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Program Evaluation • Consultation • Market Research

The Amazing Nano Brothers Juggling Show Outcomes Evaluation

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EXECUTIVE SUMMARY

In late spring 2010, Goodman Research Group, Inc. (GRG) was contracted by the Museum of Science, Boston, to conduct an outcomes evaluation of their educational live performance, *The Amazing Nano Brothers Juggling Show* (ANB). The show presents scientific concepts about atoms and nanoscience in a highly entertaining and engaging performance. The evaluation focused on the learning outcomes of children, adults, and middle school students.

KEY FINDINGS

- Despite all of the virtual and digital learning media available – or maybe because of it – the drama of live performance is captivating for audiences of all ages.
- By watching the show, both children and adults learned new information about nanoscience and technology. The show was also rated as highly educational by the adult audience members. Teachers found the show to correlate well with science standards and reinforce lessons from the classroom.
- Sections of the show involved a combination of theatrical techniques that engrossed the audience and heightened their learning potential.
- The medium of juggling as used in this context is highly successful for teaching children, teens, and adults about nanoscience – particularly about the structure, movement and manipulation of atoms.
- For teens and adults already familiar with these scientific concepts, the visualizations from the performance provided excellent reinforcement and clarity for deeper understanding of these concepts.

KEY RECOMMENDATIONS

- Continue to explore the medium of juggling, drama, and other performance arts as teaching tools for scientific material.
- The performance provides various levels of educational depth for audiences of all ages to learn something. For audiences of mostly teens and adults, adding more advanced scientific content may increase learning outcomes.
- When replicating the show, maintain the fast pace and high energy of the performance for the audience's entertainment and engagement.
- Consider adjusting the opening of the show when performing for mostly teen audiences.
- In addition to recall and recognition of scientific content, further research on ANB should address retention of that content over time.

INTRODUCTION

In partnership with the Center for High-rate Nanomanufacturing and the Harvard Nanoscale Science and Engineering Center, and with funding from the National Science Foundation[1] and the Massachusetts Technology Collaborative, Boston's Museum of Science (MoS) developed The Amazing Nano Brothers Juggling Show (ANB) with performance artists Dan Foley and Joel Harris as part of the Museum's effort to engage public audiences in learning about nanoscience and nanotechnology. The show uses juggling to model and dramatize the nanoscale world including: exploring atoms, molecules, nanoscale forces, and scanning probe microscopy. The program is offered in live performances at MoS and is also part of a DVD set on nanoscience.[2]

In May 2010, MoS contracted Goodman Research Group, Inc. (GRG), a research firm in Cambridge, MA that specializes in the evaluation of educational programs and materials, to conduct an outcomes evaluation of ANB. The goal of this evaluation was to examine the effectiveness of the show in increasing audiences' knowledge of and interest in nanoscience and nanotechnology. Prior to the onset of GRG's evaluation, museum comment cards provided evidence that audiences enjoyed the performance. Therefore, this evaluation sought to uncover the educational content that audiences have learned from the show. In addition, the evaluation addressed outcomes of audience engagement.

METHODS

Between May 23, 2010 and June 30, 2010, GRG collected evaluation data from three different sources: children and adult audience members, who were surveyed either before or after a performance, and teachers, who had seen ANB as part of a field trip with their classes. The surveys and procedures were approved by the MoS Institutional Review Board. For the live show audiences, GRG distributed one pre-performance or post-performance survey for teens and adults and a second pre-performance or post-performance survey for children 12 and under. Ten teachers were interviewed between June 14 and June 30. The following sections describe the methods of data collection used for the evaluation.

SURVEYS AT LIVE PERFORMANCES

Audience surveys were collected from 131 children between six and 12 years old and from 223 adults either before or after a total of six performances given on May 23, June 6, and June 13, 2010. The post-surveys were administered directly after the end of the first performance of the day and the pre-surveys were administered just before the beginning of the second performance of the day. The surveys took about five minutes to complete and participants received a small rub-on tattoo as a token of appreciation. Between one-third and one-half of the families in the audience participated at each performance. ANB performance

[1] NSF PHY-0646094 and NSF EEC-0425826
[2] *Talking Nano*, see talkingnano.net

programs, which contain considerable content that would normally reinforce the educational messages of the show, were not available to audience members on the survey days.

For the pre-performance survey, GRG researchers approached individuals and asked them if they were interested in participating in a brief survey as part of the research on the show, and passed out the pre-surveys and pencils to those who were willing to participate. As the start time of the show approached, researchers walked around the theater to collect completed surveys.

For the post-performance survey, during the show's finale a cast member made an announcement about the opportunity to provide feedback that day's show. After the show ended, GRG researchers walked down the aisles of the theater handing out post-surveys to those who wanted to participate. Individuals handed completed surveys to researchers as they left the theater. Appendix A contains both adult and child pre- and post-performance survey instruments.

Although many children under the age of 6 took the children's pre- and post-performance surveys (n=41), their responses were removed before the formal analysis of the children's data because they were not old enough to understand much of the educational content in the show. Responses to the children's surveys by teens and adults were also excluded (n=10). For the adult survey, responses by children 12 and under were excluded (n=6), and since few 13-17 year-olds completed the surveys (n=9), only adult responses from visitors 18 years and older were analyzed.

During the on-site data collection, field researchers made specific efforts to recruit teens to participate. However, teens appeared to be underrepresented among the audience, which consisted mostly of families with younger children. Most, if not all, teens in the audience completed a survey. There were no school trips during the data collection period. Therefore, the teacher interviews were the main source of data for 13-year-olds in the show's target school audiences of youth ages 8-13 and middle school groups.

TEACHER INTERVIEWS

GRG completed teacher interviews with ten teachers. A representative from MoS sent an introductory email to teachers who had led field trips to the MOS about interviewing them about their classes' experience watching ANB. GRG followed up by contacting each teacher to schedule a 15-20 minute interview. The interview questions asked teachers to reflect on their perception of their students' knowledge and attitudes before, during, and after seeing ANB. Appendix A contains the interview protocol.

FINDINGS

This section first presents findings from the children's survey and then from the adult survey, followed by themes from the teacher interviews. Detailed charts with all of the participants' responses are available for reference in Appendix B.

CHILDREN'S AUDIENCE SURVEY

(The pre- and post-performance survey instruments are in the Appendix on p.A1-A4 and the annotated instrument with children's data is on p. A16.)

Child Demographics

A total of 131 children participated in "The Amazing Nano Brothers Challenge" surveys either before or after watching the show. Table 1 presents the age and gender of the children for the pre and post surveys.

Table 1. Children's Age and Gender

	Percentage of Respondents	
Age in Years	**Pre-Performance (N=73)**	**Post-Performance (N=58)**
6	12%	17%
7	21%	14%
8	18%	19%
9	18%	17%
10	21%	16%
11	7%	10%
12	4%	7%
Gender	**Pre-Performance (N=72)**	**Post-Performance (N=55)**
Boy	43%	45%
Girl	57%	55%

N=131

**Totals may exceed 100% due to rounding*

Children's Enjoyment of the Show

Overall, children were highly engaged during the show. Children enjoyed the ANB performance, with 97% of the post-performance survey responses at the highest enjoyment rating. Sixty-five percent of the children said that they learned "a lot" from the show. Eighty-eight percent of the children felt the show was a good length. Overwhelmingly, most children's favorite part was the finale, when the jugglers performed on unicycles.

When comparing the pre- and post-performance survey responses regarding the child's favorite exhibit or program at the MoS, ANB made a pronounced impression. Before seeing the show, the children's choices of favorite museum exhibit were mostly evenly distributed across a variety of programs (six different programs were named by at least four children each). After seeing the show,

more than half of the children cited ANB as their favorite, with no other program receiving more than three responses.

Children's Content Quiz Items

Children learned specific science content about atoms from ANB, most notably that scientists can move individual atoms. For each of the eight content questions, the post-performance children had a higher percentage of correct responses than did the pre-performance children. Table 2 presents the pre- and post-performance survey responses and identifies the four content questions which yielded significant differences, indicating that more children learned the information from the ANB show.

Table 2. Children's Increase in Content Knowledge

Questions	Answer[3]	Answered Correctly Before Seeing ANB	Answered Correctly After Seeing ANB	*% Increase*
Can scientists move individual atoms?	Yes	46%	83%	***37%****
Is everything made of atoms?	Yes	71%	100%	***29%****
Do atoms stick to each other?	Yes	75%	95%	***20%****
Which do you think is smallest? (out of 4 choices)	An atom	61%	80%	***19%****
What is nanotechnology? (out of 5 choices)	Working with very tiny things	29%	44%	***15%***
About how big is a meter?	A yard	56%	68%	***12%***
When atoms get warmer, do they move slower or faster?	Faster	75%	81%	***6%***
Can scientists shrink people down to the size of ants?	No	93%	96%	***3%***

N=70-73 (Before ANB); N=55-58 (After ANB)
*p<.05

For the questions that did not show statistically significant differences, there are at least two possible explanations:

- Children may already have known the answer to the question before coming into the show, and the small percentage who did not know the answer did not learn it from watching the performance.
- Children did not know the answer to the question ***before*** coming into the show and did not learn it from the show.

For the first explanation, perhaps these questions were "too easy" for the age group. Many children already knew that the atom was the smallest of the choices, that heat makes atoms move faster, and almost all knew that scientists cannot shrink people down to the size of ants (or atoms). For those who did not know,

[3] For all of the answer choices, see appendices

there was not a significant change in the types of incorrect answers the children chose.

For the second explanation, these quiz items often asked children to integrate what they learned from the show and may not have been said verbatim by the actors. For example, the size of a meter was not explicitly taught in the show. The definition of nanotechnology was a challenge for children to conclude. The wording of one of the answer choices, "the engineering of nanos," seemed to mislead the children away from the correct answer, "working with very tiny things."

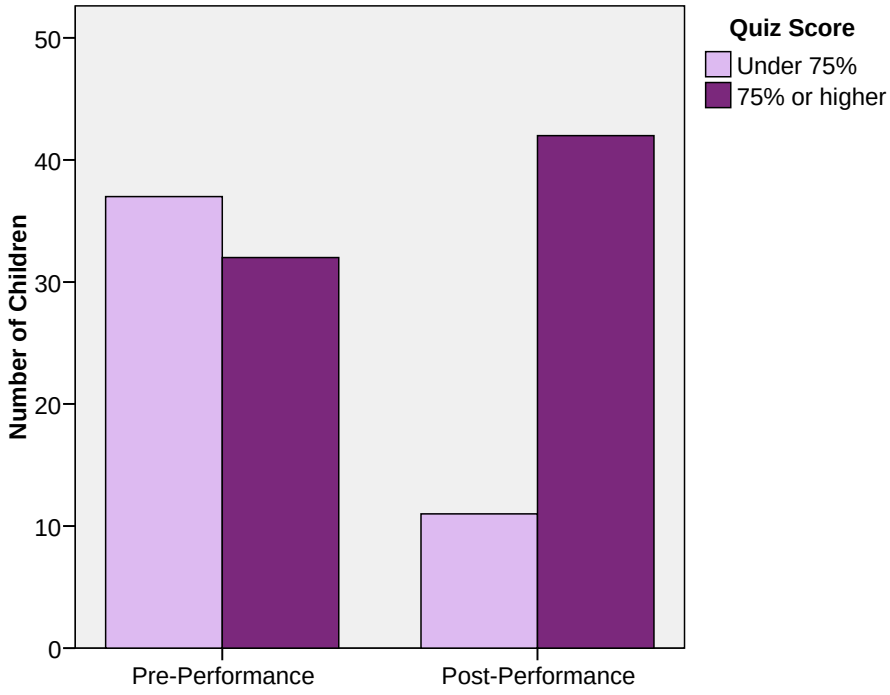
Children's Content Quiz Overall Scores

(See Appendix B for children's quiz data on pp. A18-A19.)

On average, children who took the survey after the performance scored 18% higher on the content quiz compared to children who took the survey before the performance. There were no differences by gender or age on the content quiz scores.

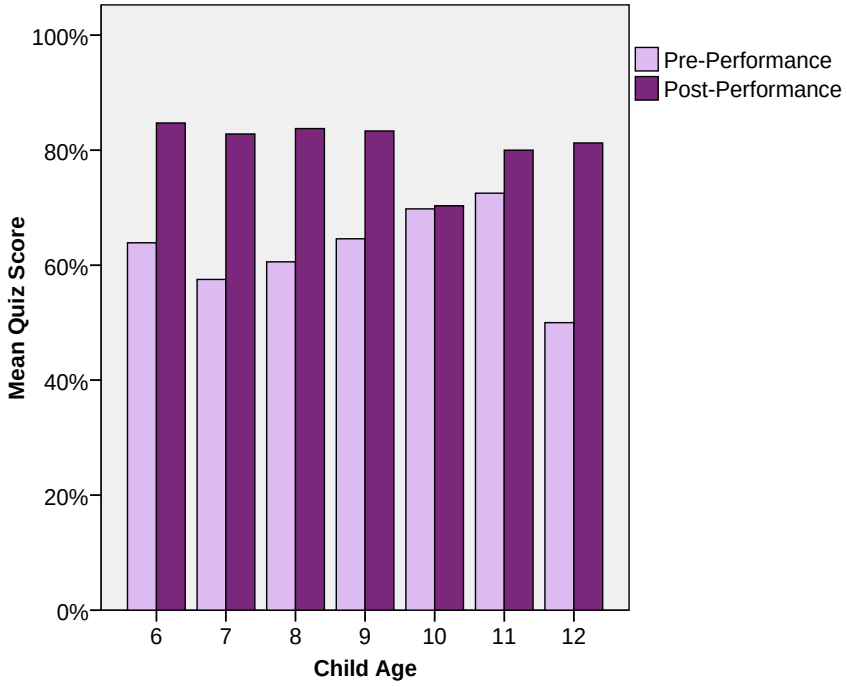
Figure 1 compares the numbers of children scoring above and below 75% before seeing the show with the numbers of children scoring above and below 75% after seeing the show. Less than half of the pre-performance children scored above 75%. On the other hand, 80% of the post-performance children scored a 75% or higher on the quiz. Not shown in Figure 1, but of significance: The number of children receiving a perfect score on the quiz tripled.

Figure 1. Comparison of Children's High/Low Scores Before or After the Performance



There were no significant differences by age when looking at the quiz scores in general; however, when comparing pre-performance and post-performance survey scores by age, children between the ages of six and nine, as well as twelve-year-olds, had the largest differences between pre- and post-performance mean quiz scores (Figure 2).

Figure 2. Age Differences on Content Quiz Scores Before and After the Performance



ADULT AUDIENCE SURVEY

(The pre- and post-survey instruments are found in the Appendix on pp. A5-A8.)

Adult Demographics

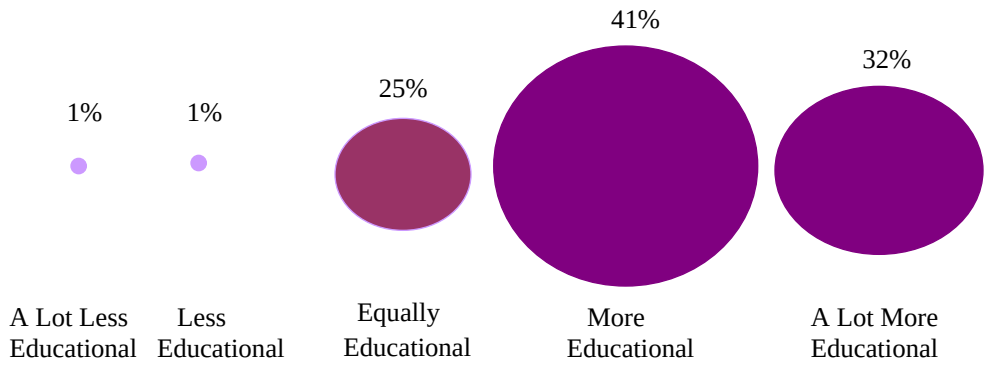
The adult audience survey was completed by 223 individuals, roughly half before and half after an ANB performance. Surveys from adults who indicated they had seen the performance prior to the day of the survey were discarded. A total of 105 pre-performance surveys and 96 post-performance surveys were included in the analysis.

The adults pre-surveyed had similar demographics to the adults post-surveyed. There was an even number of men and women and a normal distribution (bell shape) for respondents' age group and highest level of education. In both groups, just under half of the respondents either worked or had a family member who worked or studied a science-related field. Most adults found out about the performance by MoS staff (35%) or a sign in the lobby of the museum (38%). For detailed charts of these demographics, please see Appendix B.

Adults' Perceived Value of ANB Show

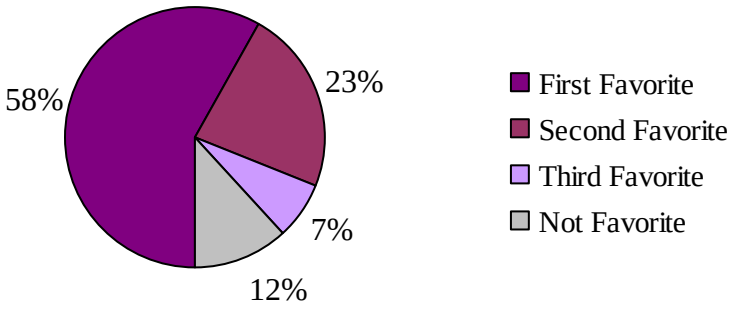
Post-performance surveys showed that adults judged ANB to be very educational, and 73% of the adults rated the show as more educational than other exhibits or programs at the museum (Figure 3).

Figure 3. Adults' Ranking of ANB Educational Value Compared to Other Museum Offerings



Adults also greatly enjoyed the ANB show. Eighty-eight percent of the adults rated the show in their top three favorite exhibits or programs from that day's visit to the Museum. Of those who listed ANB, 66% ranked it as their top favorite (see Figure 4 for details).

Figure 4. Adults' Ranking of ANB in Favorite Museum Offerings



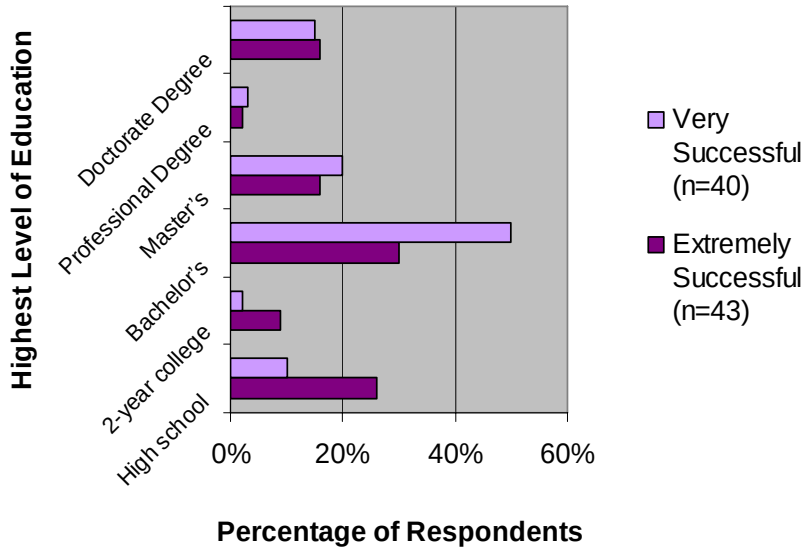
When examining the data by age, gender, education level, having a family member in a science field, and familiarity with nanoscience, there were no significant differences in ratings of the show's educational or enjoyment value.

Adult Learning Outcomes from ANB

On post-performance surveys, adults were asked to rate the show's success at increasing their interest in science, helping them learn something new about science, and making learning about science fun. Adults gave the show high ratings on all three measures of success. On the following page, Figure 5 presents three charts representing adults' responses for these questions.

Since the performance had a positive impact on almost the entire adult audience, we conducted statistical analyses to examine whether there were any differences between someone who would rate the show ***very successful*** versus ***extremely successful.*** One relationship discovered was between a respondent's highest level of education and their rating for the show's success in increasing their interest in science. Those with Bachelors and Masters Degrees tended to rate the show ***very successful*** while those with high school or 2-year college completion rated the show ***extremely successful*** (see Figure 6).

Figure 6. The Relationship between Highest Level of Education and Success of ANB in Increasing Adult's Interest in Science



The performance clearly supported learning at all education levels, and supported the needs of those with less completed education particularly well.

Adult Content Quiz Items

(See Appendix B for adult's pre- and post-survey quiz data on p. A22-A24.)

A content quiz was administered to examine adults' learning outcomes from watching the performance. Quiz results from individuals who had attended the show on a previous date were removed from both the pre- and post-survey groups.

Figure 5. How successful was the ANB Juggling Show at…

- Almost 95% of the adults rated the show ***very*** or ***extremely successful*** at making learning about science fun.
- Over 85% rated the show as ***very*** or ***extremely successful*** at helping learn something new about science.
- Over 60% rated the show as ***very*** or ***extremely successful*** at making them more interested in nanoscience.

Adults learned specific new facts from the performance. When asked in a free response question to list two interesting science concepts they learned from the show, 54% of the responses covered the following facts:

- The scale or size of a nanometer
- The function of the scanning probe microscope
- That atoms are mostly empty space
- That we can manipulate individual atoms

(See Figure 7 for a graphic representation of the prevalence of particular concepts mentioned in responses.)

The adults' gain in knowledge related to nanoscience was also evidenced by the content quiz scores. Table 3 presents the items which were answered correctly by significantly more people in the post-survey than the pre-survey. (The correct answers are bolded, underlined and capitalized.)

Table. 3

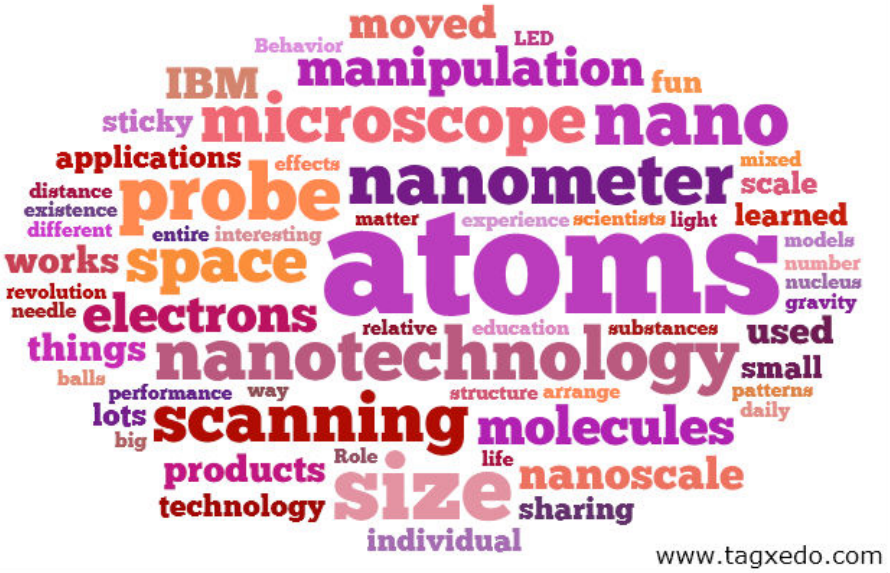
Questions	Answer Choices	Answered Correctly Before Seeing ANB	Answered Correctly After Seeing ANB	*% Increase*
Circle the smaller one in each pair:	Microscale **NANOSCALE**	88%	100%	***12%***
	10 MILLION **NANOMETERS** A meter	84%	96%	***12%***
What is the approximate size of an atom if the nucleus was the size of a basketball?	The size of: A basketball hoop A car A football stadium **A LARGE CITY** The United States	12%	37%	***25%***
Atoms can be felt with special instruments, but not seen	**TRUE** False	35%	64%	***29%***
Gravity affects the movement of individual atoms	True **FALSE**	49%	68%	***19%***

N= 96-105 (Before ANB), N=87-96 (After ANB)

Regarding survey questions that did not reveal statistically significant increases in learning, the explanation is probably similar to that applied to the results of the children's survey: most adults either knew the answers before coming to the show (e.g. "Everything is made of atoms") or they did not learn the information from the show (e.g. "Which is smaller: 100 billion nanometers or a meter").

Figure 7 is a graphic representation of the relative prevalence of words used in answering the open-ended post-performance survey question "What were two interesting science concepts you learned at today's show?" The size of the word corresponds with its frequency in the data.

Figure 7.



Adult Overall Quiz Scores

There was a significant increase in average quiz scores when comparing the pre- and post-show audiences, indicating that adults learned about nanoscience from the show.

Further analysis revealed that three factors contributed the most towards a higher score: seeing the ANB show, gender, and previous familiarity with nanoscience. Please see Figures 8 and 9 to see how these variables affected the mean quiz scores.

When taking the effects of gender, previous familiarity, and survey status into account:

- The post-survey adult scored 9% higher on the quiz than did the pre-survey adult.
- Adults with higher levels of familiarity with nanoscience scored better on the survey; on average an increase in experience by one level corresponded with a 3% increase on the survey score.
- Males scored 6% higher on the quiz than females.

When considering all of those factors together, an average adult audience member could range from a 63% pre-survey score to an 82% post-survey score, a difference of 18%, depending on their gender and previous familiarity with nanoscience.

No other demographic information significantly influenced overall quiz scores.

Figure 8. Differences in Adults' Quiz Scores Before or After ANB by Familiarity with Nanoscience

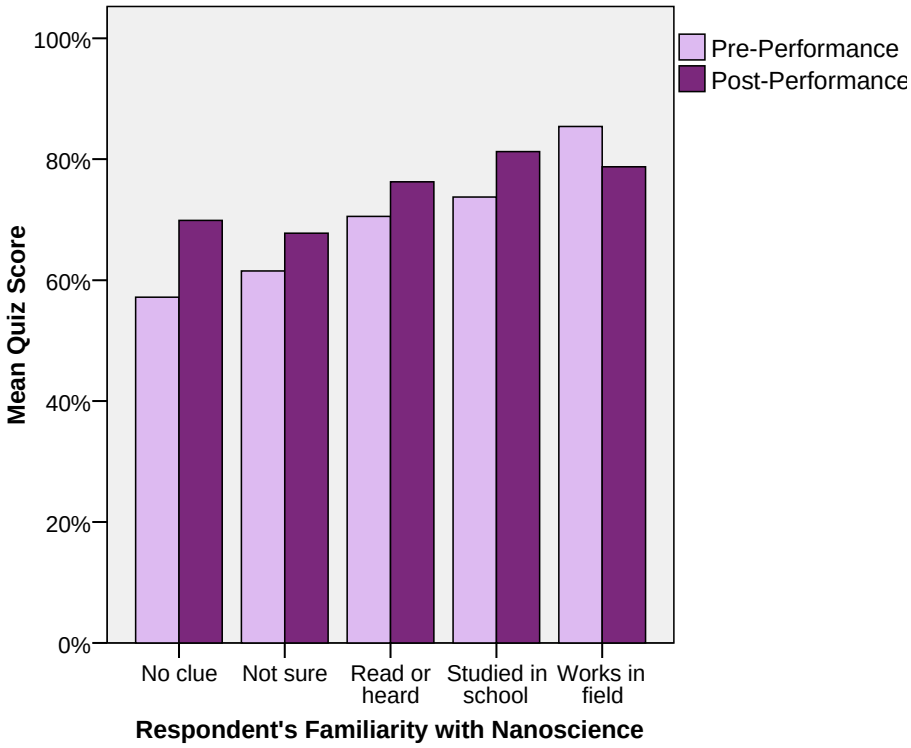
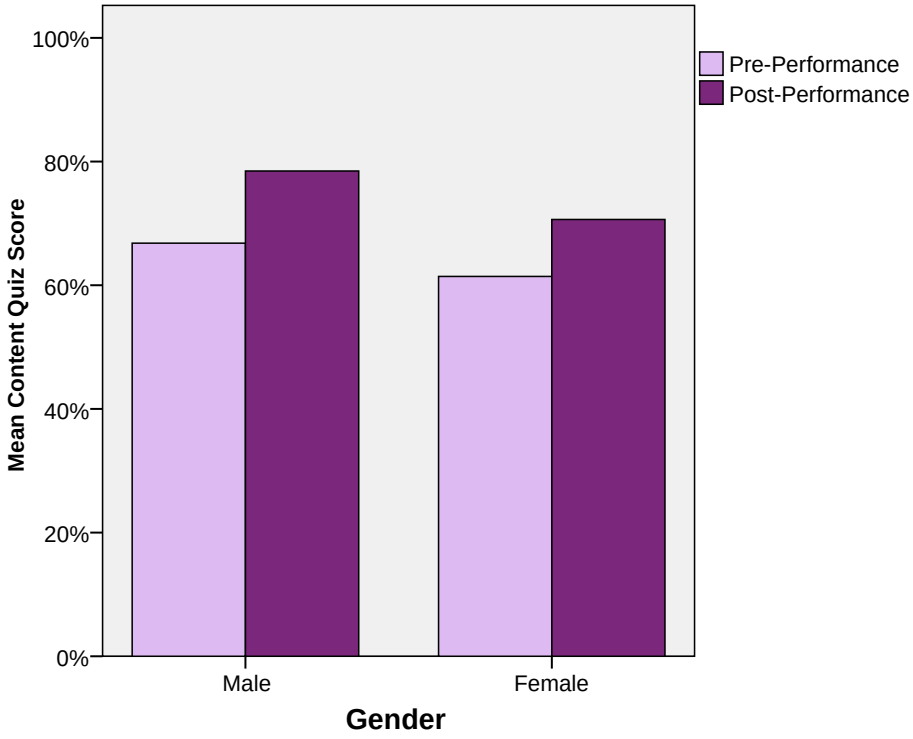


Figure 9. Differences in Adults' Quiz Scores Before or After ANB by Gender



TEACHER INTERVIEWS

Responses from the teacher interviews were grouped into three themes:

- Teaches' Responses to Show as a Museum Performance
- Students' Reactions to ANB Show
- ANB Show's alignment with curriculum

Each theme is discussed below. See Appendix A, pp. A9-A15, for the interview protocol, and Appendix B, pp. A27-A39 for detailed interview responses.

Theme 1: Teachers' Response to ANB Show

Most of the teachers interviewed heard about *The Amazing Nano Brothers Juggling Show* from their school's field trip coordinator or from a Museum of Science field trip coordinator. All teachers knew that they would be seeing the juggling show as part of their trip, but they did not know exactly what to expect. None of the teachers viewed the teacher guide on the website.

Besides ANB, the school groups saw a variety of other exhibits, presentations, demonstrations or shows as part of their trip to the Science Museum. Among others, teachers mentioned the Omni theater show, the Science in the Park exhibition, and the Theater of Electricity. Several teachers recalled the Nano Brothers show as a highlight for students, and all of the teachers said they found the show to be equally or more effective than the other exhibits and shows because it was so engaging. One teacher who found it *more* effective reflected that, "the fact that they were so amazed by the juggling, and were making connections to what they had already learned regarding matter -- they could actually visualize it -- reinforced their learning."

All of the teachers interviewed were unsure as to whether they would have attended the show if it meant paying extra for their visit. Some of this uncertainty was based on the methods their school used to pay for the field trip and other budgetary constraints. Similar concerns were highlighted in teachers' willingness to recommend to their principals to bring the show to their schools. Although almost all of the teachers reacted positively to the suggestion, many listed budget concerns as a limiting factor. If the Nano Brothers Show does decide to go forward with either or both of these plans, the ability to work within schools' budgets will likely play a large role.

Theme 2: Students' Reactions to ANB Show

All of the teachers interviewed described their students' experiences as positive; the majority of teachers said their students seemed extremely engaged and entertained by the show. The teachers perceived the students as liking the performance aspects of the show the best; specific highlights mentioned by more than one teacher included: the juggling component, unicycles, and the comedic aspects.

One area noted by teachers for improvement was the introduction to the show (before the juggling began); several teachers thought the beginning of the show may have been slow or too "cheesy" for a mostly teen and pre-teen audience. Nonetheless, notably, the show was engaging for a vast majority of students, not just a select few. One teacher said she was "totally amazed. [They were] totally focused on the show. Numerous ELL learners saw the show and because of all the visualization, it really helped their learning as well. It applied for everyone. There wasn't anyone that was not interested." This teacher also explained that the slow introduction of the material was especially helpful for English Language Learners.

All ten teachers found the show to be age and grade appropriate for their students. However, three out of the seven middle school teachers (grades 6-8) found certain components of the show to be more age-appropriate than others. For example, one teacher found the content to be age-appropriate, but thought the presentation was targeted towards a younger crowd. All of the teachers said that the juggling effectively presented the content visually to either introduce the concept of nanoscience (younger grades) or to reinforce the physics content that they covered in the classroom (older grades).

Theme 3: Alignment with the Curriculum

Many of the teachers mentioned that the show both introduced new concepts and reinforced lessons that students had already learned. Almost all of the teachers thought the science ideas in the show fit in well with the Massachusetts science standards. Although a few teachers mentioned briefing the students in the relevant subject matter before attending the ANB performance, 9 out of 10 of the teachers did not do specific preparations with the students or on their own before attending.

Likewise, none of the teachers mentioned a formal follow-up upon return to the classroom. This lack of formal preparation and follow-up may be explained by the close alignment of the show's content matter with the schools' existing curriculum. For example, as one teacher said, "I think it's worked out nicely, we studied magnetism after – and [the show] was an activator to tie [the content] back to them. The unit was like a summarizer and they kept revisiting [the show] throughout the unit."

Most teachers were satisfied with the museum's help in preparing teachers for the show, although a few teachers mentioned that they would have liked to see the whole show beforehand if possible. Interestingly, only one teacher was aware of the printed show program, and none of the teachers reported using it. Teachers were mixed about whether they would like the museum to provide more follow-up materials; several mentioned they would welcome post-show activities, whereas others did not feel it was necessary or that they had the time to use them in the classroom.

CONCLUSIONS AND RECOMMENDATIONS

Juggling in the context of a dramatic scripted performance was an effective medium for helping the audience visualize and conceptualize the nanoscale and the behavior of atoms at the nano level. Below are our conclusions and recommendations based on the results.

CONCLUSIONS

Despite all of the virtual and digital learning media available – or maybe because of it – the drama of live performances are captivating for audiences of all ages.

- Children from six- to 12-years-old highly enjoyed the performance and learned "a lot" from it.
- Middle-school students were also highly engaged in the juggling performances and the visual representations of science.
- Adults found the show entertaining and successful in making learning about science fun.

The medium of juggling in the context of dramatic performance is highly successful for teaching children, teens, and adults about nanoscience – particularly about the structure, movement and manipulation of atoms.

The content learned directly from the show directly corresponded with specific scripted juggling acts. The sections that most successfully transferred the scientific concept from the visual representation included:

- Juggling silly objects during "Everything is Made of Atoms" (particularly for young children)
- Including a participant from the audience in the modeling of the atom in "The Mysterious Atom" (teachers said it brought it to their students)
- The use of lighting and special effects also during the modeling of the atom (a particular favorite)
- Juggling stopped abruptly by Velcro representing the stickiness of atoms
- Riding the unicycle over bumps on the floor of the stage to represent the tip of the scanning probe microscope in "Feeling Atoms"

Sections of the show involved a combination of theatrical techniques that engrossed the audience and heightened their learning potential.

These techniques included:

- Humor and playfulness
- Sophisticated juggling skills
- Audience participation
- Special effects (glow in the dark balls, Velcro)
- Repetition and clarity in presentation of scientific material

- Dramatic story arc involving conflict and resolution between two distinct and classic characters, a naïf and a know-it-all

For teens and adults already familiar with some of these scientific concepts, the visualizations from the performance provided excellent reinforcement and clarity for deeper understanding of the concepts.

Teachers explained how during the show, students expressed comments of awe and understanding, and that students referred back to the performance throughout the nanoscience or physics unit in school.

RECOMMENDATIONS

Continue to explore the medium of juggling, drama, and other performance art as teaching tools for scientific material.

The combination of theatrical techniques was highly effective for visualizing nanoscience and could also be used to visualize other types of abstract scientific concepts that students have difficulty grasping.

Add more advanced scientific content for teens and adults.

Since adults already knew many of the facts in the show and teens are learning this material in school, we recommend adding more scientific content to support deeper learning for these ages.

When replicating the show, maintain the fast pace and high energy of the performance for the audience's entertainment and engagement.

The audiences were enthralled by the arts and talents of the performers.

Consider adjusting the opening of the show when performing for teen audiences.

Although adults and younger children appreciate the humor in the opening of the show, there is a risk that teenagers may feel the start of the show is childish or below their level.

APPENDICES

Appendix A A1

Appendix B A16

The Amazing Nano Brothers Challenge

Are you a: BOY GIRL **Your age: _____**

1. **Which do you think is the smallest?** *(Choose only one.)*

   ○ Molecule ○ Bacteria Cell

   ○ Atom ○ Grain of Sand

2. **About how big is a meter?** *(Choose only one.)*

   ○ Six feet ○ A yard

   ○ An inch ○ A mile

3. **Can scientists shrink people down to the size of ants?**

   ○ Yes ○ No

4. **Is everything made of atoms?**

   ○ Yes ○ No

5. **Do atoms stick to each other?**

   ○ Yes ○ No

6. **When atoms get warmer, do they move slower or faster?**

   ○ Slower ○ Faster

7. **Can scientists move individual atoms?**

   ○ Yes ○ No

8. **What is nanotechnology?** *(Choose only one.)*

   ○ A very small music player

   ○ The engineering of nanos

   ○ Working with very tiny things

   ○ Devices that help elderly people

   ○ None of the above

9. **During your visit to the Museum today, what has been your favorite exhibit or program so far?**

   _____

   _____

   _____

   _____

Thank you for taking this survey!

For parents or guardians of minors (under 18):

I have been informed of my rights and the rights of my child regarding his or her voluntary participation in this survey, and I consent to his/her participation in this survey.

Name _____

Signature _____ Date ___ /___ /___

The Amazing Nano Brothers Challenge

Are you a: BOY GIRL **Your age: _____**

1. **How much did you enjoy this show?**
   - ○ Not at all ○ A little
   - ○ Some ○ A lot
2. **How much did you learn about atoms from this show?**
   - ○ Not at all ○ A little
   - ○ Some ○ A lot
3. **This show was…**
   - ○ Too long ○ Too short ○ Just right
4. **What was your favorite part of the show?**

   _____

   _____

   _____
5. **Which do you think is the smallest?** *(Choose only one.)*
   - ○ Molecule ○ Bacteria Cell
   - ○ Atom ○ Grain of Sand
6. **About how big is a meter?** *(Choose only one.)*
   - ○ Six feet ○ A yard
   - ○ An inch ○ A mile
7. **Can scientists shrink people down to the size of ants?**
   - ○ Yes ○ No
8. **Is everything made of atoms?**
   - ○ Yes ○ No
9. **Do atoms stick to each other?**
   - ○ Yes ○ No
10. **When atoms get warmer, do they move slower or faster?**
    - ○ Slower ○ Faster
11. **Can scientists move individual atoms?**
    - ○ Yes ○ No
12. **What is nanotechnology?** *(Choose only one.)*
    - ○ A very small music player
    - ○ The engineering of nanos
    - ○ Working with very tiny things
    - ○ Devices that help elderly people
    - ○ None of the above
13. **During your visit to the Museum today, what has been your favorite exhibit or program so far?**

    _____

    _____

    _____

    _____

For parents or guardians of minors (under 18):

I have been informed of my rights and the rights of my child regarding his or her voluntary participation in this survey, and I consent to his/her participation in this survey.

Name _____

Signature _____ Date ___ /___ /___

The Amazing Nano Brothers Challenge

1. Have you ever seen The Amazing Nano Brothers Juggling Show before?

O No O Yes, once O Yes, more than once

2. How did you find out about the show?

O Museum of Science (MoS) staff O MoS lobby sign O MoS program or flyer
O Friend, acquaintance or family member O MoS website O Other website _____
O Other _____

3. How familiar are you with nanoscience or nanotechnology?

O I really don't have a clue
O I've heard of it, but I don't really know what it is
O I've read or heard something about it
O I've studied it in school
O I work in nanoscience or a related field

For the next 3 questions, please try to guess if you don't know the answer.

4. Circle the SMALLER ONE in each pair:

atom	**OR**	nanometer
atom	**OR**	molecule
microscale	**OR**	nanoscale
bacteria	**OR**	virus
10 million nanometers	**OR**	a meter
100 billion nanometers	**OR**	a yardstick

5. If the nucleus of an atom was the size of a basketball, approximately how large do you think the whole atom would be?

O The size of a basketball hoop
O The size of a car
O The size of a football stadium
O The size of a large city
O The size of the United States

6. Which of the following statements do you think are true? *(Choose all that apply.)*

O Everything is made of atoms.
O Atoms can be felt with special instruments but not seen.
O Scientists can move groups of atoms, but not individual atoms.
O Temperature affects the movement of individual atoms.
O Atoms tend to stick together.
O Gravity affects the movement of individual atoms.
O Products using nanotechnology are already in stores.
O Nanotechnology has been proven safe.
O None of these are true.

TURN OVER

7. Please list your three favorite exhibits or programs from today's Museum visit so far.

1st favorite _____

2nd favorite _____

3rd favorite _____

8. Are You:

O Male O Female

9. How old are you?

O 12 and under O 13-17 O 18-24 O 25-34 O 35-44 O 45-54 O 55+

10. Do you or anyone in your family study or work in a science-related field?

O Yes O No

11. What is the highest degree you have earned?

O Less than High School
O High School or equivalent
O 2-year college degree
O Bachelor's degree
O Master's degree
O Professional degree
O Doctorate degree

For parents or guardians of minors (under 18):

I have been informed of my rights and the rights of my child regarding his or her voluntary participation in this survey, and I consent to his/her participation in this survey.

Name _____

Signature _____ Date ___ /___ /___

The Amazing Nano Brothers Challenge

1. Have you ever seen The Amazing Nano Brothers Juggling Show before today's performance?

O No O Yes, once O Yes, more than once

2. How did you find out about the show?

O Museum of Science (MoS) staff O MoS lobby sign O MoS program or flyer
O Friend, acquaintance or family member O MoS website O Other website _____
O Other _____

3. How successful was the Juggling Show at…

	Not at All Successful	**A Little Successful**	**Somewhat Successful**	**Very Successful**	**Extremely Successful**
Making you more interested in nanoscience?	O	O	O	O	O
Making learning about science fun?	O	O	O	O	O
Helping you learn something new about science?	O	O	O	O	O

4. <u>Before today's show</u>, how familiar were you with nanoscience or nanotechnology?

O I really didn't have a clue about it
O I had heard of it, but I didn't really know what it was
O I had read or heard something about it
O I had studied it in school
O I work in nanoscience or a related field

5. Compared to other Museum of Science exhibits and programs, this show was:

A lot less educational	Less educational	Equally educational	More educational	A lot more educational

6. What were two interesting science concepts you learned at today's show?

A. _____

B. _____

For the next 3 questions, please try to guess if you don't know the answer.

7. Circle the SMALLER ONE in each pair:

atom	**OR**	nanometer
atom	**OR**	molecule
microscale	**OR**	nanoscale
bacteria	**OR**	virus
10 million nanometers	**OR**	a meter
100 billion nanometers	**OR**	a yardstick

8. If the nucleus of an atom was the size of a basketball, approximately how large do you think the whole atom would be? *(Choose only one.)*

- O The size of a basketball hoop
- O The size of a car
- O The size of a football stadium
- O The size of a large city
- O The size of the United States

9. Which of the following statements do you think are true? *(Choose all that apply.)*

- O Everything is made of atoms.
- O Atoms can be felt with special instruments but not seen.
- O Scientists can move groups of atoms, but not individual atoms.
- O Temperature affects the movement of individual atoms.
- O Atoms tend to stick together.
- O Gravity affects the movement of individual atoms.
- O Products using nanotechnology are already in stores.
- O Nanotechnology has been proven safe.
- O None of these are true.

10. Please list your three favorite exhibits or programs from today's Museum visit so far.

1st favorite _____

2nd favorite _____

3rd favorite _____

11. Are You:

O Male O Female

12. How old are you?

O 12 and under O 13-17 O 18-24 O 25-34 O 35-44 O 45-54 O 55+

13. Do you or anyone in your family study or work in a science-related field?

O Yes O No

14. What is the highest degree you have earned?

- O Less than High School
- O High School or equivalent
- O 2-year college degree
- O Bachelor's degree
- O Master's degree
- O Professional degree
- O Doctorate degree

For parents or guardians of minors (under 18):

I have been informed of my rights and the rights of my child regarding his or her voluntary participation in this survey, and I consent to his/her participation in this survey.

Name _____

Signature _____ Date ___ /___ /___

The Amazing Nano Brothers Juggling Show – Teacher Interview Protocol

Introduction

Thank you very much for taking some time today to talk about The Amazing Nano Brothers Juggling Show that you took your class to see at the Museum of Science. Everything that you say today will be confidential and no names will be used in any of the reporting from these interviews. If there are any questions that you prefer not to answer, let me know and we can stop at any time.

The interview will be about 15-20 minutes long. Is now still a good time?

IF YES: Great, so let's begin.

IMMEDIATE REFLECTION

First I'd like you reflect on your class's experience at The Amazing Nano Brothers Juggling Show.

1. Could you please tell me what would be the "tagline" for your class's experience at the show? It could be sentence, a word or a phrase (positive, negative or neutral) that summarizes the experience.

FIELD TRIP DETAILS

Next I'd like to get some details about your field trip. I have that you went to the museum on [state date] and that you teach [grade level]. Is that correct?

2. Did all the students from your class attend the Amazing Nano Brothers show during this field trip?

IF NOT, how many students went to the show?

3. Besides the Amazing Nano Brothers Show, what other exhibits, presentations, demonstrations or shows do you remember the students seeing during your trip?

4. What was the highlight of the field trip for your students?

PROBE: What did they talk about the most?

OVERALL REFLECTION

For the next set of questions, please reflect on your class's overall experience seeing the Amazing Nano Brothers Show.

5. Compared to other Museum of Science exhibits and shows would you say that the Amazing Nano Brothers Show is less effective educationally, equally effective educationally, or more effective educationally for your students?

PROBE: Could you explain your answer?

6. Do you feel that the show was appropriately targeted for the age and grade level of your students?

PROBE: Could you describe why you think the show was/wasn't appropriate? (Based on content? Comedic style?)

7. For which grade levels is the Amazing Nano Brothers Show most appropriately targeted?

BEFORE THE SHOW

For the next set of questions, please think back to before you went on the field trip to the Museum of Science.

8. How did you first hear about the ANB show?

PROBE: Why did you decide to include the show in your visit?

9. Is there anything particular that you did with your students to prepare them for seeing the show?

PROBE: Is there anything/else you would do next time?

PROBE: Did you look up the show on the museum website? Did you see/use the pdf about the show's connections to science standards in the Educational section?

10. What else could the museum do to help teachers better prepare their students for viewing the Amazing Nano Brothers Show with their classes?

DURING THE SHOW

For the next set of questions, please think back to the time while you were watching The Amazing Nano Brothers Amazing Nano Brothers Show.

11. During the show, what were your students' reactions to the performance?

12. What part(s) of the show did your students enjoy the most?

13. Were there any parts of the show when you noticed the students losing interest?

14. Did you or your students take one of the show's printed programs?

IF YES: Is there any particular way that you or your students used the show's program? How was it helpful?

AFTER THE SHOW

And for the next few questions, think about the next few days after field trip.

15. Did your students talk about the Amazing Nano Brothers Show afterwards?

IF YES: What specific things were they saying?

16. Is there anything in particular that you did to follow up on content presented in the Amazing Nano Brothers Show?

17.Was the show especially good at getting across any particular concepts or insights that students had not been exposed to or that they had had difficulty grasping before seeing the show?

18.Did you find the students were confused by any ideas presented in the show? Was there anything they had questions about?

19. Do you think there is anything that the Museum could provide teachers with to help debrief with students after the show or reinforce concepts presented in the show?

20. The MA curriculum standards for your grade level include: [briefly describe the standards]. Which science ideas do you think the show was particularly good at getting across? (Will National standards for the non-Mass schools.)

PROBE: How did you or would you incorporate the show into your grade's curriculum?

PROBE: Had the students already been taught about atoms and molecules?

ADDITIONAL COMMENTS

21. What suggestions do you have for improving The Amazing Nano Brothers Juggling Show for students like yours?

PROBE: Would you recommend the show to other teachers?

22. There was no additional fee for seeing The Amazing Nano Brothers Show as part of your field trip because it was supported by a grant. We are wondering if, once the grant runs out, if we could sustain the show by adding on an additional cost, let's say similar to a Film or Special Exhibit ticket. Knowing what you know now, would you have paid to see the show as part of your visit?

IF ASK: "how much extra." We might ask – Would you pay $5/per student? Would you pay $3 per student?

PROBE: Why? or Why not?

23. The Museum is considering hiring out the Amazing Nano Brothers Show for performances in schools and community centers. If they do this, would you recommend to your principal to bring the show to <u>your</u> school?

IF YES: What exactly would you say to convince him or her of the show's value?

IF NO: Could you explain why you wouldn't recommend it?

24. Is there anything else you'd like to share about your experience with the Amazing Nano Brothers Show?

YOUR SCHOOL AND STUDENTS

These last few questions are about you and your school.

25. Is your school public or private? Religious or non-religious?

26. Would you describe your school as being in a community that is urban, suburban or rural?

27. What percentage of your school is eligible for reduced or free lunch?

28. Please <u>estimate</u> the racial/ethnic composition of the students with whom you work?

29. What year were you born?

30. Do you have a degree in a specific science field?

Appendix B

The Amazing Nano Brothers Juggling Show
Children's Survey Ages 6-12

Description of Children

Time of Survey	Percentage of Respondents
Pre-Survey	56%
Post-Survey	44%
Total	131

Gender	Percentage of Respondents	
	Pre	Post
Boys	43%	46%
Girls	57%	54%
Total	72	55

Age	Percentage of Respondents	
	Pre	Post
6	12%	17%
7	21%	14%
8	18%	19%
9	18%	17%
10	21%	16%
11	7%	10%
12	4%	7%
Total	73	58

Note: Totals may exceed 100% due to rounding

How much did you enjoy this show? (post only)

	Number of Respondents (N= 58)
Not at all	0%
A little	2%
Some	2%
A lot	97%
Mean (1-4)	3.95

The Amazing Nano Brothers Juggling Show
Children's Survey Ages 6-12

How much did you learn about atoms from this show? (Post only)

	Number of Respondents (N=57)
Not at all	0%
A little	19%
Some	16%
A lot	65%
Mean (1-4)	3.49

This show was too long, too short, or just right? (Post only)

	Number of Respondents (N=56)
Too long	5%
Too short	7%
Just right	88%

What was your favorite part of the show? (Post only)

Top Ten Responses	Number of Respondents
Finale on unicycles	23
Juggling	4
Everything	4
Glow in the Dark	2
Child Participation	2
Other*	5
Number of Responses	40

*A complete list of other responses is available upon request.

During your visit to the Museum today, what has been your favorite exhibit or program so far?

Top Ten Responses	Number of Pre-Survey Respondents	Number of Post-Survey Respondents
The Amazing Nano Brothers Juggling Show	1	27
Science in the Park	4	3
Theater of Electricity	4	2
Dinosaur	6	1
Space Module	2	1

Everything	2	1
Live Animals	7	0
Butterfly Garden	5	0
Seeing is Deceiving	5	0
Light House	4	0
Other*	10	5
Number of responses	50	40

*A complete list of other responses is available upon request.

Content Quiz

For the content quiz, correct answers will be underlined and capitalized.

Which do you think is the smallest? (Choose only one.)

	Percentage of Respondents	
	Pre	**Post**
ATOM	61%*	80%*
Molecule	14%	13%
Bacteria Cell	8%	2%
Grain of Sand	17%	5%
Number of Responses	72	56

*Statistically significant difference in choice of atom from pre to post ($p<.05$)

About how big is a meter? (Choose only one.)

	Percentage of Respondents	
	Pre	**Post**
An inch	10%	11%
A YARD	56%	68%
Six feet	31%	16%
A mile	4%	5%
Number of Responses	72	56

Can scientists shrink people down to the size of ants?

	Percentage of Respondents	
	Pre	**Post**
Yes	7%	4%
NO	93%	96%
Number of Responses	73	56

The Amazing Nano Brothers Juggling Show
Children's Survey Ages 6-12

Is everything made of atoms?

	Percentage of Respondents	
	Pre*	**Post***
YES	71%	100%
No	29%	0%
Number of Responses	73	58

*Statistically significant difference between the pre and the post ($p<.01$)

Do atoms stick to each other?

	Percentage of Respondents	
	Pre*	**Post***
YES	75%	95%
No	25%	5%
Number of Responses	73	55

*Statistically significant difference between the pre and the post ($p<.05$)

When atoms get warmer, do they move slower or faster?

	Percentage of Respondents	
	Pre	**Post**
Slower	25%	19%
FASTER	75%	81%
Number of Responses	72	58

Can scientists move individual atoms?

	Percentage of Respondents	
	Pre*	**Post***
YES	46%	83%
No	54%	17%
Number of Responses	70	57

*Statistically significant difference between the pre and the post ($p<.05$)

What is nanotechnology? (Choose only one.)

	Percentage of Respondents	
	Pre	Post
A very small music player	3%	4%
The engineering of nanos	42%	40%
WORKING WITH VERY TINY THINGS	29%	44%
Devices that help elderly people	4%	0%
None of the above	22%	13%
Number of Responses	72	55

Have you ever seen The Amazing Nano Brothers Juggling Show before today's performance?

	Percentage of Pre-Survey Respondents (N=119)	Percentage of Post-Survey Respondents (N=104)
No	88%	96%
Yes, once	6%	3%
Yes, more than once	6%	1%

How did you find out about the show?

	Percentage of Respondents
MoS lobby sign	38%
Museum of Science (MoS) staff	35%
MoS program or flyer	9%
Friend, acquaintance or family member	9%
MoS website	5%
Other website*	<1%
Other *	6%

N=220
Note: Total exceeds 100% because respondents could choose multiple options.
*A complete list of other responses is available upon request.

How successful was the Juggling Show at…

	N	Mean (1-5)	Not at All Successful	A Little Successful	Somewhat Successful	Very Successful	Extremely Successful
Making you more interested in nanoscience?	108	4.25	0%	3%	13%	41%	20%
Making learning about science fun?	109	4.60	1%	1%	5%	25%	69%
Helping you learn something new about science?	107	4.37	0%	2%	11%	36%	51%

Compared to other Museum of Science exhibits and programs, this show was:

Mean (1-5)	A Lot Less Educational	Less Educational	Equally Educational	More Educational	A Lot More Educational
4.03	1%	1%	25%	41%	32%

N=105

Before today's show, how familiar were you with nanoscience or nanotechnology?

	Percentage of Pre-Survey Respondents (N=117)	Percentage of Post-Survey Respondents (N=101)
I really didn't have a clue about it	26%	18%
I had heard of it, but I didn't really know what it was	19%	20%
I had read or heard something about it	46%	38%
I had studied it in school	6%*	19%*
I work in nanoscience or a related field	3%	6%

*Statistically significant difference between pre and post ($p<.05$)
Difference may be due to memory recognition and recall, rather than a different in experience.

What were two interesting science concepts you learned at today's show?

Top Ten Responses	Number of Comments
The scale or size of a nanometer	20%
Comment about atoms or nanotechnology in general	17%
The function of the scanning probe microscope	13%
Atoms are mostly empty space	11%
We can manipulate individual atoms	10%
How things move at the nanoscale	8%
The applications of nanotechnology	8%
Structure of Molecules	4%
Comment about the performance	4%
Other*	5%

Note: 74 individuals made 93 comments
*A complete list of responses is available upon request.

The next 16 items represent the content quiz. Correct answers will be bolded and capitalized.

PLEASE NOTE: For the content quiz results, audience members who had seen the show before have been removed from both the pre- and post-survey groups to reflect the impact of the performance on audience learning after seeing the show one time.

Respondents were asked to circle the SMALLER ONE in each pair: *The percentage signified the percentage of people who circled that choice.*

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
ATOM	44%	49%
Nanometer	56%	51%
Total number of responses	98	91

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
ATOM	78%	84%
Molecule	22%	17%
Total number of responses	100	91

	Percentage of Pre-Survey Respondents*	Percentage of Post-Survey Respondents*
Microscale	13%	0%
NANOSCALE	88%	100%
Total number of responses	96	90

*Statistically significant difference between pre and post ($p<.001$)

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
Bacteria	41%	46%
VIRUS	59%	54%
Total number of responses	98	89

Circle the SMALLER ONE in each pair:

	Percentage of Pre-Survey Respondents*	Percentage of Post-Survey Respondents*
10 MILLION NANOMETERS	84%	96%
A meter	16%	4%
Total number of responses	99	88

*Statistically significant difference between pre and post ($p<.05$)

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
100 billion nanometers	50%	54%
A YARDSTICK	50%	46%
Total number of responses	97	86

If the nucleus of an atom was the size of a basketball, approximately how large do you think the whole atom would be? (Choose only one.)

	Percentage of Pre-Survey Respondents (N=101)	Percentage of Post-Survey Respondents (N=87)
The size of a basketball hoop	14%	10%
The size of a car*	24%	7%
The size of a football stadium*	38%	24%
THE SIZE OF A LARGE CITY*	12%	37%
The size of the United States	13%	22%

* Answer choices contributing to a statistically significant difference between pre and post ($p<.05$)
Note: totals may exceed 100% due to rounding.

Which of the following statements do you think are true? *Respondents were asked to choose all that apply.*

	True or False	Percentage of Pre-Survey Respondents checked True (N=105)	Percentage of Pre-Survey Respondents checked True (N=96)
Everything is made of atoms.	True	83%	91%
Atoms can be felt with special instruments but not seen.	True	35%*	64%*

	True or False	Percentage of Pre-Survey Respondents checked True (N=105)	Percentage of Pre-Survey Respondents checked True (N=96)
Scientists can move groups of atoms, but not individual atoms.	False	24%	16%
Temperature affects the movement of individual atoms.	True	79%	79%
Atoms tend to stick together.	True	70%	69%
Gravity affects the movement of individual atoms.	False	51%*	32%*
Products using nanotechnology are already in stores.	True	59%	65%
Nanotechnology has been proven safe.	False	39%	26%
None of these are true.	False	1%	0%

*Statistically significant difference between pre and post ($p<.05$)

Please list your three favorite exhibits or programs from today's Museum visit so far.

ANB Rank	Percentage of Post-Survey Respondents
Ranked ANB as first favorite	58%
Ranked ANB as second favorite	23%
Ranked ANB as third favorite*	7%

N ranges from 43 to 67
Note: A complete list of other responses is available upon request.

	Number of Responses					
	1st Favorite		2nd Favorite		3rd Favorite	
	Pre	Post	Pre	Post	Pre	Post
Amazing Nano Brothers	2	39	1	13	3	3
Theater of Electricity	14	6	7	6	5	6
Butterfly Garden	13	1	6	7	4	3
Dinosaurs	7	2	10	1	4	2
Seeing is Believing	6	-	2	1	1	1
Mathematica	4	-	3	2	5	2
Live animals	4	2	6	3	4	3
Science in the Park	1	1	8	1	1	1
Other	36	16	29	23	23	22
Total number of responses *	87	67	72	57	50	43

Note: A complete list of responses is available upon request.

Gender

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
Female	49%	53%
Male	51%	47%
Total number of responses	122	101

Do you or anyone in your family study or work in a science-related field?

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
Yes	46%	43%
No	54%	57%
Total number of responses	122	105

Age

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
12 and under	3%	3%
13-17	4%	4%
18-24	10%	9%
25-34	11%	14%
35-44	46%	38%
45-54	17%	19%
55+	9%	14%
Total number of responses	121	104

What is the highest degree you have earned?

	Percentage of Pre-Survey Respondents	Percentage of Post-Survey Respondents
Less than High School	7%	4%
High School or equivalent	15%	18%
2-year college degree	11%	6%
Bachelor's degree	24%	37%
Master's degree	24%	17%
Professional degree	10%	5%

	Percentage of Pre-Survey Respondents	**Percentage of Post-Survey Respondents**
Doctorate degree	9%	15%
Total number of responses	123	106

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

1. Could you please tell me what would be the "tagline" for your class's experience at the show? It could be sentence, a word or a phrase (positive, negative or neutral) that summarizes the experience.

1	Enjoyable, interesting, fun, and presented good information
2	They were just talking about it again today. While learning about magnetism, something about atoms came up and a child mentioned the show, and a bunch of kids were like "oh I just thought of that too!" It really stuck with them.
3	They took something that as a teacher, I thought was valuable, and incorporated academics into fun, and the kids definitely learned something, and I learned something as well. It was definitely worth our time, and beneficial to the kids.
4	The show opened up their eyes to the world of nano technology
5	Thought it was fantastic and really able to understand what an atom was much better.
6	I think that they were really excited about it.
7	It was both mesmerizing and a learning experience. The kids loved it and so did the teachers.
8	It was terrific – kept the students totally engaged. A review for us, the matter information etc. so totally engaging
9	They were entertained
10	Entertained, engaged

FIELD TRIP DETAILS

Grade Level	Number of Teachers
Elementary School	3
Middle School	7

2. Did all the students from your class attend the Amazing Nano Brothers show during this field trip?

IF NOT, how many students went to the show?

Teachers responded that all of the students in the class attended the show in most schools. In one school, half the group saw the show and the other group did not.

3. Besides the Amazing Nano Brothers Show, what other exhibits, presentations, demonstrations or shows do you remember the students seeing during your trip?

Science in the Park
Omni theater film on coral reef
Sleeping under the Dinosaur
Another exhibit with nanotechnology
Theater of Electricity
Bobsled Challenge
Recycling Activity / Consumption
Model Making
Identity

4. What was the highlight of the field trip for your students?

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

PROBE: What did they talk about the most?

1	Probably the bobsled, they really get excited by actually using science to change it [the bobsled], they liked the fact, to get theirs to go the slowest or the fastest. Someone from the museum ran the activity.
2	I think it would be the Omni theater show. Nano brothers close second. Really enjoyed it, I was afraid it would be a little over their heads.
3	The Omni movie and the lightning show (electricity theater), slept under the dinosaur.
4	They enjoyed the playground a lot – the interactivity – and the Nano brothers show. Initial response that it was for a younger group, but then as the show progressed they became engaged in the information, and they didn't feel that way as much.
5	That and the art project in recycling with bottles and paper bags –and those two were mentioned the most doing reflections.
6	They really liked the show and talked about it after, they do a states of matter unit, so they know about parts of the atom and were familiar about what was going on.
7	Everybody likes the show with the Vandergraph Generator – theater of electricity.
8	The main purpose was the science in the park. Then try to pick other programs that would work. Had never seen the juggling show. Main goal to introduce motion, forces and energy.
9	Just going around the museum. They saw the juggling show as well.
10	Design challenge, Identity

OVERALL REFLECTION

5. Compared to other Museum of Science exhibits and shows would you say that the Amazing Nano Brothers Show is less effective educationally, equally effective educationally, or more effective educationally for your students? PROBE: Could you explain your answer?

1	Equally educational. In the past have seen a show, over beyond where the hunting(?) room is in the bottom level, and they would do little experiments for the kids, and two or three would take part. This year, it was equally good, but I enjoyed them both.
2	Because they were talking about it today, that would make it more effective, three months later.
3	More effective
4	Equally effective – initial set up was below their age level, not as engaged at the start as they could have been. Lost a bit of momentum to start – especially compared to physics playground they were fully engaged and invested immediately.
5	It reinforced some of the things they already knew – equally effective.
6	Equally or more – give it the plus because they were great and my particular curriculum is involved with physics and forces and motion – so they could relate to it.
7	More effective – I think the fact that they were amazed by the juggling, and were making connections to what they had already learned regarding matter – they could actually visualize it – reinforced their learning.
8	Less effective educationally – it didn't go into depth about nanotechnology and doesn't connect with the curriculum with middle schools. Surveyed a bit of what have been covering in chemistry. Connection to real world applications didn't really come through.
10	Equally, but differently effective educationally., but less interactive

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

6. Do you feel that the show was appropriately targeted for the age and grade level of your students? PROBE: Could you describe why you think the show was/wasn't appropriate? (Based on content? Comedic style?)

1	Yes I do. The way that the concepts were presented was visual. The explanation used vocabulary that they understood. Plus it able to keep their attention; they were quite funny.
2	Yes, like I said, worried the content would be beyond them, but they really seemed to get it. If there were things beyond their understanding, in terms of humor, they didn't realize that it went above them. It kept them entertained.
3	Yes – some stuff nano brothers talked about – already knew the basics, but it was really nice to have that basic – they went quite a bit further – just enough to a link to the nanoscale. For them it was a lot of new information. Juggling was far more interesting than learning it some other way – progressive and relevant to the kids. They were very engaged.
4	I think that beginning was geared towards 5th or 6th or younger, then as information continued, it was closer to what they had been learning in class and they could see the applications. 7th graders are tricky age group – they say they don't like something, but then they do.
5	Yeah definitely. They used a lot of manipulative that the kids could see, and sized that kids could wrap their hands around – and fun to pique interest, a circus like atmosphere.
6	Yeah, a lot of the terminology was relative to middle school. Could have used the right terminology for any grade level. They were consummate pros and if performing for a high school, they could have upped the vocabulary and complexity and accommodate the language. And they accommodated the 7th grade.
7	I do. Yes, 8th grade.
8	It might have been a little immature – the juggling and skill of the performers, but the jokes were too juvenile for them.
10	Yes, it seemed to appeal to a wide range, including 7th graders

7. For which grade levels is the Amazing Nano Brothers Show most appropriately targeted?

1	7-9th grade
2	4th grade and up. Content, MA framework, probably more specific for upper grades, but it really surprised me that 3 months later, they were able to apply it to the stuff we were doing today.
3	5th-7th
4	5th or 6th or younger (see above)
5	8th grade
6	5th-8th. Before that atoms are too difficult to teach.
7	Middle to high school. The performance aspect is a big part of it – may be a scientist but a big supporter of the arts, so to see artists and performers do such a great show. Can talk the talk, but they walked the walk. They were performers. They totally went with the flow and willing to watch and accept anything. Kids going to these types of shows – they need to be mature enough to handle what comes at them. Polite to be a good audience.
8	6-8, middle school.
9	The science content was fine for 7th or above, the presentation better suited for 5-6th
10	5-7th graders

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

BEFORE THE SHOW

8. How did you first hear about the ANB show? PROBE: Why did you decide to include the show in your visit?

1	The arrangements were made with the curriculum office – I don't always participate in science curriculum meetings. I have been in language arts curriculum team this year. I teach Math/science/language arts/ social studies. It is unique, regular education setting.
2	[MoS staff member] emailed and said it was going to be offered, and would like slots. I think content wise, knowing the 4th grade science frameworks, seemed good tie in, it was interesting. Planetarium was closed for renovations, in the past kids have seen two shows, so if not the planetarium, then do this instead. The kids didn't feel like they had missed out. The show also fit in well with their schedule for getting home. Some classes didn't get to stay and they were disappointed.
3	From the museum trip coordinator
4	It was planned that they would see the show and they timed the visit purposefully. Timing of the visit was a part of the science and tech units they were doing – so planned to be a part of the visit.
5	Yes, usually see cold science – a magnet show – but they saw it already in the 7th grade, so they still wanted to do a physics activity and [ANB show] fit into the curriculum.
6	Yes, signed up for it specifically. Because taught that unit and also another teacher does electricity and magnetism.
7	Never heard of the show.
8	We had been working with [MoS staff member] and went in and worked on a Saturday at the museum. Had to rearrange field trip schedule and shared the options with them.
9	Knew it would be part of the trip – tour with [MoS staff member] – told about the show and new to museum, so decided to it.
10	Suggested by MOS ed department - [MoS staff member]

9. Is there anything particular that you did with your students to prepare them for seeing the show?

PROBE: Is there anything/else you would do next time?

PROBE: Did you look up the show on the museum website? Did you see/use the pdf about the show's connections to science standards in the Educational section?

1	Not specifically. I think its part of a unit that we do in the spring anyway. No, wouldn't do anything different. It stood on its own. Did not look up website.
2	No, really wasn't sure what it was going to be about. Knew it was going to be about molecules, but did not really know. I think it's worked out nicely, we studied magnetism after – and [the show] was an activator – to tie [the content] back to them. The unit was like a summarizer and they keep revisiting [the show]. Don't remember, probably did. No. just a descriptions.
3	No, just a description. Before went to museum, a science teacher from our school did a refresher on basic sub atomic particles.
4	Looked at the resources on the website – and also nanotechnology website too. Used some of those and videos. They were absolutely helpful.
5	Had already covered atoms and in the middle of the nano unit – talked a bit about physical changes and conservation of matter, and quite a bit of stuff on the subject
6	I told them that they would be seeing a show about atoms – are we going to see an atom? - I don't think so. Being a good audience. Looked up the shows, and then called to get. No did not see the pdf.
7	Think some of the kids did relate their performance to some of the things that were enhanced in the hallways. No.
8	We had the DVD, but did not use it. just talked about nanotechnology a little bit before, not a great deal, and told them it would be reinforcing the unit – they were just finishing it up the unit.
9	I had showed them the introduction to the nano juggling show, but didn't do anything particular to address the content. Not covering it in the curriculum

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

10. What else could the museum do to help teachers better prepare their students for viewing the Amazing Nano Brothers Show with their classes?

1	In the past, I know that the museum offered different programs for us [teachers] to come in, and kind of go over things – I know that everyone is busy these days, but it certainly would have been helpful if I had seen the show first. Although this still worked fine. It just would have given me a little bit more advanced knowledge. You used to send passes for teachers to come in and view things. I probably would have used that in this case.
2	Probably upper grades can do more, at my level, I don't think me trying to explain stuff would be good – it would probably confuse them more.
3	I don't know
4	I think it was fine, it was what we were prepared for. As a teacher bringing a group of students for the first time – I really had to have the experience in order to know what I would do next time. There is nothing museum could have done to help. I couldn't have made adjustments after I've seen it. I had not seen nano bros with my family before, but was able to other things because I have a family membership to the museum.
5	No more than they normally do. Teachers went in and had a day and prep and professional development around the trip. Did not see show, just heard about it. And saw the video of the show too, so we knew exactly what would be in the show.
6	Probably not anything – don't think that would have been helpful. Didn't want too much info going in. general information about the show gave a clear picture of what was going to be seeing.
7	Nothing – hope that if we do it again, hope to see them again. First time doing the overnight at the museum – a good trip. Tony Williams organized the whole thing. Hopefully do that again.
8	Don't think so – they did a great deal of work on that Saturday – and aware of all the science in the park changes and worked with the staff to get questions ready. A working Saturday.
9	I don't think the nano show needed preparation, it's more of a survey for the students. If for older kids, would have used more activities prior to seeing the show, but since we were not, just said a survey presentation.

DURING THE SHOW

11. During the show, what were your students' reactions to the performance?

1	They laughed, they clapped. They were engaged.
2	Positive reactions. They were definitely engaged.
3	They were very engaged. They were "hooked" from the start and it maintained their interest.
4	Comic styling was not appealing at first – but then they embraced it as the show went on. [already answered this above] One of the moms bought the DVD and some children asked to watch the DVD and some asked if they could watch it again. That surprised me a little bit.
5	Very interested in it, when opportunity to interact, they did. Very focused, not talking to each other, except about the show.
6	They were really excited. A couple kids – "oh look at that" that's what we learned "that's what we talked about" really excited, a lot of students don't get to go out into Boston and experience a cultural experience – so that was a big deal – a circus and a show.
7	It was basically "oohs" and "aahs," excitement and corny jokes, laughs. Dory to awesome, 7th graders are unpredictable. Have friends that are artist.
8	Again, totally amazed – totally focused on the show. Numerous ELL learners that saw the show and because of all the visualization it really helped their learning as well. It applied for everyone. There wasn't anyone that was not interested.
9	I was sitting next to some students, they would give him a funny look, understand that humor, but too young for them. Funny looks from students.
10	Laughter, engagement

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

12. What part(s) of the show did your students enjoy the most?

1	The unicycles were pretty cool.
2	Definitely when kids get to be part of the show – even if it's someone they know or in their school going up on stage. That's nice for them. I'm pleasantly surprised how much they still talk about it. I have a lot of challenges this year and significant learning challenges. That the show kept them engaged is more positive for me as a teacher. And the quick pace.
4	Portion of the show where the room was dark and the atom was glow in the dark – 4 or 5 kids said "Wow, I get it" – that visual was very strong tool to help them understand
5	Comedy they liked, unicycles and talking about objects.
6	They really enjoyed the unicycles and throwing the different pieces back and forth about how electrons work.
8	Probably towards the end when they were juggling lots of usual object.
9	They enjoyed the juggling, anything that was very well skilled by the performers, as well as the parts that they had covered in the curriculum. Structure of atoms, they knew more about it and more engaged during that part of the presentation.

13. Were there any parts of the show when you noticed the students losing interest?

1	No. It was engaging, a good length.
2	One third of the class has ADD or ADHD, and the quick pace, they were just moving, moving, moving, and no eyes were wandering. The students were completely engaged the whole time.
3	(did not get to this question)
4	No, just a slow to warm up. Wait time before show start.
5	No, interested for the whole show, right length. ELL students, intro may have been skewed young, but for our kids maybe it gave them time to understand what was going on due to the language barrier. It probably would have taken them a few minutes to figure out what was going on.
6	Don't think so – engaged most of the show.
7	[he didn't remember anything particular from the show]
8	no
9	Perhaps in the beginning, introducing what nanotechnology was. Trying to figure out how small a nano was – microscope, stage – they were waiting for the educational part to start.

14. Did you or your students take one of the show's printed programs?

IF YES: Is there any particular way that you or your students used the show's program? How was it helpful?

1	Not that I was aware of.
2	No, and I don't remember any being offered.
3	(did not get to this question)
4	Do not remember seeing it. printed out some worksheets from the museum.
5	No, didn't see them.
6	Don't remember seeing them.
7	I think there was a program.
8	no
9	No didn't see it.
10	No

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

AFTER THE SHOW

15. Did your students talk about the Amazing Nano Brothers Show afterwards?

IF YES: What specific things were they saying?

1	They did. They were just amazed by some of it. They thought it was cool.
2	Probably right after, it was more about the tricks and the juggling. The concepts sunk in later.
3	They had fun, were really impressed – it was great and they enjoyed it.
4	Talked about it as a group, a wrap up in school afterwards. Throughout the year, time to time, the class revisited the topic and students mentioned the museum trip and the juggling show. Right up to the last week of school, as they were reviewing material from the year, there was a common theme of nano-technology – that lesson really made an impression – because of the hands on aspect at the museum and the juggling show – they always say they don't like something, but then still talking about it two months later.
5	They liked it very much, they learned more about what an atom was, that they – I know when we had them write reflections, half focused on the show and what they learned from it.
6	I think a couple kids might have mentioned the show and related it back to what learning in the classroom. Why important to go to museums. Overall the museum experience was beneficial.
7	I'm sure that they did – like I said, in the future should conduct the interview right away. In 7th grade middle school it's in the dust right now. These kids are stimulated by the minute.
8	The next day, talked a bit about the show and reflected on the show. Can't remember right now. They did a reflection piece. When they were describing what they enjoyed the most – it was the juggling show.
9	Yeah, mostly just talking about the juggling, not much the content.

16. Was there anything in particular that you did to follow up on content presented in the Amazing Nano Brothers Show?

1	I think, and again, because I wasn't part of the curriculum team in science. Some follow up activities, some simple things back here at school, would have hammered the ideas home. Although, I'm not riding a unicycle.
2	Not right away, those teachable moments have come up since. [The show has] been mentioned to reinforce concepts or bring it back to them. Mostly [the students] have been the ones initiating the connections from class back to the show.
3	-- maybe science teacher did – we just had a general discussion about the trip.
4	The fact that the presentation reinforced a few things again and again. Mostly above average learners, but some students with differentiated learning styles and they were particularly fully engaged in the juggling show. It was something new to them. Unfortunately, they are at an age of needing to be entertained as they learn.
5	Were already working on the nano unit in school.
6	Not really, talked about why we went to see the show and how it related to curriculum
7	Talked a bit about things that related to the class, but don't remember. There was a lasting impression, last day of school. They would remember it.
8	The next day, talked a bit about the show and reflected on the show.]
9	No, because already moved in to chemistry with the students.

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

17. Was the show especially good at getting across any particular concepts or insights that students had not been exposed to or that they had had difficulty grasping before seeing the show?

1	Nothing specific jumps to mind.
2	We've studied electromagnets this year, and we were trying to get the students to come up with definitions of why it works. The kids were talking about the electricity moving in the same way, the magnet it making it go in the same direction – a big concept for a 9 year old to get. Because of what they have seen [in the Juggling show], they were able to make that jump. In 11 years of teaching 4th grade, I have never had children make those connections, bridging once concept to the next. In the past I haven't pushed them. The molecular thing that they watched [in the show] maybe gave them the background knowledge to make that leap. They were able to visualize it – [Dan and Joel] made the kids see [the atoms].
3	Processing with them afterwards, which we did in science class, retained quite a bit of knowledge.
4	That it is relevant to their lives and their future.
5	Nothing standing out.
6	I think the size of the atom, talking about how particularly small it is, human eye can't see it, and students know about place values, millionth and trillionth place, and then were able to understand the miniscule level.
7	[he didn't remember anything particular from the show]
8	Reinforcement talking about atoms and molecules, just finishing up. And then talking about how things are so small.
9	I wouldn't' say difficulty, but it's a good visual way of seeing the part and positions of the different pieces of the atom. That was particularly strong, and one of his students were chosen to hold the nucleus.

18. Did you find the students were confused by any ideas presented in the show? Was there anything they had questions about?

1	No. We talked about it, but nothing overwhelming.
2	They didn't ask anything.
3	
4	Don't believe so.
5	No questions, don't think so. Already working on it. The show just reinforced some of the ideas we were already working on.
6	Not that I remember. Pretty straight forward.
7	[he didn't remember anything particular from the show]
8	
9	No, don't think so.

19. Do you think there is anything that the Museum could provide teachers with to help debrief with students after the show or reinforce concepts presented in the show?
PROBE: how would you have liked to have gotten that information?

1	Some follow-up activities for the classroom Through the school coordinator or by email, they are equally effective.
2	Not sure about that. Except to connecting it to units I already do, I don't know what I would want. If I taught an older grade, more direct impact on the classroom. These kids are not excited about science, so that aspect alone, you could see light-bulbs going off and the excitement of science. Not sure about middle school, maybe more of a direct impact for them [on the content of the show].
3	Again – don't know.
4	Had some worksheets for during the day. It's difficult to find time to fit it all in. I always struggle

	with how to debrief – should I go over the worksheets or what? I'd be curious to know how do other teachers handle that?
5	We did fine on our own.
6	No not for me.
7	Would have to think about it. Yes, the pdf is very helpful (but he didn't know about it) – maybe collect emails from teachers who would like follow up stuff. Love emails! A follow up from the show or curricula, would have appreciated it and followed up.
8	Did not see the DVD, borrowed it, maybe that would have been good for follow-up. That was provided, but didn't get to look at it. If they were not in the DVD, some follow-up questions more guided. Guide with the DVD may have been helpful.
9	Maybe after, give a small bookmark that would show the different uses of nano technology or science. For example, why is it called an ipod nano, connect it.

20. The MA curriculum standards for your grade level include: [briefly describe the standards]. Which science ideas do you think the show was particularly good at getting across? (Will read national standards for the non-Mass schools.)

PROBE: How did you or would you incorporate the show into your grade's curriculum?

PROBE: Had the students already been taught about atoms and molecules?

1	Both of those topics were things were doing here in class. So kids came into [the show] with a level of knowledge. It wasn't a brand new topic. The periodic table of elements piece was probably clearer. We do quite a bit with that before and after we visited the show. It was perfect timing for that this year. The trip came right in the middle of the physics unit.
2	Models are difficult for them to grasp, even when we were doing solar systems. They may remember [that part of the show], but not necessarily connect it. (They know about when things are warmer they move faster.)
3	(did not get to this question – but he refers to it when he said: I would say, first of all it's what I liked about the show was that it goes beyond the curriculum and frameworks")
4	Did an excellent job meeting the MA standards – it introduced the topic to the kids, opened doors about applications in field for the future – it showed them why what they are studying in 7th grade is important and how it impacts their lives and their families' lives.
5	Perfectly fit the standards.
6	Yes, definitely.
7	A little advanced for the grade level, but it was fine. Certainly once we got into the unit, I'm sure they – it was really right on. Kids absorb a lot – so even if not familiar, they could have been refreshed by the curriculum or lessons.
8	It did.
9	Not for his school with his curriculum.

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

ADDITIONAL COMMENTS

21. What suggestions do you have for improving The Amazing Nano Brothers Juggling Show for students like yours?

PROBE: Would you recommend the show to other teachers?

1	I don't have any. Thought it was fun and engaging and interesting. Definitely would recommend.
2	No, surprised. Sometimes live performances are too hokey or corny. The comic style was appropriate. There were older groups there and that also was fine.
3	(did not get to it)
4	Maybe having a show that was more middle-high school, and this was more for upper elementary.
5	I thought it was perfect for our kids.
6	I think they could have talked a little bit about the corks inside of the atom - inside the protons and neutrons – and the strong force that holds them together. Introducing a little more detailed vocabulary. We talk about the states of matter – within atoms, how closely spaced the atoms are to each other in solids, liquid, gas.
7	No, don't. would love to see it again. And knowing that going to be interviewed. Just an amazed audience member.
8	No.
9	Maybe asking the students some more questions in the introduction – gauge their understanding of nanotechnology at the beginning or as it goes – to lead into the show a little better.
10	No suggestions. It is well done. Yes, I would recommend it to students who have had some intro to topic. The show is a nice counterpoint to the interactive exhibits.

22. There was no additional fee for seeing The Amazing Nano Brothers Show as part of your field trip because it was supported by a grant. We are wondering if, once the grant runs out, if we could sustain the show by adding on an additional cost, let's say similar to a Film or Special Exhibit ticket. Knowing what you know now, would you have paid to see the show as part of your visit?

IF ASK: "how much extra." We might ask – Would you pay $5/per student? Would you pay $3 per student? Why? or Why not?

1	REED fund supports the trip, close relationship to the museum. Teaching in Salem 25 years, the trip is part of it. The fund was left to use by an estate and it is to be used for teaching science. (would you have chosen to see they show if it were optional?) Yes, it had a direct connection to the curriculum that they were doing here.
2	It is so expensive, so far away – we take a boat and a bus and rental cars. Budget wise we already do a lot of fundraising for it. If still taught in Arlington, we probably would. Everyone was happy with the show being a substitute for planetarium. The cost of their trip to the Museum (overnight) is $12,000 total with transportation and everything.
3	(did not get to it)
4	Depends on price point. They received support through the museum to pay for one of the school buses. It would just depend on the situation when the time comes.
5	It would depend on the price. It depends on the kids and the bus. REED foundation.
6	If it was a movie and didn't cost anything extra, but wouldn't pay anything extra. Can't fund it. didn't see a movie as part of their trip this time. Would pick this show again.
7	Would go again -. A real "wow" kind of thing. absolutely – depends on the budget, if there was an additional fee. Maybe would try to fundraise. Didn't do the planetarium this time.

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

23. The Museum is considering hiring out the Amazing Nano Brothers Show for performances in schools and community centers. If they do this, would you recommend to your principal to bring the show to <u>your</u> school?

IF YES: What exactly would you say to convince him or her of the show's value?
IF NO: Could you explain why you wouldn't recommend it?

1	Yeah, it would be fun. Certainly for some of the other grade levels too, even though they don't do the curriculum directly, they would benefit. We can go to the museum and see it, so having the show come here probably wouldn't make sense. For our school, the kids only paid for the busses and the admissions were free for the city as part of the arrangement with the REED fund.
2	I would be willing to look into funding for that. I would just say, we so many kids who are apathetic. Science has become reading a vocabulary list – this is a way to get kids to really thing and do. On a grander scale, [the show helped children see that science is] not just what you do between 11 and 11:45 - it's actually life.
3	I would say, first of all it's what I liked about the nano show is that it goes beyond the curriculum and frameworks – it's relevant in the sense of exploring new frontiers and realized while watching show – this is completely uncharted territory and our kids will be the pioneers of it – they already know some info and the show will build up on it. We are not able to teach it like that – the juggling hooks the kids and kept them hooked for the whole time.
4	Yes absolutely – one of the biggest challenges is to transport the kids, $10 per kid just for the busses – definitely. Also local cultural commission would support it if wrote a grant. If science teachers collaborated – yes, probably, every 3 years or something.
5	No, because of funding.
6	I think it would be interesting if it was a longer show. For 40 minutes – maybe if an hour, to disrupt.
7	Definitely – would compose a paragraph of all the right a word.
8	Possibly – depends on the cost. That is a real issue. REED grant.
9	Yes, as well as maybe, if they did that, check with the teachers to what content they would like to focus on – more supplementary to what the school is covering. I think – in chemistry, one of the branches of science, working at the microspoic level and struggle with the abstract level and the nano show helps students visualize what we cannot see without the microscope and also very engaging for students.
10	The show is highly engaging and educational.

24. Is there anything else you'd like to share about your experience with the Amazing Nano Brothers Show?

1	Salem has had a wonderful relationship with the museum. [The museum] continues to expand and grow and change, and everything involved there is well put out and appropriate for the kids.
3	Loved it – its fantastic and really enjoyable.
5	I think the adults enjoyed it too.
6	I think was a great show and the museum continues.
8	We really thoroughly enjoyed it and happy for half of the class to see it. had to rearrange the schedule and it was because of harry potter being extended. Sorry both classes couldn't see it.
9	No, I think shared pros and cons of the show.
10	I didn't know what to expect, was impressed with juggling, humor used to teach concepts about atoms/molecules

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

When necessary, the following two probes were added:

The producers of the show really want to know what students learn from the show on its own.

1	On its own – well, they certainly were exposed to some of the ideas. But there had to be a connection made before and after.
2	Not show was not "dumbed down" and not over their heads either. Once time when at the planetarium, the presenter was talking like he was in a room with astrophysicists, and here we were sitting with eight year olds. The show presented some tough ideas and did a nice job with it.
3	(he basically said that it covered some things they already knew and also taught them new things: They learned about nanoscale, sub atomic particles. The way that particles act on the nanoscale.)
4	Opened their eyes about how science isn't all in a book, it's all around you, and there are lots of ways to learn about science. So many of [the students] say they can't do it, but that's when they've only experienced it through a book.
5	[hard to know if from the show or from what they were doing in class]

What about the show's ability to pique students interest to learn more?

1	Certainly. It brought the ideas alive a little bit more for them, not just looking at a picture in the book. At this age they really like to be entertained.
2	Pleasantly surprised that it did.
5	[fun and interesting for them]
6	With most of population – don't have a community interested in learning and education. A few kids said "that was interesting" but for the most part, no. different populations may have been more interested.
7	Yes, definitely.
8	For some, it's probably just an introduction that may perk their curiosity to look further.
9	Maybe not with nano technology, but yes in terms of chemistry.

YOUR SCHOOL AND STUDENTS

25. Is your school public or private? Religious or non-religious?

- Six public schools
- One private school that was religious

26. Would you describe your school as being in a community that is urban, suburban or rural?

- Four urban schools
- One school with parents from urban backgrounds
- Two rural schools

27. What percentage of your school is eligible for reduced or free lunch?

- Two schools between 1% and 10%
- Two schools between 11% and 50%
- One school over 50%

The Amazing Nano Brothers Juggling Show – Teacher Interview Responses

28. Please <u>estimate</u> the racial/ethnic composition of the students with whom you work?

- Three diverse students
- Three mostly Caucasian students

29. What year were you born?

- 1940-1955 – 4 teachers
- 1955-1970 – 2 teachers
- 1970-1985 – 3 teachers

30. Do you have a degree in a specific science field?

- K-8 Education – 2 teachers
- Science Education – 2 teachers
- Science Field – 3 teachers
- Other field – 4 teachers

Note: teachers mentioned degrees from multiple levels of education.

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