DDR)

Group Study on Adult Learning at The Explora Science Center, Albuquerque, New Mexico, U.S.A.

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GROUP STUDY ON ADULT LEARNING

In an age when great emphasis is placed on science literacy, it is important to determine what role museums and science centers contribute to an individual's development of science knowledge. These leisure time education facilities can give educators and scientists a deeper insight into how and why people learn. From studies performed at these public facilities, information on individual or group learning patterns can be studied, thereby uncovering aspects of learning potentially hidden from observation in a more formal educational setting.

The purpose of this research is to determine some of the factors that influence the learning process in an informal science education setting. The Explora Science Center, located in downtown Albuquerque, New Mexico, was chosen as the setting for this study for two major reasons. First, the theme of Explora is a hands-on or interactive approach to learning basic science principles. Second, great potential exists for person to person interaction at its exhibits which can be documented by a research team.

The goals of this research project fall into two categories. The educational goals meet the TLT 561 requirement for a scholarly educational study of adult learning. Scientific goals involve determining some of the key elements of adult learning by conducting research in an informal educational setting. These objectives are enumerated as follows:

1. Educational

a. Apply the theories of learning taught in class to a real life situation.

b. Determine the patterns of learning that were observed by the research team.

c. Evaluate the effectiveness of the learning that was occurring.

d. Cooperative research learning among the research team.

e. Draw conclusions regarding:

   1) strengths and weaknesses of the exhibits in promoting learning.

   2) types of learner characteristics observed.

2. Scientific

   a. Do a qualitative as well as quantitative study on adult learning in an informal hands-on science setting.

   b. Observe and determine the learner characteristics which are crucial to the learning experience.

   c. Determine the multi-cultural use factors in a culturally diverse community.

Current literature which focuses on museum learning covers a number of important aspects of learning. Table 1 shows which topics are covered by each study reviewed.

By far the most researched aspect of learning in informal science education settings is that of exhibit and social interaction. Out of the twenty-two papers reviewed, twelve deal with exhibit and social interaction among the museum attendees. Reviewing these, one finds a general consensus that the greatest degree of learning between individuals (i.e. family unit, small group or couple) occurs as they converse with one another. The studies of Silverman and Wolins (1989) emphasize the key role of family learning, even to the point of suggesting that museums devise their exhibits with family communication therapy as one of their primary goals.

Nearly one half of the studies focused on who attended the museums and why. The majority of those attending museums are white, with a substantial percentage also from the major ethnic group of that particular community. It was generally found that the least represented groups are the Afro-Americans and Native Americans. The work of Mathers (1990,1993) is unique in that the setting is South Africa.

Most people visited a museum primarily for the benefit of children, whether it was a family function or a school function. The second greatest reason for visiting museums was for interest or excitement. In most cases this involved active participation on the part of the attendees. Purely educational purposes were low as a reason for attending the museum.

Nine out of the twenty studies included aspects of learning patterns and/or gender differences. Generally the learning pattern was that of social learning, with adults demonstrating degrees of previous knowledge to work from. Genderwise, women generally enjoyed the group activity and were the instruction readers, whereas the men were the gadget operators.

The final research area that offered a significant contribution was that of suggestions for improvement. Ten out of the twenty-two studies listed their suggestions. Interestingly, these suggestions centered upon increasing the cognitive learning theory concept of schema in light of family and group interactions. Hilke (1989) suggests that museum professionals consider family behavior in the design of exhibits and museums. Gunther (1994) advocates that learning and fun should go hand in hand, providing for all learning styles and educational levels. The text of the exhibits seems to be the major area targeted for improvement, especially avoiding canned presentations. Kropf and Wolins (1989) capsulate these conclusions by stating that exhibits should be entertaining and engaging, evoke curiosity, require active learning, and encourage practice of new concepts learned.

T A B L E 1
(Museum Studies)

STUDY CODE	WHO COMES	REASONS FOR COMING	INTERACTIONS EXHIBIT/SOCIAL	GENDER DIFFERENCE	EXHIBIT TIME	LEARNING PATTERNS	EXHIBIT DESIGN	THEME OF EXHIBIT	EXHIBIT CHOICE
1			X		X				X
2			X			X			
3			X	X		X			
4	X	X			X	X			
5		X	X						
6	X								
7			X						
8	X	X						X	
9	X	X							
10	X	X		X					X
11									X
12				X					
13						X			
14			X						
15	X		X						
16	X	X							
17		X	X					X	
18	X	X	X	X					
19			X	X			X		
20		X							
21			X				X		

CODE KEY
1. Cone and Kendal (1978)
2. Diamond (1986)
3. Dierking and Falk (1992, 94)
4. Falk (1991, 1993)
5. Gunther (1994)
6. Hanna and West (1989)
7. Hilke (1989)
8. Hood (1983, 88, 89)
9. Jensen (1994)
10. Klein (1990)
11. Koran (1984)
12. Korn (1990)
13. Kropf (1989)
14. Lavilla-Havelon (1989)
15. Leichter (1989)
16. Linton (1992)
17. Mathers (1990, 93)
18. McManus (1987, 88,89,94)
19. Patterson (1988)
20. Silverman (1989)
21. Treinen (1993)

METHODOLOGY

The study area centers on the Explora! Science Center located in the Galeria in downtown Albuquerque, New Mexico. The museum provides interactive exhibits with directions, instructions, information, and a central location for the Albuquerque metropolitan area. The group members obtained data by observing participants as they interacted with the Tectonic Basin, the Recollections III, the Light Island, and the Flight Demonstrator exhibits. (See figures # 1,2,3,4) The data includes:

gender

approximate age (beginning with teens and in progressive ten (10) year increments

ethnicity (Native American, African American, Asian, Hispanic, Caucasian, and an "unknown" category)

size of the visiting group

time spent on reading the instructions and information before, during, and after the activity

the form/direction of instruction - adult to adult, adult to child, and child to adult

the time spent at each exhibit

active and passive involvement

The Tectonic Basin exhibit shows the participant the "shifting sands of time" through simulated earth plate movements. The participants can move some of the sand and observe the resultant interaction between a vibrating base and the surface particles. As with the earth, seemingly solid ground gradually flows like fluid. Participants can visually see the accelerated sand movements and the resulting land patterns.

The Recollections III exhibit involves a camera which records a bright light's reflection off a gray wall around the subject's shadow and back to the camera. A computer electronically stores, colors, and manipulates the image onto a giant screen. As the subject moves, the computer produces a series of reflection in a variety of duplicate images, colors, and sizes.

The Light Island exhibit demonstrates how light beams can reflect and refract through a series of hands-on material. Light is emitted through a series of openings in a central unit/source. Participants can place concave and convex lenses, as well as a variety of filters and mirrors in front of the light source openings to see the diversion of light and the changing of light color as one moves the lenses and filters.

The Flight Demonstrator exhibit purports to explain the "principals [sic] of flight" and the effect of wind on an aircraft. Through a variety of hand and foot controls, participants can simulate the model aircraft's take-off, flight, and landing. The participant controls the plane's rotation, flight altitude, speed, direction, and angle of ascent and descent. The instructions and controls are all within easy reach of the pilot's chair.

Each of the four members of the project committee visited the museum on different days. The members gathered statistics strictly from observation without intruding or verbally communicating with any members of the study group. Each of the Museum Group members selected an exhibit which would serve as an interactive medium from which observational data originated. The members of the Museum Group averaged 40 observations, bringing the group's total to one hundred and sixty (160) entries.

As participants wandered through the science center, group members recorded the data and noted the characteristics central to the data base. Statistical analyses was conducted on the coded data to identify characteristics of adult learners at the Explora! Science Center.

Results Section Explora Study

Subjects Demographics

- Gender

Male	60
Female	87
Unknown	0

- Age

Teenager	33
20s,30s	45
40s,50s	47
60s,70s	17
Unknown	4

- Ethnicity

Native American	44
African American	11
Hispanic	33
Caucasian	50
Unknown	8

Summary of Data

- Directions Read

Before	51
During	24
After	11
Unknown	61

- Explanation

Adult to Adult	28
Adult to Child	36
Child to Adult	4

- Type of Involvement

Active	116
Passive	31

- Time spent at Exhibit

Mean	223 seconds
Std. Dev	216 seconds
Median	180 seconds

Comparison of Time spent on Exhibits to Age ANOVA

The null hypothesis was that there is no difference in the population in the mean time spent on exhibits by subjects of different observed ages. These ages were divided into four groups, teenagers, subjects in their 20s&30s, subjects in their 30s&40s and subjects in their 60s&70s. Alpha was set at 0.05.

Sample Data:

Age Group	Mean time spent (seconds)	Standard Deviation (sec)	Number of subjects (n)
Teenagers	371	291	32
20s-30syrs	239	217	45
40s-50s yrs	149	117	47
60s-70s	143	113	17

Sample size was 141, with 4 missing cases.

The mean time spent by teenagers is higher, roughly two minutes longer than the next highest group. The trend is for time spent to decrease with age.

Two of the assumptions underlying the use of a paremetric test were not met: age did not distribute normally, and group sizes were not equal. A third assumption, that of homogeneity of variance was not tested. An analysis of variance was calculated to test the null hypothesis ($F=9.01$, $n=141$, $df= 3,137$): $p<0.0001$. The null hypothesis may thus be rejected: It seems likely that in the population at least two of the groups' mean time spent on exhibits differ.

A multiple-comparison test (Scheffe) was calculated. The time spent by teenagers differs significantly from that of each of the other age groups. The null hypotheses for these comparisons may thus be rejected: It seems likely that in the population teenagers spend more time at the exhibits than any other age group. The null hypothesis for the remaining age groups must be retained: There is insufficient evidence to conclude that subjects in the other age ranges differ significantly in the mean time spent on exhibits.

Comparison of Time spent on exhibits to Ethnicity ANOVA

The null hypothesis was that there is no difference in the population in the mean time spent on exhibits by subjects of different ethnicity's. These ethnicity's were divided into five groups, Native Americans, African Americans, Hispanics, Caucasians and Unknown. Alpha was set at 0.05.

Sample Data:

Ethnicity	Mean time (seconds)	Standard Deviation	Number of subjects
Native American	117	119	44
African American	429	347	11
Hispanic	265	227	33
Caucasian	243	196	48
Unknown	324	264	5

Sample size was 137, with 8 missing cases.

Two of the assumptions underlying the use of a paremetric test were not met: ethnicity did not distribute normally, and group sizes were not equal. A third assumption, that of homogeneity of variance was not tested. An analysis of variance was calculated to test the null hypothesis ($F=6.67$, $n=141$, $df= 4,136$): $p=0.001$. The null hypothesis may thus be rejected: It seems likely that in the population at least two of the groups' mean time spent on exhibits differ.

A multiple-comparison test (Scheffe) was calculated. The time spent by Native Americans differs significantly from that of

Hispanics and African Americans. The null hypotheses for these comparisons may thus be rejected: It seems likely that in the population Native Americans spend less time at the exhibits than either Hispanics or African Americans. The null hypothesis for the remaining ethnic group comparisons must be retained:. There is insufficient evidence to conclude that subjects in the other ethnic groups differ significantly in the mean time spent on exhibits.

Comparison of Type of Explanation and Gender Chi Square

The null hypothesis that there is no difference in the mean type of explanation utilized by men and women was tested. The type of explanation was rated as either adult to adult, adult to child or child to adult.

Sample data

Type of explanation	Male	Female
Adult to adult	n=13 46%	n=15 35%
Adult to child	n=13 46%	n=23 53%
Child to adult	n=1 4%	n=3 7%

Sample size was 68 with 57 missing cases. The large number of missing cases is due to two effects, individuals who were alone and those which were not observed entering into an explanation.

There was not a considerable difference between sample groups.

Pearson's chi square was calculated to test the null hypothesis. Some cells had an expected frequency less than 5. $X2=10.05$ $(df=5)$ $p=.074$ thus $p>.05$. The null hypothesis may not be rejected. It seems likely that there is no significant difference in the population in the type of explanation used by men and women.

Comparison of Time spent on Exhibit and Gender T-Test-Independent Samples

The null hypothesis that there is no difference in the population in the mean time spent at exhibits for men and women. Alpha was set at 0.05, two-tailed.

Sample data:

	mean minutes spent at exhibit	Standard deviation	number of subjects
Men	243	242	60
Women	210	196	85

The sample size was 145 with no missing cases.

Two of the assumptions underlying the use of a parametric statistic were not met: the number of minutes did not distribute normally and sample sizes of women and men were not equal. An F-test was performed to check the homogeneity of variance assumption: p=.078: therefore p > .05. The assumption was thus considered met and an independent samples t-test using the pooled variance estimate was calculated to test the null hypothesis: t=.91 (df=143), two -tailed p=.363. The null hypothesis must thus be retained: There is insufficient evidence to conclude that women's and men's mean time spent at the exhibits differ in the population.

Comparison of Time spent at Exhibit and Age Kendall's Tau

The null hypothesis that in the population the correlation coefficient between mean time spent and age is 0. Age was rated in four categories teenagers, 20s &30s, 40s & 50s and 50 & 60s. Alpha was set at .05, one tailed. Based on previous research the direction of the relationship was predicted to be negative. Examination of the scatterplot showed the relationship to be roughly linear. Kendall's tau was thus calculated for the sample: Tau=-.27, n=141 with 4 missing cases. There is thus a low, negative correlation between the variables. A slight tendency for older subjects to spend less time at the exhibits was noted.

A one tailed test of the null hypothesis was conducted: $p<.001$. The null hypothesis may thus be rejected: It seems likely that there is a negative relationship between time spent at the exhibit and age.

Comparison of Age and Gender on Time spent at Exhibit

MANOVA

The null hypothesis that an there was no interaction effect between age, gender and mean time spent at the exhibit was tested. Alpha was set at 0.05

Sample Data

Source of Variation	SS	DF	MS	F	Sig of F
Within cells	5467112	133	41106		
Gender	11059	1	11059	.27	.605
Age	1010887	3	336962	8.2	.000
Gender by Age	82627	3	27542	.67	.572

As F=.572 for the interaction effect the null hypothesis must be retained. It is probable that there is no interaction effect between age, gender and time spent at the exhibit.

A Summary of Interaction effects using Pearsons R

Interaction Effects

	Gender	Age
Gender		.0514
Age	.0514	
Time	-.0761	-.3815 *

*significant at .01 level

Summary of Results

The following null hypotheses were tested.

Null Hypothesis	Outcome	Conclusion
There is no relationship between gender and time spent at exhibit	Null was true.	Men and women spend the same amount of time at the exhibits
There is no relationship between gender and when directions are read.	Null was true.	Men and women are equally likely to read directions before, during or after using exhibit
There is no relationship between gender and the type of explanation	Null was true.	Men and women show no difference in the use of adult-adult, adult-child and child-adult
There is no relationship between gender and the type of explanation	Null was true.	Women and men are show no difference in passive or active involvement.
There is no relationship between age and time spent at exhibit.	Null was false.	Teenagers spend more time at the exhibits than the other age groups.
There is no relationship between ethnicity and time spent at exhibit.	Null was false.	Native Americans spend less time at the exhibits than the Hispanics or African Americans

There is no interaction effect between age, gender and time spent at exhibit.	Null was true.	A combination of age and gender does not affect time spent at the exhibit.

Conclusion

We were seeking to determine what aspects of informal adult science education in a science museum are statistically significant. We hoped to identify learning theories exhibited in adult interactions with the exhibits at the Explora museum, identify patterns of learning and learner characteristics, evaluate the effectiveness of the exhibits, and to determine if there are cultural differences in interaction with the exhibits. We made 160 observations of adults interacting with the exhibits at the Explora Science Center. We recorded information on the time spent at each exhibit, ethnicity of visitors, details of label reading, number of members in each group, gender of visitors, and noted any extraordinary details. We discovered that teenagers spent significantly more time at the exhibits than any other age group and that Native Americans spent substantially less time at the exhibits than all other ethnic groups. Hispanics spent more time at the exhibits than did Native Americans and less time than African Americans. Our sample of Caucasians was not large enough to make comparisons with the other groups.

We definitely observed andragogy in action. Attending the Explora is a voluntary activity. Interacting with the exhibits is a self-directed undertaking. The visitors determined what to interact with and how long to spend at each exhibit according to their level of interest. Interaction with exhibits is an active process which hopefully led to some intellectual development. The fact that teenagers spent more time at the exhibits may suggest something about their willingness to explore or may indicate an increased tolerance for assimilation of learning.

Without collecting data about socioeconomic status, education, or other personal characteristics we are unable to speculate on the applicability of Miller's Force Field Model to the behavior patterns observed. Teenagers do seem to have a greater level of what Grow termed, "self-direction," than all other age groups. Self-direction in the different ethnic groups may have

been inhibited by environmental or other factors. Without collecting additional data we cannot offer any conclusions in this regard.

Behaviorism and cognitivism/constructivism are evident in exhibit interactions when people are observed spending extensive lengths of time at the exhibits. It is impossible to determine if pleasure (behaviorism) or development of schema (cognitivism/constructivism) is occurring from our limited observations.

Social learning takes place in groups and was observed when one participant shows another some aspect of an exhibit. The fact that a person chooses to visit a museum is an indicator of humanistic theory in that the visitor consciously makes the choice to visit with the intention of developing intellectually from the visit.

Because of the limitations placed on the study by our decision not to survey the subjects were unable to evaluate the effectiveness of the exhibits in regards to cognitive development or the exhibits particular strengths and weaknesses. In summary, there are age and ethnic effects in adult visitor interaction with the exhibits at the Explora. We are unable to draw specific conclusions about the nature of the differences because of our methods of data collection. There is ample opportunity for more in-depth study into the causes of our observed differences. We would suggest a more naturalistic approach to future investigators and also suggest interviews and surveys as data collection methods.

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DATA SHEET

GENDER F OR M	AGE RANGE	ETHNICITY	GROUP SIZE	EXHIBIT	DIRECTIONS READ	EXPLAINED BY	TIME INTR.	INVOLVEMENT A OR P	NOTES
	teen 20's, 30's,40's 50's,60's 70's	NA, AA, A, HIS, C, U			B--D--A	A-A A-C C-A		A P	
	teen, 20's 30's 40's 50's 60's 70's	NA, AA, A, HIS, C, U			B--D--A	A-A A-C C-A		A P	
	teen 20's 30's 40's 50's 60's 70's	NA, AA, A HIS, C, U			B--D--A	A-A A-C C-A		A P	
	teen 20's 30's 40's 50's 60's 70's	NA, AA, A HIS, C, U			B--D--A	A-A A-C C-A		A P	
	teen 20's 30's 40's 50's 60's 70's	NA, AA, A HIS, C, U			B-D---A	A-A A-C C-A		A P	

Before

ADULT
Child

Active
Passive

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