Urban Children's Understanding of Basic Botanical Concepts at The Brooklyn Children's Museum and Brooklyn Botanic Garden

Barbara A. Birney
Consultant
Vancouver, British Columbia, Canada

The Brooklyn Children's Museum and Brooklyn Botanic Garden strive to create among their constituents an awareness of the natural world, an appreciation for nature, and a deeper understanding of the complex biological world in which humans live. The urban environment surrounding the Museum and Garden is felt to influence children's perceptions of plants negatively by distancing children, as humans, from their dependence on plant life.

Consistent with their philosophy of developing participatory exhibits which enable children to explore nature and to better understand the interdependence of humans and plants, the two institutions are collaborating on a series of educational programs and exhibits entitled *Breaking Ground.* These public programs are intended to teach basic science principles related to botany, ethnobotany, and urban ecology. They are also intended to promote urban children's understanding of the importance of plants to humans, biologically and culturally. Finally, program and exhibit developers wish to foster positive environmental ethics in children 6 to 12 years of age.

Research Questions

1) What portion of the children who attend either the Museum or the Garden in the Fall hold misconceptions that staff have documented in casual interviews and conversations?
2) Do children who are sampled at the Museum differ significantly in their knowledge of botanical concepts from children sampled at the Garden?
3) Do children in the 4th, 5th, and 6th grades differ significantly in their knowledge of botanical concepts from children in the first, second, and third grades?
4) Are there demographic variables which explain children's knowledge scores?

Methods

Sample

Children visiting both institutions in casual groups were sampled during the Fall of 1992. A total of 274 children who attended grades 1-6 were interviewed. Of these, 172 were sampled at the Museum (63%) and 102 were sampled at the Garden (37%).

Measures

Questions were organized around the main concepts that *Breaking Ground* will address (Appendix A). A questionnaire composed of 22 closed-ended questions was used. Children could respond that a statement "Makes sense," "Is just okay," "Is not so good," or "Sounds silly." Faces with appropriate expressions accompanied each of the answers to facilitate young children's understanding.

Procedure

Sampling took place every weekend from September 17 to November 29, between the hours of 10:00 and 3:00. At both sites, children who were members of organized programs or clubs were excluded from the study. These children visit the institution more frequently, but do not necessarily represent the knowledge level and interests of the general public. Hence, the study focused on children who were not already involved on a regular basis.

Analysis

Frequencies and percents were calculated for individual questionnaire items to confirm or offset staff perceptions of how many children hold misperceptions about plants. True-false response categories were not used since these children might be leery of tests and try to guess. The four response categories (ranging from Strongly Agree to Strongly Disagree) were reduced to two: correct and incorrect answers, a procedure which permitted stronger chi-square analysis. A total score for correct answers was computed, and a stem-and-leaf plot was conducted. In additional, all demographic variables were correlated with respondents' scores to explore the degree to which those variables were associated with one another.

To examine group differences between grades, children were placed into two groups: grades 1-3 and grades 4-6. To examine ethnic group differences, three categories were used (Caucasian, African-American, and Other. A t-test of independent groups compared the scores of children sampled at the Museum with those interviewed at the Garden, and between children from different grade levels to see if they were significantly different.

A regression analysis was conducted to examine which variables most explained the scores of all 274 respondents, and analyses of variance were conducted to see whether there were interactions among a few key variables.

Sixteen children were omitted from the last two analyses since some of the data were missing.

Results

Demographic Differences Between Museum and Garden Respondents

The Museum and Garden subsamples differed significantly with respect to age (Chi-square=11.701; df=5; p<.05). While 67% of the Museum respondents were in grades 1-3, 52% of the Garden respondents were of that educational level.

A key difference between the two Fall subsamples involved how often respondents' families reported coming to the institution. Overall, 53% of the respondents reported coming annually or less often. Thirty-five percent of participants were first-time visitors, a figure which is exceptionally high.

Museum and Garden respondents differed significantly with respect to how often they reported coming. Forty-six percent of the Garden respondents reported coming five or more times annually and 24% reported coming two to four times annually. Hence, while 70% of the Garden respondents came two or more times annually, 43% of the Museum respondents reported doing so. Annual visit statistics were very similar (Museum=13% and Garden=11%). However, while 20% of the Garden respondents were first-time visitors, 44% of the Museum respondents reported that they were. One reason for this may have been related to a children's club for frequent users. These children are often part of the planning process for the Museum, and staff requested that they be omitted from sampling procedures.

Predictably, membership and frequency of visit were significantly related (Chi-square=23.004; df=4; p=.000). Of the 27 member groups, 85% reported coming two or more times annually. Of the 247 non-member groups, 55% reported coming this often.

Overall, 10% of the adults indicated that they had a membership to one of the institutions. There was a significant difference between the two institutions (Chi-square=6.222; df=1; p<.01). While 6% of the Museum sample reported being members, 16% of the Garden sample did.

Table 1 shows that the ethnic composition of the two subsamples differed significantly (Chi-square=43.642; df=5; p=.000). While the Museum sample contained 26% self-defined whites and 51% African-Americans, the Garden sample was composed of 61% whites and 18% African-American.

Table 1

Distribution of Respondents' Self-Defined Ethnic Background at the Museum Versus the Garden in the Fall Season

Ethnicity	Museum (n=172)	Garden (n=102)
African-American	51%	18%
Asian	3%	3%
Hispanic	8%	4%
Multi-racial	7%	13%
White	26%	61%
Other	5%	1%

Income data were not available on 18 of the 274 individuals. Of the remaining groups, self-reported income levels were as follows:

Under 10,000	9%
10,000-19,999	10%
20,000-39,999	25%
40,000-49,999	21%
Over 50,000	34%

A chi-square analysis revealed that no significant differences were found between the income levels of respondents sampled at the Museum, and those sampled at the Garden ($p<.16$).

Table 2 shows that the higher the respondents' income level, the more likely respondents were to have houseplants (Chi-square=12.549; df=4; $p<.01$). In contrast, the 45 respondents who did not have houseplants were evenly distributed across all income levels. Overall, 83% of the groups indicated that they owned a houseplant of some type. There was no difference between Museum and Garden respondents with respect to plant ownership.

The same pattern was even more distinct for respondents who reported having gardens (Table 2). There was a significant positive relationship between maintaining a garden and income level (Chi-square-19.422; df=1; $p<.000$). Again, the 146 respondents who did not have a garden showed an even distribution across all income levels.

Overall, 42% of the 274 individuals said they had a garden. There was a significant difference between Museum and Garden respondents (Chi-square=4.713; df=1; $p<.05$). While 36% of the Museum respondents reported having a garden, 50% of the Garden respondents did so.

Table 2

Distribution of Respondents by Income and Ownership of Houseplants or a Garden, in Percents

Income Level	Respondents Have:			
	Houseplants		Garden	
	Yes	No	Yes	No
Sample Sizes	(n=210)	(n=45)	(n=109)	(n=146)
Under $10,000	7%	17%	3%	14%
$10,000 to 19,999	8%	17%	9%	12%
$20,000 to 39,999	25%	29%	19%	30%
$40,000 to 49,999	22%	17%	21%	21%
$50,000 and over	37%	17%	49%	23%

To create a context in which to consider subsequent results, the findings regarding demographic differences between the two institutions can be summarized. The Museum sample contained significantly more children in grades 1-3. While 44% of the Museum sample were first-time visitors and 43% were frequent visitors, 70% of the Garden sample contained frequent visitors. There were proportionately more members in the Garden sample as well. Using this information, the task of the research team was to determine which of these variables best explain children's performance on a test of basic botanical concepts.

An Analysis of Those Factors Most Likely to Influence Children's Knowledge of Basic Botanical Concepts

The scores of the overall sample (N=274) were found to be normally distributed. The highest possible score was 21. The median score for the sample was 13, while the lowest score obtained was 6 and the highest was 20.

Table 3 reflects the results of a regression analysis performed to examine which of eight variables were significant factors in explaining children's knowledge scores. These variables included grade level, institution visited, ethnic background, family income level, membership, frequency of visit, houseplant ownership, and "has a garden."

The variables found to be significant factors in explaining children's knowledge scores were grade level, income level, institution at which they were sampled, and ethnic background. The comparatively high R of this model shows that 30% of the variance in children's scores was explained by these four factors.

Table 3

Relationship Between Children's Score on a Test of Botanical Concepts and Demographic Characteristics

Variable	Coefficient	Standard Error	T-ratio	P
Constant	8.655	0.538	16.079	0.000
Grade level	0.685	0.087	7.873	0.000
Income level	0.350	0.120	2.918	0.004
Ethnicity	0.192	0.087	2.193	0.029
Institution	0.717	0.328	2.185	0.030

n=255

ANALYSIS OF VARIANCE

SOURCE	SS	DF	MEAN-SQUARE	F-RATIO	P
Regression	590.526	4	147.632	26.923	0.000
Residual	1370.870	250	5.483		

It is logical that scores would be progressively higher for older children than younger children. Indeed, the mean score for children attending Grades 1-3 was 12.310, whereas the mean score for children attending Grades 4-6 was 14.774.

Why might income be a factor in children's knowledge of botany? Recall that children from families with higher income levels were also significantly more likely to report having a garden. Are higher scores the result of both having a higher income level *and* maintaining a garden? A two-way analysis of variance revealed no interaction effect for these two variables.

However, income is also associated with ethnicity, and ethnicity is the third explanatory variable in the regression equation. What role does ethnicity play? For ease in reporting, African-Americans will be referred to as "black" in the remainder of this report.

Table 4 shows that the income level of respondents' families was significantly related to whether they defined themselves as white, African-American, or belonging to a different ethnic group (Chi-square=40.671; df=8; p=.000). Blacks were evenly distributed across all income categories. In contrast, 35% of the whites reported annual income levels between 20,000 and 50,000 dollars while an additional 55% of the whites report making over $50,000 annually. Could the variation in children's scores be due to an interaction between their ethnic background and family income

level? Again, a two-way analysis of variance revealed no interaction effect for ethnicity and income level.

Table 4

Distribution of Respondents by Income and Ethnicity

Income Level	Self-defined Ethnicity		
	Blacks	Whites	Other*
Sample Size	(n=101)	(n=99)	(n=55)
Under $10,000	12%	4%	13%
$10,000 to 19,999	14%	5%	13%
$20,000 to 49,999	57%	35%	47%
$50,000 and over	17%	56%	27%
Column percents	100%	100%	100%

n=255

Ethnicity appears to have entered the regression analysis table as an explanatory variable of children's scores because of its connection to gardening, rather than income only, ethnicity only, or the institution the sample was drawn from. Only 25% of the black respondents' families said that they had a garden, in contrast to 60% of the white respondents and 39% of all other groups (Asian, Hispanic, and Other). Hence, regardless of their income level, whites are significantly more likely to maintain a garden than blacks (Chi-square=27.453; df=2; p<.000). Ethnicity appears to influence children's scores, because it is strongly associated with their prior experience with plants, through gardening. A two-way analysis of variance revealed that children's scores are affected by a significant interaction between ethnicity and maintaining a garden (Table 5).

Finally, a t-test revealed that the mean score of Garden children was significantly higher than the mean of Museum children at p<.000 (Garden=14.196 versus Museum=12.709). Also, children sampled at the Garden were significantly more likely to have a garden than were Museum attendees. Could the variation in children's scores be due to an interaction between the institution they were sampled at, and whether they had a garden? An analysis of variance revealed no such interaction. We return to the significance of this in the Discussion Section.

Table 5

Interaction Between Ethnicity and Gardening

SOURCE	SS	DF	MEAN-SQUARE	F-RATIO	P
Garden	8.421	1	8.421	1.225	0.269
Ethnicity	63.507	2	31.754	4.618	0.011*
Garden by Ethnicity	92.336	2	46.168	6.715	0.001**
Error	1842.718	268	6.876		

n=274

Discussion

The range of scores obtained by children on this survey indicates that, indeed, misconceptions are held by a portion of the children sampled at the two sites. The degree to which children hold these misconceptions varies, both as a result of specific demographic factors and in response to individual question items.

Overall, children sampled at the Garden scored higher than children sampled at the Museum. This may be due to demographic differences in the children, but the analyses conducted in this study seem to infer that it reflects mostly the neighborhoods children come from and whether gardening is part of their family's activities. That is, families who have gardens at home are predisposed to visit the Garden, and this indicates an intrinsic interest in botany.

At first glance, differences between the Museum and Garden children's scores may appear to be due to differences in their overall family income level and ethnic background. However, no interaction effects were found between income, race, or the sampling site. It's important to remember that "having a garden" was included in the original regression equation but *dropped out* as an explanatory factor on its own. Still, there was a strong interaction effect between ethnicity and gardening.

This implies that these children's scores are influenced in two possible ways by the presence of a family garden. First, families with higher income levels may simply live in neighborhoods where they have enough space to maintain a garden. This suggests that these children have a greater opportunity to acquire prior experience with plants.

Second, the interaction between ethnicity and gardening (but not income) suggests that even when African-Americans have the economic means to maintain gardens, they tend not to be engaged in this type of

activity. Hence, these black children are less likely to be able to acquire prior experience with plants. Note that having houseplants was rarely linked to differences in children's responses, even though this variable was included in all analyses against all items.

At all times, it must be remembered that these data were collected in the Fall, since this is a limited portion of the institutions' annual attendance. However, the high portion of first-time visitors to the Museum, and frequent visitors to the Garden, enables developers to contrast how these audience segments can be approached differently with respect to programs and exhibits.

Appendix A

Breaking Ground Concepts

Plants are living things, and their parts perform different functions which enable them to live and grow. Related processes include phototropism, water transport, seed dispersal, and pollination.

Plants occur in diverse forms which often reflect the environmental conditions that surround them.

Plants create their own food, through photosynthesis. They are primary producers and form the basis for the food chain.

Plants and animals are interdependent.

Plants and plant products are present in human culture worldwide.

Plants have influenced the development of human culture and civilization. Human inventions are often based on a study of natural designs and processes.

Plants serve as icons in human culture, and have both a popular image, and a personal meaning.

Human actions can either stress or support plant life.