Evaluation of Mad Science®: Educational Science Enrichment for Children

Submitted to
The Mad Science Group®
by

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Acknowledgments

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Educational Science Enrichment for Children

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Executive Summary

Mad Science is a leading provider of educational science enrichment to elementary school-aged children around the world. In fall 2005, the Mad Science Group commissioned an evaluation study with Char Associates, an independent research group in Montpelier, Vermont, to assess the educational impact of Mad Science on school children in the United States.

This national study examined whether exposure to Mad Science positively affects children's interest in, and understanding of, science, as compared to children who have not had exposure to Mad Science.

Background and Methodology:
The educational impact of Mad Science on school children was assessed by selecting a random sample of third grade students representing four regions across the United States. Classrooms within each region were randomly assigned by the evaluation team to either "Experimental" (Mad Science) or "Comparison" (Non-Mad Science) groups. The study's final sample consisted of a total of 470 students, from 28 third grade classrooms (14 Experimental and 14 Comparison) in seven elementary schools.

Geographic Site	**Experimental Group (Mad Science)**	**Comparison Group (Non-Mad Science)**	**Total Classrooms**
US (Northeast) (Western New England)	2 classrooms *(29 students)*	2 classrooms *(26 students)*	4 classrooms *(55 students)*
US (Midwest) (St. Louis, MO)	4 classrooms *(81 students)*	4 classrooms *(81 students)*	8 classrooms *(162 students)*
U.S. (West) (Las Vegas, NV)	4 classrooms *(62 students)*	4 classrooms *(70 students)*	8 classrooms *(132 students)*
U.S. (South) (Austin, TX)	4 classrooms *(65 students)*	4 classrooms *(56 students)*	8 classrooms *(121 students)*
Total across sites	**14 classrooms (237 students)**	**14 classrooms (233 students)**	**28 classrooms (470 students)**

Our evaluation addressed the following primary research questions:

Did students who participated in Mad Science experience significant change in:

- *Science content knowledge specific to the Mad Science presentations?*
- *Interest in science?*
- *Positive attitudes about science?*
- *Overall views of science?*

and,

Did students who participated in Mad Science experience significantly greater change than comparison students in these same four science areas?

The main evaluation instruments consisted of pre- and post-test written student questionnaires that assessed children's interest in and attitudes toward science, and their understanding of science content and concepts addressed in the tested Mad Science (MS) units.

All Mad Science (experimental) classrooms received an identical series of two 60-minute MS science presentations, spaced roughly two weeks apart. The two presentations featured space science from a MS/NASA unit (#2: *Atmosphere and Beyond*; and #8: *Living in Space*), and were delivered by the regular Mad Science franchisee instructor.

All experimental and comparison classrooms were administered the pre-test survey at the beginning of the study, and administered the post-test survey approximately three weeks later. The Mad Science experimental classrooms also received the two MS space science presentations during the intervening weeks. All data collection for the study was conducted in late winter/early spring 2006 (February – April 2006).

Analysis of the surveys involved both quantitative and qualitative data analysis. Students' pre and post-tests were examined using descriptive statistics (means and frequencies), and t-tests of both composite means and individual item means. Qualitative content analysis entailed coding open-ended prose items for major issue and content themes, which were then quantified to identify predominant themes.

MAJOR FINDINGS

Among the study's major findings, this national study revealed that exposure to Mad Science significantly increased:

- Students' knowledge of science content and concepts;
- Students' interest in engaging in science-related leisure activities;
- Students' enjoyment of science and view that science is fun; and
- Students' view that most people should learn about science.

We also found that students more positively inclined towards science were more likely to experience greater gains in the science content knowledge following their Mad Science visits.

Students found the Mad Science visits fun and highly engaging, and desired longer and more frequent Mad Science visits to their classrooms.

Each of these areas of impact is described below.

<u>Increased science knowledge</u>: Children who experienced Mad Science demonstrated increased knowledge of science content and concepts. After receiving the Mad Science

visits, pilot (experimental) group students significantly increased their content knowledge of science information related to the Mad Science lessons.

Pilot students experienced gains for many of the individual science content items. After experiencing the Mad Science visits, significantly more students now understood that:

- Air takes up space, and has weight;
- Space shuttles must deal with very hot and very cold temperatures in space;
- Colorful skies at sunset are due to dust particles in the Earth's air;
- Astronauts train underwater before going into space because people don't weigh much in both water and in space; and
- Spacesuits that do not control for air pressure would cause an astronaut to expand and swell up like a balloon.

<u>Increased interest in science-related leisure activities</u>: Children experiencing Mad Science subsequently expressed significantly higher levels of interest in engaging in science-related leisure activities, specifically related to space. Science interest was assessed through interest in various leisure activities, such as articles read in a children's magazine, activity kits purchased at a toy store, or places of interest to visit.

Regarding the individual interest items, students in the pilot group expressed a significantly increased level of interest in reading about stars and planets, and about space travel; buying activity kits to make models of space stations; and visiting a mountain top to look at stars at night.

<u>Positive science attitudes</u>: There was little change in children's attitudes towards science as a consequence of experiencing Mad Science. However, students generally started with such positive attitudes toward science that little change was likely to appear.

Pilot students, however, did indicate more positive attitudes towards science for a subset of individual survey items. Following their MS visits, pilot students were more likely to indicate that they liked science, think science is fun, feel that most people should learn about science, and have a favorable view of their abilities in science.

<u>Relationship between science attitudes and gains in science knowledge</u>. There was an inter-connection between students' prior view of science and their gains in content area science knowledge. Based on regression analysis on pilot students, we found that students who were more positively inclined towards science were more likely to experience greater gains in the science content knowledge following their Mad Science visits.

<u>Favorite aspects of Mad Science visits</u>: Students particularly enjoyed the active, hands-on science of Mad Science. When asked what they liked best about the Mad Science visits, students most frequently reported that they liked either the hands-on activities or the experiments. Humor and the zany personality of the Mad Science host were also favorite qualities of the visits. Students offered few recommendations for needed improvement.

Evaluation of Mad Science: Educational Science Enrichment for Children

A Report to the Mad Science Group

Char Associates
Montpelier, VT

Mad Science is a leading provider of educational science enrichment to elementary school-aged children around the world. In fall 2005, the Mad Science Group commissioned an evaluation study with Char Associates, an independent research group in Montpelier, Vermont, to assess the educational impact of Mad Science on school children in the United States. This national study examines whether exposure to Mad Science positively affects children's interest in, and understanding of, science, as compared to children who have not had exposure to Mad Science.

Background and Methodology

The educational impact of Mad Science on school children was assessed by selecting a random sample of third grade students representing four regions across the United States. At each site, local Mad Science franchisee representatives assembled lists of local elementary schools and their third grade teachers who would be willing to participate in the evaluation. Classrooms within each site were then randomly assigned to either "Experimental" (Mad Science) or "Comparison" (Non-Mad Science) groups.

Our primary evaluation method consisted of student pre and post-test questionnaires to assess children's interest in and attitudes toward science, and their understanding of specific science content and concepts addressed in the tested Mad Science unit. All students (both experimental and comparison) completed identical written pre-test questionnaires after being randomly assigned to the experimental or comparison groups. After completion of the pre-test, all Mad Science (experimental) classrooms received an identical series of two 60-minute MS science presentations, spaced roughly one week apart. The two presentations focused on space science from the NASA unit (#2: *Atmosphere and Beyond* and #8: *Living in Space*), and were delivered by the regular Mad Science franchisee instructor. The written post-test questionnaire was administered to both the experimental and comparison groups after Mad Science experimental classrooms' receipt of the presentations, approximately three weeks after the pre-test, and roughly one week after the second Mad Science visit to the experimental classrooms. The questionnaires took approximately 20 minutes for students to complete.

All data collection for the study was conducted in late winter/early spring 2006 (February – April 2006).

Sample

The study was undertaken in four regions across the United States: Western New England (MA and CT), St. Louis, MO, Las Vegas, NV, and Austin, TX. Table 1 shows that the study's final sample consists of a total of 470 students, from 28 third grade classrooms (14 Experimental and 14 Comparison) in seven elementary schools. The 237 experimental students were comprised of 121 boys (54%) and 103 girls (46%) and the 233 comparison students were comprised of 119 boys (51%) and 114 girls (49%).

Table 1: Final sample by region and group

US Geographic Site	**Experimental Group (Mad Science)**			**Comparison Group (Non-Mad Science**			**Total**		
	# Schools	*# Classrooms*	*# Students*	*# Schools*	*# Classrooms*	*# Students*	*# Schools*	*# Classrooms*	*# Students*
Northeast (West'n New England)	1	2	29	1	2	26	1	4*	**55**
Midwest (St. Louis, MO)	2	4	81	2	4	81	2	8	**162**
West (Las Vegas, NV)	2	4	62	2	4	70	2	8	**132**
South (Austin, TX)	2	4	65	2	4	56	2	8	**121**
Total Across Sites	**7**	**14**	**237**	**7**	**14**	**233**	**7**	**28**	**470**

(Note: A total of 8 classrooms were initially part of the Western New England Sample. However, two comparison classrooms were unable to submit completed post-test surveys. Subsequently, these two comparison classrooms, along with two paired pilot classrooms, were not included in the final sample, and only four total classrooms were included from Western New England.)

Research Questions

We conducted quantitative and qualitative analyses on data collected to assess the extent to which exposure to Mad Science positively affects children's interest in, and understanding of, science, as compared to children who have not had exposure to Mad Science. Specifically, our analyses addressed the following research questions:

1) Did students who participated in Mad Science experience significant change in:

- *Science content knowledge specific to the Mad Science presentations?*
- *Interest in science?*
- *Positive attitudes about science?*
- *Overall views of science?*

2) Did students who participated in Mad Science experience significantly greater change than comparison group students in:

- *Science content knowledge specific to the Mad Science presentations?*
- *Interest in science?*
- *Positive attitudes about science?*
- *Overall views of science?*

3) Are there differences in pre to post change based on additional student characteristics, of:

- *Gender?*
- *Level of interest in science based on teacher reports?*
- *Special education status?*
- *ESL (English as a Second Language)?*
- *District?*
- *Previous exposure to space curriculum earlier in the fall?*
- *Previous exposure to Mad Science content?*

Instruments and Questionnaire Design

Science knowledge, attitudes, and behaviors were the three primary foci of the research study. The ***student pre-test questionnaire*** consisted of 28 items: 8 multiple choice science content knowledge items, 16 science attitude items (10 rating scale science attitude items and 6 "word pair" items), 3 science interest items (a check list of leisure activities) and 1 open-ended prose item on attitudes toward science.

The eight *science content knowledge* items were specially designed to target the kinds of science concepts and information featured in the two Mad Science sessions. For each science content knowledge item, students were presented with four response choices: one correct response and three incorrect, but highly plausible, responses.

Three different sets of survey items assessed students' *science attitudes*: statements about science rated along an "agreement" scale; word pairs of opposite adjective terms; and a "complete the sentence" task. For the science statement items, students were asked to rate each statement along a 4-point "agreement" scale (i.e., whether each statement was one with which they agreed a lot, agreed a little, disagreed a little, or disagreed a lot). For the word pairs, students were presented with a set of pairs of opposite adjective terms (e.g., easy vs. hard; interesting vs. boring), and were asked to select which word or phrase best described how the student personally viewed science. For the complete-the-sentence task, students indicated whether or not they wanted to learn about science, and wrote reasons for this view.

To assess science interest and behavior, the survey contained three "check list" leisure activity items. Each item featured a certain kind of leisure activity, such as different articles in a children's magazine they might read, different activity kits at a toy store they might buy, or different places they might most like to visit. For each item, students were presented with a variety of 6 or 7 options (e.g., different articles, activity kits or places), and students indicated which two or three options they found most appealing.

The **post-test questionnaire** consisted of 31 items and was identical to the pre-test questionnaire, with the exception of three additional open-ended prose items on the survey version that pilot (experimental) students were asked to complete. Students were also asked to write what they felt they had learned from the MS visits, as well as what they liked best about the MS visits. Students were also asked for suggestions about how MS visits could be improved.

The student questionnaires were first piloted with a small group of third graders, prior to finalizing the questionnaire design for administration to the study's full sample.

In addition to the student questionnaires, teachers completed a **classroom recording sheet** that provided additional student information. Teachers were asked to list the names of students in their class and to provide information pertaining to each student's gender, special education status, ESL (English as a Second Language) status, grade in science during last academic quarter, interest level in science (low, medium, high) prior to the study, and previous exposure to Mad Science (MS) presentations.

Analytic Methods

A variety of analyses were conducted to answer our research questions. Students' pre and post-tests were first examined using descriptive statistics (means and frequencies). We conducted a series of independent and paired-sample t-tests of means to look at change within groups (experimental pre to post change and comparison pre to post change), and also to look at *differences* in pre to post-test change between groups (experimental versus comparison).

Second, in addition to an examination of individual survey items, we developed four composites comprising the individual items that were specific to our research questions (see Table 2 for composite details). The pre and post composite means were analyzed using a variety of analysis methods, which included independent and paired-sample t-tests, and regression analysis. We tested for significant differences based on additional child characteristics (gender, level of science interest, special education and ESL status, district, and previous exposure) during each set of analysis. Please note that although we intended to look at differences in student performance/change based on prior grades received in science, we could not use the data provided by teachers because of inconsistency in grading procedures and inconsistent receipt of this information due to student confidentiality issues.

Table 2: Pre and post-test composite details

Composite Name	# Individual Items	How formed	Composite Range
Content Knowledge	8	Calculation of percent correct out of 8 possible items	0% to 100%
Interest in Science	3	3 items asked students to identify top 2 or 3 choices of most interest. Choices that reflected high science interest were totaled and formed the composite.	0-7
Positive Attitudes about Science	10	10 statements that were rated on a 4-point rating scale (0=negative science attitude; 3=High positive science attitude) were totaled.	0-30
Views of Science	6	6 item pairs that represented a measure of negative and positive science views (0 = negative view; 1 = positive view) were totaled.	0-6

Third, qualitative content analysis was performed on the open-ended prose items from all students in the sample. Prose responses were coded for major issue and content themes. They were later quantified to identify predominant themes, possible changes from pre to post-test performance, and differences between pilot and comparison groups.

RESULTS: IMPACTS OF EXPERIENCING MAD SCIENCE

The major findings from this national study indicate that exposure to Mad Science significantly increased:

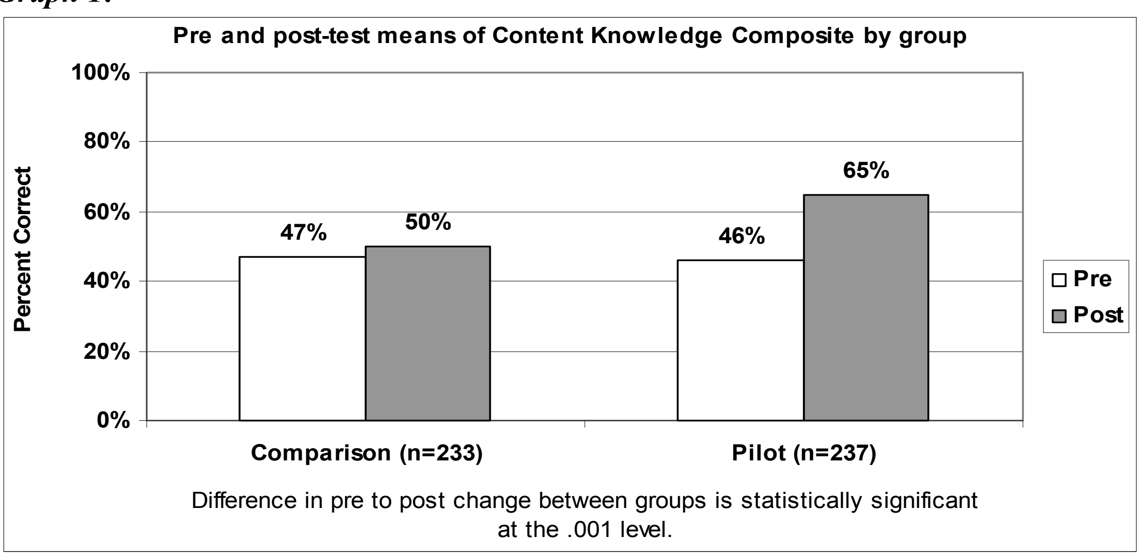
- Students' knowledge of science content and concepts;
- Students' interest in engaging in science-related leisure activities;
- Students' enjoyment of science and view that science is fun; and
- Students' belief that most people should learn about science.

Students also found the Mad Science visits fun and highly engaging, and desired more frequent and longer Mad Science visits to their classrooms.

Each of these impact areas is described further in the sections below.

Increased Science Knowledge: Exposure to Mad Science significantly increased students' knowledge of science content and concepts, as related to the concepts addressed in the lessons. As Graph 1 shows, while about half the pilot and comparison group students, on average, answered the set of science content items on the pre-test correctly, only the pilot group students significantly increased their content knowledge in the post-test, after receiving the Mad Science visits. These differences in pre- to post-test change were significant at the .001 level. This was true for science content addressed in each of the two space units (#2: *Atmosphere and Beyond* and #8: *Living in Space)*.

Graph 1:



Pilot students experienced significant gains between pre- and post-tests for 7 out of the 8 science content items. After experiencing the Mad Science visits, significantly more students now understood that:

- Air takes up space, as evidenced by an upside-down plastic cup plunged in a tube of water still containing air;

- Air has weight, as evidenced by a blown up balloon tied on one end of a balanced rod being lower than the end with a deflated balloon;

- In space, the space shuttle must deal with very hot and very cold temperatures;

- The sky looks orange and red at sunset due to dust particles in the Earth's air;

- An astronaut wearing a spacesuit that does not control for air pressure would expand and swell up like a balloon; and

- Astronauts train underwater before they go into space because in both water and space you don't weigh very much.

(See Table 3 for specific increases in percentage of students answering science content items correctly on post-tests.)

Table 3: Pre to post test change in percent correct on items assessing science content knowledge, by group

	Comparison		**Pilot**		**Difference**	
	Pre test % Yes	*Post test % Yes*	*Pre test % Yes*	*Post test % Yes*	*Comparison*	*Pilot*
Students selecting correct answer						
Q1a: Submerged upside-down cup not fill up with water	28%	36%*	30%	60%****	.08	.30****
Q1b: Because air takes up space	37%	43%	43%	79%****	.05	.36****
Q2: Inflated balloon heavier	56%	60%	58%	66%*	.04	.08
Q3: Space shuttle deals with very hot and very cold temperatures	49%	51%	42%	54%**	.02	.12
Q4: Earth is the only planet with oxygen gas in its air	64%	65%	55%	60%	.02	.05
Q5: Colorful sky at sunset caused by dust particles in the Earth's air	33%	37%	35%	60%****	.03	.25****
Q6: Without space suit controlling for air pressure, astronaut would expand (swell up) like a balloon	27%	28%	30%	65%****	.01	.35****
Q7: Astronauts train	77%	77%	72%	81%**	.00	.09*

underwater because in both space and underwater, you don't weigh very much						

(Comp) n=233; (Pilot) n=237
*Significant difference in pre to post change at p<.05
**Significant difference in pre to post change at p<.01
****Significant difference in pre to post change at p<.0001

In contrast, comparison group students experienced significant gains in only 1 of the 8 science content items. Furthermore, when looking at the "change scores" (differences between pre- and post-test performances for students), pilot students significantly outperformed comparison group students on 5 out of the 8 science content items.

When asked to describe one or more things they found out by having the Mad Science Group visit their classrooms, the most common response vividly recalled by students concerned learning that air takes up space, and the related science activities engaged in by students (e.g., plunging a cup into water and blowing up a balloon in a bottle). This response was mentioned by one in five, or 20% of all pilot students. The second most frequently reported discovery was learning that astronauts would swell up like a balloon if their space suits didn't control for air pressure (13% of pilot students).

Smaller numbers of pilot students (5% - 10% of pilot students) also recalled learning about how dust particles in the air caused colorful sunsets and how rainbows were created, what life in space is like without gravity and how astronauts train underwater, how difficult it is to build things in space (using space gloves), and the atmospheres of different planets.

Amongst the variety of discoveries students acquired through Mad Science, students reported that they learned:

> *When you put a glass in a cup of water, the water does not go in the glass and the air stays inside the cup.*
>
> *That if a person is in a spacesuit that has no air pressure, the person inside will expand.*
>
> *That the dust in the air makes the sun make the sky orange.*
>
> *You can't eat food that makes crumbs in space.*
>
> *I learned that astronauts have to be strapped down to sleep and go to the bathroom.*

I figured out that it is hard for people in space to put things together.

If you have a spacesuit that does not have bands, it is hard to move.

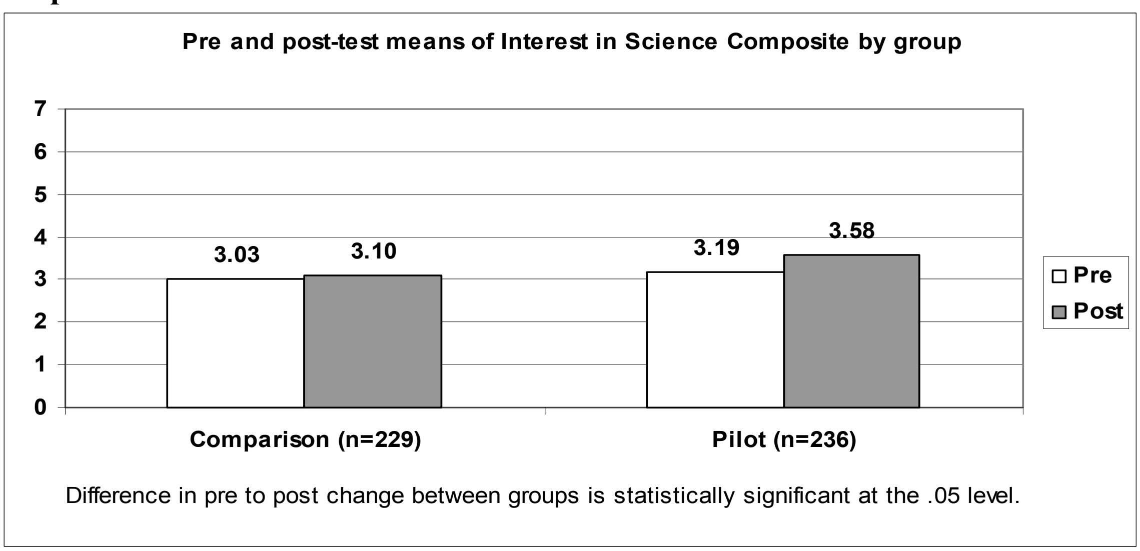
I learned an astronaut's suit never had pressure points so they couldn't bend their arms. But now the suit has pressure points.

All the planets have a different environment.

I've learned that 75% of the earth's air is nitrogen.

Increased Interest in Science-related Leisure Activities: Following their Mad Science visits, pilot students expressed significantly higher levels of interest in engaging in science-related leisure activities, specifically related to space. As Graph 2 shows, the composite score of these three items indicated that students in the pilot group were significantly more likely than comparison students to choose science- related leisure activities ($p < .05$).

Graph 2:



An examination of the individual interest items showed that students in the pilot group expressed a significantly increased level ($p<.05$) of interest in the following leisure activities:

- reading about stars and planets
- reading about space travel

• buying activity kits involving making models of space stations; and

• visiting a mountain top to look at stars at night.

In contrast, students in the comparison group showed no change in these areas. (See Table 4 for specific increases in percentage of students choosing science-related leisure activities on post-tests.)

Table 4: Pre to post test change in percent selecting leisure activities pertaining to science, by group

	Comparison		Pilot		Difference	
	Pre test % Yes	*Post test % Yes*	*Pre test % Yes*	*Post test % Yes*	*Comparison*	*Pilot*
Q10: I most want to read about: (Comp) n = 221; (Pilot) n = 234						
Space travel	38%	36%	42%	51%*	-.02	.09*
Animals in Africa	28%	28%	34%	22%****	.00	-.12*
History of the Wild West	19%	22%	18%	18%	.03	.00
Stars and planets	39%	42%	43%	53%*	.03	.10
Writing poems an d stories	17%	16%	14%	9%	-.01	-.05
Math puzzles	15%	15%	17%	15%	.00	-.02
Painting and drawing	34%	35%	33%	29%	.01	-.04
Q11: I most want to buy activity kits: (Comp) n = 228; (Pilot) n = 235						
Making an ant farm	18%	21%	23%	16%*	.03	-.07
Making a model of a space station	43%	48%	46%	55%*	.05	.09
Making a tie-dyed shirt	23%	22%	18%	20%	-.01	.02
Making a leather drum	15%	17%	13%	13%	.02	.00
Making a mobile with different animals	19%	24%	19%	17%	.05	-.02
Making a mobile with the suns and planets	31%	33%	39%	43%	.02	.04
Making a model of a castle	44%	32%	38%	34%	-.12	-.04
Q12: I would most want to go: (Comp) n = 229; (Pilot) n = 235						
A museum with hand-on science experiments	58%	55%	63%	68%	-.03	.05
A museum to see art made by kids	26%	27%	21%	20%	.01	-.01
A beach to go swimming	59%	57%	58%	53%	-.02	-.05
A beach to learn about animals that live in the water	52%	58%	53%	48%	.06	-.05*
A mountain top to look at stars at night	42%	41%	34%	43%*	-.01	.09*
A mountain top to camp in a tent overnight	45%	42%	49%	49%	-.03	.00

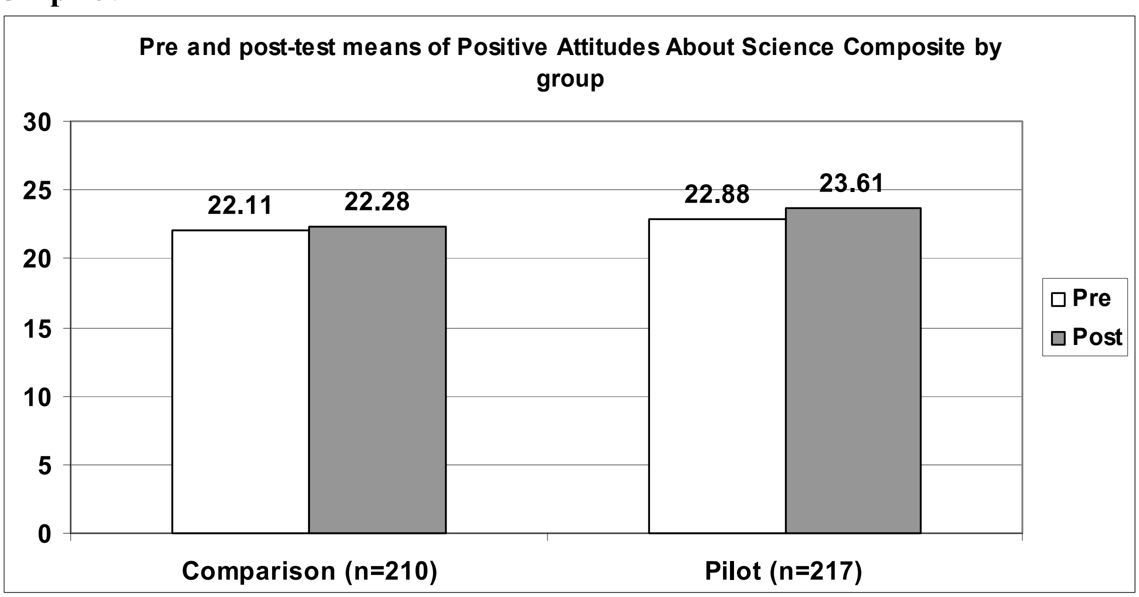
Significant difference in pre to post change: *p<.05; ****p<.0001;

Positive Science Attitudes: Our pre-tests revealed that a high proportion of both pilot and comparison group students began the study with generally positive attitudes towards science. Three sets of survey items assessed students' science attitudes: *statements about science* that students rated along a 4-point "agreement" scale; *word pairs* of opposite adjective terms that best described how students viewed science; and a *"complete the sentence"* task in which students indicated whether or not they wanted to learn about science, and reasons for their view.

Science Statements*:* On their pre-tests, most students agreed with statements concerning the *importance and relevance of learning science* (e.g., that most people should learn about science and that science is helpful in understanding today's world) and their *interest in science* (e.g., they liked science and want to learn more about science). Similarly, many were inclined to disagree with a statement such as "there is little need for science in most jobs." (See Table 5)

While the overall composite of science attitudes indicated no significant changes between pilot and comparison students' pre- and post-test scores, nor between pilot and comparison group students (see Graph 3), most students had already indicated fairly positive attitudes towards science on their pre-tests. Thus, lack of substantial change in this area could be due to a "ceiling effect" (i.e., there is relatively little room to move upwards in the rating scale in the post-test).

Graph 3:



Analysis of the ten individual survey items that comprise the science attitudes composite showed statistically significant change for pilot students for 3 out of 10 items related to positive attitudes towards science. Following their MS visits, students were more likely to agree that they *liked science*, and *thought most people should learn about science* ($p < .01$). The gains for these two statements between pre- and post-test surveys were also significantly higher for the pilot students than the comparison group students ($p < .05$).

Table 5: Pre to post test change in mean on items assessing attitudes towards science, by group

	Comparison (n=231)		**Pilot** (n=234)		**Difference in pre-post means**	
(4-point rating scale: 3 – Agreed a lot; 2 = Agreed a little; 1 = Disagreed a little; 0 = Disagreed a lot)	*Pre test Mean*	*Post test Mean*	*Pre test Mean*	*Post test Mean*	*Comparison*	*Pilot*
How do you feel about the following?						
I think most people should learn about science	2.46	2.45	2.42	2.59**	-.01	.17*
I like science	2.40	2.38	2.49	2.63**	-.02	.14*
I am good at science	2.14	2.07	2.18	2.17	-.07	-.01
I think science is more for boys than for girls	2.31	2.37	2.48	2.58	.06	.10
No matter how hard I try, I cannot understand science	2.20	2.22	2.21	2.35*	.02	.14
I want to learn more science	2.38	2.37	2.56	2.62	-.01	.06
I remember most of the things I learn in science	2.10	2.06	2.04	2.15	-.04	.11
I think there is little need for science in most jobs	1.48	1.55	1.77	1.74	.07	-.03
I think science is helpful in understanding today's world	2.54	2.59	2.58	2.69	.05	.11
I would like to spend less time in school doing science	1.87	1.92	2.10	2.11	.05	.01

Note: Sample sizes for individual items vary slightly, due to missing data.
Significant difference in pre to post change: *p<.05; **p<.01; ***p<.001; ****p<.0001

Significantly more pilot students were also more likely to disagree with the statement that "no matter how hard I try, I cannot understand science" after Mad Science exposure. This did not, however, appear as a significant group difference between pilot and comparison group students. (Note: Rating scales were converted during analysis, so a higher number reflects a more positive science attitude).

<u>*Science Descriptors*</u>: Most students in both pilot and comparison groups began the study with positive views of science, seeing science as interesting, and involving doing activities (vs. reading books). Many students also believed that science was fun and easy. Students were about evenly split as to whether they viewed science as about looking and touching (vs. talking and listening) or about asking questions (vs. remembering facts). (See pre-test scores in Table 6.)

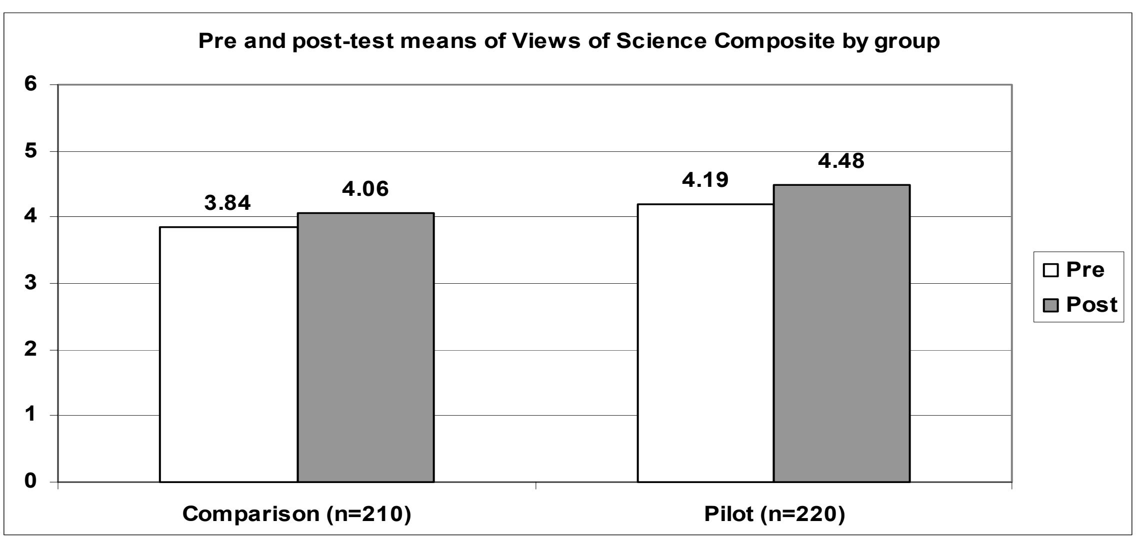
Table 6: Pre to post test change in percent selecting positive science attitude descriptors, by group

	Comparison (n=223)		**Pilot** (n=230)		**Difference**	
	Pre test % Yes	*Post test % Yes*	*Pre test % Yes*	*Post test % Yes*	*Comparison*	*Pilot*
Did student chose positive science attitude response?						
Q9a: Easy	63%	65%	65%	67%	.02	.02
Q9b: Interesting	82%	84%	93%	94%	.02	.01
Q9c: Fun	67%	68%	70%	83%****	.01	.13**
Q9d: Doing Activities	70%	81%***	85%	90%*	.11	.05
Q9e: Looking and Touching	53%	61%*	56%	60%	.08	.04
Q9f: Asking Questions	51%	51%	53%	56%	.00	.03

Note: Sample sizes for individual items vary slightly, due to missing data
Significant difference in pre to post change: *p<.05; **p<.01; ***p<.001; ****p<.0001

When analyzing the composite set of the six adjective pairs, there were no significant differences between pre- and post-test performances for either pilot or comparison group students, nor between the two groups (see Graph 4).

Graph 4:



When examining individual survey items, pilot students on their post-tests were significantly more likely to indicate that science was fun ($p < .0001$), a difference that was significantly higher than that of comparison group students ($p < .01$). (See Table 6 above.) Students in both comparison and pilot groups indicated a significant increase in thinking that science involved doing activities ($p < .001$ for comparison and $p < .05$ for pilot students).

Reasons for Wanting to Learn Science: Both pre-test and post-test surveys asked students to write about whether or not they wanted to learn science, and reasons for their view. The vast majority of students (86% - 92%) positively reported that they wanted to learn science. This was consistently expressed by students from both pilot and comparison groups, and on both pre-tests and post-tests (Table 7).

Table 7: Percent indicating desire to learn science, by group

	Comparison		**Pilot**		**Total Sample**	
	Pre test %	*Post test %*	*Pre test %*	*Post test %*	*Pre test %*	*Post test %*
Wants to learn science						
	86%	87%	92%	91%	89%	89%

Students' primary reasons for wanting to learn science were that they regarded science as either *fun* or *interesting* (by 39% and 20% of all students, respectively). These two reasons were consistently expressed by students from both pilot and comparison groups, and across both pre-tests and post-tests (Table 8).

Table 8: Primary reasons for desiring to learn science, by group

	Comparison		**Pilot**		**Total Sample**	
	Pre test %	*Post test %*	*Pre test %*	*Post test % Yes*	*Pre test*	*Post test*
Primary reason for learning science						
Fun	35%	38%	34%	39%	35%	39%
Interesting	20%	23%	21%	18%	20%	20%

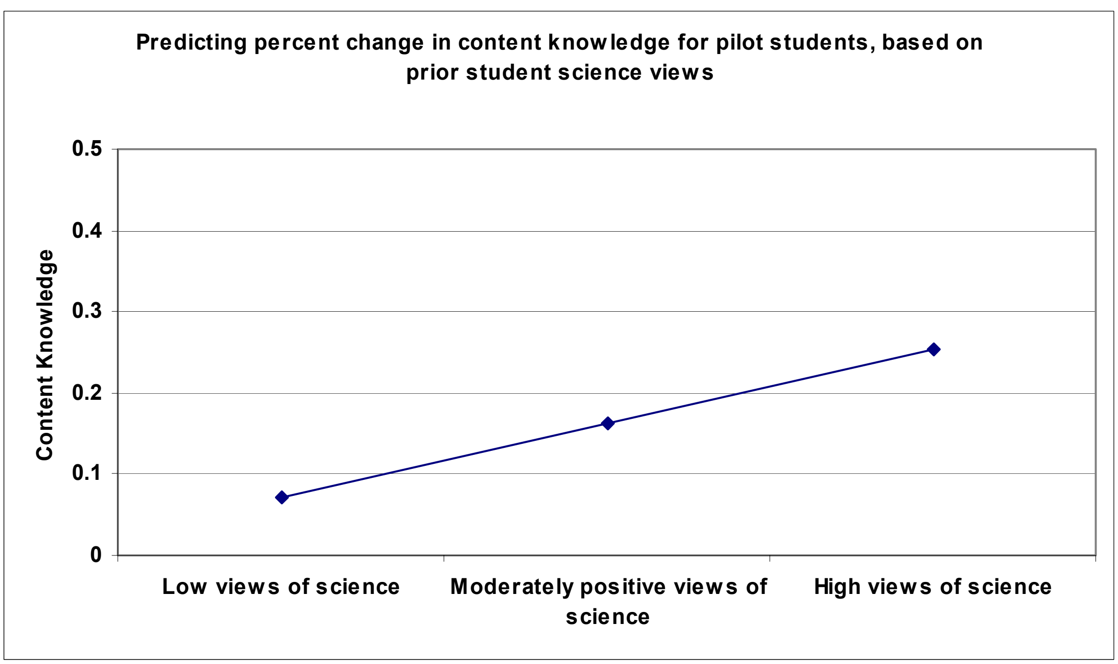
Roughly 5% of all students reported that they wanted to learn science for future jobs they might aspire to, or because they were curious about particular science topics.

Student Factors and Regression Analysis

For all the quantitative analysis results presented above, none of the following factors or covariates – gender, special education status, ESL status, prior exposure to Mad Science, or prior exposure to space curriculum in the fall – was found to be a factor influencing pre- to post-test response changes.

We used regression analysis to examine the relationship between change in students' science area content knowledge and their interest in, attitudes toward, and views of science. We only found one statistically significant relationship. There is an inter-relationship between pilot students' prior view of science and their gains in content area science knowledge due to exposure to Mad Science. Pilot students who displayed more positive views of science prior to exposure to Mad Science showed significantly more change in their content area knowledge overall than pilot students who reported less positive views of science prior to exposure. Specifically, a 1-point difference in students' prior views of science is significantly associated with a 2-percentage point change in their content knowledge ($t = 2.65$; $p < .01$) and explains 3 percent of the variation in change in content knowledge. As Plot 1 shows, students who were more positively inclined towards science were more likely to experience greater gains in the science content knowledge following their Mad Science visits.

Plot 1:



Favorite Aspects of Mad Science Visits: Students particularly enjoyed the active, hands-on science of Mad Science. When asked what they liked best about the Mad Science visits, the most common response, produced by 18% of pilot students, was that they liked either the hands-on activities or the experiments. As one student remarked, "Through Mad Science, I found out science isn't just studying or looking in a book."

Some students answered this question by citing specific favorite activities. The top two activities students described were building the space model with gloves (*Working in Space* in the NASA unit *Living in Space*), mentioned by 12% of students, and placing the toy astronaut in the cup of water to demonstrate how air takes up space (the *Aquanaut* activity in the NASA unit *Atmosphere and Beyond*), mentioned by 8% of students.

Humor and the zany personality of the Mad Science host were also favorite qualities of the visits. A number of students (13%) specifically mentioned liking their Mad Science host, particularly for his or her humor, or the fact that the visits were very funny.

> *I liked the Mad Science that came to our class because he was funny and he showed us a magic trick with a nose – a fake nose.*
> *I liked Nitro Joe.*
> *Electronic John is very funny; I liked his magic trick.*

Suggested Improvements to Mad Science: Many students were hard-pressed to come up with recommendations of how Mad Science could be improved. One fourth (25%) voiced that they thought Mad Science was good just the way it was, and had no specific suggestions for how it could be improved.

The next most common responses were that students simply wanted the Mad Science visits to last longer, occur more often, or feature more activities or experiments. 8% of students made each of these three types of suggestions. Some students also commented that they wanted the Mad Science instructor to use more student volunteers and assistants. Students offered the following kinds of suggestions:

> *Come every single day and teach us new things.*
> *Come Monday through Friday for 2 hours.*
>
> *I think they need more time, to do more things.*
> *By doing it longer and having a little store.*

Have more experiments and more time and talk about more stuff and have more assistants.

Have more volunteers to help Electron John.
I think when you choose people to help you, pick a girl then, a boy, and so on.

Concluding Remarks

In summary, this national study found Mad Science to be an educationally enriching science experience for children. Exposure to Mad Science increased children's knowledge of science concepts and content, their interest in engaging in science-related leisure activities, and their views of science as an appealing and worthwhile endeavor.

About the Research Team

This research study was conducted by Char Associates, an independent consulting firm, based in Montpelier, Vermont, specializing in the design and evaluation of educational programs and products. The firm provides program and materials development, program evaluation, and training for a wide variety of clients, including educational organizations, corporations, non-profit groups, higher education, government agencies, museums, and schools.

Our work spans all areas of learning, from early childhood to elementary and secondary schooling, to adult and informal education. Established in 1996 by Dr. Cynthia Char, Ed.D., Char Associates draws upon over 25 years of experience in educational program design and evaluation, and has clients throughout the United States.

Dr. Char has conducted evaluations and design work for many programs throughout the country. Current and previous work includes projects for Apple Computer, IBM, Children's Television Workshop, Scott Foresman, Harvard Graduate School of Education, Dartmouth College, Boston Public Schools, Vermont State Department of Education, Montshire Museum of Science, Indianapolis Children's Museum, and numerous US Department of Education and National Science Foundation projects.

Further information on the study can be obtained from:

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