

Final Scientific/Technical Report

to the

U.S. Department of Energy

on

NOVA's Einstein's Big Idea

(Project Title: $E=MC^2$, A Two-Hour Television Program on NOVA)

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Executive Summary

A woman in the early 1700s who became one of Europe's leading interpreters of mathematics and a poor bookbinder who became one of the giants of nineteenth-century science are just two of the pioneers whose stories NOVA explored in *Einstein's Big Idea*. This two-hour documentary premiered on PBS in October 2005 and is based on the best-selling book by David Bodanis, *E=mc²: A Biography of the World's Most Famous Equation*. The film and book chronicle the scientific challenges and discoveries leading up to Einstein's startling conclusion that mass and energy are one, related by the formula $E = mc^2$.

In addition to the television program, viewers were able to deepen their understanding of the scientific concepts by utilizing the project's content-rich Web site, which included such features as audio of ten top physicists describing Einstein's famous equation in two minutes or less and an interactive quiz about the energy contained in the mass of small objects. The extensive site continues to serve as a stand-alone resource.

To maximize the reach and impact of the project, NOVA conducted a multi-pronged promotion effort that resulted in coverage in *TV Guide*, *The New York Times*, and *Entertainment Weekly*. Production of Library and Teacher's Guides, plus associated educational outreach to libraries and schools, raised awareness of the film and provided additional avenues for expanded learning.

A range of indicators demonstrates the success of the project. Examples include:

- 4.7 million viewers during the first week of broadcast
- 350,000 visitors to the Web site during the premiere month
- enthusiastic comments from viewers, e.g., "This is the first time ever that I have an understanding of this equation!"
- widespread media acclaim, e.g., *The Boston Globe* wrote, "It is impossible to walk away from this program without a better understanding of Einstein's great discovery."
- Gala event celebrating the upcoming program, co-hosted by the National Academies, PBS, The Department of Energy, the American Physical Society and the Universities Research Association, Inc.

The Department of Energy's grant of \$250,000 was crucial to our success because it contributed directly to the scientific quality of the program and the program's educational reach. A major portion of the funds from the U.S. Department of Energy went towards enhancing and strengthening the impact of the program with additional research and filming of scientists at the Stanford Linear Accelerator Center (SLAC), as well as additional computer-generated animations so that the scientific concepts presented could be made more understandable. In addition, Department of Energy funds allowed us to develop a print-based version of the online *Einstein's Big Idea* Teacher Guide for physics teachers and DOE research laboratory education staff. In September 2005, 3,000 guides were distributed through U.S. Department of Energy labs nationwide, and an additional 19,000 copies were mailed directly to middle and high school physics teachers and middle school science supervisors.

Report of Project Activities

Introduction

The ultimate goal of *Einstein's Big Idea* was to make physics both entertaining and comprehensible to everyone. It also aimed to correct misleading popular images of scientists and the scientific process, to show that people outside the mainstream (including women) often made significant contributions to science, and to reveal the formidable class barriers that many investigators had to overcome. The vivid portraits of pioneers in the film still have strong resonance today for young people who face gender, racial, educational, and financial barriers in becoming scientists and engineers. Throughout the program, *Einstein's Big Idea* reveals the way in which individuals can make a deep impact on science and on world events.

The Broadcast

Based on the best-selling book by David Bodanis, *E=mc²: A Biography of the World's Most Famous Equation*, the two-hour NOVA program was broadcast nationally on PBS on Tuesday, October 11, 2005. The program, which was narrated by well-known actor John Lithgow, was unusual for NOVA in that it combined documentary interviews with experts and dramatic historical scenes of scientists who contributed to our understanding of the famous equation $E = mc^2$. Actors included Aiden McArdle, who played Einstein; Emily Woof as Lise Meitner; and Shirley Henderson as Einstein's wife, Mileva.

One hundred years before our film premiered, Albert Einstein grappled with the implications of his revolutionary theory of relativity and came to a startling conclusion: mass and energy are one, related by the formula $E = mc^2$. This equation was just one of several extraordinary breakthroughs that Einstein made in 1905, including the completion of his special theory of relativity, his identification of proof that atoms exist, and his explanation of the nature of light, which would win him the Nobel Prize in Physics. To honor the centenary of these achievements, 2005 was declared the World Year of Physics by the International Union of Pure and Applied Physics.

Among Einstein's ideas, $E = mc^2$ is by far the most famous. Yet how many people know what it really means? NOVA illuminated this deceptively simple formula by unraveling the story of how it came to be. The program explored the lives of the men and women who helped develop the concepts behind each term in the equation: E for energy; m for mass; c for the speed of light; and 2 for "squared." Scientists featured in this program include Michael Faraday; Antonine-Laurent Lavoisier and his wife, Marie Anne; James Clerk Maxwell; Emilie du Chatelet; Otto Hahn; Fritz Strassmann, Lise Meitner; and Otto Robert Frisch. Genius by genius, idea by idea, *Einstein's Big Idea* demonstrated how Einstein's remarkable predecessors provided the intellectual tools for his extraordinary breakthrough—and helped viewers understand this famous equation as never before.

Web Site

The *Einstein's Big Idea* Web site (pbs.org/wgbh/nova/einstein) was designed to extend the reach and impact of the film. The site was launched in July 2005 with a video clip of the program in

order to provide advance promotion for the premiere broadcast. The full Web site includes 14 content features with a mix of styles—from text-based articles and interviews to more interactive content such as quizzes, games, and slide shows. The most popular feature on the site was “E = mc^2 Explained,” an audio feature in which ten leading experts were asked to explain the equation in a few minutes. This feature was also used as the basis for a podcast series, which was launched in August 2005, with one explanation being fed each week leading up to the broadcast.

Other engaging Web site features include:

- **The Legacy of E = mc^2 :** Einstein’s big idea has been enormously influential, in ways that reach far beyond the purely scientific.
- **The Equation of Today:** Three young physicists contemplate how a 100-year-old equation figures into their careers.
- **The Theory Behind the Equation:** Explore the eureka moment when Einstein came up with special relativity, the theory that spawned $E = mc^2$.
- **Relativity and the Cosmos:** Examine what many consider Einstein’s greatest achievement—general relativity.
- **The Power of Tiny Things:** How much energy does a paper clip pack? Test your intuition in this quiz.
- **Ancestors of E = mc^2 :** Meet the visionary scientists whose experiments paved the way for Einstein.
- **The Light Stuff:** Find out why the speed of light isn’t always 186,000 miles per second.
- **Time Traveler:** Explore time dilation in this interactive version of Einstein’s “twin paradox.”
- **Einstein Time Line:** Follow the arc of Einstein’s life from his birth in 1879 till his death in 1955.

Educational Outreach

The goals of both the informal and formal educational outreach was to extend the impact of the NOVA program and provide additional avenues for individuals of all ages to learn about the scientists and science behind $E = mc^2$. Two educational guides and a multifaceted outreach plan extended the impact of *Einstein’s Big Idea* beyond the broadcast to reach audiences of all ages.

The DOE came on as an additional funder, allowing us to develop a print-based version of the teacher guide to be distributed to physics teachers and DOE research laboratory education staff. The brochure had a DOE Logo prominently displayed. In addition, libraries that participated in outreach for the program in some cases formed partnerships with DOE laboratories.

Outreach to Libraries

The *Einstein’s Big Idea* Library Guide contains resources for developing displays, science activities, and community events. The 32-page guide is enclosed with this report and includes a full-color poster, display sheets, reproducible handouts, hands-on science activities, event directions, and a template for creating $E = mc^2$ stickers and magnets. In August 2005, NOVA

worked with the American Library Association (ALA) to distribute a listserv message alerting 10,000 librarians to the upcoming arrival of the Library Guide. The guide was distributed to all 16,000 public libraries around the country and to 1,000 afterschool programs. The guide is also available online in html and PDF formats at www.pbs.org/nova/einstein.

In April 2005, WGBH distributed an RFP inviting public libraries to apply to become one of 20 *Einstein's Big Idea* outreach sites with the goal of developing programming and activities to take place in the fall 2005. The RFP was posted online, and the ALA shared this opportunity with librarians by sending a message to four ALA electronic lists. The response was strong. WGBH received 91 applications detailing programming and partnership ideas. From these, WGBH chose 20 mini-grant recipients that represented a range of geographic and socio-economic diversity:

- Bettendorf Public Library, Bettendorf, IA
- Birmingham Public Library, Birmingham, AL
- Catawba County Library System, Newton, NC
- Curtis Memorial Library, Brunswick, ME
- Henderson District Public Libraries, Henderson, NV
- Hingham Public Library, Hingham, MA
- Irving Public Library System, Irving, TX
- Johnson County Library, Shawnee Mission, KS
- Laramie County Library System, Cheyenne, WY
- Mamie Doud Eisenhower Public Library, Broomfield, CO
- Milanof-Schock Library, Mount Joy, PA
- Northfield Public Library, Northfield, MN
- Omaha Public Library, Omaha, NE
- Ridgefield Library, Ridgefield, CT
- Sachem Public Library, Holbrook, NY
- Springfield-Greene County Library District, Springfield, MO
- Sunnyvale Public Library, Sunnyvale, CA
- Waukesha Public Library, Waukesha, WI
- Westmont Public Library, Westmont, IL
- White Lake Community Library, Whitehall, MI

In addition, WGBH notified the PBS stations that serve the model library communities to help establish a new relationship or solidify an existing one between the two organizations. WGBH also distributed a press release about the outreach initiative and educator guides, and it developed a press release template for the library outreach sites to use with their local media.

In June, WGBH held a training workshop for the outreach sites during the ALA Conference in Chicago, Illinois. The library representatives were active and enthusiastic participants as they learned about the NOVA program and library resources. They had a great time tackling some of the hands-on activities offered in the guide, including an interactive puzzle activity for kids and an adult trivia game, and sharing some of their $E = mc^2$ programming ideas.

The library outreach sites launched their fall displays and events in September with great success. They formed partnerships with a total of 72 local organizations, including DOE

laboratories, museums, universities, school districts, planetariums, and technology companies. They also surpassed their project requirements by offering many more programs and reaching more patrons than expected. The 20 sites offered a total of 228 events, and they reached over 9,000 patrons through events held at libraries, schools, universities, planetariums, museums, and coffee shops. Programs included trivia nights, scavenger hunts, hands-on science activities, lectures, theatrical performances, book discussions, film screenings, and geocaching (descriptions of several events are included in Attachment A).

Outreach to Schools

The *Einstein's Big Idea* Teacher's Guide contains resources to help teachers and students learn more about the stories and science behind this famous formula. Intended for middle and high school classrooms, the 32-page guide includes a full-color poster, timeline insert, and five lesson plans. (A sample guide is enclosed.) One of the lessons and the pullout timeline both explore the individuals in the program who contributed to the equation, and four additional lessons investigate the science behind each part of the equation— E , m , and c^2 —and the meaning of the equation as a whole.

DOE funds allowed us to develop a print-based version of the online *Einstein's Big Idea* Teacher Guide for physics teachers and DOE research laboratory education staff. In September 2005, 3,000 guides were distributed through DOE labs nationwide, and an additional 19,000 copies were mailed directly to middle and high school physics teachers and middle school science supervisors. The guide is also available online in html and PDF formats at www.pbs.org/nova/einstein. An announcement about the online Teacher's Guide appeared in the fall issue of *The Physics Teacher*. The guide was also shared at conferences and workshops, including:

- National Science Teachers Association
- Massachusetts Association of Science Teachers
- Thirteen/WNET educator conference
- Boston University and Northeastern University student teacher programs
- American Physical Society/Division of Plasma Physics' fall expo for high school teachers and students
- NSF event for winners of Presidential Awards for Excellence in Mathematics and Science Teaching

Promotion

NOVA used a multi-pronged promotional approach to build excitement in advance of the broadcast and ensure that it reached broad and key audiences. High profile events; outreach to scientists; print, radio, and Web/online promotion; and innovative advertising comprise the wide-ranging techniques employed by NOVA. They are described in detail below.

Events

Television Critics Association Press Tour (Summer 2005)

NOVA debuted *Einstein's Big Idea* for the nation's foremost television writers at the PBS portion of the July 2005 TCA Press Tour. On hand to preview the film and take questions from more than 70 reporters were: Paula S. Apsell, senior executive producer; David Bodanis, author of *E=mc²: A Biography of the World's Most Famous Equation*; Jim Gates, John S. Toll Professor of Physics at the University of Maryland; actress Shirley Henderson ("Mileva Marie"); producer-writer-director Gary Johnstone; actor Aidan McArdle ("Einstein"); and actress Emily Woof ("Lise Meitner").

Einstein's Big Idea Gala, in Washington, D.C.

On September 27, 2005, NOVA toasted the PBS premiere of *Einstein's Big Idea* at the National Academy of Sciences, in Washington, D.C. The event featured film clips plus a celebration of the 100th anniversary of $E = mc^2$ and the World Year of Physics. Co-hosted by the National Academies, PBS, the U.S. Department of Energy, the American Physical Society, and the Universities Research Association, Inc., the gala boasted an attendance of more than 500 members of the area's scientific community, including representatives from the Department of State; the Environmental Protection Agency; NASA; the U.S. Institute of Peace; the Smithsonian Institution; U.S. Science Fellows; and the National Science Foundation. Then-President and CEO of PBS, Pat Mitchell, NSF President Arden Bement, National Academies President Ralph Cicerone, American Physical Society President Marvin Cohen, and WETA Vice President Kevin Harris were on hand to present an extended film clip, which was followed by a lively Q&A featuring Paula Apsell; former TIME managing editor, Walter Isaacson; David Bodanis; Gary Johnstone; and MIT physicist and historian, David Kaiser.

The gala represented a first for WGBH: invitations were issued exclusively via HTML email — and, in light of the turnout, with excellent effect. The e-vite also allowed NOVA to cast a much broader net (e.g., more than 13,000 members of the Washington, D.C. science community were invited) and encouraged partner organizations to share the e-vite and/or a slightly more generalized program announcement with their *national* memberships.

Science Community Outreach Initiative

Specially designed HTML or electronic (e-) postcards proved an important tool in reaching out to thousands of individuals in the sciences and related fields. The e-postcards, which were designed to include an auto-RSVP function, featured program and tune-in detail, direct links to the *Einstein's Big Idea* Web site, and a four-minute video preview of the film. NOVA and partner organizations — from the APS to the AAAS to Sigma Xi — distributed the e-card to members and conference-goers, both nationally and internationally.

Major Media Initiative

Press Materials

Among the press materials developed in support of the program launch were a super-size print postcard/program announcement (to long-lead and daily press), an e-postcard (through press, targeted, blast, and partner organization email campaigns), a detailed press release, NOVA

Online/*Einstein's Big Idea* Web release, $E = mc^2$ timeline, biographies of talent, production principals, and program photography.

Print Promotion

Print promotion involved hundreds of personal telephone pitches, thousands of email pitches to general consumer and special-interest press, and press preview DVD mailings to a broad range of media outlets and writers, including television critics; feature and entertainment reporters; syndicates; television book editors; and media, science, and education reporters nationwide. Additionally, photo editors at hundreds of magazines, newspapers, television books, and PBS station member guides received a robust selection of signature program photography.

Radio Promotion

In support of the program launch, NOVA worked with News Broadcast Network to secure a two-day radio tour featuring author David Bodanis. Stations were encouraged to book morning and afternoon drive-time interviews on October 10 and/or 11; listeners were encouraged to tune-in to the program premiere and to visit the *Einstein's Big Idea* Web site.

Web/Online Promotion

Web/Online promotion of the *Einstein's Big Idea* companion site included distribution of the site press release to over 100 Web writers and reviewers; a cross-linking campaign with relevant/subject-compatible Web sites; search engine registration for major terms and search phrases; and a pair of online chats (Jim Gates, Gary Johnstone), before and following the premiere, on washingtonpost.com.

Advertising

Barnes and Noble | GoCards Campaign

NOVA bought an *Einstein's Big Idea* presence at 47 Barnes and Noble outlets — scattered cross-country — through a free-to-patrons printed postcard giveaway. The postcard featured a pixilated close-up of Einstein, a signature quote (“Imagination is more important than knowledge”), program and tune-in detail, and the program’s Web address. More than 20,000 units were distributed nationally.

National Public Radio Drive-Time Sponsorship

WGBH secured four ten-second spots — two each on *Morning Edition* (October 10 and 11) and *All Things Considered* (October 11). Estimated reach: approximately 7 million listeners (adults 25-54) per spot.

Wireless | AvantGo Campaign

An AvantGo wireless ad buy channeled the *Einstein's Big Idea* tune-in message to tens-of-thousands of hand-held devices (or PDAs). The effort generated just under 116,000 impressions and well over 15,000 click-thrus, representing a click-thru rate of 13.3%, which is significantly higher than the AvantGo average (4 to 5%). Of the users who clicked through the ad, 28% took a further action: more than 4,300 chose to subscribe to the NOVA e-newsletter.

Measurements of Success

Large audiences, continued traffic to the Web site, and high praise from viewers and the media all demonstrate the success of *Einstein's Big Idea* on many levels.

Audience Response

Einstein's Big Idea achieved a 2.5 AA HH Rtg—reaching more than 4.7 million viewers. It outperformed both the NOVA season to date average and the PBS Primetime average as well as similar cable competition:

NOVA (Season to date)	2.4 AA HH rating
History Channel Primetime	0.8 AA HH rating
Discovery Primetime	0.7 AA HH rating
TLC Primetime	0.5 AA HH rating
Discovery Health Channel	0.2 AA HH rating
Discovery Science Channel	0.1 AA HH rating

PBS Primetime 1.7 AA HH rating

(Source: NTI. NOVA 10/05-5/06, PBS and Cable 9/04-9/05)

Viewers raved about the program, praising it for helping them understand $E = mc^2$ for the first time and for showing the humans behind the science, especially the women. Whole families watched and learned together—following are one family's comments:

I liked the fact that you emphasized women, because I didn't know there were so many women in early science. I have been trying to learn about atoms and nuclei in school, and I never understood until I watched your program - Elisabeth, age 12

I thought the show was really interesting, especially about how mass can be energy and energy can be mass ... now I understand about atoms - Gardner, age 9

I also liked the focus on women, not just men. I liked how you really explained it - Gillian, age 8

Thanks for making such a fantastic program - the whole family was fascinated, and I especially appreciated how you clearly explained complex concepts - Mom

Additional sample comments from viewers are included as Attachment B.

Response to Web Site

The Web site received 350,000 visitors during the premiere broadcast month. The podcast series, based on the Web site's most popular feature, rose to the #2 position overall on iTunes a month before the premiere and continues to be available on iTunes. On average, the site has received more than 93,000 visitors per month since the premiere. Traffic continues to be strong.

During October 2006—a year after the premiere—the site received almost 70,000 visits. The positive response to the site is evident in this comment from a Web site visitor:

Thank you very much for building up this page. It is clear, understandable and easy to use, as well as beautifully done. I am a graphic design student needing to understand $E = mc^2$ for an anniversary poster on Einstein's development. I was not supposed (sic) to understand it, but I DID need it. One of the most helpful parts of the website has been the "live" explanations given by the ten physicists. I am not really into physics, but could grasp the main sense and the philosophical part of all it. Thanks again.

—Ana

The results of a summative evaluation conducted by the Goodman Research Group (detailed later in this report) showed that the majority of visitors were *very* or *extremely* satisfied with the site, that they would visit it again, and recommend it to others. In terms of reaching new audiences, a notable percentage (25%) reported that *Einstein's Big Idea* was the first NOVA Web site they had ever visited. After visiting the site, visitors' agreement with three of four learning goal statements had increased at a statistically significant level, including their belief that science is a human endeavor, a creative process, and a field that thrives on the contributions of diverse groups of people.

Accolades from the Media

The debut of *Einstein's Big Idea* at the summer 2005 Television Critics Association Press Tour created buzz, with dozens of placements in fall preview round-up stories, and a healthy account of banked reviews and interviews. Leading up to the premiere, attention continued to be drawn to *Einstein's Big Idea* as a result of NOVA's promotion. Print coverage was composed of reviews, features, interviews, and listings/highlights in scores of the country's top outlets including: *TV Guide*, *The New York Times*, *Associated Press*, *USA Today*, *Entertainment Weekly*, *The Washington Post*, *Popular Science*, *Chicago Tribune*, *Discover Magazine*, *Los Angeles Times*, *The Hollywood Reporter*, *Seattle Times*, *The Boston Globe*, *New York magazine*, and *The San Francisco Chronicle*, to name just a handful. *Einstein's Big Idea* also achieved the TV book Trifecta, earning TV book cover features in *The New York Times*, the *Los Angeles Times*, and *The Washington Post* the weekend prior to premiere. Following is a sample quote from a review, additional examples are included as Attachment C.

Even if you're no mathlete, this documentary should help you understand the magnitude — indeed, the beauty — of Einstein's discovery. Teachers should think about bringing copies of the film into the classroom: it might change the minds of at least a few young folks who think math and science are boring.

— *Chicago Tribune*

National, international, and major market radio secured for the two-day radio tour featuring author David Bodanis included: USA Radio Networks; NBC Radio Network; CNN Radio Networks; Cable Radio Network; Metro Networks; Voice of America; and WNYC (Leonard Lopate). In all, NBN estimates that the radio tour reached an audience of 16 to 21 million [confirmed broadcasts/feeds and (pre-packaged) radio news release broadcasts, respectively].

On the heels of premiere, *Einstein's Big Idea* even made the cut at VH1's *Best Week Ever*, the popular end-of-week roundup of favorite moments in popular culture.

Awards

Einstein's Big Idea won two awards from Vedera la Scienza (an annual Science in Drama Festival, in Milan) for Best Portrayal of Science through TV Drama/Docu-Drama and Best TV Drama Production Drawing on Science and Technology. The PAWS (Public Awareness of Science) Drama Fund joined forces with Vedere la Scienza to host the awards ceremony in London, where writer and director Gary Johnstone accepted the award for the program.

The *Einstein's Big Idea* Library Guide and program was lauded by the publishing and library communities. The Library Guide won finalist status in the Association of Educational Publishers Distinguished Achievement Awards. *Booklist* magazine, the review journal of the American Library Association (ALA), announced the *Einstein's Big Idea* Video/DVD among its 2005 Top of the List winners. The eight winning titles were chosen from the annual Editors' Choice selections as the best books and media of 2005.

Evaluation

Goodman Research Group (GRG) conducted a summative evaluation in which the program received some of the most positive feedback of any NOVA program that has undergone evaluation. Results showed that the dramatic format of the show — a combination of documentary and dramatic scenes with dialogue — helped viewers to understand the very complex information about $E = mc^2$, which led to further interest in engaging with the content presented in the program. Some of the major findings include:

- 1) *Einstein's Big Idea* was a successful program and the docudrama presentation format appealed to its audience; it was particularly effective in demonstrating the role that women and other “outsiders” have made to science across history. Specifically, the vast majority of participants in the two viewer studies rated the program positively, with adults rating it *very good* or *excellent* and students rating it *good* to *very good*.
- 2) As a result of watching the program, NOVA viewers and high school students showed *statistically significant* increases in their ability to identify the terms of the $E = mc^2$ equation.
- 3) The NOVA program was particularly effective in providing NOVA and student viewers with a deeper understanding of the multiple scientists whose work contributed to the famous equation. Adults, in particular, reported learning about women and other “outsiders” in science at a high level.
- 4) Almost all viewers of the NOVA program either continued engaging with content related to *Einstein's Big Idea* or had plans to do so. Many had visited the program's Web site or taken steps to learn more. About one-quarter of the students also planned engaging further with the program's content.

Outcomes and Impact

In May 2006, GRG also delivered a formal summative evaluation of the activities undertaken by the libraries and their impact. In general, the libraries hosted successful programs and found the resources to be useful, and their visitors enjoyed the events as they learned about science. When the libraries were asked about their outreach site experience, four key benefits stood out:

- **Bringing in new audiences:** Many libraries found that the *Einstein's Big Idea* program helped them to attract new visitors. For example, one library noted that the Trivia Night pulled in people who might not otherwise attend a library program.
- **Creating interest among a wide range of patrons:** The *Einstein's Big Idea* program served public libraries well because it appealed to all ages. In addition to specific programs for children, young adults, and adults, several libraries offered family events that encouraged kids, teens, and adults to work together in teams.
- **Adding science programs to their current programming:** Some libraries reported that the Einstein project was their first experience with science-related programming, and because their experiences were so positive, they will incorporate science in an ongoing way.
- **Building partnerships:** Several librarians mentioned that they were able to strengthen their connections to local schools and colleges.

The GRG report also includes visitor survey results which echo the librarians' positive responses:

Adults The majority of adults found the programs very or extremely enjoyable (89%) and informative (82%), and 79% were very or extremely interested in attending future events at the library. Approximately two-thirds of the adults surveyed said would continue to engage with *Einstein's Big Idea* content by watching the NOVA program, learning more about Einstein, and seeking out other science events. The library event itself had a huge influence on their plans as more than half of those who planned to watch the broadcast and learn more about Einstein would not have done so otherwise, and 44% of those seeking out science events believed that these plans were influenced a great deal by attending their library's event.

Young Adults More than half of the young adults found the programs enjoyable or informative, and 39% were very or extremely interested in attending future events. In addition, more than one quarter of students were interested in watching the broadcast, learning more about Einstein, and/or seeking out other science events. This was especially impressive given that teen audiences are often a difficult age group to attract. Several young adults attended events through mandatory school programs and still found that they enjoyed them and learned a lot.

Children The children's responses were extremely positive. More than two-thirds of children said that they had a lot of fun at the events, and 85% would like to attend future science events at the library or elsewhere in the community.

In general, it appears that science programming and public libraries are a great combination for reaching out to the community. While more than half of adults came to events specifically

because they are interested in science or Einstein, 26% were exposed to science and Einstein who wouldn't have been otherwise, simply because they attend library events regularly. Also, libraries are great places to connect with people of all ages, and multigenerational programs helped to attract new audiences. More than 20% of adults wanted to take their kids to science events and in turn, were exposed to science themselves at events that were geared to all ages. See the complete GRG report for more information.

Anecdotes

Library-based Outreach Each of the 20 model library sites completed a final report in December 2005 that details their use of the Library Guide and their local activities. The majority of the sites also provided sample materials including photos, press clippings, and publicity materials. WGBH staff compiled an event chart that combines information on all of the sites. A few examples include:

- Birmingham Public Library (Birmingham, AL) partnered with the McWane Center science museum, host to a traveling Einstein exhibit, to offer the “Einstein Challenge” program where visitors could become “Einstein certified” by engaging with Einstein content. Action steps for certification included attending a library event, watching *Einstein's Big Idea* on PBS, touring the Einstein museum exhibit, or reading a book or visiting a Web site about Einstein. In addition, Birmingham reached 134 people of all ages through hands-on activities and Brown Bag Lunch presentations at the library, and an impressive 1,141 students through their “What is a scientist?” program offered at 28 local elementary schools.
- Sunnyvale Public Library (Sunnyvale, CA) reached a total of 826 people through a range of events including a scavenger hunt, trivia night, book discussion, presentation by a representative of NASA's Education Division, and hands-on science programs led by The Tech Museum of Innovation and local high school students. 300 visitors attended a lecture by a Foothill College professor and filled the library's auditorium to capacity. The scavenger hunt was also a great success. According to librarian Susan Denniston, “the scavenger hunt promoted active learning in teams. It was great to see teams of parents and kids focusing on research and working together all over the library.”
- Ridgefield Public Library (Ridgefield, CT) offered programs that reached a total of 1278 visitors. The screening of “Einstein's Big Idea” kicked off their programming and was a huge success. In addition to the film, patrons enjoyed the event's science kaffeehaus theme, trivia, and Q&A with an IBM scientist. Ridgefield also offered a book discussion of David Bodanis' “ $E=mc^2$: A Biography of the World's Most Famous Equation,” and David himself joined the discussion via Web cam from his home in Oxford, England. Ridgefield also arranged for a school program for 11-13 year olds in connection to their “Inspiring Girls in Science” program. Female scientists from technology, pharmaceutical, space science, and oil research spoke to several classes (525 students total) about their work and how they became scientists and engineers. They also linked their work to Einstein's theories and offered hands-on activities. In addition, Ridgefield was the proud recipient of the 2006 Excellence in Library Service Award, an honor given out annually by the Connecticut Library Association, in recognition of their work on the *Einstein's Big Idea* and Inspiring Girls in Science projects.

- Sachem Public Library (Holbrook, NY) partnered with Brookhaven National Laboratory to present a program about the “Quantum Diaries” blogging project celebrating the “World Year in Physics.” According to the Community Services Librarian Frances Altemose, “The blogging program introduced the current practicality of scientists communicating online and exchanging ideas, much easier to do now than in 1905. The necessity and obsession of those driven by scientific inquiry, and the human struggle for answers, thus leading to more questions, became obvious. Scientific discovery was shown as an attainable goal and achievable pursuit, hopefully inspiring some and found admirable by the others attending.” In addition to their 7 programs reaching 252 visitors, Sachem also sent letters to legislators inviting them to their *Einstein’s Big Idea* events and coordinated with high school teachers to implement an extra credit program for teens attending science lectures at the library.

- Northfield Public Library (Northfield, MN) reached 700 visitors with programs for all ages including lectures by Carleton College professors and an event held at a local observatory. The “Einstein Exploratorium” family event featured hands-on physics activities and demonstrations by college student volunteers. According to Children’s Librarian Kathy Ness, “So many families told me later that their kids only wanted to do experiments for the rest of the weekend....The volunteers from the library had a lot of fun as did the library volunteers. While it really ‘took over’ the library—furniture moved etc., no one complained! We are seriously considering making it an annual fall event.”

Teacher Guide The response to the teacher guide was also positive. One teacher affiliated with the Argonne National Laboratory who shared the guides with teachers at an event representing 15 schools and commented, “Everyone was thrilled to have them, and most perused them and got back to me before the day was over...quite excited to go back to school and use the books!...What a really great idea, we can all use new materials frequently. Thank you!”

Lessons Learned

In addition to the findings reported by GRG, there are several other lessons learned from the project that may help guide the development of future projects.

The partnership with ALA was limited but sufficient for this project. They used their various communications outlets to notify libraries about the project and to solicit applications in response to our RFP. A limited role like this for the ALA worked well for both parties.

Libraries themselves were enthusiastic partners. The fact that the project was based on a book and connected to a national event (the centennial of Einstein’s discovery of $E=mc^2$) was also appealing for them. Because the workshop was held in conjunction with the ALA annual meeting, we were able to gather all but one of the model sites at no additional cost to the project. The workshop itself was a key element in the success of the outreach initiative. It helped introduce the components to the sites, energized them about the project, and laid the groundwork for launching local activities.

The Department of Energy was interested in broad distribution of the teacher guide, and shared contact information for all of their national labs. Providing training to the personnel at the laboratories as to how to distribute the guide effectively should be part of our future partnerships.

Conclusion

With *Einstein's Big Idea*, NOVA clearly made great strides toward its goals. It attracted a much broader audience than would normally be drawn to a physics program and helped viewers understand the challenging ideas it explored—all in an entertaining and engaging manner. By presenting the vibrant and fascinating stories of science pioneers, the film helped counteract negative perceptions of scientists and science. Highlighting the contributions of those in the past who faced gender, ethnic, educational, and financial barriers may serve as an inspiration to young people today who still face those same barriers to becoming scientists and engineers.

Through rebroadcasts, streaming on the web, and use in classrooms and other educational venues, the film will continue to reveal the ways in which individuals can make a deep impact on science and world events. The Web site serves as an evergreen resource for Internet users seeking information about Einstein and his “big idea,” as well as the engrossing stories and important contributions of his predecessors.

The Department of Energy's grant played a critical role in the success of *Einstein's Big Idea*. NOVA deeply appreciates the DOE's support of this program, and we look forward to future opportunities to work with the DOE toward our shared goals of enhancing the public's understanding of science and inspiring young people.

Sample Viewer Comments

As a mother of two high school students I have seen how difficult science has been for them to understand, specially (sic) Physics. On October 8, 2005 I was channel surfing and this program was on the air. It got my instant attention. It was fascinating to see the background work that served as the basis for Einstein's extraordinary work. To my surprise, my daughter, who already took her Physics class, sat down with me and she got trapped as well. The opportunity to see the human behind the inventor was something that young students are not frequently exposed to. Normally science is too much theory, formulas and arid subjects. She was commenting on how much easier would be for her to understand the physics concepts covered in the program, if she had the opportunity on seeing this kind of program as part of her class. I commend your staff, everyone involved in this project, and I look forward to seeing Newton's Dark Secret.

— *Migdalia*

Thanks. I just "got it". After a 41 year career in pharmacy, almost failing physics, at 70 years of age I "got it"! Am still reeling! Thanks so much.

— *Myra*

Loved the show! I don't know much about science but I loved the way the story was presented. Thank you!

— *Christine*

I loved this program as well as the explanations from the physicists on the web site. This is the first time ever that I have an understanding of this equation! Fantastic!

— *Almasd*

Thank you PBS for broadcasting a wonderfully educational and entertaining program about Einstein's Theory of Relativity. The knowledge I gained from watching this two program far surpassed my physics knowledge for sixteen plus years of education! Including scientists' accomplishments from the past (especially women scientists), proved to be very enlightening for me. The director's choice of settings, costumes, and actors to recreate exact moments in time was astounding! Einstein's discoveries will continue to amaze us. Thank you, PBS, for continue to also amaze me with brilliant programming that educates us all. Einstein himself would probably be thrilled by this program if he were alive to see it!

— *Dawn*

My children (ages 8, 10) were riveted to the TV during the program. And I was shocked to see how interested they were.

— *Chris*

I don't think I've enjoyed anything more than to catch a glimpse of understanding into Einstein's theories. The program was so informative, yet easy to understand — I can't believe how much it has expanded my outlook on so many aspects of my life! Thanks for the great work!

— *Bev*

Sample Media Quotes

You don't have to be a genius to appreciate a new special on the last century's most famous scientist. But you'd be a dummy to miss it.

— *Minneapolis Star Tribune*

NOVA brings coherence and context to the subject. . . . It is impossible to walk away from this program without a better understanding of Einstein's great discovery.

— *The Boston Globe*

Provocative and effective.

— *wired.com*

A fantastically grand docudramatic adaptation of David Bodanis' book $E=mc^2$.

— *Los Angeles Times*

The website was developed to provide a host of complementary resources to the actual television program . . . anyone with even a trace of interest in the history of science or physics will want to take a close look. The interactive features are excellent. . . . The essays top-notch.

— *The Scout Report*

Moving, ambitious and marvelously realized.

— *The Wall Street Journal*

Fascinating stuff.

— *Variety*