

# “Treating Tumors with Gold” Stage Presentation

Formative Evaluation

By Elizabeth Kunz Kollmann

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## Acknowledgements

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### **THIS IS A FORMATIVE EVALUATION REPORT**

Formative evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analyses
  - brief reports
- **look at an earlier version** of the exhibit/program, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit/program

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Research and Evaluation Department  
Museum of Science  
Science Park  
Boston, MA 02114  
researcheval at mos dot org  
617.589.0302  
TTY 617.589.0480  
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## Executive Summary

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This study was completed as a part of the formative evaluation of nanotechnology informal science education programming conducted with support from the Center for High-rate Nanomanufacturing (CHN), headquartered at Northeastern University and the University of Massachusetts, Lowell. The purpose of the study was to provide Museum of Science nanotechnology education associates with visitor feedback that they could use to improve their presentations as well as to provide other potential program presenters with information that they can use to modify the presentation effectively. As a part of the study, two nanotechnology presentations were evaluated: one presentation developed by each education associate. This report is a formative evaluation for “Treating Tumors with Gold,” a presentation created by Lisa Regalla during her tenure as an education associate at the Museum of Science. The presentation describes research conducted at Rice University to create a cancer therapy using gold nanoshells and infrared light.

To collect visitor feedback that could be used to improve this program, 41 visitors were asked to fill out exit surveys. These visitors were asked to rate the presentation on various factors including: their enjoyment of the program, the clarity of the content, the appropriateness of the content level, and the presentation’s relevance to their lives. In addition, the visitors were asked to rank their engagement with the various presentation technique implementations used including communication, illustrative, audience engagement, and multimedia techniques (Chin, 2007). Visitors were also asked to answer open-ended questions about the most interesting things they learned and how we could improve the presentations. Finally, visitors were asked to answer demographic questions about their age and gender.

Results from the exit survey indicate that:

1. Visitors found the content of the presentation highly appealing and clear, and only a few visitors felt changes might improve the presentation.
2. Visitors reported learning interesting things about about gold, infrared light, and blood vessels. They recalled parts of the four intended learning goals.
3. Visitors were split as to which presentation technique implementations were most engaging indicating that it is the way the technique is applied that is important to engaging visitors.
4. Females found some of the multimedia presentation technique implementations significantly more engaging than males.

Based on these findings, it is suggested that the education associate or other potential program presenters consider:

- Re-evaluating the vocabulary and amount of information contained in the presentation to ensure that they are appropriate;
- Lengthening the presentation to include more detail about the Rice University research;
- Simplifying and/or repeating the presentation goals so that they are more easily retained;
- Removing or changing the audience polling since it was not engaging for visitors; and
- Changing and testing new versions of the PowerPoint graphics and the gold nanoshell therapy animation to make them more appealing for males.

## I. Introduction

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### About the Stage Presentation

Every day, multiple stage presentations are presented in the Gordon Current Science & Technology Center at the Museum of Science. Presentations performed in this area provide visitors with the chance to stop and experience brief 20-minute talks about current science and technology topics during their visit. The content of these presentations are usually aimed at visitors 12 years of age and older. For the past couple of years, many of these presentations have focused on the topic of nanotechnology.

Museum of Science nanotechnology stage presentations are created and delivered by education associates with support from the Center for High-rate Nanomanufacturing (CHN), headquartered at Northeastern University and the University of Massachusetts, Lowell as well as support from the “Science of Nanoscale Systems and their Device Applications” Nanoscale Science and Engineering Center headquartered at Harvard University. Nanotechnology informal science education programs are overseen by Carol Lynn Alpert, Director of Strategic Projects at the Museum of Science.

This evaluation focuses on one of the programs created and delivered by Lisa Regalla during her tenure as an education associate at the Museum. The name of this presentation is “Treating Tumors with Gold.” The presentation’s content focuses on research being conducted at Rice University which aims to create a new cancer therapy that uses gold nanoshells and infrared light. As a part of this therapy, gold nanoshells are injected into the bloodstream. They travel through the bloodstream until they reach a cancer tumor in which they become stuck. Then, the gold nanoshells are heated with infrared light, and the tumor tissue surrounding the gold nanoshells is destroyed.

In order to present the content in a compelling way, Regalla used a series of the methods described by Chin (2007) in her “Nanotechnology Onstage at the Museum of Science” report. In this report, Chin identifies the types of presentation techniques that educators use during their programs as communication, illustrative, audience engagement, and multimedia techniques. The presentation techniques that Regalla used during “Treating Tumors with Gold” include the following:

- *Communication Techniques*
  - Analogies and metaphors
- *Multimedia Techniques*
  - Graphics
  - Videos
  - Animations
- *Illustrative Techniques*
  - Demonstrations
  - Models
- *Audience Engagement Techniques*
  - Polling the audience
  - Magician’s assistant

The “Treating Tumors with Gold” presentation was created in part through workshops conducted by the Nanoscale Informal Science Education (NISE) Network Programs Team. During these workshops, learning goals were formulated for the presentation. Those learning goals are the following:

1. Scientists in nanotechnology bridge the gap between disciplines to try and solve research problems.
2. The size of a material (like gold) determines its properties and its interaction with light.
3. Gold nanoshells can be fabricated to absorb infrared light and produce heat.
4. The size of the nanoshell enables it to enter the tumor site.

## About the Evaluation

The purpose of this evaluation was to provide visitor feedback to the nanotechnology education associates so that they could make changes to their presentations based on the needs of visitors. This evaluation was also conducted to provide educators from other institutions, specifically those who might encounter the presentation materials through NISEnet.org, with feedback they can use to determine how to modify this presentation to make it more effective. Therefore, the evaluation is formative and not summative in nature. The overarching questions that the evaluation sought to address included the following:

1. What about the content of the presentation works well and what needs to be changed to make the presentation more appealing and easier to understand?
2. Which presentation methods work well and which need to be changed to make the presentation more engaging?
3. What learning goals are visitors learning and not learning, and what about the presentation needs to be changed to make it more likely visitors will learn the goals?

Ideally, the education associate would be given preliminary results as data collection is progressing so that she could use the results to make changes to her presentation. However, Lisa Regalla left the Museum of Science soon after the data collection ended making it impossible to provide her with any evaluation data before she left that could be used to make changes to the presentation. Still, this information could be used by others who wish to present “Treating Tumors with Gold” to improve and modify this presentation to make it more effective.

The planning for this evaluation began in March 2008. Evaluators collected data for this evaluation between March and April 2008. The final evaluation report was released in February 2009.

## II. Methods

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Data were collected at four “Treating Tumors with Gold” presentations presented at the Museum of Science between March and April 2008 (Table 1). Evaluators gathered feedback from visitors who attended these four presentations through exit surveys. The methods that evaluators used to select study participants, and the questions asked on the exit survey are described below.

**TABLE 1. Number of Surveys Collected at the Four “Treating Tumors with Gold” Presentations that are a Part of this Study.**

	<b>Number of Surveys Collected</b>
March 23	8
April 5 Show #1	13
April 5 Show #2	17
April 8	3
<b>Total</b>	<b>41</b>

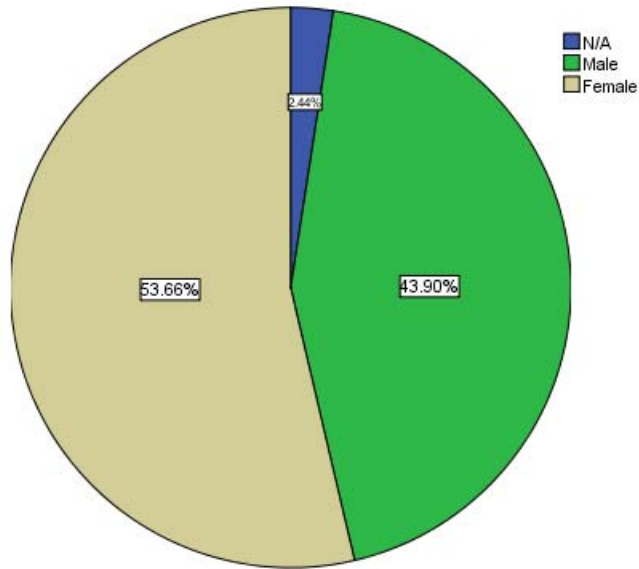
### Recruitment of Study Participants

At the beginning of the “Treating Tumor with Gold” presentations, exit surveys were offered to audience members who were asked if they would be willing to give the Museum feedback about the presentation. Evaluators began handing surveys out to audience members just before the show started and continued to hand surveys out to new audience members through the first two PowerPoint slides of the presentation. Exit surveys were not handed out to new audience members after this point because it was felt that these audience members did not see enough of the presentation to adequately answer the survey questions. Evaluators collected the surveys from the audience members at the end of the presentation after they had a chance to fill them out. Using these methods, 41 surveys were collected (Table 1). Just over half of the survey respondents (54%) were female, and the average age of the survey respondents was 34 (SD<sup>1</sup>=16) (Graphs 1 & 2).

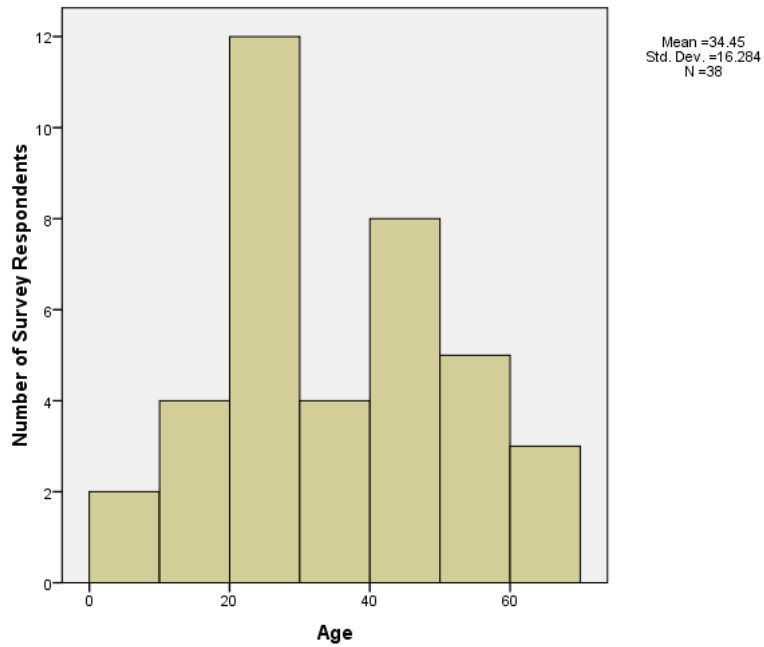
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<sup>1</sup> “SD” means standard deviation.

**GRAPH 1. Gender of Survey Respondents. (N=41)**



**GRAPH 2. Histogram of Survey Respondent Ages. (N=38)**





## Exit Survey Questions

Audience members were asked a series of questions on the exit survey in order to provide information about what segments of the presentation work well and what segments need to be modified. First, visitors were asked a series of Likert scale questions about the topic and content of the presentation including the following:

- How much they liked the presentation,
- How interesting they felt the topic was,
- How much the presentation increased their curiosity,
- Whether the content was confusing or clear,
- Whether the vocabulary used was difficult or easy,
- Whether the presentation provided too much or too little information,
- How much they learned, and
- How relevant the content was to issues that concern them or their community.

After that, visitors were asked to answer two open-ended questions: one seeking information about what interesting things visitors learned from the presentation, and the other seeking information about what could be done to improve the presentation. Twenty-five of the 41 survey respondents (61%) answered the learning question, and 18 of the 41 survey respondents (43%) answered the improvement question. In order to learn what visitors thought of the presentation techniques used, visitors were asked to rate the level of engagement of the different presentation technique implementations. The presentation technique implementations used in “Treating Tumors with Gold” that visitors were asked to rate included the following:

- *Communication Techniques*
  - The presenter’s analogies and metaphors
- *Multimedia Techniques*
  - The graphics
  - The gold nanoshell beaker video
  - The chicken breast experiment video
  - The gold nanoshell therapy animation
- *Illustrative Techniques*
  - The cancer tumor model
  - The leaky blood vessel demonstration
- *Audience Engagement Techniques*
  - Polling the audience
  - The infrared light demonstration

Finally, to better understand the make-up of the audience, audience members were asked to provide demographic information including their ages and genders. A copy of the exit survey can be found in Appendix A.

## Data Analysis

Data collected through the exit survey were both qualitative and quantitative in nature. Quantitative data were analyzed through descriptive statistics such as percentages, counts, and means. In addition, comparative tests of significance were sometimes conducted. The level of significance was set at 0.05, and only statistically significant results are described in this report. Qualitative data were analyzed using inductive coding. Inductive coding analysis involves “immersion in the details and specifics of data to discover important patterns, themes, and interrelationships” (Patton, 2002, p.41).

### III. Results and Discussion

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Based on the responses from the surveys, the four main findings about the “Treating Tumors with Gold” presentation were the following:

1. Visitors found the content of the presentation appealing and clear, and only a few visitors felt changes might improve the presentation.
2. Visitors reported learning many specific things about gold, infrared light, and blood vessels through the presentation, but often this learning did not exactly match the learning goals of the presentation.
3. Overall, visitors were split as to which presentation technique implementations were the most engaging indicating that it is the way the technique is applied and not the technique itself that is important to engaging visitors.
4. While males and females generally found the presentation technique implementations equally engaging, females found some of the multimedia presentation technique implementations significantly more engaging.

#### **1. Visitors found the content of the presentation appealing and clear, and only a few visitors felt changes might improve the presentation.**

On the exit survey, visitors were given pairs of phrases that allowed them to rank the appeal and clarity of the presentation on a scale of one to five. They were also asked to rank the relevance of the presentation content to issues that concern them or their communities on a four-point scale that ranged from “not at all relevant” to “very relevant.” Overall, the responses from these questions indicate that visitors found “Treating Tumors with Gold” highly appealing and very clear. However, a small number of visitors felt that the presentation might be improved by adding more information and modifying the vocabulary.

#### ***1.1 Visitors found “Treating Tumors with Gold” highly enjoyable and interesting.***

Visitors, who watched the “Treating Tumors with Gold” presentation, found the presentation both very enjoyable and interesting. When visitors were asked how much they liked the presentation, they gave it an average rank of 4.9 out of 5 (SD=0.4) with all 41 visitors, who answered the question, choosing either a four or five as their ranking. This indicates that visitors liked the presentation to a very high degree. Similar results were found when visitors were asked if the presentation’s topic was interesting. The mean rank that visitors gave their interest in the topic was 4.9 out of 5 (SD=0.4), and once again, all 41 respondents chose either four or five as their ranking implying that visitors found the topic highly interesting. Finally, visitors were asked to rank whether the presentation decreased or increased their curiosity. The mean rank visitors gave to these phrases was 4.8 out of 5 (SD=0.4) with all 40 respondents choosing a four or five. This finding shows that visitors felt that the presentation increased their curiosity in the topic. Together these findings indicate that “Treating Tumors with Gold” was a highly appealing presentation for visitors: they liked it, found the topic interesting, and their curiosity was stimulated. A summary of these findings can be found in Table 1.

**TABLE 1. Visitor Responses to the Quantitative Pair Questions about the Appeal of the Presentation.**

	N <sup>2</sup>	Mean	SD	Minimum Rank	Maximum Rank
Disliked the presentation - Liked the presentation	41	4.9	0.4	4	5
Uninteresting topic - Interesting topic	41	4.9	0.4	4	5
Decreased my curiosity - Increased my curiosity	40	4.8	0.4	4	5

Visitors also found the presentation highly relevant to issues that concern them or their community. When asked to rank the relevance of the presentation content on a scale of “not at all relevant,” “not particularly relevant,” “fairly relevant,” and “very relevant,” all the survey respondents said that “Treating Tumors with Gold” was either “not particularly relevant,” “fairly relevant,” or “very relevant” to them. By giving “not at all relevant” a score of one, “not particularly relevant” a score of two, “fairly relevant” a score of three, and “very relevant” a score of four, it was found that the mean ranking visitors gave this question was 3.5 out of 4 (SD=0.6). Despite the fact that some visitors said the presentation content was “not particularly relevant,” the average ranking of this question indicates that most visitors felt the presentation content was relevant to them or members of their community (Table 2).

**TABLE 2. Visitor Responses to the Close-Ended Question: “How relevant is the presentation content to issues that concern you or your community?” (N=38)**

Mean	SD	Minimum Rank	Maximum Rank
3.5	0.6	2	4

**1.2 Visitors found the content generally clear and the vocabulary at an appropriate level, but reviewing vocabulary would increase visitors’ comfort level.**

In general, visitors found the content presented in “Treating Tumors with Gold” understandable. Visitors were asked to rank the content of the presentation on a five-point scale of “generally confusing” (a one on the scale) to “generally clear” (a five on the scale). The visitors ranked the content between a three and five on this scale, and the mean ranking of the participants was 4.7 out of 5 (SD=0.5) indicating that most visitors felt that the content was “generally clear.” When visitors were asked to rank the vocabulary on a five-point scale where one meant that the vocabulary was “too difficult” and five meant that the vocabulary was “too easy,” all the visitors’ responses were between three and five. The mean ranking for the vocabulary of the session was 3.9 out of 5 (SD=0.8). This average indicates that in general visitors felt that the vocabulary was slightly too easy (see Table 3). However, in response to an open-ended question, two (of 18) respondents said they felt the vocabulary was too difficult (see Table 4). One of these visitors said, “[The presentation could be improved with] easier vocabulary” (Survey #23). The other visitor echoed this sentiment. Even though the number of visitors who asked for this change is small, reviewing the vocabulary used in the presentation may raise the visitors’ comfort level.

<sup>2</sup> Number of visitors who answered the question.

**TABLE 3. Visitor Responses to the Quantitative Pair Questions about the Clarity and Difficulty of the Presentation.**

	N	Mean	SD	Minimum Rank	Maximum Rank
Generally confusing content - Generally clear content	41	4.7	0.5	3	5
Vocabulary too difficult - Vocabulary too easy	39	3.9	0.8	3	5

**TABLE 4. Visitor Responses to the Open-Ended Question: “How could we improve the presentation to make it more appealing or clearer to you?” (N=18)<sup>3</sup>**

	Number of Respondents	Quotes
Don't change anything	6	"Excellent as is." (Survey #9)
Add more detail	3	"Very good-- perhaps a little less background and a little more detail." (Survey #13)
Increase the presentation's length	3	"A bit longer would be good." (Survey #20)
Make the vocabulary less complex/easier	2	"Easier vocabulary." (Survey #25)
I'm not sure what to change.	2	"Not sure." (Survey #29)
Add more animations and videos	1	"Honestly I think is good. You can try with more computer animations and videos." (Survey #39)
Add a question and answer session	1	"Chance to ask questions." (Survey #37)
Do the presentation in a quieter space.	1	"Quieter area. I was here on busy Saturday." (Survey #28)

**1.3 Most visitors felt that the presentation contained an appropriate amount of information but one-quarter desired more depth or a longer presentation**

Besides the other presentation factors that visitors were asked to rank, they were also asked to rank on a five-point scale whether “Treating Tumors with Gold” contained “too little” or “too much” information. The visitors had a range of answers to this question with people choosing all the possible responses on this scale. This means that some visitors felt that the presentation contained “too little information” while other visitors felt that the presentation contained “too much information.” When the data from all the visitors were combined and averaged, a mean ranking of 3.6 out of 5 (SD=0.9) was produced (Table 5). Because this average falls near the middle of the one to five scale, it indicates that overall visitors felt the presentation contained an appropriate amount of information but that more people felt the presentation contained “too much information” than “too little information” (see Table 5).

**TABLE 5. Visitor Responses to the Quantitative Pair Questions about the Amount of Information in the Presentation (N=39).**

	Mean	SD	Minimum Rank	Maximum Rank
Too little information - Too much information	3.6	0.9	1	5

<sup>3</sup> The number of respondents is greater than 18 because some visitors' responses fit into more than one category.

Despite the fact that overall, visitors seemed satisfied with the level of the content or thought that it may contain a little too much information, some visitors (5 of 18 question respondents) thought that the presentation could be improved with more information. When asked what could be done to improve the presentation, the second most common responses were to add more detail (3 of 18 question respondents) and increase the length of the presentation (3 of 18 question respondents) (see Table 4). One of these participants said, “Make it a little deeper” (Survey #3). Another participant said, “Perhaps make [the presentation] slightly longer” (Survey #26). These data represent a quarter of the question respondents; thus, even though visitors were happy with the amount of content presented overall, some still felt that adding more information would improve “Treating Tumors with Gold.”

Overall, visitors found “Treating Tumors with Gold” highly enjoyable and relevant to them, and felt the content was appropriately and clearly presented. However, a few visitors contradicted some of these findings and expressed that the presentation might be improved by adding more information to the presentation and modifying its vocabulary. Therefore, anyone presenting “Treating Tumors with Gold” should consider doing the following:

- Further evaluating the presentation to ensure that:
  - The vocabulary used in the presentation is neither too difficult nor too easy; and
  - The amount of information presented is satisfactory.
- Adding more information about the gold nanoshell cancer therapy by:
  - Lengthening the presentation or
  - Adding more details about the cancer therapy and research.

## **2. Visitors reported learning interesting things about gold, infrared light, and blood vessels through the presentation but recalled only parts of the four intended learning goals.**

Through the “Treating Tumors with Gold” presentation, educators attempted to impart a series of learning goals to the visitors including the following:

1. Scientists in nanotechnology bridge the gap between disciplines to try to solve research problems.
2. The size of a material (like gold) determines its properties and its interaction with light.
3. Gold nanoshells can be fabricated to absorb infrared light and produce heat.
4. The size of the nanoshell enables it to enter the tumor site.

Results of the visitor survey reveal that visitors felt they learned a lot of interesting information from the presentation, including parts of the learning goals listed above, but they did not learn all of what the educators intended.

### ***2.1 Overall, visitors reported learning a lot from the presentation, but those who answered the open-ended learning question learned significantly more than those who did not answer this question.***

On the whole, visitors reported learning a lot from “Treating Tumors with Gold.” Visitors were asked to rank how much they learned on a five-point scale where one meant they “learned nothing” and five meant they “learned a lot.” All the visitors picked between a three

and five on this scale, and the mean ranking of this question was 4.7 out of 5 (SD=0.6). This indicates that many visitors felt they learned a lot from the presentation. Interestingly, when the visitors were split into two groups, those who did and did not answer the open-ended learning question, the data indicate there is a difference in how much visitors perceived they learned. A t-test shows that those who answered the open-ended learning question reported learning significantly more (N=24, M=4.9, SD=0.3) than those who did not answer the question (N=16, M=4.4, SD=0.7) (N=40,  $t(18.045)=-2.51$ ,  $p=0.022$ ). This may indicate that people will only answer an open-ended learning question if they feel they have learned a lot from a presentation. It may also indicate that the people who said they learned less happened to be in more of a hurry to complete the survey so they skipped the open-ended question. Nevertheless, the data indicate that in this case, the open-ended question data are not representative of those who ranked their learning on the lower end of the scale, and that during future studies evaluators need to consider whether an open-ended learning question will elicit responses that are representative of all the study participants. A summary of the data described above can be found in Table 6.

**TABLE 6. Visitor Responses to the Quantitative Pair Questions about Whether They “Learned Nothing” or “Learned A Lot” Clumped Together and Split by Whether They Answered the Open-Ended Learning Question.**

	N	Mean	SD	Minimum Ranking	Maximum Ranking
All respondents	40	4.7	0.6	3	5
Respondents who answered the open-ended learning question	24	4.9	0.3	4	5
Respondents who did not answer the open-ended learning question	16	4.4	0.7	3	5

**2.2 Many visitors reported learning interesting facts pertaining to the learning goals, but few recalled information encompassing a full message.**

Despite the fact that the analysis reported above indicates that the responses to the open-ended learning question may not be representative of the visitors who felt they learned less from the presentation, the open-ended question data were still analyzed to understand what respondents felt were the most interesting things they learned from the presentation.

One of the learning goals of the “Treating Tumors with Gold” presentation was that: “Gold nanoshells can be fabricated to absorb infrared light and produce heat.” Visitors recalled pieces of this message, but only one visitor (of 25) articulated this entire message. This visitor said, “[The most interesting thing I learned is] the infrared [light] - nano particle - heating connection” (Survey #38). However, many other visitors reported learning other concepts central to this message. The most common response (6 of 25 respondents) given was that one of the most interesting things visitors learned was that gold could be used as a treatment for cancer. One of these visitors said, “[The most interesting thing I learned was] about how the gold go inside our body [and] then we can destroy the bad cell that causes cancer” (Survey #23). Another topic that visitors (5 of 25 respondents) reported was one of the most interesting things they learned through the presentation was that infrared light can pass through tissue. One of these participants said, “[One of the most interesting things I learned was that] infrared light passes through human tissue...” (Survey #13). Neither of these topics fully encapsulate the learning goal, but they are important to understand if you are going to learn the entire goal.

Another presentation learning goal was that “The size of the nanoshell enables it to enter the tumor site.” Again, only one visitor response (of 25) recalled this entire learning goal: “[The most interesting thing I learned is] how the gold particles can escape the blood vessels to enter the tumor” (Survey #27). Some respondents (3 of 25) reported that the most interesting thing they learned was that tumor blood vessels are different from other blood vessels, a concept that is important to understanding this goal. One of these respondents said, “[One of the most interesting things I learned was that] ...blood vessels walls in tumors are different that normal ones...” (Survey #20).

Few visitors reported that the most interesting things they learned related to the other two learning goals for “Treating Tumors with Gold.” The first of these messages was that “The size of a material (like gold) determines its properties and its interaction with light.” Only two visitors’ responses (of 25) indicated that the most interesting thing they had learned was this entire goal, and no one else reported learning any other concepts central to this goal. One of the visitors, who reported learning this goal, said, “[The most interesting thing I learned was that when] gold nanoshells [are] in chicken infrared light burns only the nanoshells (tumor)” (Survey #28). Finally, no visitors reported the full presentation message that “Scientists in nanotechnology bridge the gap between disciplines to try to solve research problems.” However, a couple of visitors (2 of 25 respondents) reported learning about methods that researchers use to solve problems. One of these visitors said, “[The most interesting thing I learned was that] new research [is] being developed to fight cancer” (Survey #7) (Table 7).

While most of the question respondents (16 of 25) reported that the most interesting things they learned were facts directly related to the learning goals of the presentation, other question respondents (9 of 25) reported that the most interesting things they learned about was a topic in general. Some respondents (4 of 25) reported that the most interesting thing they learned about was nanomedicine in general. One of these visitors said, “[The most interesting thing I learned about was] Nano Therapy” (Survey #8). Other visitors (2 of 25 respondents) said they learned about nanotechnology. One of these visitors said, “[The most interesting thing that I got from this presentation was a] better understanding of nanotech and its uses” (Survey #37). Finally, a couple of respondents (2 of 25) said the most interesting thing they learned about was gold nanoshells in general. One of these people said, “[The most interesting thing I learned about was] Nano Gold” (Survey #17) (Table 7).

The responses to the open-ended learning question indicate that most visitors recalled as interesting at least parts of the presentation’s four messages. However, it was unlikely that visitors would describe an entire learning goal, given the question that was asked: “what are the most interesting things you learned.” It is possible that if visitors had been interviewed instead of surveyed that evaluators could have asked follow-up questions, which would indicate if more visitors learned entire learning goals. It is also possible that if visitors had been asked what new things they learned instead of what interesting things they learned that more visitors would have described the learning goals in their answers. Still, in order to increase a visitor’s learning and retention of the learning goals, the educator who presents “Treating Tumors with Gold” should consider adding more visual and auditory repetitions of the goals.

Another interesting thing of note is that while many visitors learned at least part of three of the learning goals, only two people reported learning even part of the goal about scientists bridging disciplines to solve scientific problems. These visitors reported that the most interesting thing they learned about was methods that scientists use to solve research problems. No visitors mentioned anything about the interdisciplinary aspect of the research



being conducted by the researchers at Rice University. It is possible that this learning goal was brought up by few visitors because it was not emphasized during the presentation, or because visitors did not feel it was the most interesting thing that they had learned. If the educator feels that this is an important goal for the visitors to attain, then she should spend more time talking about the collaboration between the two research labs in the presentation. A summary of all the responses given to the open-ended learning question can be found in Table 7.

**TABLE 7. Visitor Responses to the Open-Ended Question: “What are the most interesting things that you learned from this presentation?” (N=25)<sup>4</sup>**

	Number of Respondents	Quotes
Gold can be used as a treatment for cancer.	6	"Why gold is seen as a possible solution to the problem of isolating tumors for destruction." (Survey #30)
Infrared light can pass through tissue.	5	"Infrared goes through human tissue..." (Survey #14)
Something general about nanomedicine.	4	"The properties of nano medicine" (Survey #3)
Tumor blood vessels are different than normal blood vessels.	3	"That blood cell structures are quickly constructed around tumors." (Survey #26)
The size of the material affects its interaction with light.	2	"Gold interacts different with light at nano-scales..." (Survey #20)
Something different about infrared light.	2	"How little infrared was needed." (Survey #18)
Something general about nanotechnology.	2	"How nanotechnology works" (Survey #9)
Something general about gold nanoshells.	2	"Goldshells is good." (Survey #16)
Methods that scientists use to solve research problems.	2	"...Problem solving solution." (Survey #24)
The properties of a tumor allow for certain therapies.	1	"How biology of abnormal tumors allows for certain kinds of treatments." (Survey #29)
The size of the material enables it to enter the tumor.	1	"How the gold particles can escape the blood vessels to enter the tumor." (Survey #27)
Gold nanoshells can be fabricated to absorb infrared light and produce heat.	1	"The infrared - nano particle - heating connection" (Survey #38)

**3. Overall, visitors were split as to which presentation technique implementations were the most engaging indicating that it is the way the technique is applied and not the technique itself that is important to engaging visitors.**

In the 2007 report “Nanotechnology Onstage at the Museum of Science,” Elissa Chin determined that there are a series of presentation techniques that are used by educators to explain their content. Those techniques include communication, multimedia, illustrative, and audience engagement techniques. In observing “Treating Tumors with Gold,” it was found that

<sup>4</sup> The number of respondents is greater than 25 because some visitors’ responses fit into more than one category.

the educator utilizes all of these techniques during the course of the presentation. On the presentation survey, visitors were asked to rank how engaging they found many of the specific technique implementations found in the presentation on a scale of “not at all engaging,” “somewhat engaging,” “engaging,” and “very engaging.” In order to create average engagement rankings for all the techniques, “not at all engaging” was given a score of one, “somewhat engaging” was given a score of two, “engaging” was given a score of three, and “very engaging” was given a score of four. Results from these questions showed that visitors ranked all of the presentation techniques (communication, multimedia, illustrative, and audience engagement) highly, but variation in the mean scores of the technique implementations show that visitors had mixed feelings about the individual implementations of these techniques.

**3.1 Visitors ranked all of the presentation techniques highly.**

As stated above, the educator used all the possible presentation techniques (communication, multimedia, illustrative, and audience engagement) during “Treating Tumors with Gold.” However, some techniques were used more times than others. During “Treating Tumors with Gold,” the educator implemented the multimedia technique four times (PowerPoint graphics, gold nanoshell beaker video, chicken breast experiment video, gold nanoshell therapy animation), the illustrative technique two times (cancer tumor model & infrared light demonstration), the communication technique once (presenter’s analogies and metaphors), and the audience engagement technique two times (polling the audience & leaky blood vessel demonstration). Visitors were asked to rate their engagement with each implementation of these presentation techniques individually. However, to create a mean technique rank for each visitor, all the implementation ranks for that technique were averaged together. For example, to generate the mean technique rank for the illustrative technique, a mean was taken of the rankings for the cancer tumor model and infrared light demonstration. Next, the mean technique rank for all the visitors were averaged together to create the overall mean technique rank for the entire visiting population. This allows for comparisons to be made between the different presentation techniques used during “Treating Tumors with Gold.”

The overall mean technique ranks for all the presentation techniques are high. The overall mean ranks for the multimedia and illustrative techniques were 3.4 out of 4 (Multimedia SD=0.5, Illustrative SD= 0.5). The overall mean rank for the communication technique was 3.3 out of 4 (SD=0.6), and the overall mean rank for the audience engagement technique was 3.2 out of 4 (SD=0.7). These high rankings indicate that on the whole most visitors felt very similarly about the different presentation techniques and that for them all the presentation techniques were “engaging” or “very engaging.” A summary of the overall mean technique ranks can be found in Table 8.

**TABLE 8. Mean Visitor Responses to the Questions about the Engagement Level of Presentation Technique Implementations used by the Educator Combined to Create Mean Technique Ranks.**

Presentation Technique	N	Overall Mean Technique Rank	SD
Multimedia	40	3.4	0.5
Illustrative	38	3.4	0.5
Communication	40	3.3	0.6
Audience Engagement	39	3.2	0.7

**3.2 Visitors felt that some of the implementations of the multimedia techniques were slightly more engaging than others.**

There were four multimedia techniques used by the educator during the course of “Treating Tumors with Gold”: the chicken breast experiment video, the gold nanoshell therapy animation, the gold nanoshell beaker video, and the PowerPoint graphics. Visitors ranked two of the multimedia techniques very highly. The mean ranking for the chicken breast experiment video was 3.6 out of 4 (SD=0.5) with all the visitors ranking this technique either “somewhat engaging,” “engaging,” or “very engaging.” The mean ranking for the gold nanoshell therapy animation was 3.5 out of 4 (SD=0.6). All the visitors ranked this multimedia technique implementation either “somewhat engaging,” “engaging,” or “very engaging.” Visitors ranked the other two multimedia technique implementations slightly lower. The mean ranking for the gold nanoshell beaker video was 3.3 out of 4 (SD=0.6) with everyone ranking this multimedia technique implementation either “somewhat engaging,” “engaging,” or “very engaging.” The mean ranking for the graphics was also 3.3 out of 4 (SD=0.8). Some of the visitors ranked this implementation “not at all engaging,” but given the mean rank of 3.3 many more visitors ranked this implementation either “somewhat engaging,” “engaging,” or “very engaging.” The differences in the mean rankings are small indicating that overall visitors found all the multimedia technique implementations engaging. However, they still illustrate some preference for the chicken breast experiment video and gold nanoshell therapy animation over the PowerPoint graphics and gold nanoshell beaker video. These differences in preference may reflect that visitors found movies and animations (chicken breast experiment video & gold nanoshell therapy animation) more engaging than static images (PowerPoint graphics), or that visitors preferred the multimedia technique implementations more central to the presentation’s learning goals (chicken breast experiment video & gold nanoshell therapy animation). A summary of the multimedia technique implementation rankings can be found in Table 9.

**TABLE 9. Visitor Responses to the Close-Ended Question about the Multimedia Technique Implementations: “How engaging were the following methods used by the presenter?”**

	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>Minimum Rank</b>	<b>Maximum Rank</b>
The chicken breast experiment video	40	3.6	0.5	2	4
The gold nanoshell therapy animation	40	3.5	0.6	2	4
The graphics	40	3.3	0.8	1	4
The gold nanoshell beaker video	40	3.3	0.6	2	4

**3.3 Visitors ranked one of the audience engagement technique implementations as significantly more engaging than the other.**

There were two implementations of the audience engagement technique used by the educator during “Treating Tumors with Gold”: an infrared light demonstration and polling the audience. The mean ranking of the infrared light demonstration was 3.6 out of 4 (SD=0.6). The visitors, who ranked this implementation, chose all the possible rankings from “not at all engaging” to “very engaging.” However, because the average ranking was so high, this indicates that most visitors ranked the infrared light demonstration either “engaging” or “very engaging.” The mean ranking visitors gave to polling the audience

(M=3.1, SD=0.8) was much lower. Again visitors chose all the possible options from “not at all engaging” to “very engaging.” However, because the average ranking was lower, this indicates that fewer people thought polling the audience was “engaging” or “very engaging.” As a matter of fact, visitors gave a significantly higher engagement ranking to the infrared light demonstration than polling the audience (N=79,  $t(77)=-2.205$ ,  $p=0.030$ ) indicating the audience’s strong preference for the infrared light demonstration. This difference in engagement may be result of the tender subject visitors were polled on during the presentation (do you know anyone who has had cancer), or it may reflect how interesting visitors found viewing invisible, infrared light (which was observed with an infrared camera when the light was passed through an audience member’s fingers). A summary of the rankings of the audience engagement technique implementations can be found in Table 10.

**TABLE 10. Visitor Responses to the Close-Ended Question about the Audience Engagement Technique Implementations: “How engaging were the following methods used by the presenter?”**

	N	Mean	SD	Minimum Rank	Maximum Rank
The infrared light demonstration	40	3.6	0.6	1	4
Polling the audience	39	3.1	0.8	1	4

**3.4 Visitors felt similarly about the engagement level of the two illustrative technique implementations.**

There were two implementations of illustrative techniques used during the “Treating Tumors with Gold” presentation: the cancer tumor model and the leaky blood vessel demonstration. The mean ranking visitors gave to the cancer tumor model was 3.3 out of 4 (SD=0.7). The visitors answering this question chose either “somewhat engaging,” “engaging,” or “very engaging” as their ranking for this illustrative technique implementation. However, because the mean ranking is high, this indicates that most visitors felt the implementation was either “engaging” or “very engaging.” The mean ranking visitors gave to the leaky blood vessel demonstration was 3.4 out of 4 (SD=0.7). Visitors were mixed as to how they felt about this illustrative technique implementation as the visitors chose from “not at all engaging” to “very engaging” as their ranking. However, once again, the high mean ranking indicates that most visitors felt the leaky blood vessel demonstration was either “engaging” or very engaging.” These two mean rankings illustrate that visitors felt very similarly about the two illustrative technique implementations. A summary of the audience engagement technique implementation rankings can be found in Table 11.

**TABLE 11. Visitor Responses to the Close-Ended Question about the Illustrative Technique Implementations: “How engaging were the following methods used by the presenter?”**

	N	Mean	SD	Minimum Rank	Maximum Rank
The leaky blood vessel demonstration	40	3.4	0.7	1	4
The cancer tumor model	38	3.3	0.7	2	4

The data in this section show that visitors found all of the presentation techniques used during “Treating Tumors with Gold” engaging. Visitors did not have any clear preference between the illustrative, communication, multimedia, and audience engagement techniques indicating that any presentation technique can be engaging to visitors. However, the data do show that there were some differences in visitors’ engagement with different implementations of the techniques. Significant differences were seen in the rankings of the engagement of the two audience engagement implementations, and there was some variation in the mean rankings given to the four multimedia technique implementations. This suggests that decisions made about how to implement a presentation technique and not the presentation technique itself affects visitors’ engagement levels. Therefore, it is important to test each presentation technique implementation to ensure that visitors find them engaging. In this case, visitors found all of the presentation technique implementations at least relatively engaging. However, the presentation may be improved by removing or changing the polling of the audience as this implementation was ranked the lowest of all the presentation technique implementations. None of the other technique implementations need to be changed.

#### **4. While males and females generally found the presentation technique implementations equally engaging, females found some of the multimedia presentation technique implementations significantly more engaging.**

In order to determine whether there were any further differences in the way audience members reacted to the presentation, the sample was split in different ways. The sample could not be split by age because not enough data were collected from children under the age of 18. However, the sample was split by gender. There were no significant differences in the way males and females ranked the Likert scale questions which described the presentation overall. Statistics also indicate that this is true for most of the presentation technique implementations. This is true for the communication technique implementation (presenter’s analogies and metaphors), the audience engagement implementations (infrared light demonstration & polling the audience), and the illustrative implementations (leaky blood vessel demonstration & cancer tumor model). It is also true of one of the multimedia technique implementations: the gold nanoshell beaker video (Table 12). There were, however, significant differences in how engaging males and females found the other multimedia implementations.

Females found three of the four multimedia techniques significantly more engaging than male audience members. The mean ranking that females gave the PowerPoint graphics was 3.6 out of 4 (SD=0.5) with all females saying the graphics were either “engaging” or “very engaging.” Males, who answered this question, gave the PowerPoint graphics a mean ranking of 2.9 out of 4 (SD=1.0), and their answers to this question ranged from “not at all engaging” to “very engaging.” The mean engagement ranking that females gave the graphics was significantly higher than the mean engagement ranking that males assigned it (N=39,  $t(37)=-2.72$ ,  $p=0.010$ ). Similar results are seen for the chicken breast experiment video. Females gave this multimedia implementation a mean ranking of 3.7 out of 4 (SD=0.5) with all females saying the chicken breast experiment video were either “engaging” or “very engaging.” Males gave the chicken breast experiment video a mean ranking of 3.4 out of 4 (SD=0.6) with the males choosing either “somewhat engaging,” “engaging,” or “very engaging” as their ranking. Once again, this difference meant that females found the chicken breast video significantly more engaging than males (N=39,  $t(37)=-2.20$ ,  $p=0.034$ ). Females also found the gold nanoshell therapy animation more engaging than males. The mean ranking that females gave this multimedia

implementation was 3.7 out of 4 (SD=0.6) with the females choosing either “somewhat engaging,” “engaging,” or “very engaging” as their ranking. The mean ranking males gave the gold nanoshell therapy animation was 3.2 out of 4 (SD=0.6) with all the males choosing either “somewhat engaging,” “engaging,” or “very engaging” as their ranking (Table 12). The mean ranking that females gave the gold nanoshell therapy animation was significantly higher than the mean ranking males gave the implementation (N=39,  $t(37)=-2.45$ ,  $p=0.019$ ) indicating that again females found this presentation technique implementation significantly more engaging. It is unclear why females found these multimedia techniques significantly more engaging than males. It is possible that females find visual media more engaging than males in general, or that females found it more engaging in this case to be able to have not just verbal descriptions but also visual descriptions of how the gold nanoshell therapy works. It is also possible that these numbers reflect females’ increased engagement with the presentation topic in general.

Table 12 shows that generally males and females found the presentation technique implementations equally engaging. This indicates that generally educators do not need to worry about whether the presentation techniques they use will be more engaging to one gender or the other. However, this does not seem to be the case for the multimedia technique implementations used during “Treating Tumors with Gold.” Females found three of the four implementations (chicken breast experiment video, gold nanoshell therapy animation, and graphics) significantly more engaging than the male audience members. This indicates that, at least for the multimedia presentation technique implementations used, educators need to be mindful of how appealing they may be to males. In this case, educators should consider different ways to make the PowerPoint graphics and the gold nanoshell therapy animation more appealing to males. It is possible that both these implementations might be more appealing to males if they contained more realistic and less stylized animations and drawings. Educators should not worry as much about the chicken breast experiment video because although females found it more engaging than males, male engagement was still high.

**TABLE 12. Visitor Responses to the Close-Ended Question: “How engaging were the following methods used by the presenter?” Split by Gender.<sup>5</sup>**

	Gender	N	Mean	SD	Minimum Rank	Maximum Rank
<b>Multimedia Technique Implementations</b>						
The chicken breast experiment video*	Male	17	3.4	0.6	2	4
	Female	22	3.7	0.5	3	4
The gold nanoshell therapy animation*	Male	17	3.2	0.6	2	4
	Female	22	3.7	0.6	2	4
The graphics*	Male	17	2.9	1.0	1	4
	Female	22	3.6	0.5	3	4
The gold nanoshell beaker video	Male	17	3.1	0.6	2	4
	Female	22	3.4	0.7	2	4
<b>Audience Engagement Technique Implementations</b>						
The infrared light demonstration	Male	17	3.4	0.8	1	4
	Female	22	3.6	0.5	3	4
Polling the audience	Male	17	2.9	0.7	2	4
	Female	21	3.1	0.9	1	4
<b>Illustrative Technique Implementations</b>						
The leaky blood vessel demonstration	Male	17	3.2	0.9	1	4
	Female	22	3.5	0.5	3	4
The cancer tumor model	Male	16	3.1	0.8	2	4
	Female	21	3.4	0.5	3	4
<b>Communication Technique Implementations</b>						
The presenter's analogies and metaphors	Male	17	3.1	0.6	2	4
	Female	22	3.5	0.6	2	4

<sup>5</sup> A star next to a presentation technique implementation means that t-tests indicated that females were significantly more engaged with the technique than males ( $p < 0.05$ ).

## IV. Conclusion

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The data illustrate that visitors greatly enjoyed the “Treating Tumors with Gold” presentation. Visitors found the presentation highly engaging, interesting, and relevant to their lives. In addition, they generally felt the presentation contained an acceptable amount of information and that the vocabulary used was appropriate. They also felt that the presentation techniques used were engaging, and that they learned a lot through the presentation.

Despite the high praise visitors gave “Treating Tumors with Gold,” there were some areas where changes might improve the program. A couple of visitors felt that though the vocabulary was appropriate it could be improved if it was slightly less difficult. One-quarter of visitors suggested more depth or a longer presentation. These changes might be difficult to make given the constraints placed upon the Museum of Science Current Science & Technology programs, and they may not have much impact on visitors’ experiences with the program. Therefore, it is not very important that educators attempt to make these changes. However, other changes could have more impact.

Many visitors reported interesting things they learned that related to the four learning goals of “Treating Tumors with Gold.” Few of the surveyed visitors spontaneously recalled an entire presentation message as the most interesting thing they learned. Visitors were likely to mention information about the topics of gold, infrared light and blood vessels, but they were not as likely to discuss the research and collaboration goal of the program. One reason for this may be because the scientific goals were clearly reinforced through the use of the presentation technique implementations, but the research and collaboration goal was not. In order to increase visitors’ abilities to articulate the full learning goals of “Treating Tumors with Gold,” it is suggested that the educator add visual and verbal reminders about the goals throughout the program. It is also suggested that the educator consider simplifying the learning goals to make them easier for visitors to retain.

In addition, the results illustrate that though visitors generally found the presentation technique implementations engaging they found some more engaging than others. This is especially true of polling the audience which had the lowest mean engagement ranking. It is possible that visitors were not as engaged with this implementation because the educator asked people to visually show other members of the audience if they knew anyone who had cancer—a sensitive subject. It is also possible that compared to the other more interesting information presented through the other presentation technique implementations, visitors did not find the polling very engaging. Because of this implementation’s relatively low score, the educator should consider changing or removing the polling from the presentation. The educator also needs to think about how the engagement levels differed between males and females. Males ranked their engagement with the PowerPoint graphics and the gold nanoshell therapy animation low compared to females. This may be because females found the visuals more engaging in general or because females were more engaged with the presentation topic. Therefore, the educators should test out different ways to make these presentation technique implementations more appealing to males such as by shortening them or using more realistic pictures and animations, but they should not remove these implementations altogether.



## References

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Chin, E. (2007). *Nanotechnology onstage at the Museum of Science* (Report No. 2007-14). Boston: Museum of Science.

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## Appendix: Exit Survey

Date: \_\_\_\_\_

### CHN “Gold Nanoshell” Presentation Survey

Help the Museum of Science improve future presentations by providing us with feedback.

**What is your gender?**  Male  Female  
 \_\_\_\_\_ years

**What is your age?**

**How do you feel about this presentation? Circle one number on the scale of 1 to 5 for each pair of descriptions below. Read the opposite descriptions carefully.**

Disliked the presentation	1	2	3	4	5	Liked the presentation
Uninteresting topic	1	2	3	4	5	Interesting topic
Decreased my curiosity	1	2	3	4	5	Increased my curiosity
Generally confusing content	1	2	3	4	5	Generally clear content
Vocabulary too difficult	1	2	3	4	5	Vocabulary too easy
Too little information	1	2	3	4	5	Too much information
Learned nothing	1	2	3	4	5	Learned a lot

**How relevant is the presentation content to issues that concern you or your community?**

Very relevant  Fairly relevant  Not particularly relevant  Not at all relevant

**What are the most interesting things that you learned from this presentation?**

**How could we improve the presentation to make it more appealing or clearer to you?**

**How engaging were the following methods used by the presenter?**

	Not at all Engaging	Somewhat Engaging	Engaging	Very Engaging
The presenter’s analogies and metaphors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Polling the audience	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The graphics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The cancer tumor model	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The gold nanoshell beaker video	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The chicken breast experiment video	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The gold nanoshell therapy animation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The infrared light demonstration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The leaky blood vessel demonstration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**On the back of this survey, please tell us any questions you still have about the content, or share any additional comments. Thank you!**