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AUTHOR Shore, Linda S.
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ABSTRACT

The primary goal of the Exploratorium "Science At Home" project is to provide parents with activities that help foster a culture of learning in their homes. This study explores the impact of this program on family participation in science related activities, parental attitudes toward science, parental participation in science, and parental perceptions of their child's ability to do science and choose science as a career. A 50-item "gender questionnaire" was used to collect data. The demographics of the participants in the project support the theory that well-educated professional parents tend to create home environments that support scientific curiosity and nurture interest in science. Results indicate that it is possible for informal science education centers to create home-science activities that encourage active participation by both women and young girls. Other findings include: the project did not positively improve how women judge their own aptitude for learning science; participation in the project may have encouraged mothers to purchase more science toys for their children; fathers appeared to hold fewer gender biases than mothers when assessing a child's science interest and capabilities; and both mothers and fathers have more positive expectations for sons than daughters with regard to careers in science. The survey instrument is appended. Contains 11 references. (JRH)

Developing Gender Equity At Home:
The Influence Of The Exploratorium "Science At Home" Project On Parental Attitudes, Perceptions, And Behaviors.

Linda S. Shore
Exploratorium
3601 Lyon Street
San Francisco, CA 94123

Paper presented at the annual meeting of the National Association For Research In Science Teaching (NARST), St. Louis, MO. (April 2, 1996)

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Linda S. Shore, Exploratorium, 3601 Lyon St., San Francisco, CA 94123

Statement of Purpose

A longitudinal survey of parents engaged in a twelve-month, Exploratorium "Science At Home" project was conducted. The study set out to answer the following questions: What kinds of parents will actively participate in home-science activities with their children? How will the science interests and attitudes of parents change as a result of participating in this project? How will the interests and attitudes of fathers and mothers differ over time, if at all? How will fathers and mothers differ in their involvement in other science-related family activities and how will this involvement evolve over time? Finally, how do fathers and mothers differ in their career aspirations for their sons and daughters -- and how will these aspirations change as a result of participating in this project, if at all?

Background

Researchers investigating the problem of gender equity in science have examined the influence that home environment has on a girl's future interest and participation in science. Factors that initially seemed important in predicting whether a girl chose a scientific major or career included a number of socio-economic factors, including family income and being raised by highly educated parents (Kahle & Meece, 1994).

But when correlations between the science achievement of girls and these socio-economic variables were examined more closely, parental attitudes toward education, parental aspirations for their children, and the cultural and intellectual activities undertaken by the family proved to be more important factors (Kahle and Meece, 1994). In other words, having wealthy, well-educated, professional parents in itself didn't influence the future science achievement of girls. It was the positive home environments that some of these parents were able to create that lead to the success and interest in science among their daughters.

However, for the vast majority of households, boys are far more likely than girls to grow up in homes that nurture future interest and success in science. Inequities in the home science environments of girls and boys have been investigated by a number of researchers. For example, grade school boys have more "at home" opportunities to use science equipment, perform science experiments, and go on science related family trips than girls (Kahle and Lakes, 1983). As these boys reach adolescence, they are increasingly more likely to report having had experiences

"trying to fix something mechanical." Teenage girls were far less likely to have similar hands-on experiences with mechanical objects (Mullis and Jenkins, 1988). Researchers have also found that parents structure family science activities differently for boys and girls. For instance, parents tend to buy more science games and toys for their sons compared to their daughters (Astin, 1974; Casserly, 1980; Hilton and Berglund, 1974; Maccoby and Jacklin, 1974).

Parents also have different career aspirations for their sons than for their daughters. When parents of gifted children were asked to list careers they would like to see their children pursue, science-related professions were selected for 2/3rds of the boys but only 1/3rd of the girls (Brody and Fox, 1980). Parents are also more likely to advise boys to take advanced courses in science than they are girls (Eccles, 1989).

While home environment is highly influential in developing a child's science interest and achievement, to what extent do mothers especially influence and socialize their daughters toward or away from scientific careers? How are young girls negatively influenced by mothers who feel uncomfortable with science? How might a girl's interest in science increase if they did science activities at home with their mothers? Research supports the view that mothers have a powerful impact on the career paths and interests of their children. Schreiber (1984) found that while young girls initially enjoy and are interested in science, exposure to a variety of negative messages about science from their mothers contributes to the erosion of these positive attitudes.

This study examines whether an informal science education program can have an impact on how science is perceived and engaged in at home. In particular, can a museum "home science" program increase participation in science among parents and children. And if a museum program can succeed in increasing family participation in science related activities, how might these experiences change (1) parental attitudes toward science, (2) parental participation in science, (3) parental perceptions of their child's ability to do science and choose science as a career. In the analysis of the findings, special attention was paid to gender differences.

Description Of The Exploratorium "Science At Home" Project

The Exploratorium "Science At Home" Project began piloting activities with families in June, 1994. The project was conceived after we discovered that one of the Exploratorium activity books developed for science teachers (*The Exploratorium Science Snackbook*) was being purchased by parents who wanted Exploratorium-type science experiences for their children to do at home. We decided that parents and children needed an activity book specifically

designed for them. After a convening a focus group of families to help conceptualize the project, pilot testing of activities began in the late summer of 1994. For one year, over 800 families participated in the pilot testing of hands-on activities developed by the Exploratorium staff. Most of these families lived in the Bay Area, but some participants lived outside of California.

Activities in the "Science At Home" Project were especially developed for home use. Most activities were derived from our successful Children's Outreach Program. The activities stressed the development of science concepts and inquiry skills over the acquisition of science facts. Topics included static electricity, bubbles, the night sky, flight, hearing, sound, illusions and perception, light and color, and "kitchen chemistry." Written descriptions of science activities along with background information for parents were mailed every six weeks to families, along with questionnaires that elicited general reactions to the experiments.

Based on the results of the initial focus group of parents, children aged 6-9 years were the target audience of the activities. There was a concern expressed among parents (and educators at the museum) that younger children would not be developmentally ready to do the science activities. It was also suggested that older children might not be interested in working with their parents. During the course of the project, we found that the activities attracted children ranging in age from 4 to 13 years with a mean of 7.5 years.

Methodology

Research Design

This study of gender equity issues in the home employed a longitudinal survey design to examine the evolving attitudes and perceptions of adults participating in a twelve-month "Science At Home" Project.

The Instrument

A 50 item "gender questionnaire" was developed by the author, a science education researcher at the Exploratorium (see appendix). Items on the survey consisted of multiple choice questions and Likert-type questions with a five point continuum. Readability of the gender questionnaire was evaluated by the editorial department of the museum. Special attention was paid to making questions unambiguous, simple, and unbiased.

The gender questionnaire was divided into three parts: **Part 1** provided us with demographic information on the adults participating in the project (age, profession, education,

etc.). **Part 2** was designed to gather data on general attitudes toward science and science learning. **Part 3** asked questions about the subject's direct participation in science with children at home. For example, adults were asked to identify how often they helped their children with science homework, answered children's science questions, purchased science books and toys, or visited science museums. In **Part 4** adults were asked a series of questions about the oldest child under 12 still living at home. These questions were designed to elicit perceptions that adults had about a randomly selected child. For example, in this section, adults were asked to evaluate the science aptitude of the child and the likelihood that this child would pursue a career in science.

The Sample

The population for this survey consisted of all adults actively participating in the Exploratorium "Science At Home" Project. Families were recruited at Exploratorium events, through announcements in various Exploratorium publications, and via the Exploratorium World Wide Web home page. About 35% of the families were Exploratorium members. As the project progressed, an increasing number of new families were added to the mailing list as information about the project spread -- largely through word of mouth among families.

Every six weeks, families received a packet of activities and a brief questionnaire that elicited general reactions to the materials. In order to receive the next monthly packet, completed questionnaires had to be returned before a certain date. Packets were sent to an average of 210 families every mailing. Typically, about 50% of the families who received packets returned questionnaires and received a new set of activities. Statistics kept on individual families showed that the average family actively participated in five consecutive mailings. While roughly equal numbers of girls and boys participated in the activities, mothers out numbered fathers by almost 2:1.

When the gender questionnaire was administered, two copies of the survey were included in each packet so that both mothers and fathers could respond to the questions individually. Adults were instructed to fill out a gender questionnaire if they had actively participated in that month's activities. The completed gender questionnaires were returned with the other questionnaires included in the mailing. About 75 adults returned completed gender questionnaire each time it was administered. Consistent with the pattern of participation in the project, significantly more women (an average of 44) responded to the gender questionnaire than men (an average of 28).

Procedures

The gender questionnaire was mailed out to families participating in the project three times during the pilot testing phase -- in the beginning of the project (August 1994), midway through the year (January 1995), and at the end of the pilot test (July, 1995). These mailings corresponded to the 3rd, 6th, and 10th set of activities.

Returned surveys were sorted into two categories: "new participants" (those who were pilot testing activities for the first time) and "continuing participants" (those already participating in the *Science At Home* project). "New participants" were removed from the study so that we could examine the responses of parents who had been involved in previous mailings. Responses from these "continuing participants" were sorted by gender to compare the science attitudes, perceptions, and behaviors of women and men.

Results

Part I: "Tell Us About Yourself"

Table 1 summarizes the demographics of the adults who responded to the gender survey during the fall 1994, spring 1995, and summer 1995. This section describes the key demographical findings from the three administrations of the gender questionnaire. Unless otherwise stated, percentages reported in this section are the averages over the three surveys.

Parents who were attracted to this project were extremely well educated. Forty-four percent of mothers and 62% of fathers held masters degrees or higher. Of those with bachelor's degrees or higher, 55% of the men and 27% of the women had college degrees in the sciences. While about half of all participants had taken science courses as undergraduates, 38% of the men had taken science as graduate students compared to 25% percent of the women.

The majority of the women described their current profession as "homemakers" (43%). Of those women who worked out of the home, most were teachers (27%). Slightly over 10% of the women were actively involved in science research, engineering, or healthcare. In contrast to the women, the majority of the men had professions in science -- specifically in either scientific research (15%), engineering (33%), or healthcare (6%). Relatively few men listed "teaching" as their profession (9%) and none described themselves as "homemakers."

There were few significant variations in the demographics that might influence the results of this longitudinal study. Two notable exceptions were the percentage of women (1) with

college degrees in science and (2) who described their profession as "homemaker." Both factors steadily increased by 10% over the three administrations of the questionnaire.

DEMOGRAPHICS	FALL 1994	SPRING 1995	SUMMER 1995
1. Average Age (years)			
Women	40	39	40
Men	42	42	42
2. Relationship to Children			
Women (Mothers)	100%	96%	96%
Men (Fathers)	100%	97%	100%
3. Highest Level of Education			
Women	(40)	(48)	(45)
HS/AA	13%	23%	18%
BA	40%	40%	36%
MA	35%	33%	38%
D	13%	4%	9%
Men	(29)	(29)	(26)
HS/AA	3%	10%	12%
BA	34%	24%	31%
MA	24%	24%	27%
D	38%	41%	31%
4. Percentage With College Degrees in Science			
Women	20%	29%	31%
Men	55%	52%	58%

Table 1: Demographics of participants in the "Science At Home" Project

Table 1 Continued . . .

DEMOGRAPHICS	FALL 1994	SPRING 1995	SUMMER 1995
5. Current Profession			
Women	(40)	(48)	(45)
Science Research	5%	2%	4%
Engineering	3%	6%	7%
Healthcare	3%	4%	2%
Teaching (science)	3%	15%	7%
Teaching (not science)	28%	10%	18%
Homemaker	38%	44%	47%
Other	20%	19%	16%
Men	(29)	(29)	(26)
Science Research	10%	21%	15%
Engineering	31%	38%	31%
Healthcare	10%	3%	4%
Teaching (science)	3%	0%	0%
Teaching (not science)	14%	3%	8%
Homemaker	0%	0%	0%
Other	31%	34%	42%
6. Formal Science Background			
Women	(40)	(48)	(45)
high school	23%	17%	18%
college	55%	54%	58%
graduate school	23%	29%	23%
Men	(29)	(29)	(26)
high school	14%	10%	12%
college	52%	48%	50%
graduate school	34%	41%	38%

Part II: "How I Feel About Science"

Figures 1 through 3 summarizes attitudes toward science and science learning. This section describes the responses to items 1-12 of the gender questionnaire (see appendix).

Attitudes toward science and learning are reported in three different categories. The first is the respondents' interest in watching science documentaries, reading about science, and visiting science museums (Figure 1). The second category is interest in learning more about various scientific disciplines (Figure 2). The third category is the participants' attitudes toward teaching and learning science which includes a self-assessment of their aptitude for learning science, ability to teach science to their children, and comfort participating in science experiments and activities (Figure 3). In all three cases, results are broken down by gender.

Unless otherwise stated, the ratings reported in this section are the averages over the three surveys.

Interest In Science (tv, books, articles, museums)

- Men rated visits to science museums (4.61), reading science articles (4.55), and watching science documentaries (4.40) of roughly equal interest. Reading science books scored slightly lower (4.20). *Participation in the project seemed to have little impact in these ratings over time.*

- Women demonstrated a clear and consistent preference for science museums (4.58), followed by television documentaries (4.23), science articles (4.11), and science books (3.62) respectively. Overall, these ratings were somewhat lower for women than they were for men. With *the possible exception of "reading science books" which showed a slight increase during the third survey, participation in the project seemed to have little impact in these ratings over time.*

Interest In Science Disciplines (physics, chemistry, biology, astronomy)

- There did not appear to be a significant difference between the interest that women had in the specific disciplines. Women indicated that they were interested in learning more about all of these subject areas. However, women showed a slight preference to astronomy (4.22) and biology (4.19) over physics (4.02) and chemistry (3.91). Furthermore, women's responses to items 5 - 8 in this section did not appear to change over the course of the project. *Participation in the project seemed to have little impact in the women's interest in learning more about various scientific disciplines.*

• There did not appear to be a significant difference between the interest that men had in the specific disciplines. However, responses by the men suggested a very slight preference to astronomy (4.41) and physics (4.39) over chemistry (4.12) and biology (4.11). Furthermore, men's responses to items 5 - 8 in this section did not appear to change over the course of the project. *Participation in the project seemed to have little impact in the men's interest in learning more about various scientific disciplines.*

Attitudes Toward Science Teaching and Learning

• There did not appear to be significant differences between how men rated items 9 - 11 in this section. Men felt equally comfortable doing science experiments with children (4.63), helping children with science homework (4.58), and teaching children science concepts (4.55). Men rated "having an aptitude for science" (4.36) slightly lower than the other items relating to attitudes toward science teaching and learning. *Participation in the project seemed to have little impact on the pattern of responses to these items.*

• While women's ratings were slightly lower than men's, women also appeared most comfortable doing experiments with children (4.54), followed by helping children with science homework (4.37) and teaching children science concepts (4.22). *Participation in the project seemed to have little impact on the pattern of responses to these items.*

• Women rated item 12 , "I have an aptitude for learning science " (3.83), consistently lower than the men. *This rating did not vary significantly over the course of the project.*

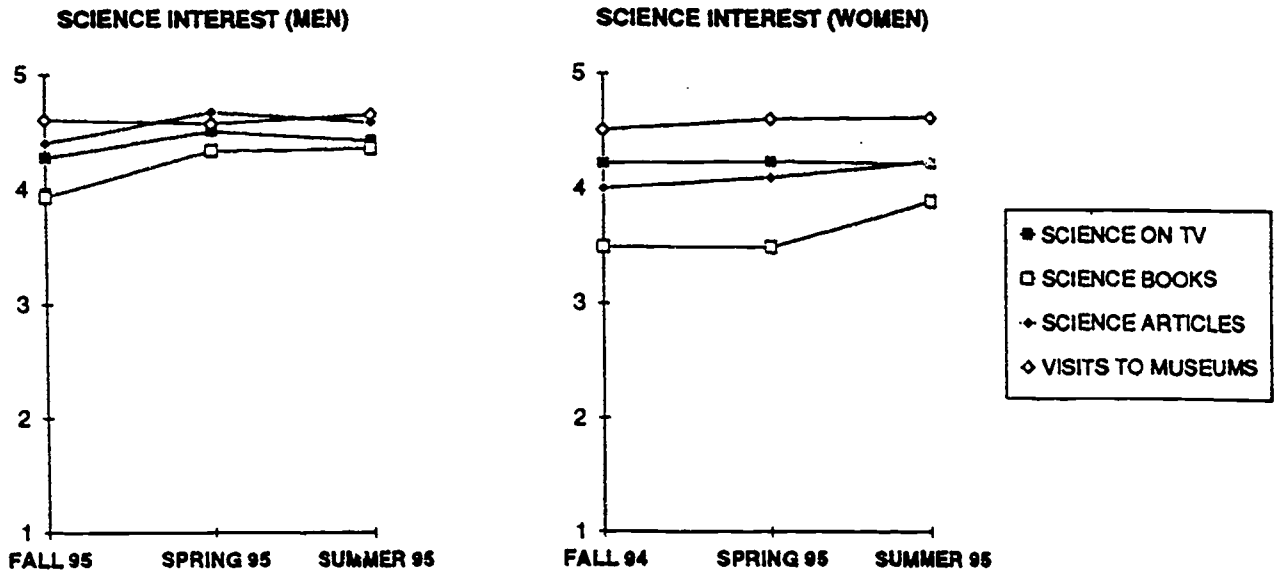

Figure 1: Interest in science documentaries, articles, books, and museums.

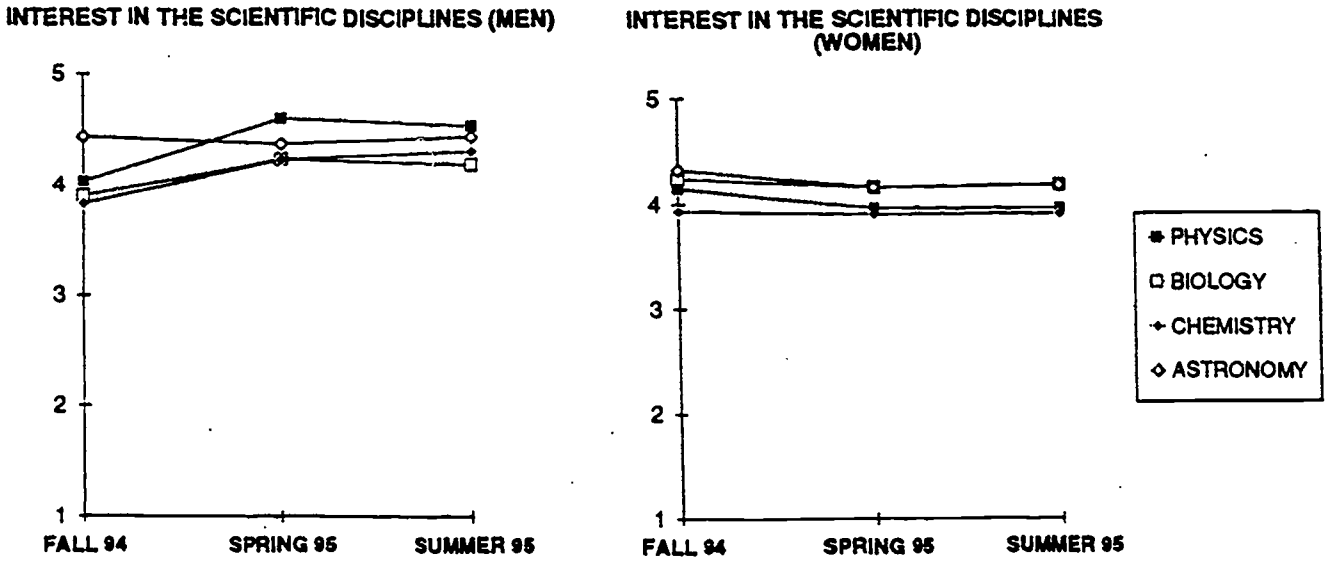

Figure 2: Interest in learning more about the science disciplines

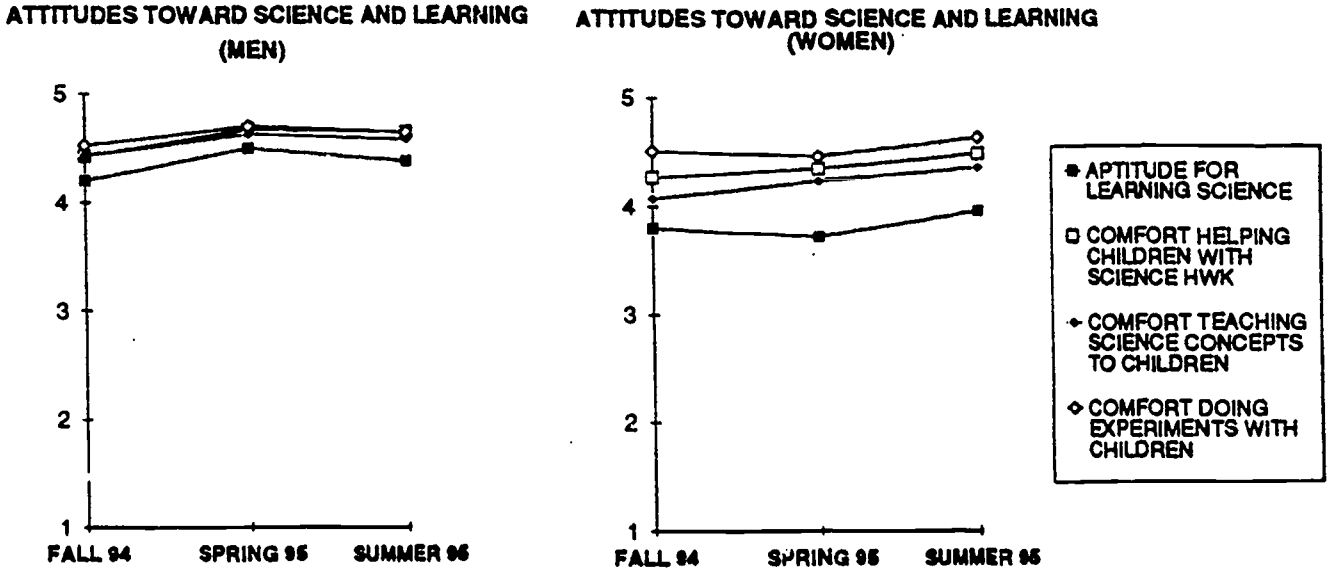

Figure 3: Attitudes toward science learning and teaching science to children

Part III: "Science At Home"

Figures 4 through 9 summarize the degree to which respondents participated in science-related activities with their children. This section describes the key results from items 13 - 35 of the gender questionnaire (see appendix).

Parental participation in science-related activities with (or for) their children are reported below in six different categories. In all three cases, results are broken down by gender. These categories are:

(I) going on science-related trips (Figure 4),
(II) purchasing science-related materials (Figure 5),
(III) "taking things apart," repairing things, and maintaining nature collections (Figure 6),
(IV) teaching science and answering questions (Figure 7),
(V) participating in the "Science At Home" activities (Figure 8), and
(VI) participating in other science experiments and activities (Figure 9).

Unless otherwise stated, percentages reported in this section are the averages over the three surveys.

I. Science-Related Trips (Items 13-17)

- When asked whether they had taken children in the household on science-related trips within the previous three months, both mothers and fathers responded most frequently to visits to museums (76% for women, 69% for men), nature parks (71% for women, 64% for men), and aquariums (52% for women, 42% for men), respectively. Significantly fewer parents visited planetariums (15% for women, 16% for men) or research labs (16% for women, 12% for men) with their children.

- Over the course of the project, a higher percentage of mothers visited science museums, nature parks, aquariums, and research labs with their children compared to fathers.

- With the exception of visits to research labs, the pattern of responses for mothers showed relatively little variation over the course of the project. *This results suggests that the Science At Home project may have had little affect on the number of science-related trips mothers and their children engaged in over the course of the year.*

• Over the course of this study, there was little change in how fathers responded to items concerning research lab tours or visits to a planetarium. However, there appeared to be considerably more variation in the frequency of visits to museums, nature parks, and aquariums. The response rates for these items dropped noticeably in the spring, 1995. Since these items asked parents to report on the trips taken during the previous three months, the results suggests that fathers were more likely to accompany children on science related trips during the summer months.

II. Science Materials Purchased (Items 18-21)

• Over the course of the study, their was little variation in the frequency of science software and video purchases reported by mothers or fathers. In addition, both mothers and fathers consistently reported purchasing science books and toys more frequently than science videos and/or software.

• On average, a higher percentage of mothers purchased science books (69%) and toys (67%) for their children compared to fathers (51% and 52%) over the course of the project. However, a higher percentage of fathers bought science-related software (30%) compared to mothers (25%).

• Over the course of the project, their appeared to be a steady increase the percentage of mothers who reported purchasing "science toys" for their children (59%, 67%, and 76%). *This results suggests that the Science At Home project may have positively influenced mothers to purchase more science toys for their children.*

III. Taking Things Apart, Repairing Things, Maintaining Nature Collections (Items 22-24)

• Over the course of the project, a higher percentage of fathers (55%) compared to mothers (24%) reported having had "repaired a mechanical device" with their children.

• Over the course of the project, a higher percentage of fathers (55%) compared to mothers (30%) reported having had "taken a mechanical device apart" with their children.

• Over the course of the project, a higher percentage of mothers (56%) compared to fathers (33%) reported having had "helped maintain a nature collection" with their children.

• Between spring, 1995 and summer, 1995, there was a sharp increase in the percentage of mothers who reported having had "helped maintain a nature collection."

• Over the duration of the project, there was a steady increase in the percentage of fathers who reported having had "taken a mechanical device apart." The increase between spring and summer may be due to an activity packet mailed during those months in which families were given the opportunity to take a disposable camera apart.

• Between spring, 1995 and summer, 1995, there was a sharp increase in the percentage of mothers who reported having had "taken a mechanical device apart." This corresponds to the mailing of a packet which included an activity in which families were given the opportunity to take a disposable camera apart. *This result suggests that the "Science At Home" project was successfully able to encourage mothers to take a mechanical device apart with their children.*

IV. Teaching Science and Answering Questions (Items 25-28)

• On average, a higher percentage of mothers compared to fathers reported having "answered a science question" (90% for mothers, 84% for fathers), "helped with math homework" (62% for mothers, 47% for fathers), "helped with science homework" (43% for mothers, 30% for fathers), and "helped with a science project" (30% for mothers, 17% for fathers).

• There was a drop in the percentage of both mothers and fathers who reported helping children with math homework, science homework, and science projects during the last administration of the questionnaire. (Since this final administration of the instrument occurred during the summer months, it is likely that the decrease in response rates have to do with children being out of school.)

• The drop in positive responses to items 26-28 observed during the last administration of this questionnaire was sharper among fathers than the mothers. (The large number of "home-schooling mothers" who reported being responsible for the education of their children may account for this difference between the responses of men and women.)

V. Participation In Science At Home Project (Items 29-30)

• During the course of the project, a higher percentage of both mothers and fathers did Exploratorium "activities designed for kids" (83% for mothers, 66% for fathers) with their children than Exploratorium activities designed specifically for adults (72% for mothers, 54% for fathers).

• During the course of the project, the percentage of mothers who did Exploratorium "activities for kids" with their children stayed relatively constant with an average of 83%. However, the percentage of fathers who did the "activities for kids" with their children was constant during the first two administrations of the questionnaire (70%), but then dropped to 58% by the end of the project.

• The percentage of mothers who did Exploratorium "activities designed for grown-ups" with their children increased steadily over the course of the project (63%, 71%, and 82%).

• The percentage of fathers who did Exploratorium "activities designed for grown-ups" with their children appeared to decrease sharply between spring 1995 (63%) and summer 1995 (38%).

VI. Participation in Additional Science Activities (Items 31-34)

• On average, a higher percentage of mothers (25%) than fathers (13%) did additional biology experiments with their children.

• On average, an equal percentage of mothers (18%) and fathers (20%) did additional physics experiments with their children. However, the percentage of men doing physics activities with their children increased (13%, 17%, 31%) during the last administration of the questionnaire.

• On average, an equal percentage of mothers (15%) and fathers (13%) did additional chemistry experiments with their children.

• On average, an equal percentage of mothers (10%) and fathers (6%) did additional astronomy experiments with their children.

• Overall, percentages of parents doing additional science experiments with their children were low and did not appear to vary over the course of the project. *This results suggests that participation in the Science At Home project appeared to have little effect on whether mothers and fathers did additional science experiments with their children.*

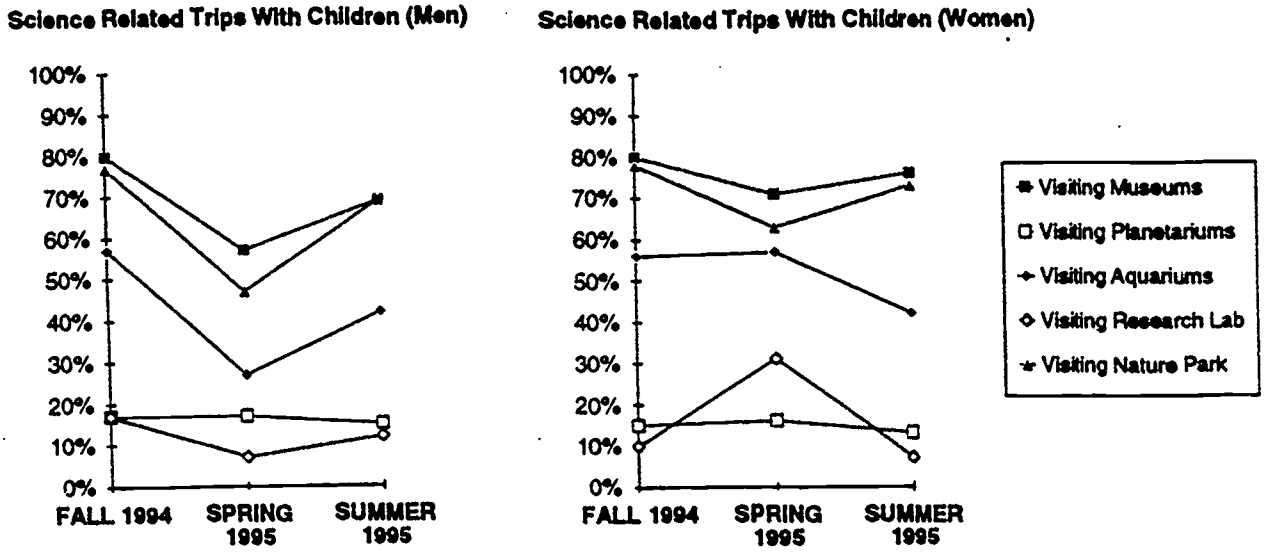

Figure 4: Going on science-related trips with children.

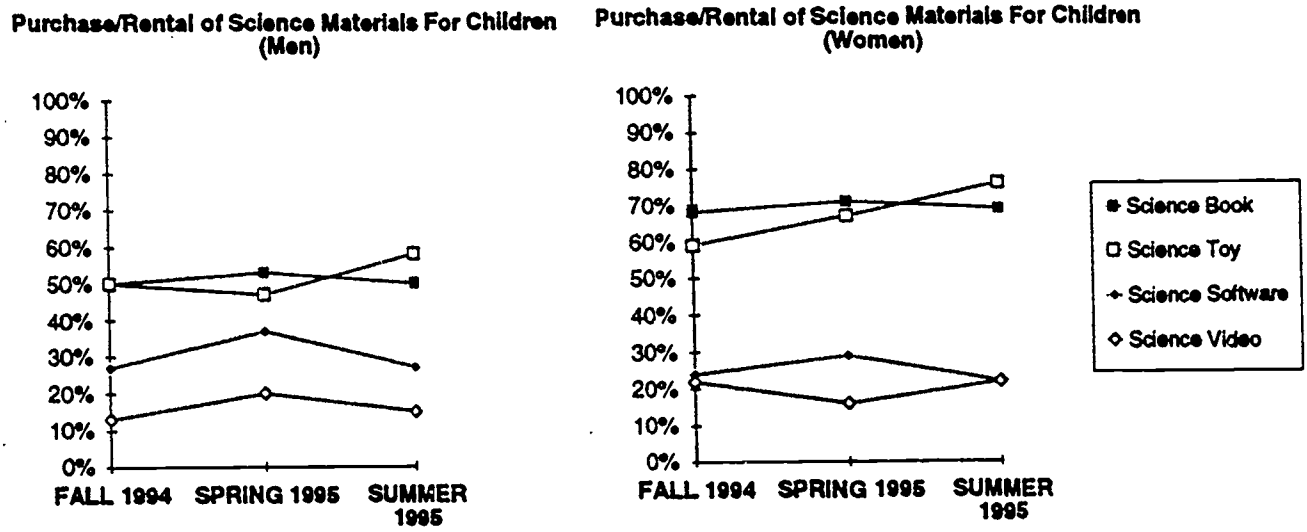

Figure 5: Purchasing or renting science-related materials for children.

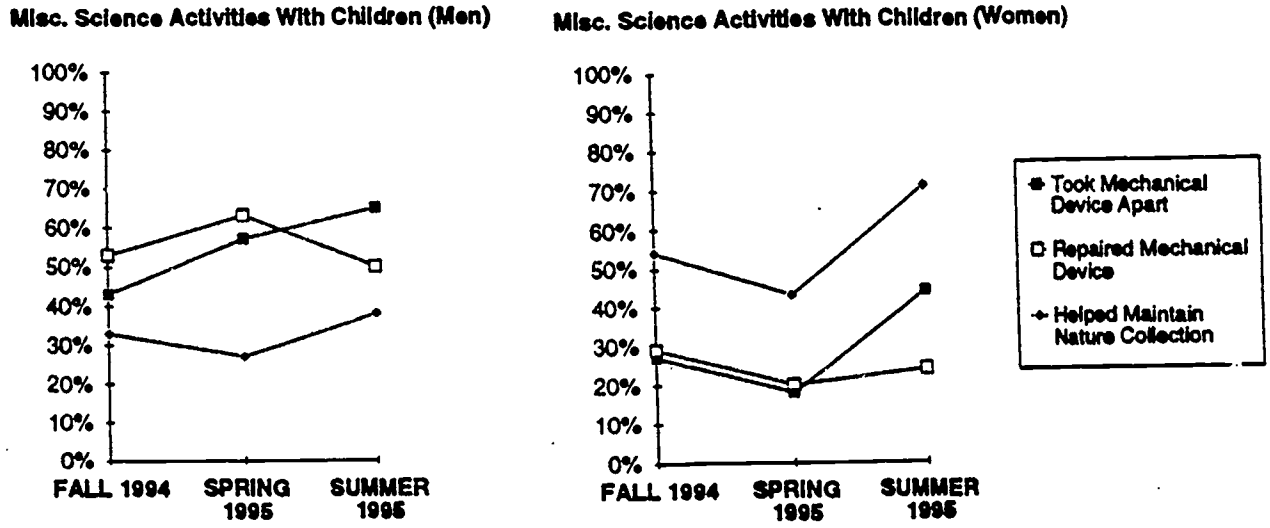

Figure 6: Participating in miscellaneous science activities with children.

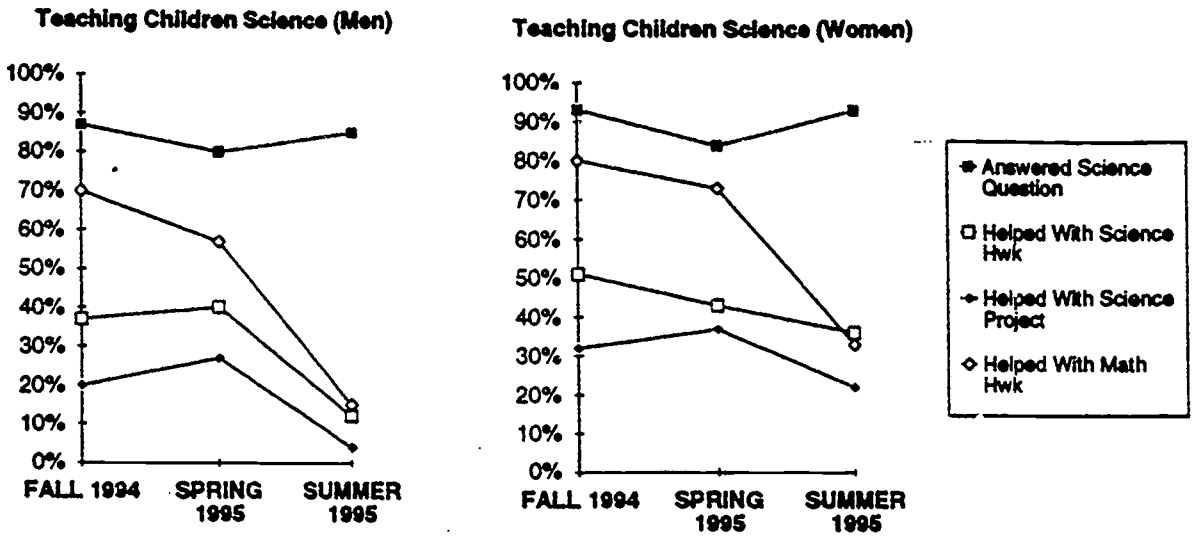

Figure 7: Teaching children science and answering their questions.

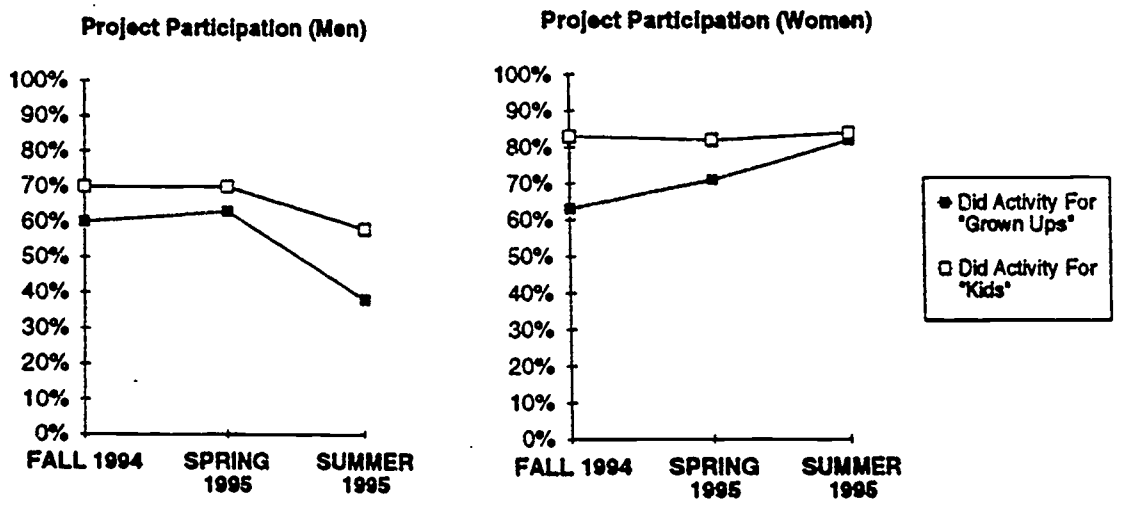

Figure 8: Participation in the "Science At Home" Project.

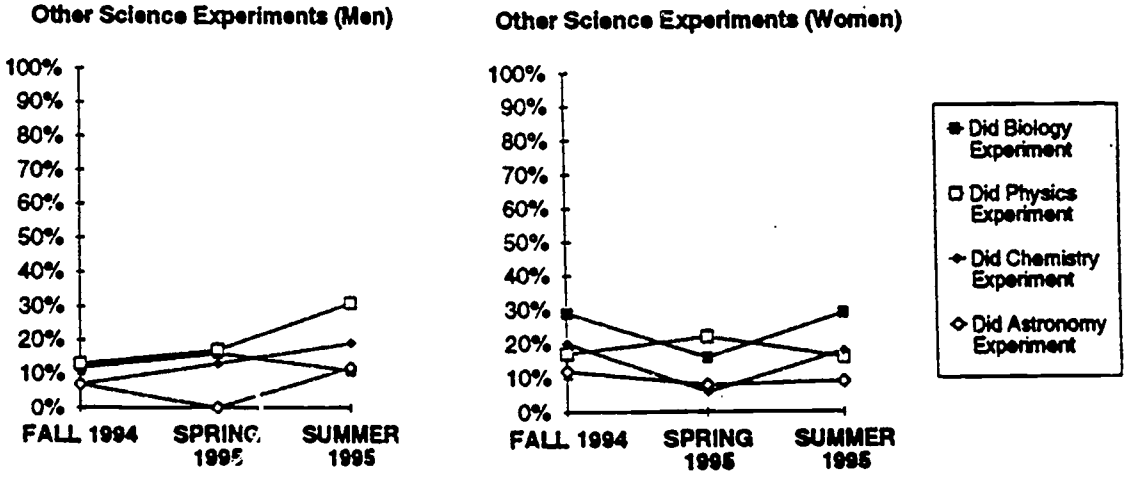

Figure 9: Participating in other science experiments and activities with children.

Part IV: "Your Children's Interest In Science"

Figures 10 through 14 summarize perceptions that parents had about their oldest child (under 12 years of age). In this section, adults were asked to evaluate the science interest and aptitude of this child as well as the likelihood that he or she will pursue a career in science. This section describes key results from items 37-41 of the gender questionnaire (see appendix). Unless otherwise stated, the ratings reported in this section are the averages over the three surveys. Results in this section are broken down by the gender of the parent as well as the child.

- Fathers gave boys and girls nearly equal ratings when asked whether the child "enjoys science" (4.57 for boys, 4.52 for girls) and "does well in science at school" (4.48 for boys, 4.44 for girls). Fathers also rated boys and girls equally when asked if the child "is an active participant in the Science at Home project" (4.54 for boys, 4.43 for girls).

- When asked whether the oldest child "enjoys science," mothers gave their girls nearly the same ratings as the fathers did. However, mothers gave boys higher ratings (4.85 for boys, 4.50 for girls). Mothers also rated boys higher than girls when asked to evaluate whether the child "does well in science at school" (4.70 for boys, 4.34 for girls). *These results suggest that fathers may hold fewer gender biases compared to mothers concerning their child's interest and abilities in science.*

- Mothers rated boys and girls equally when asked if the oldest child "is an active participant in the Science at Home project" (4.58 for boys, 4.46 for girls). The ratings given by the mothers were nearly equal to the ratings given by fathers.

- When asked whether the oldest child "frequently asks me questions at home," both mothers and fathers had the same response patterns for boys and girls. Both mothers and fathers perceived that boys asked them science questions more frequently than girls in both the fall 1994 and summer 1995. During the spring 1995, their was little difference in the way that mothers and fathers rated boys and girls. (Note that the spring 1995 measurement corresponds to the middle of the school year. Children were not in school during the fall 1994 and summer 1995 questionnaires. Therefore, the increase in questioning behavior in the girls may be motivated by concepts covered in school.)

- When asked whether the oldest child "will probably have a career in science," both mothers and fathers rated boys higher than girls. Mothers gave their sons an average rating of 3.54

compared to 3.05 for their daughters. Likewise, boys received an average rating of 3.53 from their fathers compared to 3.04 for the girls.

- While both mothers and fathers rated boys higher than girls when asked whether the child "is likely to have a career in science," the father's ratings were more consistent over the course of the project. The mother's ratings were more variable, and in fact, mirrored their response pattern for item 39 ("child frequently asks me questions about science at home"). *This result suggests that a mother's predictions concerning her child's future scientific career may be tied to whether the child asks them questions about science.*

- Since their was little variation in the response patterns to items 37-41, *the "Science At Home" project appeared to have little affect on the perceptions held by parents concerning the science interest and aptitudes of their children.*

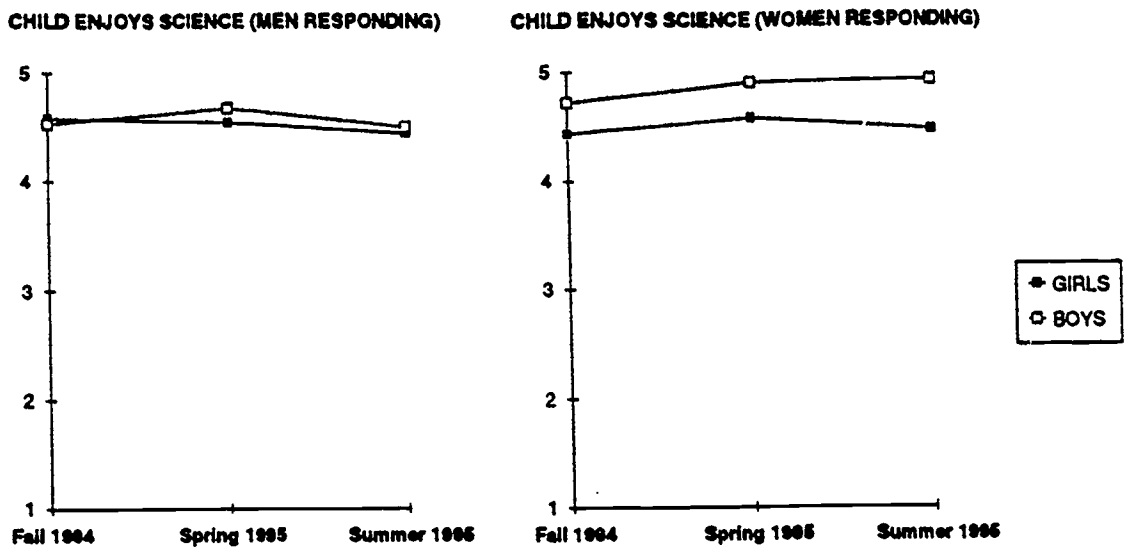

Figure 10: Parent's perceptions of whether the oldest child "enjoys science."

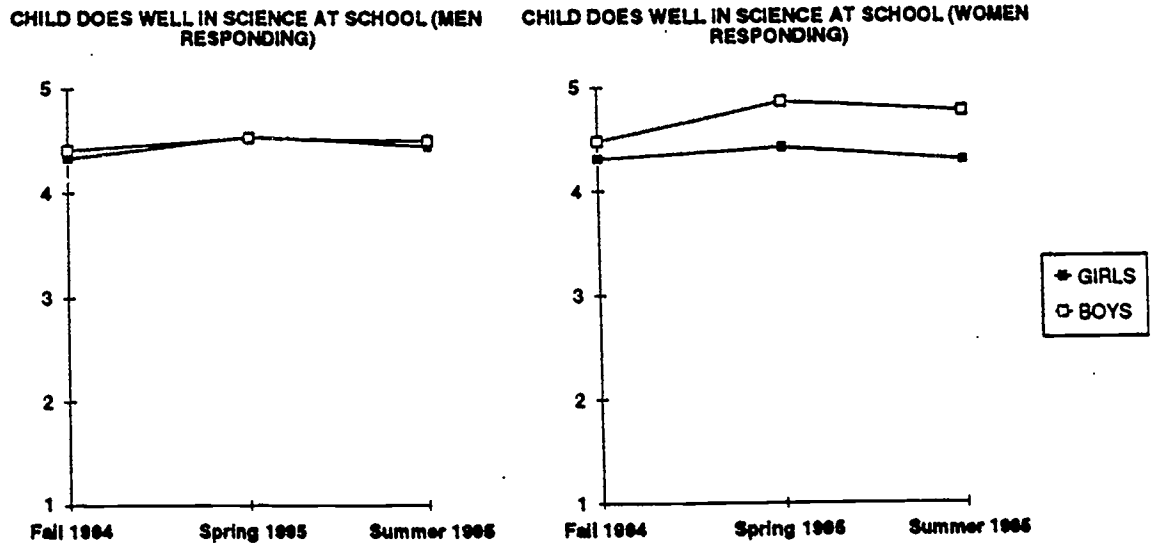

Figure 11: Parent's perceptions of whether the oldest child "does well in science at school."

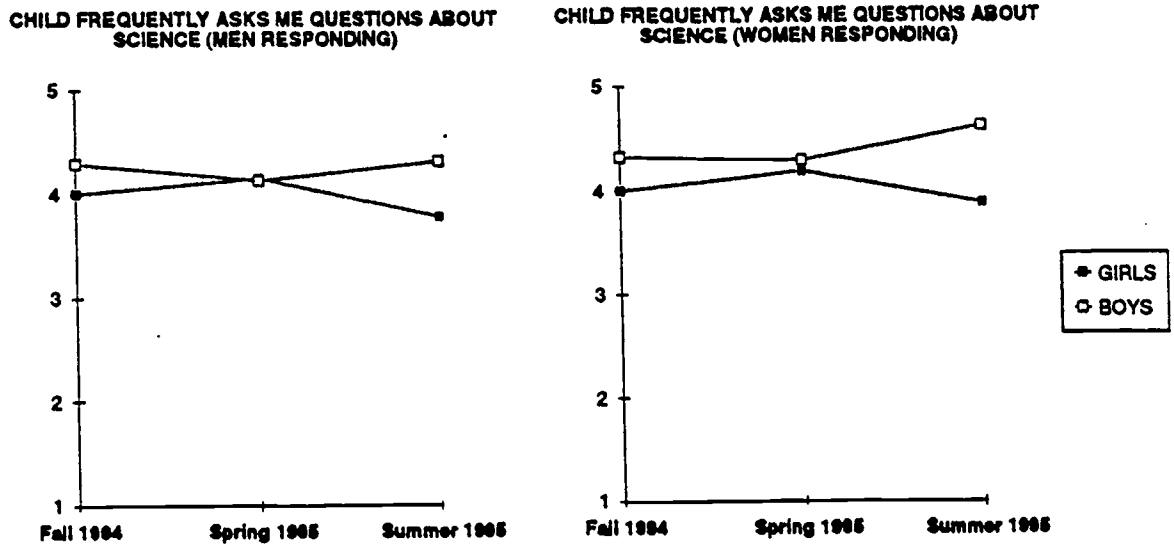

Figure 12: Parent's perceptions of whether the oldest child "frequently asks science questions ."

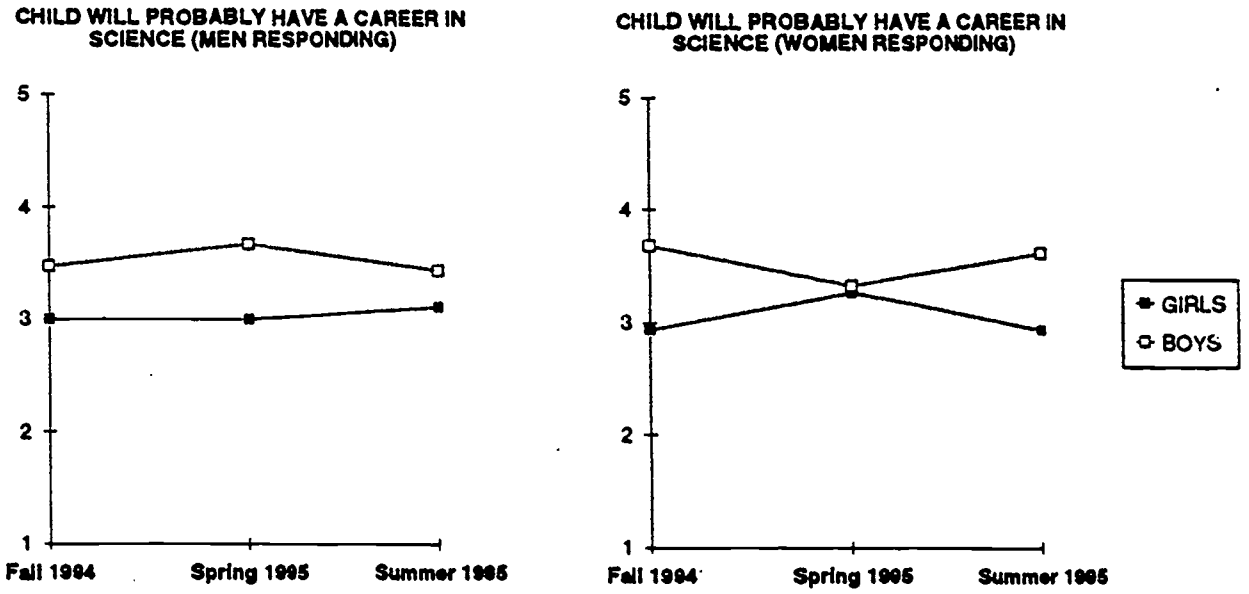

Figure 13: Parent's perceptions of whether the oldest child "will likely have a career in science."

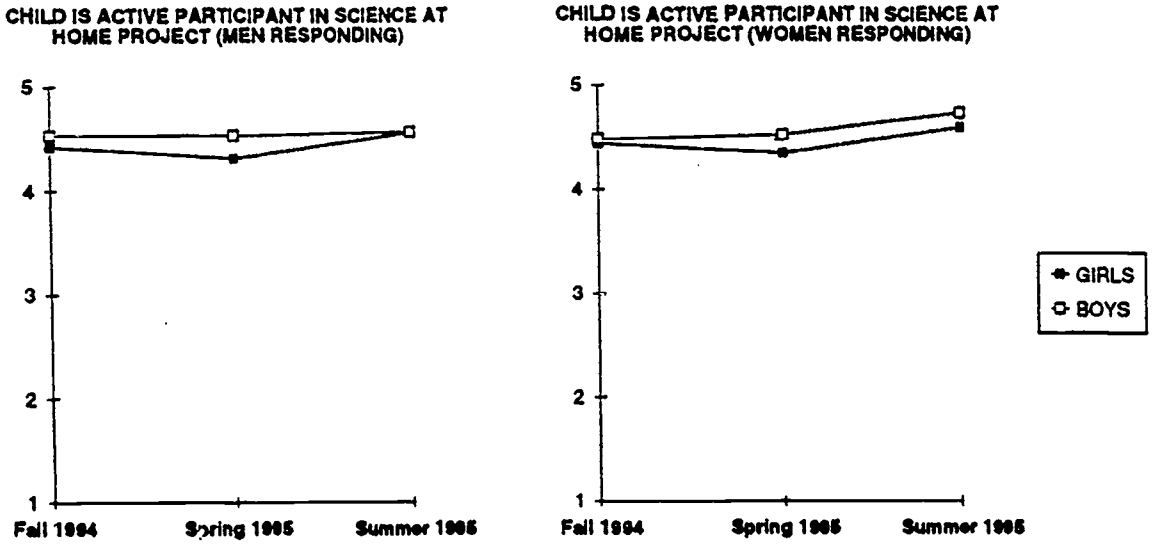

Figure 14: Parent's perceptions of whether the oldest child "is an active participant in the 'Science At Home' project."

Summary Of Results and Implications

The following is a summary of the key findings from the three administrations of the gender questionnaire:

1. The demographics of the participants in the "Science At Home" project support the theory that well-educated, professional parents tend to create home environments that support scientific curiosity and nurture interest in science.

Despite numerous efforts to recruit families from a variety of different cultures and educational backgrounds, the Exploratorium "Science At Home" project attracted an unusually high percentage of families with at least one parent holding master's degrees or doctorates. Eighty-two percent of the fathers and 44% of the mothers held advanced degrees. The high percentage of professional, well-educated parents that were attracted to this project supports the theory that these parents are more likely than other adults to seek out opportunities to enrich their child's education with home-science experiences. These parents seem intrinsically motivated to engage in science activities with their children and actively support science learning in the home.

2. The "Science At Home" project attracted parents with strong interests in learning more about various scientific disciplines.

In addition to being well-educated, the parents who actively participated in the project were very interested in learning more about astronomy, biology, chemistry, and physics. There were no significant differences with regard to the interest expressed by men and women and participation in the "Science At Home" project did not appear to increase their already high interest level. This finding suggests that science-at-home projects not only attract professional, well-educated parents -- but those with strong, pre-existing interests in science as well. Special recruiting efforts may be required to attract parents with less intrinsic interest in learning more about science.

3. It is possible for informal science education centers to create home-science activities that encourage active participation by both women and young girls.

Roughly equal numbers of girls and boys participated throughout the project. The average age was 7.5 years. Analysis from the "questionnaires for kids" included in each mailing uncovered no significant gender differences in the overall positive reactions children had to the activities. Mothers participating in the project out numbered fathers by nearly 2:1. These

results suggest that it is possible for science museums to develop home science activities that are highly motivating to both young girls and mothers.

4. The "Science At Home" Project did not positively improve how women judge their own aptitude for learning science.

Throughout the project, fathers and mothers reported being equally comfortable helping children with science homework, answering science questions, and doing science experiments at home. In addition, mothers were more likely than fathers to have answered a science question, helped with science homework, or helped with a school science project. Yet despite feeling very comfortable helping children learn science, being heavily involved in the formal science education of their children, and being actively engaging in the "Science At Home" project, women continued to score significantly lower than men when asked if they felt they "had an aptitude for learning science." The fact that more fathers than mothers held advanced science degrees and were employed in science-related professions is a confounding factor that also needs to be considered when postulating causes for these gender differences. However, *this result suggests that being well-educated, having a strong, pre-existing interest in science, and actively engaging in a number of family science activities may not positively affect how women judge their aptitude for learning science.*

5. Participation in the "Science At Home" project may have encouraged mothers to purchase more science toys for their children.

Over the course of the project, the number of mothers who reported having purchased science toys for their children increased steadily. Several researchers (Astin, 1974; Casserly, 1980; Hilton and Berglund, 1974; Maccoby and Jacklin, 1974) have reported that one source of gender inequity in the home is the fact that parents are more likely to buy science toys for sons than daughters. While this study did not examine whether mothers bought these science toys for boys or girls, the overall increase in purchases may also correspond to an increase in the number of science toys daughter received from mothers.

6. Participation in the "Science At Home" project successfully encouraged mothers to take a mechanical device apart with their children.

Numerous researchers have found that childhood experiences of "taking things apart" seems to correlate to interest in science in adulthood. However, girls are often discouraged from having experiences with mechanical objects. Girls are often made to feel over' concerned about their safety, especially around hand tools. Boys, on the other hand, are encouraged to use tools. Furthermore, children rarely encounter adult women who are as comfortable around tools and

mechanical objects as men. This further reinforces the stereotype that women are unable to use tools, are "not mechanically inclined," and have no intuition about how things work. If mothers can be encouraged to "take things apart" with their children, it is possible that some of these stereotypes can be eliminated.

During the first two administrations of the gender survey, significantly more fathers than mothers reported having "taken a mechanical device" apart with their children. However, during the final administration of the survey, families were asked to dissect a disposable camera. This dissection activity nearly doubled the number of mothers who reported having had "taken apart a mechanical device" with their children. This result suggests that it is possible to develop science activities that encourage mothers to take a mechanical objects apart.

7. When assessing a child's science interest and capabilities, and fathers appeared to hold fewer gender biases than mothers. Participation in "science at home" activities appeared to have had little affect on the gender biases held by mothers.

When asked whether their oldest child (under 12 years old) was an "active participant in the Science At Home project," both mothers and fathers rated boys and girls equally. Parents of either gender perceived that their children were very active participants. However, gender differences were uncovered when parents were asked to judge their child's interest and abilities in science. While fathers gave boys and girls nearly equal ratings when asked whether the child "enjoys science" and "does well in science at school," mothers gave *the same boys* consistently higher scores on these two items.

One could argue that mothers may have been more accurate in their evaluations than fathers. Perhaps boys actually enjoy science more than the girls. Maybe the boys are actually more successful in science at school. In addition, many of the mothers were solely responsible for the home-schooling of their children. Their perceptions of their child's science interest and achievement may be more accurate than the father's because it is based on direct experience.

However, the vast majority of families were not involved in home-schooling. Perceptions about academic achievement were not necessarily based on direct observation. Furthermore, parents were asked to answer this series of questions for children younger than 13 years old. The average age of "the oldest child" was only slightly over 8 years. At this young age, few children have been exposed to enough science in school for parents to accurately judge academic success. Furthermore, studies of young children have shown that interest in science is nearly equal for young girls and boys. In fact, some researchers report that interest in science

may be higher among the girls. It is only during adolescence that science interest declines sharply among girls (Kahle and Meece, 1994). Therefore, it is likely that differences in the way mothers judged their sons and daughters was due to a gender bias.

Whether a gender bias existed or not, active participation in the *Exploratorium "Science At Home"* project appeared to have little affect on the outcome that mothers perceived that the girls were slightly less interested and slightly less successful in science than the boys.

8. When asked to predict whether their child will pursue a career in science, both mothers and fathers have more positive expectations for sons than daughters.

Participation in "science at home" activities appear to have little affect on the perceptions of mothers and fathers. Furthermore, when asked to predict whether a child will have a career in science, mothers appeared to base their response on the frequency that this child asks them questions about science. Predictions that fathers made about a child's future career in science appeared unrelated to whether or not the child asked questions frequently of him.

The finding that parents are more likely to predict a scientific career for their boys than their girls is consistent with results reported in the gender equity literature. Researchers have found that parents are more likely to have science career aspirations for their sons than their daughters. Since the average of the children being evaluated was slightly over 8 years, results of this study further suggest that the gender biases held by parents form early in a child's life.

The finding that mothers may have based their career predictions on the frequency that a child asks them questions about science is particularly compelling. If a causal relationship truly exists, then it may be possible to positively affect how mothers view their daughter's future career in science by creating at-home science experiences that encourage girls to ask more questions of their mothers.

Conclusion

The Exploratorium is a interactive museum of science, art, and human perception. Its mission is to fundamentally change the way the public thinks about science. Instead of presenting facts, the Exploratorium provides people with "hands-on" opportunities to explore scientific concepts for themselves. It is a place where questions are more important than answers. Moreover, the Exploratorium is dedicated to promoting "cultures of learning"

(Delacôte, 1995) -- environments where children and adults explore phenomena together and learn from one another.

The primary goal of the Exploratorium "Science At Home" Project was to provide families with the same kinds of opportunities for exploration and discovery that has been a part of the museum's exhibits, children's outreach programs, and teacher enhancement workshops for more than a decade. We wanted to provide parents with activities that help foster a "culture of learning" in their homes . And we wanted to develop science experiences for families that break down gender inequities in the home.

The project attracted over 800 families over the course of the year. The typical family participated in almost half of the activity-sets mailed. But more importantly, boys and girls participated in the activities in roughly equal numbers. Mothers who actively participated in activities out-numbered fathers by almost 2:1. This finding suggests that it possible for museums to develop science activities for the home that (1) attract families in large numbers, (2) encourage mothers to actively participate in "at-home" science activities with their children and (3) increase the number of girls who grow up in households that encourage their participation in science. Furthermore, this project was able to encourage mothers and daughters to engage in science activities typically done by fathers and sons -- e.g. taking a mechanical device apart.

When the demographics of the participating adults was examined, we also discovered that the vast majority of parents were very well-educated and already intrinsically interested in learning more about science. Most of the fathers were working in science-related fields. Most of the mothers held masters degrees or higher and worked solely as homemakers. Numerous efforts to recruit families with different backgrounds failed to change the demographics of the participants. While this finding makes it impossible to generalize results of this study to a broader population of families, it does highlight a fundamental (and perhaps, intractable) problem that needs to be addressed if all children are to have an equal chance at success in science. What can science museums do to foster "cultures of learning" in a wider range of families -- regardless of educational background, socio-economic status, and interest in science?

Because the parents were already highly motivated to learn science and deeply committed to providing science experiences for their children, this project did relatively little to change already positive attitudes and behaviors. However, even within these exceptional families, gender inequities were uncovered which were unaffected by this project. For example, mothers consistently rated their own "aptitude for learning science" lower than fathers. Mothers

gave boys consistently higher scores than girls when asked whether the child "enjoys science" and "does well in science at school." And when asked to predict whether their child will pursue a career in science, both mothers and fathers held more positive expectations for sons than daughters. The fact that these gender inequities were not affected by the "Science At Home" Project suggests that science museums may have to develop additional strategies for addressing gender-biased attitudes and perceptions held by parents.

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Appendix:
Gender Questionnaire

"Science At Home" Survey For Grown Ups

Part I: Tell Us About Yourself

Name _____ Age ____ Gender (circle one) M F
first last

Number of children living in your house: Boys _____ Girls _____
List ages of children Boys _____ Girls _____

Your relationship to the children in the household:
❑ mother ❑ father ❑ grandmother ❑ grandfather ❑ aunt ❑ uncle
❑ other (describe) _____

Your **highest** level of education
❑ high school diploma or GED ❑ AA or some college
❑ BA/BS (in what?) _____ ❑ MA/MS (in what?) _____
❑ doctorate (in what?) _____ ❑ other (describe) _____

Your profession
❑ homemaker ❑ teacher (not science) ❑ teacher (science)
❑ engineer/computer scientist ❑ science researcher ❑ healthcare
❑ other (describe) _____

Your formal science training
❑ high school courses ❑ college courses ❑ graduate school courses
❑ other (describe) _____

Part II: How I Feel About Science

Circle the number that best corresponds to your feelings.

Item #		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
1	I enjoy watching science documentaries.	1	2	3	4	5
2	I enjoy reading books about science.	1	2	3	4	5
3	I enjoy reading science articles in newspapers or magazines	1	2	3	4	5
4	I enjoy visiting science museums.	1	2	3	4	5
5	I'm interested in learning more about physics.	1	2	3	4	5
6	I'm interested in learning more about biology.	1	2	3	4	5
7	I'm interested in learning more about chemistry.	1	2	3	4	5
8	I'm interested in learning more about astronomy.	1	2	3	4	5
9	I have an aptitude for learning science.	1	2	3	4	5
10	I'm comfortable helping the children in my household with their science homework.	1	2	3	4	5
11	I'm comfortable teaching science concepts to the children in my household.	1	2	3	4	5
12	I'm comfortable doing science experiments with the children in my household.	1	2	3	4	5

CONTINUED ON THE BACK . . .

Part III: Science At Home

Item #

Check all the boxes that correspond to science activities you did during the LAST THREE MONTHS **with or for the children** in your household:

13 ☐ Visited a science museum.
14 ☐ Visited a planetarium.
15 ☐ Visited an aquarium.
16 ☐ Took a science research lab tour.
17 ☐ Visited a nature preserve/national park.
18 ☐ Bought a children's science book
19 ☐ Bought a science/nature toy.
20 ☐ Bought science education software or CD ROM.
21 ☐ Bought or rented a science/nature video for children.
22 ☐ Took a mechanical or electrical device apart (i.e. a radio, toaster, watch).
23 ☐ Repaired a mechanical or electrical device (i.e. a radio, toaster, watch).
24 ☐ Helped start or maintain a nature collection (i.e. butterflies, rocks, fossils).

Check all the boxes that correspond to science activities you did during the LAST WEEK **with the children** in your household:

25 ☐ Answered a science question.
26 ☐ Helped with science homework.
27 ☐ Helped with a school science project.
28 ☐ Helped with mathematics homework.
29 ☐ Did an Exploratorium "Home Science" activity designed for grown ups.
30 ☐ Did an Exploratorium "Home Science" activity designed for kids.
31 ☐ Did a biology experiment (not part of Exploratorium project).
32 ☐ Did a physics experiment (not part of Exploratorium project).
33 ☐ Did a chemistry experiment (not part of Exploratorium project).
34 ☐ Did an astronomy experiment (not part of Exploratorium project).
35 ☐ Used a scientific instrument (i.e. telescope, microscope, etc.)
36 ☐ Used science education software or CD ROM.

Part IV: Your Children's Interest In Science

Circle the number that best corresponds to your reactions to each statement. These statements refer to the **OLDEST** child (12 yrs or under) still living in your household.

Age of Oldest Child ____ Gender of Oldest Child (circle one) M F

Item #

		Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
37	This child enjoys science.	1	2	3	4	5
38	This child does well in science at school.	1	2	3	4	5
39	This child frequently asks **me** questions about science at home.	1	2	3	4	5
40	This child will probably have a career in science.	1	2	3	4	5
41	This child is actively participating in the Exploratorium "Home Science" project.	1	2	3	4	5

You're done! Thank you for your participation in this study.
Please feel free to call the Exploratorium "Science At Home" Hotline (415/353-0442) if you have comments or questions regarding this form.

GQ1