NOVA MAKING STUFF: SEASON 2

U.S. DEPARTMENT OF ENERGY
FINAL SCIENTIFIC/TECHNICAL REPORT

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EXECUTIVE SUMMARY

Over the course of four weeks in fall 2013, 11.7 million Americans tuned in to PBS to follow host David Pogue as he led them in search of engineering and scientific breakthroughs poised to change our world. Levitating trains, quantum computers, robotic bees, and bomb-detecting plants—these were just a few of the cutting-edge innovations brought into the living rooms of families across the country in NOVA's four-part series, *Making Stuff: Faster, Wilder, Colder,* and *Safer.* Each of the four one-hour programs gave viewers a behind-the-scenes look at novel technologies poised to change our world—showing them how basic research and scientific discovery can hold the keys to transforming how we live. *Making Stuff Season 2* (MS2) combined true entertainment with educational value, creating a popular and engaging series that brought accessible science into the homes of millions.

NOVA's goal to engage the public with such technological innovation and basic research extended beyond the broadcast series, including a variety of online, educational, and promotional activities: original online science reporting, web-only short-form videos, a new online quiz-game, social media engagement and promotion, an educational outreach "toolkit" for science educators to create their own "makerspaces," an online community of practice, a series of nationwide Innovation Cafés, educator professional development, a suite of teacher resources, an "Idealab," participation in national conferences, and specialized station relation and marketing.

A summative evaluation of the MS2 project indicates that overall, these activities helped make a significant impact on the viewers, users, and participants that NOVA reached. The final evaluation conducted by Concord Evaluation Group (CEG) confidently concluded that the broadcast, website, and outreach activities were successful at achieving the project's intended impacts. CEG reported that the MS2 series and website content were successful in raising awareness and sparking interest in innovation, and increased public awareness that basic research leads to technological innovation; this interest was also sustained over a six month period. Efforts to create an online community of practice were also successful: the quality of collaboration increased, and community members felt supported while using Maker pedagogy.

These findings provide clear evidence that large-scale science media projects like MS2 are an effective means of "moving the needle" on attitudes about and excitement for science. NOVA's broadcast audience and ratings have always indicated that a large portion of the population is interested in and engages with educational science media on a weekly basis. Yet these evaluation results provide the empirical evidence that beyond being capable of attracting, maintaining, and growing a dedicated group of citizens interested in science, these shows—with their diverse content provided on a variety of media channels—are capable of sparking *new* interest in science, raising public awareness of the importance of science, and maintaining and growing that interest over time. In a country where approximately a quarter of the population doesn't know the earth rotates around the sun,[1] roughly half still don't accept evolution,[2] and about 20% don't think climate change is happening,[3] the importance of these findings cannot be overstated. The success of MS2 suggests that large-scale media projects dedicated to and linked by coverage of scientific "big ideas" are an effective means of shifting public opinion on—and improving understanding of—science.

PROJECT GOALS & ACCOMPLISHMENTS: COMPARISON

Innovations in the MS2 Series

The strategy behind MS2 was to build upon the success of the first season of *Making Stuff* by focusing the series content on the process of innovation, both within the field of materials science and across multiple STEM disciplines. MS2 delivered on this by conceiving, producing, and editing series content to ensure that a range of STEM disciplines were featured—and that the processes of scientific innovation, research, and discovery were presented and highlighted (the contents of each episode are covered in the next section). MS2 was also designed to build on the first season by expanding on the existing outreach coalition model to create a "community of practice" that invites greater and more sustained participation among existing and new collaborators, and developing and disseminating new outreach activities. All of the objectives associated with these series innovations were accomplished, and are presented below.

Project Goals

The series innovations were selected not only to expand upon and further improve an existing, successful model of informal science education, but also achieve a broader project impact in terms of the following three project goals:

1. To increase public understanding that basic research leads to technological innovation;
2. To increase and sustain public awareness and excitement about innovation and its impact on society; and
3. To establish a community of practice that enhances the frequency and quality of collaboration among STEM researchers and informal educators.

These goals address a wider societal issue and an important element of the overall mission of NOVA: to inspire new generations of scientists, learners, and innovators. By creating novel and engaging STEM content, reaching out to new partners, and developing new outreach tools, MS2 was designed to reach new target audiences including underserved teens and college students crucial to building a more robust and diversified STEM workforce pipeline.

Goals Achieved

Across four separate, rigorous studies, Concord Evaluation Group (CEG) collected evidence that the MS2 series, website, and outreach efforts were successful at achieving these three goals:

> Goal 1: Increased Public Understanding. The MS2 television series and website were able to significantly increase public understanding that basic research leads to technological innovation and to help the public understand the importance of it. The series and the website also significantly helped to increase viewers' awareness of scientific innovation.
>
> Goal 2: Increased & Sustained Public Awareness and Excitement. The series and the website engaged the public and made them significantly more excited about scientific

innovation. MS2 viewers were significantly more likely than non-viewers to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation. Also, through a rigorous, six-month longitudinal study, CEG found evidence that NOVA was able to achieve sustained and, in some cases, growing public awareness and excitement about scientific innovation. They observed that interest and awareness in scientific and technological innovation were sustained over time—and even grew in some cases.

Goal 3: Building a Community of Practice. CEG found evidence that the MS2 Community of Practice (CoP) enhanced the quality of collaboration among members and encouraged members to continue using Maker pedagogy. CoP members reported that their involvement in the project was valuable to their own outreach efforts and local delivery of their own programming. Thousands of citizens, young and old, were reached with MS2 activities across the country.

Project Objectives

These goals were achieved through the success of MS2's deliverables, or project objectives. The table below presents each project objective and how and when it was accomplished.

OBJECTIVE	STATUS
Television Miniseries	***Complete***
Making Stuff: *Faster*	Broadcast October 13, 2013
Making Stuff: *Wilder*	Broadcast October 23, 2013
Making Stuff: *Colder*	Broadcast October 30, 2013
Making Stuff: *Safer*	Broadcast November 6, 2013
Digital Content	***Complete***
Online game	52 weekly quizzes published
Original Reporting	11 science journalism articles published
Short Form Video	8 short-form video assets created & published
Promotion	***Complete***
Station Relations	***Complete***

Education Outreach	***Complete***
Target Audiences	Audiences expanded with new collaborations.
Collaborations	Collaborated with Make Education, New York Hall of Science, the Exploratorium, UC Berkeley's Lawrence Hall of Science, Yale University, Princeton University, Quality of Life Technology Center, National Collegiate Inventors and Innovators Alliance, Nanoscale Informal Science Education Network, National Engineers Week Foundation, Alpha Sigma Mu
Community of Practice	Created a MAKING STUFF Outreach Community, engaged members and collaborators through social media
Education Outreach Deliverables	Created 75 Project Boxes*, an Innovation Science Café series with 40 registered Cafés, a suite of teacher resources (including 10 digital teacher resources, teacher professional development, promotion through the NOVA SPARK newsletter), an IdeaLab event with media resources

Enhanced Education Outreach	***Complete***
Making Stuff IdeaLab online collection and screening event	A screening of *Making Stuff: Wilder* kicked-off the 4-day event (Jan 10-13, 2014); a professional film crew captured the event, the footage from which was used to create an online collection of 4 videos and one lesson plan on innovation, engineering, and design; funding allowed an additional 5 college students from underserved groups to attend the IdeaLab
Additions to Project Boxes* and 25 additional kits	Creation and distribution of 25 additional Project Boxes; collaboration with Evaluneer to adjust Project Box activities for individuals with special needs, and the creation of a *Making Stuff* 2 resource brochure
Participation in national Maker Faire events	Attendance at Sept 2013 NYC Maker Faire with David Pogue and attendance at May 2014 San Francisco Bay Area Faire.

**Note*: The "outreach toolkits" in the proposal were renamed to MS2 "Project Boxes." All subsequent references to this deliverable in the report will be "Project Box."

PROJECT SUMMARY

4-part Television Series

Technology matters: it touches every part of our modern lives, from how we communicate and travel to how we stay healthy and safe. While we have so many remarkable conveniences and lifesaving technologies, there are still many more to come. MS2 went on a mission with host David Pogue to find groundbreaking discoveries and inventions, interviewing experts and

investigating their laboratories and factories. With his zany humor and zest for discovery, David met the scientists and engineers who are plunging to the bottom of the temperature scale, finding design inspiration in nature, and breaking every speed limit to make tomorrow's "stuff" *Faster, Wilder, Colder,* and *Safer*.

Each episode was intended to highlight the importance of basic scientific research and the transformative process by which it yields discoveries and inventions. For example, in *Making Stuff: Wilder*, viewers see how researchers are inspired by nature to come up with cutting-edge engineering innovations such as soft robotic arms modeled after elephant trunks to help reduce workplace injuries, or packing materials made of mushroom mycelium that offer a sustainable alternative to the traditional packing peanut.

Viewership & Audience Reach

MS2 had a broad audience reach; across all four episodes, the series reached 11.7 million unduplicated viewers during its broadcast and had a 1.9 average national household rating across all four episodes. At any given minute during the series 2.7 million viewers on average were watching. It also generated 186,358 online video views over seven weeks surrounding the broadcast (October 16, 2013 – December 3, 2013). Since the series aired, the number of online video views has increased to 320,273 as of as of November 16, 2014 (*Faster*: 94,677, *Colder*: 89,484, *Wilder*: 82,156, *Safer*: 53,956).

The most popular episode was *Making Stuff: Wilder*, which featured innovative new technologies inspired by nature. This episode received an average household rating of 2.1, while *Making Stuff: Faster*, *Colder*, and *Safer* were all rated at 1.8.

Episode Descriptions

From the myriad of story possibilities surrounding new technological innovation, we chose a selection of the most compelling to exemplify each of the four episodes themes, *Faster, Wilder, Colder* and *Safer*:

Making Stuff: Faster. Ever since humans stood on two feet we have had the basic urge to go *FASTER*. But are there physical limits to how fast we can go? David Pogue wants to find out, and he'll investigate everything from electric muscle cars and ultrafast cameras to quantum teleportation. Along the way, he finds that speed is more than just getting us from point A to B; it's also about getting things done in less time. From the floor of the New York Stock Exchange to UPS headquarters, David's quest for ultimate speed limits takes him to unexpected places where he'll come face-to-face with the final frontiers of speed.

Making Stuff: Wilder. What happens when engineers open up Nature's toolbox? In *WILDER*, David Pogue explores bold new innovations inspired by the Earth's greatest inventor, Life itself. From robotic "mules" and "cheetahs" for the military, to swarms of robotic bees, David travels the world seeing the "wildest" ideas put into action in new inventions and technologies. It is a journey that sees today's bacteria turned into tomorrow's metallurgists, viruses building batteries

and even DNA, the Code of Life, put to work in "living" computers. Will the "stuff" of the future take on a life of its own?

Making Stuff: Colder. Cold is the new HOT, in this brave new world. For centuries we've fought it, shunned it, and huddled against it. Cold has always been the enemy of life, but now it may hold the key to a new generation of science and technology that will improve our lives. In *COLDER*, David Pogue explores the frontiers of cold science from saving the lives of severe trauma patients and cooling a warming planet to ultracold physics, where bizarre new properties of matter are the norm and the basis of new technologies like levitating trains and quantum computers.

Making Stuff: Safer. Is it possible to engineer an absolutely safe world for ourselves? In *SAFER*, David Pogue explores the extent to which science and technology can protect us from monumental forces of nature like earthquakes and epidemics. He challenges researchers to save us from dangers of our own making, like traffic accidents and contact sports. Our increasing reliance on the Internet makes us vulnerable to new risks: David delves into cyber security, where computer experts work to shield us from attacks by hackers and terrorists. Risk is all around us, but can we be safer?

The Success of David Pogue as Host

David Pogue proved to be an engaging and entertaining host—his quick wit, enthusiasm, and lively humor helped keep the tone light and the science accessible, even while explaining complicated technologies. David's willingness to engage with science in an eager, hands-on way also kept the series entertaining, showing viewers the true nature of scientific experimentation. He was always willing to stage experiments or be experimented on: he raced on treadmills covered in monitoring devices, rode in ultra aerodynamic bicycles, played with hagfish slime, and was pummeled by weighted balls in a balance competition with a robot. Audience reception of David was also extremely positive, as evidenced by social media feedback on our Twitter and Facebook feeds. A selection of social media comments provides highlights of these comments, posted during the broadcast of *Making Stuff*:

Twitter:

- @BarbaraKB: Thanks to @Pogue and @novapbs, my teen son and I share a #science TV show together. #momofateenager *(Nov 6 2013)*
- @adamzea: @Pogue Awesome. Your Nova episodes are great! *(Oct 22 2013)*

Facebook:

- Kathy Aanestad: I love this guy. He is so entertaining while sharing good information at the same time. Love the show. *(Oct 24 2013)*
- Molly Anne Burnette: Loved it! David Pogue is a hoot! *(Nov 7 2013)*
- Ellen Fennel: Very educational for me. Love David Pogue. He makes it fun. *(Oct 31 2013)*
- Jerry Hicks: Wonderful! And Pogue is a nice blend of levity and a master explainer. *(Nov 7 2013)*
- Colton R. Dean: I appreciate David Pogue's sense of humour. He makes the science

less stuffy. *(Oct 31 2013)*

All this positive feedback was prompted not only by our Tweets and Facebook updates, but also by David himself. He helped to drum up interest and excitement for *Making Stuff* through his own loyal social media following of 1.5 million. David provided production updates and photos and behind-the-scenes "sneak peeks" of the innovations *Making Stuff* would be investigating. Some example Tweets from David during production include:

David Pogue: Shooting for **NOVA** at U of Guelph, near Toronto. Meet the hagfish: 300-million-year-old fish that SLIMES predators. pic.twitter.com/yvOwBG5iuM *(March 18, 2012)*

David Pogue: Shooting for **NOVA** at U Penn: these tiny flying robots make patterns without a leader. It's swarm intelligence. pic.twitter.com/5Jcs6VQKnW

Digital Content

To accompany the broadcast series, a variety of related MS2 website content was created and published on the NOVA website, launched for the series premiere on October 16, 2013. Traffic to the *Making Stuff* site was high: just over 15.4 million unique viewers visited the site between the series broadcast and November 16, 2014, with a total of approximately 57 million site visits as of this date as well. Traffic to the overall NOVA website was also high during the broadcast of MS2. The site saw a 28% increase in unique visitors, a 34% increase in visits, and a 47% increase in pageviews during Quarter 4 (October-December) as compared to the previous Quarter (July-September). Social media and overall audience engagement also increased, with a 53% increase in Facebook fans and a 15% increase in Twitter followers.

Online Game

To further promote interest and engagement in MS2 online and target a younger audience than the traditional NOVA broadcast viewership, we developed a unique, mobile-friendly, year-long online quiz-based game. We created all editorial content for the quiz and were responsible for its design. We launched the quiz on October 16, 2013 to coincide with the debut of MS2. Fifty-two quizzes have been written and were released each week for a year; all 52 quizzes have been published online. Approximately 43,674 unique visitors have played the quiz-game since its launch and November 16, 2014. The quiz was successful in bringing in new traffic to the NOVA website, as 39% of quiz-game players were new to the NOVA website.

The quiz-game is fully responsive and optimized for desktop computers, tablets, and mobile devices. Hosted on the NOVA/PBS website, the quiz-game features new topics related to stories featured in MS2. Each weekly quiz challenges players to answer four questions correctly, and every question offers players three hints to help them select the right answer. Photos and videos accompany many of the quiz questions, including numerous video excerpts of David Pogue on

location. These videos provide context or more in-depth information for either the questions or the answers.

To help generate enthusiasm for the game online and on social media, players are invited to compete with friends and share a link to the game on Twitter. Quizzes were released on the same night each week (Tuesday evenings) and promoted through NOVA's Twitter feed and Facebook page on Wednesday mornings. Players with perfect scores (all four questions answered correctly) earned a badge for that quiz, which they could also share on Twitter. As an additional incentive, the first player to share a badge for each weekly quiz was recognized on the NOVA Facebook page.

Original Reporting

Since writing the proposal, we have further developed our online reporting strategy. All of our reporting is now organized under *NOVA Next*, our new successful science journalism website that is a part of the larger NOVA/PBS website. *NOVA Next* provides readers with freely accessible, high-quality, in-depth scientific articles that highlight significant stories as told by some of the biggest names in science, technology, and engineering—and the best and brightest science journalists on the web. As a part of the *NOVA Next* collection, we have published eleven articles on the theme of *Making Stuff*.

Traffic to the site continues to grow significantly. Since its launch in late February 2013, more than 4.1 million unique visitors have viewed more than 8.1 million pages. *NOVA Next* has also helped us to significantly grow our own social media following by providing science stories to share among our followers on our social media feeds. We tweet links to *NOVA Next* content typically two to three times a day, and post Facebook updates when a new article is published. We have found that this strategy has been paying off: approximately 60% of visits to the site are from social media[1]. We also continue engagement with our social media audience, responding to comments and questions we get on Facebook and Twitter, or suggesting additional resources if they want to learn more.

With our increased social media presence, over 92,800 Twitter followers and 577,800 Facebook fans (Likes)—with an average engagement rate 10.7 times higher than other top Facebook pages[2]—we found we did not need to rely on outside authors to bring in a large social media following, as described in the original proposal. Instead, we are building and leveraging our own. Many of our authors do bring their own social media audiences, as presented in the table in the next section.

NOVA Next editor Tim De Chant has also built relationships with complementary media outlets to help ensure our stories continue to propagate through the blogosphere and to broader audiences. De Chant has appeared on NPR's Science Friday and PRI's *The World* to talk about

[1] As of November 16, 2014
[2] As of November 13, 2014

his article on hyper-speed trains and the hyperloop.[3] These appearances help introduce listeners to NOVA's online reporting as a source of quality science writing.

Short-Form Video

We published eight additional video assets for the NOVA/PBS website covering a variety of science, technology, and engineering topics related to those presented in the series. These videos were created using additional video content and deleted scenes shot in the field, including extra sequences of David on location. The eight videos, their publish date, and a link to the video on the NOVA/PBS website are presented in a table in the next section. David appeared in five of the eight videos, including *Cyber War Games, Mushroom Material, The Hummingbird Drone, Super Fast Cameras,* and *Cryonics.*

While at the outset of the project it was clear that this material would be used to create additional video assets, the final format of these videos was undecided at the time. Though initial suggestions included a blooper reel or video-diary, we decided to feature deleted scenes and more stories of technological innovation that didn't make it into the final episodes—as opposed to adlibs, or other bloopers. These short form videos are available on the NOVA/PBS website, as well as on other media channels, including NOVA's YouTube Channel.

Promotion

Overall, the promotional activities surrounding *Making Stuff* were a great success. We worked with 650 national TV/radio producers, 300 TV/entertainment reporters in Top 50 U.S. markets, and 600 Science/Tech reporters, bloggers, and producers. As planned, we engaged in traditional promotional activities, including targeted press outreach to TV, radio, web, and print outlets. Detailed pitches, film links, and press materials were distributed, and interviews with David and other key experts were offered. We also sent weekly email newsletters to registered viewers and conducted outreach to affinity groups, including to niche media relevant to different episode premieres, such as sailing, running, car racing, automotive, tech, robotics, biology, and health and medicine. Examples of our top coverage include:

- CBS Sunday Morning *(national TV)* - six-minute interview segment by David Pogue, with footage/plugs by host Charles Osgood for *Making Stuff Faster*
- CBS This Morning *(national TV)* - three-minute live interview with David Pogue, including b-roll from *Making Stuff* (overall series)
- CBS Sunday Morning *(national TV)* - 5 minute segment by David Pogue on self-driving race cars on 11/3/13 - NOVA is plugged in intro by host Charles Osgood and online in the text accompanying video
- The Takeaway *(national radio)* - taped interview with David Pogue
- LiveScience.com & Yahoo News: interview feature with David Pogue, experts from *Faster* episode - Peter Weyand and John Wayland

[3] "Hyperloop: Hype or Future Transportation?" Interview with Tim De Chant on NPR's *Science Friday*, Aug 16 2013.

Social Media Promotion

In addition to traditional media coverage, we were also active on social media to promote the series. Social media promotion began three months prior to broadcast in July 2013, with Facebook posts, YouTube promotional videos, and dedicated Facebook ads. We also used a hashtag during the series broadcast to help generate buzz and allow Twitter users to talk about the show and hear from David.

While we had originally planned to have a live-stream behind-the-scenes video of David Pogue and series experts immediately after broadcast, we ultimately opted to not undertake this activity, as we have found low engagement for such after-broadcast videos. For future multi-part series, NOVA is exploring other ways to engage viewers post-broadcast.

Tweetup and Twitter Hashtag

Per PBS requirements we used the NOVA hashtag—#novapbs—in place of a dedicated series hashtag. Online buzz extended beyond NOVA's social media community, as we also benefitted from David and others who promoted the series to their large community of followers. PBS expanded our social media reach significantly with its 1.8 million Twitter followers, and David tweeted, posted, and provided Instagram photos to his 1.5 million followers throughout the production and broadcast. CBS This Morning even tweeted about the series (85,000 followers).

Press Tour

NOVA's Executive Producer Paula Apsell presented at the Television Critic's Association (TCA) Press Tour Aug 5-7, 2013 in Los Angeles as a kick-off for MS2 promotional activities. Series host David Pogue and senior producer Chris Schmidt were also in attendance, and members of America's Cup Oracle Team USA made a live appearance via satellite feed.

Station Relations

All project activities were supported by an enhanced station relations plan, localizing the MS2 experience for PBS viewers. These nationwide efforts helped local stations with limited resources reach out to their local markets, expanding the project's reach in the process.

As planned, our station relations team provided strategic planning and communications in advance of the broadcast, including a series preview to all stations and one-on-one conversations with station professionals in select local markets. The team also helped produce a wealth of series promotion and station events, including those that featured series host David Pogue, Senior Executive Producer Paula Apsell, Senior Producer Chris Schmidt, and Producer Anna Lee Strachan. Collectively, these efforts contributed to 100% carriage in the top 50 markets.

SR also provided resources for families, educators, media and funders that facilitate station branding and local partnerships including customizable press materials, social media outreach and other online content. Further support was provided to stations producing local events around *Making Stuff*, listed in the table below.

Station Relations Activities for Making Stuff

Station	Date	Location	Audience	Program
KQED / San Francisco	10/02/13	Tech Museum of Innovation, San Jose, CA	200-250	Series Preview, Q&A with David Pogue & Paula Apsell, Reception
KPBS / San Diego	10/05/13	KPBS Studio	50 major donors	Series Preview, Producer's Club Event, Q&A with David Pogue & Chris Schmidt
WTTW / Chicago	10/08/13	Harold Washington, Pritzker Auditorium	Approx. 200	Series Preview, Q&A with Paula Apsell and David Pogue, Dinner
KERA / Dallas, Southern Methodist University	10/18/13	Simmons School at SMU	Approx. 130	Series Preview, Q&A with Anna Lee Strachan and Dr. Peter Weyand from the show
KOCE / Los Angeles	10/22/13	Discovery Science Center, Santa Ana, CA	50 major donors	Series Preview, Q&A with Paula

Educational Outreach

Education outreach activities for MS2 were designed to foster innovation: from revealing the process of innovation through Makerspaces and an IdeaLab conference and video collection, to delivering first-hand accounts of scientific innovation through an Innovation Café series, to bringing stories of cutting-edge scientific innovation to classrooms through a suite of teacher resources available on PBS LearningMedia.

The outreach campaign built upon the success of education activities surrounding the first season of *Making Stuff* by expanding upon the original coalition of outreach collaborators and outreach sites, leveraging the expertise and networks of these collaborators to create content for a range of educational settings (such as classrooms, museums, and afterschool programs), and by bringing new speakers and resources to the national science café network. These activities are described in detail in the following sections.

Target Audience Expansion

MS2 designed educational activities to reach children, teens, and high school students; individuals with disabilities; populations traditionally underserved in STEM; and college students. Project Boxes were designed for children, teens, and high school students in collaboration with the New York Hall of Science (NYSCI) and were shipped to high schools or science centers, such as to *All Hands Active* in Ann Arbor, MI and *Science City* in Kansas City, MO.

Through collaboration with Evaluneer, Boxes were adapted for individuals with disabilities, including physical, auditory, and visual adaptations; a Box was sent to the Quality of Life Teaching Center (QoLT) for use with individuals with disabilities. Our Boxes reached populations that are traditionally underserved in STEM, including women and diverse populations. Such sites include *Mujeres de Houston* (Houston, TX), *GEMS: Girls Excelling in Math and Science* (Franklin, PA), and *Society of Women Engineers* (Wichita, KS).

Boxes reached college audiences as well: Binghamton University hosted a "Science Olympiad" and Case Western University hosted an event using our Boxes. The IdeaLab was also designed specifically for undergraduate students, described in greater detail in the next section on *Enhanced Education Outreach.*

New Collaborations

As planned, we worked with the New York Hall of Science (NYSCI), a content development collaborator, to create our Maker Project Boxes. NYSCI (David Wells) developed, tested, and created activities for the Project Boxes, then sent them to our Education team for further editing and refinement. These activities challenged students to learn about engineering and design in a hands-on way, forming the basis of the Project Boxes. Additional collaborators who advised development of the Project Boxes include *Make Education*[4] (Steve Davee) and the Exploratorium (Mike Petrich) in San Francisco, CA.

We also developed relationships with 75 different outreach sites, which consisted of museums, schools, or organizations that hosted a Project Box to create their own local Makerspace. As planned, the UC Berkeley Lawrence Hall of Science, QoLT, Yale University, and Princeton University hosted Project Boxes to create a NOVA MS2 Makerspace. The National Engineer's Week Foundation distributed an activity from our Project Box in their "E-Week" activities packet, linked to digital activities from the Project Box on their E-Week Poster, and promoted the MS2 Project Box to their network of over 100 partners via their e-newsletter, website, and Facebook page (promotion was to recruit organizations to host Project Boxes). The Nanoscale Informal Science Education Network (NISE Net) included MS2 education outreach brochures and MS2 DVDs in their "Nanodays Tech Kits" they distributed to 225 outreach sites, primarily science museums. The National Collegiate Inventors and Innovators Alliance (NCIIA) played a large role in the IdeaLab, as NCIIA Vice President Eric Phelps co-produced the event.

NOVA also sent information about the new Innovation Café series to Alpha Sigma Mu, who offered to distribute that information to their members. Also, we had originally planned to work with IEEE to identify and train potential speakers for our Innovation Café network. However, after our IEEE contact retired, IEEE decided not to participate in this project. We instead recruited speakers through conference contacts, promotion through other professional organizations, such as the National Society of Black Physicists and AAAS, and outreach by café organizers. We also trained all speakers with our online professional development materials.

Community of Practice

[4] Previously referred to as *Make Magazine/Maker Faire* in the proposal.

In addition to working with these collaborators and outreach sites, we also used social media as a means to foster communication among this outreach community. As planned, a dedicated coalition was created, connecting our Project Box facilitators and the NOVA team. This coalition was named the *MAKING STUFF Outreach Community*, and was encouraged to communicate with one another about their personal experience with the Project Box, including success stories, ideas, and additional resources. This community was built on Google+ rather than Facebook as originally described in the proposal. The unique functionalities of Google+ allow us to keep in close communication with our community members, updating them frequently about new resources and training sessions, and encouraging them to share their experiences, photos, and stories with others in this online community. Per PBS requirements, we used the NOVA series hashtag - #novapbs - in place of a dedicated series hashtag to discuss the outreach surrounding *Making Stuff* on Twitter.

Education and Outreach Deliverables

The education outreach deliverables completed for the MS2 project included 75 Project Boxes (formerly the "outreach toolkit"), a series of Innovation Science Cafés, and a suite of teacher resources.

Making Stuff "Project Boxes"

As mentioned above, the Project Boxes were developed in collaboration with the New York Hall of Science, who led the creation, design, and testing of the Project Box activities. The activities were developed specifically for teens (middle and high-school students); advisors from *Make Education* and the Exploratorium also provided feedback for Box activities.

Each Project Box contained a digital and physical component: a facilitator's guide, instructions for activities, and a DVD with these resources and special video clips. The activities were highly interactive and hands-on as planned, challenging teen audiences to engage in open-ended design challenges with Box materials provided. The activities were also designed to be used in a variety of settings, as evidenced by the diversity of the 75 "outreach sites" NOVA made connections with and sent Project Boxes to (25 were funded by the Department of Energy; more details provided in the next section). Every facilitator who received a Project Box for their outreach site also committed to being a part of the *MAKING STUFF Outreach Community* and participating in the final Project Box and Community evaluation.

These "pop-up Makerspaces" brought teens and families into science museums, schools, community centers, libraries, or other community spaces, giving them the opportunity to engage in authentic, hands-on engineering and design problem solving. As mentioned previously, project Boxes served audiences who are traditionally underserved in STEM, such as women (e.g. *GEMS: Girls Excelling in Math and Science*) and Spanish-speaking communities (e.g. *Mujeres de Houston*). Project Boxes were also designed for individuals with disabilities through a collaboration with *Evaluneer* (physical, visual, and auditory accommodations were made). Also, while physical Project Boxes were distributed to the 75 registered outreach sites, wider

distribution of Box activities occurred through E-Week and NISE Net, and Project Box activities are available online through the NOVA website.

Project Box facilitators were not left without ongoing support— a robust community of practice was created around the Project Boxes to help facilitators use Project Boxes or tailor them to their specific outreach sites. This *MAKING STUFF Outreach Community* included 113 members from over 75 educational organizations in over two dozen states. Community members were educators from K-12 schools, science museums, libraries, maker/hacker spaces, and after-school programs. The community delivered a curriculum designed by NOVA and shared pedagogical knowledge around teaching engineering and design in a Google+ community.

NOVA used the robust *MAKING STUFF Outreach Community* as a means to deliver professional development "webinars" via Google+, including weekly "Office Hours" led by NOVA staff or 11 special "Hang-Outs on Air" with special guests, such as Steve Davee from *Make Education*. These webinars instruct our community members on how to best use Maker Project Boxes to teach the design and innovation process. The Google+ platform has proven to be an excellent platform for our purposes—it offers a simple yet effective means of delivering webinars. Additionally, it now links with YouTube, expanding how we share our resources. NOVA also created four specialized professional development videos providing detailed instructions on how to use the Project Box activities, posted on the NOVA YouTube page.

Innovation Science Cafés

The Innovation Café campaign was our most organized and concerted Science Café effort to date, with events held in more than a dozen states, reaching both adult and teen audiences. In addition to hosting cafés in the Boston area, members of our team traveled to Wisconsin and Washington D.C. to host cafés in collaboration with local organizers.

From our large, highly organized network of café organizers and speakers, we officially registered 40 Innovation Cafés nationwide, supplying them with support and NOVA branded materials such as an Innovation Café DVD to screen at events, t-shirts, coasters, and temporary tattoos. We reached approximately 1,300 people through Innovation Cafés, even expanding to cities where the science café network didn't previously have a presence, such as Mississippi, Georgia, Indiana, and Nebraska.

The revamped Science Cafés website, www.sciencecafes.org, hosted a wide range of support for people looking to organize, attend, or speak at a science café. Training materials, such as a facilitator's guide and informational videos, were made available for café organizers online, as well as access to a large database of registered café series and speakers across the nation.

Suite of Teacher Resources

As planned, we developed a collection of teacher resources on the *Making Stuff* series published on the PBS LearningMedia website, including classroom activities and professional development webinars for educators. A total of ten educational resources were created around themes from MS2 and have been published online on PBS LearningMedia. These educational resources

feature 3-5 minute video segments based upon material from MS2, are accompanied by background information, discussion questions, links to related content or additional resources and standards correlations. These resources were promoted to our large community of STEM educators through our monthly NOVA Education newsletter *SPARK:* the February and March 2014 issues featured the *Making Stuff 2* educational resources. Professional development was made available online through the Google+ community to educators.

Enhanced Education Outreach

Thanks to the support of the Department of Energy, NOVA was able to significantly deepen and expand the reach and impact of the educational outreach campaign. This support has allowed NOVA to create enhanced educational outreach activities, including a MS2 *IdeaLab* online video collection and screening event, new additions to the Project Boxes (including accommodations for individuals with disabilities), an additional 25 outreach toolkits, and participation in *Maker Faire* events. With these enhancements, we were able to reach more teens—and teens with disabilities—with the Making Stuff Project Boxes, provide new resources to teachers on the process of innovation, provide underserved students with networking opportunities and the opportunity to learn about the process of innovation, and share MS2 educational outreach experiences to other educators and thought leaders at a national conference.

Project Boxes: Enhanced and Expanded

With the support of the DOE, NOVA created and distributed an additional 25 Project Boxes to outreach sites, for a total of 75 Project Boxes—this allowed NOVA to broaden the reach of its outreach activities. NOVA has also created and printed the 2-page educational brochure highlighting the range of *Making Stuff 2* educational resources available. These brochures were distributed to educators and collaborators, including to NISE-Net through their Nanodays Tech Kits as planned.

NOVA also worked with Evaluneer to develop strategies and adaptations to the outreach toolkit to make them more readily accessible to audiences with special needs, specifically physical, auditory, and visual accommodations. As reported in an email to the DOE on August 9, 2013, NOVA arranged to work with Evaluneer instead of QoLT, with no changes to the final deliverables.

IdeaLab Workshop: Expanding Opportunity

NOVA hosted an Innovation IdeaLab, a four-day event at WGBH (January 10-13, 2014) co-produced with NCIIA (Eric Phelps, Vice President NCIIA). The theme of the event was *Making Stuff: Wilder*, featuring many examples of innovative biomimicry ideas. James Barlow of Tufts University developed the 4-day curriculum specifically for undergraduate students about the *process* of innovation, including how to develop ideas and bring them to market successfully; the student attendees were highly engaged and reported enjoying the workshop. The IdeaLab was kicked-off by a special screening of NOVA's *Making Stuff: Wilder*, an event made possible by the DOE. This gave college students the opportunity to network with leading innovators and with one another.

The DOE played an essential role in making the process of innovation presented at the IdeaLab more accessible to a wider audience: DOE funding supported videotaping the event to produce media resources for individuals who could not attend and for classroom use. The entire event was filmed by a professional crew, the footage from which was used to create an IdeaLab video collection: four videos and one lesson plan (with instructions for educators) on innovation, engineering, and the design process, which address the Next Generation Science Standards for Engineering. This IdeaLab collection is available on the NOVA website and PBS Learning Media.

Thanks to the support of the DOE, 5 students who are traditionally underserved in STEM were supported (primarily women), including their transportation, meals, hotels. NOVA and NCIIA recruited the remaining 20 undergraduate students from across the country, including from MIT, RISD, University of Texas, Austin, Worcester Polytechnic Institute, University of Georgia, Smith College, and Salisbury University.

Participation in National Maker Faire Events

NOVA attended the Maker Faire in New York City in September 2013 with David Pogue, who spoke at the event about *Making Stuff 2*; NOVA distributed promotional brochures about *Making Stuff 2* at the event. NOVA staff also attended the May 2014 Maker Faire in the San Francisco Bay Area, gave a presentation on MS2 educational outreach and provided materials to attendees.

Project Management

All of the Key Personnel presented in the proposal worked on this project as planned. Rachel Connolly, former Director of Education at NOVA, has since moved to a new position in WGBH although she continues to consult on *Making Stuff* project components on an as needed basis. Her new role is Director of STEM Education at WGBH, a position she assumed in December 2013. Also, Senior Producer and Project Director Lisa Mirowitz has since left the organization, yet project management duties have been transferred to Pam Rosenstein, Development Producer and MS2 Project Director.

Project Evaluation

Concord Evaluation Group (CEG) is an independent research consulting business that provides third party evaluations for educational and health organizations. Led by Dr. Christine Paulsen, CEG implemented an evaluation plan for *Making Stuff 2* that included a formative and summative evaluation. While NOVA worked with CEG to develop evaluations that adequately captured the intended project impacts, CEG was in charge of data collection, management, analysis, and final data reporting.

The following overview and topline findings have been excerpted from CEG's Executive Summary of the final evaluation report; please see attached MS2 Summative Evaluation for a complete report of evaluation findings.

To empirically assess whether MS2 achieved these impacts, the following four studies were undertaken by Dr. Paulsen at CEG:

- **Study 1 – TV Viewing Experiment:** This study explored the impact of the MS2 television series on a national audience compared to a control group sample of non-viewers.

- **Study 2 – Website User Experiment:** This study explored the impact of the MS2 website and its web-based resources on a national audience compared to a control group sample of non-users.

- **Study 3 – Longitudinal Study:** This study explored changes over time in individuals who were exposed to MS2 TV and/or web-based resources.

- **Study 4 – Community of Practice Evaluation:** This study included interviews with a sample of MS2 outreach community members,[5] surveys of all MS2 outreach community members, and an exploration of the online relationships of MS2 outreach community members to one another, in particular, whether the Community of Practice networks grew or changed over time.

This report details methodologies, empirical findings, and assesses the evidence for MS2 impacts.

Topline Findings

Across four separate, rigorous studies, we have collected evidence that enables us to report, with confidence, that NOVA's MS2 series, website, and outreach efforts were successful at achieving its desired impacts.

Raising Awareness. Specifically, NOVA's MS2 television series and website were able to significantly increase public understanding that basic research leads to technological innovation and to help the public understand the importance of it. The series and the website also significantly helped to increase viewers' awareness of scientific innovation.

Increasing Excitement. Beyond awareness, the series and the website engaged the public and made them significantly more excited about scientific innovation. MS2 viewers were significantly more likely than non-viewers to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation. Moreover, we found that individuals who watched the MS2 series or used the MS2 website were significantly more likely than non-viewers to report that they would likely discuss science and innovation with their friends and

[5] The original evaluation design included a mobile outreach survey designed to capture feedback from attendees at outreach events. Only six respondents completed the surveys, so we added interviews with outreach community members to the scope of work to compensate for the lack of data from the mobile surveys.

peers, look into news about innovation, watch science programs on TV, and attend or participate in other science-related events or activities.

Sustained Awareness & Excitement. Through a rigorous, six-month longitudinal study, we found evidence that NOVA was able to achieve sustained and, in some cases, growing public awareness and excitement about scientific innovation. We observed that interest and awareness in scientific and technological innovation were sustained over time and even grew in some cases. For example, NOVA viewers' awareness of scientific or technological innovation grew significantly over time. Likewise, the proportion of respondents who reported that the connections between scientific research and innovation were new and exciting to them also increased significantly over time. Similarly, the proportion of participants who reported that they enjoyed thinking about how scientific innovations can change or improve our lives increased significantly over time.

Other beliefs and attitudes were sustained over a period of six months, including the proportion of participants who believed that scientific research and innovations can lead to discoveries that can be important to society, reported interest in learning about science and innovation over time, the proportion of participants who reported engaging in activities such as "Nerd Nights," and those who reported that they watched NOVA a few times per month.

Building A Community of Practice. Related to NOVA's MS2 outreach efforts, we found evidence that the MS2 Community of Practice enhanced the quality of collaboration among members and encouraged members to continue using Maker pedagogy. CoP members reported that their involvement in the project was valuable to their own outreach efforts and local delivery of their own programming. Thousands of citizens, young and old, were reached with the MS2 activities across the country.

CoP members reported that they learned valuable lessons from one another. Most members were consumers of the CoP user-generated tips and ideas rather than generators of the content. But, all members saw significant benefits to participating in the CoP, including the feeling that they were part of a larger community.

The Community also enhanced the frequency of collaboration for some, but not all, of the project period. Despite this, most CoP members reported that they planned to continue their involvement in the Maker Movement.

Project Changes

The great majority of all project activities proceeded as planned. Only a few minor changes or adjustments were made, and have already been reported to the DOE; yet they are summarized here for reference.

As reported to the DOE in an email on August 9, 2013, the evaluation plan shifted slightly in scope to put more resources toward the summative evaluation instead of a formative evaluation for the outreach toolkit. It was determined that a formative evaluation of the outreach toolkit was unnecessary since the New York Hall of Science would be collecting feedback and testing the

outreach toolkit as they developed it, making feedback from a separate formative evaluation unnecessary.

There was a minor change in the promotional activities, as reported in an email to the DOE on August 9, 2013: the Television Critics Association Press Tour occurred in the beginning of August, 2013, as opposed to July 2013 as anticipated in the proposal.

Also, there was a change in the collaborator to help NOVA adapt activities in the outreach toolkit for individuals with special needs. As reported in an email to the DOE on August 9, 2013, we had originally planned to work with the Quality of Life and Technology Center to co-develop content for individuals with special needs. Evaluneer was selected as an alternative partner to develop these materials. Also, as reported in a July 2, 2013 email to the DOE, the Lawrence Berkeley Hall of Science was no longer a test site for outreach activities, and instead the New York Hall of Science tested the Project Box Activities.

PRODUCTS DEVELOPED UNDER AWARD

- Making Stuff 2 Official Website *(all episodes can be screened here)*: http://www.pbs.org/wgbh/nova/tech/making-more-stuff.html

- Making Stuff 2 Online Quiz: http://www.pbs.org/wgbh/nova/tech/making-stuff-quiz/

- Innovation-Themed Science Café Resource page: http://www.sciencecafes.org/

- Making Stuff 2 Online Reporting *(NOVA Next):* http://www.pbs.org/wgbh/nova/next/

NOVA Next Online Reporting

Article Title	Author	Date	Link
The Evolution of the Bioinspired Robot	Rachel Nuwer	09/17/13	*http://www.pbs.org/wgbh/nova/next/tech/evolution-of-bioinspired-robots/*
Melting to Keep Cool	Phil McKenna	09/10/13	*http://www.pbs.org/wgbh/nova/next/tech/melting-to-keep-cool/*
The Unexpected Ways Engineers Help Us Move Faster	Robert Victor	09/04/13	*http://www.pbs.org/wgbh/nova/next/tech/infrastructure-moving-faster/*
Promise and Perils of Hyperloop and Other High-Speed Trains	Tim De Chant	08/13/13	*http://www.pbs.org/wgbh/nova/next/tech/hyperloop-and-high-speed-trains/*
For More Accurate Forecasts, Follow the Fish	Jed Lipinski	10/01/13	*http://www.pbs.org/wgbh/nova/next/nature/animals-as-oceanographers/*
For Safer Food, Just Add Viruses	Cassandra Willyard	10/25/13	*http://www.pbs.org/wgbh/nova/next/nature/phages-for-food-safety/*
Bat-Inspired Tech Could Help Blind People See with Sound	Allison Eck	10/23/13	*http://www.pbs.org/wgbh/nova/next/body/bioinspired-assistive-devices/*
How Engineers Use Ground Freezing to Build Bigger, Safer, and Deeper	Jessica Morrison	10/30/13	*http://www.pbs.org/wgbh/nova/next/tech/artificial-ground-freezing/*
My Identity Was Stolen. Here's How They Did It	Phil McKenna	11/20/13	*http://www.pbs.org/wgbh/nova/next/tech/science-of-identity-theft/*
Taming the Hidden Drowsiness Epidemic	Peter Wehrwein	11/06/13	*http://www.pbs.org/wgbh/nova/next/body/science-of-drowsiness/*

A Tested, Inexpensive Way to Protect Buildings from Earthquakes	James M Kelly	11/13/13	*http://www.pbs.org/wgbh/nova/next/tech/rubber-bearings-seismic-protection/*

- *Making Stuff 2* Short-Form Videos

Video Title	Publish Date	Link
RoboBees to the Rescue	10/3/13	http://www.pbs.org/wgbh/nova/tech/robobees-rescue.html
Cyber War Games	10/31/13	http://www.pbs.org/wgbh/nova/tech/cyber-war-games.html
Cockroach Cyborgs	10/17/13	http://www.pbs.org/wgbh/nova/tech/cockroach-cyborgs.html
Carnivorous Plants, Killer Ants	10/3/13	http://www.pbs.org/wgbh/nova/nature/plants-killer-ants.html
Mushroom Material	10/17/13	http://www.pbs.org/wgbh/nova/tech/mushroom-material.html
The Hummingbird Drone	10/31/13	http://www.pbs.org/wgbh/nova/tech/hummingbird-drone.html
Super Fast Cameras	11/7/13	http://www.pbs.org/wgbh/nova/tech/super-fast-cameras.html
Cryonics	11/7/13	http://www.pbs.org/wgbh/nova/tech/cryonics.html

- *Making Stuff 2* Teacher Resources:

Resource Title	Publish Date	Link
Powering Torque in the Trunk	02/05/14	*http://mass.pbslearningmedia.org/resource/nvmms.sci.eng.trunk/powering-torque-in-the-trunk/*
The Science of Keeping Cool	02/05/14	*http://mass.pbslearningmedia.org/resource/nvmms.sci.phys.cool/the-science-of-keeping-cool/*
Wild-Inspired Robotic Arms	02/05/14	*http://mass.pbslearningmedia.org/resource/nvmms.sci.eng.roboarm/wild-inspired-robotic-arms/*
Engineering Soft-Story Safety	02/05/14	*http://mass.pbslearningmedia.org/resource/nvmms.sci.engineer.softstory/engineering-soft-story-safety/*
Fabric from Hagfish Slime	03/07/14	*http://www.pbslearningmedia.org/resource/nvmms.sci.eng.hagfish/fabric-from-hagfish-slime/*
A Green Way to Fight Fires	03/07/14	*http://www.pbslearningmedia.org/resource/n*

		vmms.sci.eng.fire/a-green-way-to-fight-fires/
Making Boats Fly	03/07/14	*http://www.pbslearningmedia.org/resource/nvmms.sci.phys.boatsfly/making-boats-fly/*
Preserving Permafrost	03/07/14	*http://www.pbslearningmedia.org/resource/nvmms.sci.phys.permafrost/preserving-permafrost/*
Swarm Robotics	03/07/14	*http://www.pbslearningmedia.org/resource/nvmms.sci.eng.swarm/swarm-robotics/*
The Math Behind Package Delivery	03/11/14	*http://www.pbslearningmedia.org/resource/nvmms.sci.eng.package/the-math-behind-package-delivery/*

- Teacher Professional Development

  11 "Hang-Outs on Air:" Available ton the NOVA YouTube Channel *(The Making Stuff hangouts are designated with the logo in the top right corner.)* https://www.youtube.com/channel/UC6vX2L72igq8PiJ0rF0329Q

  Webinars for teachers who wish to adapt Project Box activities for use in the classroom:

  - Description of MS Boxes: https://www.youtube.com/watch?v=pWuGu_-jOAU
  - Using *Wilder* activities: https://www.youtube.com/watch?v=V380f1bXCbw
  - Using *Colder* activities: https://www.youtube.com/watch?v=un4WUfT6AW8
  - Using *Safer* activities : https://www.youtube.com/watch?v=xUF_3AKbGjI

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[3] Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Rosenthal, S. (2014) Climate change in the American mind: April, 2014. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication.

Concord Evaluation Group

Concord Evaluation Group

NOVA "Making Stuff Season 2:" Summative Evaluation Report

October 2014

PO Box 694 | Concord, MA 01742 | concordevaluation.com

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Overview

Project Overview

NOVA, produced by WGBH Boston, is the highest rated science series on television and the most watched documentary series on public television. It is also one of television's most acclaimed series, having won every major television award, most of them many times over.

NOVA's *Making Stuff* Season 2 (MS2) is a four-part series featuring technology columnist and best-selling author David Pogue as host. Pogue takes a wild ride through cutting-edge science that is powering the next wave of technological innovation and meets the scientists and engineers who are plunging to the bottom of the temperature scale—finding design inspiration in nature and breaking every speed limit to make tomorrow's 'stuff' *Colder*, *Faster*, *Safer*, and *Wilder*. The series premiered on October 16, 2013 and ran for four weeks.

To accompany the TV series, the NOVA team at WGBH also developed a website (http://www.pbs.org/wgbh/nova/tech/making-more-stuff.html) containing short videos, full-length episodes, videos for teachers, blogs, games, and social media resources.

In addition to the TV series and website, NOVA also received funding from the National Science Foundation to develop educational outreach materials that could be used by informal and formal science educators to extend learning and excitement about science and technological innovation to an even broader community. Specifically, NOVA developed a specialized resource kit to give educators the tools and guidance to create their own "makerspaces." These *Maker Project Boxes* were designed for children, teens, and high school students in collaboration with the New York Hall of Science (NYSCI). Each Project Box contained a facilitator's guide, instructions for activities, and a DVD with these resources and special video clips. Boxes were distributed to over 75 educational organizations; wider distribution of Box activities occurred through Engineer's Week and Nanoscale Informal Science Education Network (NISE Net).

A robust Community of Practice (CoP) was built around the Project Boxes and supported by NOVA as well. The CoP included 100 informal and formal STEM educators from across the country, such as educators from K-12 schools, science museums, libraries, maker/hacker spaces, and after-school programs. CoP members delivered a "maker" curriculum designed by NOVA and shared

pedagogical knowledge around teaching engineering and design in a Google+ community.

Evaluation Overview

Concord Evaluation Group (CEG), led by Dr. Christine Paulsen, was hired by WGBH to perform an evaluation of NOVA's *Making Stuff* Season 2 series, website, and outreach activities. CEG also conducted a separate set of formative evaluation activities during the early stages of resource development. The findings from the formative evaluation have been delivered separately.
The goal of the summative evaluation was to explore the extent to which MS2 activities were successful at achieving NOVA's intended impacts:

1. To increase public understanding that basic research leads to technological innovation;
2. To increase and sustain public awareness and excitement about innovation and its impact on society; and
3. To establish a community of practice that enhances the frequency and quality of collaboration among STEM researchers and informal educators.

To empirically assess whether MS2 achieved these impacts, the following four studies were undertaken by Dr. Paulsen at CEG:

- **Study 1 – TV Viewing Experiment:** This study explored the impact of the MS2 television series on a national audience compared to a control group sample of non-viewers.

- **Study 2 – Website User Experiment:** This study explored the impact of the MS2 website and its web-based resources on a national audience compared to a control group sample of non-users.

- **Study 3 – Longitudinal Study:** This study explored changes over time in individuals who were exposed to MS2 TV and/or web-based resources.

- **Study 4 – Community of Practice Evaluation:** This study included interviews with a sample of MS2 outreach community members,[1] surveys of all MS2 outreach community members, and an exploration of the online relationships of MS2 outreach community members to one another, in

[1] Our original proposal included a mobile outreach survey designed to capture feedback from attendees at outreach events. Only six respondents completed the surveys, so we added interviews with outreach community members to the scope of work to compensate for the lack of data from the mobile surveys.

particular, whether the Community of Practice networks grew or changed over time.

This report details methodologies, empirical findings, and assesses the evidence for MS2 impacts.

Topline Findings

Across four separate, rigorous studies, we have collected evidence that enables us to report, with confidence, that NOVA's MS2 series, website, and outreach efforts were successful at achieving its desired impacts.

Raising Awareness. Specifically, NOVA's MS2 television series and website were able to significantly increase public understanding that basic research leads to technological innovation and to help the public understand the importance of it. The series and the website also significantly helped to increase viewers' awareness of scientific innovation.

Increasing Excitement. Beyond awareness, the series and the website engaged the public and made them significantly more excited about scientific innovation. MS2 viewers were significantly more likely than non-viewers to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation. Moreover, we found that individuals who watched the MS2 series or used the MS2 website were significantly more likely than non-viewers to report that they would likely discuss science and innovation with their friends and peers, look into news about innovation, watch science programs on TV, and attend or participate in other science-related events or activities.

Sustained Awareness & Excitement. Through a rigorous, six-month longitudinal study, we found evidence that NOVA was able to achieve sustained and, in some cases, growing public awareness and excitement about scientific innovation. We observed that interest and awareness in scientific and technological innovation were sustained over time and even grew in some cases. For example, NOVA viewers' awareness of scientific or technological innovation grew significantly over time. Likewise, the proportion of respondents who reported that the connections between scientific research and innovation were new and exciting to them also increased significantly over time. Similarly, the proportion of participants who reported that they enjoyed thinking about how scientific innovations can change or improve our lives increased significantly over time.

Other beliefs and attitudes were sustained over a period of six months, including the proportion of participants who believed that scientific research and innovations can lead to discoveries that can be important to society, reported interest in learning about science and innovation over time, the proportion of participants who reported engaging in activities such as “Nerd Nights,” and those who reported that they watched NOVA a few times per month.

Building A Community of Practice. Related to NOVA’s MS2 outreach efforts, we found evidence that the MS2 Community of Practice enhanced the quality of collaboration among members and encouraged members to continue using Maker pedagogy. CoP members reported that their involvement in the project was valuable to their own outreach efforts and local delivery of their own programming. Thousands of citizens, young and old, were reached with the MS2 activities across the country.

CoP members reported that they learned valuable lessons from one another. Most members were consumers of the CoP user-generated tips and ideas rather than generators of the content. But, all members saw significant benefits to participating in the CoP, including the feeling that they were part of a larger community.

The Community also enhanced the frequency of collaboration for some, but not all, of the project period. Despite this, most CoP members reported that they planned to continue their involvement in the Maker Movement.

Study 1: TV Viewing Experiment

Study Design

Objectives

The TV Viewing Experiment was designed to gather evidence related to Impacts #1 and #2:

1. To increase public understanding that basic research leads to technological innovation; and
2. To increase and sustain public awareness and excitement about innovation and its impact on society.

Recruitment

We invited participants from CEG's national panel of study participants to participate in the study. Participants were offered modest honoraria of $30 each to participate. Interested individuals completed a recruitment screener online (Appendix A).

From the pool of interested individuals who responded to the recruitment screener, we invited a random sample of approximately 200 individuals to participate in the study (we recruited several extra participants to compensate for anyone who did not fully complete the study). Our goal was to recruit a sample of 100 individuals for the control group and 100 individuals for the treatment group. Potential participants were randomly assigned to either a control group or a treatment group upon enrollment in the study.

Methods and Procedures

Before enrollment in the study, we contacted potential control group members to ask whether they had viewed any of the MS2 episodes (on TV or online) since the national broadcast date preceded the start of the study. Those who had viewed it were disqualified from the study. The remaining control group members were instructed to respond to a web-based survey only (Appendix B).

Treatment group members were instructed to view the four MS2 episodes that were available on the NOVA website at their leisure, and then respond to a web-based survey (Appendix C).

Participants

A total of 209 individuals participated in the TV Viewing Experiment; 104 in the control group and 105 in the treatment group. The table below summarizes the participants' demographic characteristics.

There were slightly more women in both groups (64% of the treatment group and 53% of the control group). Both groups contained a range of individuals across the lifespan, from 18 years old to over 60 years old.

Despite using random assignment, there were some differences between the treatment and control groups. For instance, there were significantly more 30-39 year olds in the treatment group than in the control group, and significantly more individuals over the age of 60 in the control group than in the treatment group. There were also significantly more White individuals in the control group and significantly more Hispanics in the treatment group.

Both groups contained individuals with a range of educational backgrounds, from high school graduates to doctorates. The most common degree in both groups was a bachelor's degree (47% of the treatment group and 32% of the control group had a bachelor's degree).

Table 1:
Participant Characteristics

Participant Characteristics	Treatment Group Count and Percent (n = 105)	Control Group Count and Percent (n = 104)
Gender		
Female	67 (63.8%)	55 (52.9%)
Male	38 (36.2%)	49 (47.1%)
*Age**		
18-29 years old	17 (16.2%)	13 (12.5%)
30-39 years old	39 (37.1%)	22 (21.2%)
40-49 years old	26 (24.8%)	22 (21.2%)
50-59 years old	18 (17.1%)	27 (26.0%)
60 years old+	5 (4.8%)	20 (19.3%)
Race / Ethnicity		
White or Caucasian**	75 (71.4%)	89 (85.6%)
Hispanic, Spanish or Latino/a***	21 (20.0%)	8 (7.7%)
Black or African-American	8 (7.6%)	5 (4.8%)
Asian	8 (7.6%)	4 (3.8%)
Middle Eastern	1 (1.0%)	0 (0.0%)
Native American or Alaskan Native	1 (1.0%)	1 (1.0%)

Participant Characteristics	Treatment Group Count and Percent (n = 105)	Control Group Count and Percent (n = 104)
Native Hawaiian or Other Pacific Islander	0 (0.0%)	2 (1.9%)
Highest Education Level Attained		
High School Diploma or GED	6 (5.7%)	11 (10.6%)
Some College, No Degree	13 (12.4%)	18 (17.3%)
Currently Enrolled in College	2 (1.9%)	7 (6.7%)
Associate's Degree	13 (12.4%)	8 (7.7%)
Bachelor's Degree	49 (46.7%)	33 (31.7%)
Master's Degree	18 (17.1%)	21 (20.2%)
Doctorate or Other Professional Degree	4 (3.8%)	6 (5.8%)

* Chi-square $_{(df=5)}$ = 16.567, p = .005.
** Chi-square $_{(df=1)}$ = 6.190, p = .013.
*** Chi-square $_{(df=1)}$ = 6.623, p = .010.

To gauge participants' prior experience with, and interest in, science-related information, we asked participants to report whether they were scientists and whether they worked or studied in a science-related field. The results are summarized in the table below. Most participants in both groups reported that they were not scientists, did not work in science-related fields, and were not studying in a science-related field. There were no statistically significant differences between the groups with respect to any of these measures.

We also asked participants which science-related television shows they regularly watched, if any. The treatment and control group members were equally likely to be NOVA viewers – there were no significant differences between groups. However, the treatment group was significantly more likely to also watch other, non-PBS science-related programs.

Table 2:
Participants' Prior Experiences with Science-Related Information

Participant Experiences	Treatment Group Count and Percent (n = 105)	Control Group Count and Percent (n = 104)
Are you a scientist?		
No	103 (98.1%)	100 (96.2%)
Yes	2 (1.9%)	4 (3.8%)
Do you work in a science-related field?		
No	97 (92.4%)	87 (83.7%)
Yes	8 (7.6%)	17 (16.3%)
Are you studying a science-related field?		

Participant Experiences	Treatment Group Count and Percent (n = 105)	Control Group Count and Percent (n = 104)
No	99 (94.3%)	92 (88.5%)
Yes	6 (5.7%)	12 (11.5%)
Science-related television shows watched		
Discovery Curiosity*	55 (52.4%)	38 (36.5%)
MythBusters**	83 (79.0%)	64 (61.5%)
National Geographic Explorer***	85 (81.0%)	70 (67.3%)
NOVA	77 (73.3%)	65 (62.5%)
Through the Wormhole****	50 (47.6%)	29 (27.9%)

* Chi-square $_{(df=1)}$ = 4.688, p = .030.
** Chi-square $_{(df=1)}$ = 6.681, p = .009.
*** Chi-square $_{(df=1)}$ = 4.389, p = .036.
**** Chi-square $_{(df=1)}$ = 7.836, p = .005.

Sample Challenges

Using random assignment, treatment and control groups are usually roughly equivalent with respect to key background variables. Of course, this is not always the case, as demonstrated here with respect to a few variables. It may simply be the result of chance. It may also be due to the fact that we disqualified from the study any potential control group members who reported that they viewed the MS2 episodes prior to the study—the average MS2 viewer may simply be different than the average non-viewer. To account for these differences and ensure that our analysis made fair comparisons between the groups, when appropriate, our data analysis controlled for any important differences between the groups.

Findings

Impact #1: Linking Basic Research to Scientific Innovation

We asked participants to report the extent to which they agreed or disagreed that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society. **We found evidence that viewing the MS2 series helped individuals understand the importance of basic research to innovation.** Treatment group members reported statistically higher levels of agreement (average = 4.80, sd = .49) than control group members (average = 4.52, sd = .67), when controlling for differences in science-TV viewing, age, and race ($F_{(df=8,\ 7.394)} = 2.739$, p = .007; effect size = .48).

We also asked participants to express their opinion of the top three factors that lead to innovation. As summarized in the figure below, participants from both groups were most likely to perceive new discoveries and experiments as the top factors driving innovation today. **Treatment group participants were statistically more likely than control group members to choose "collaboration among scientists" as a "top 3" factor (62% versus 39%).**

However, related to NOVA's Impact #1, the treatment group was not more likely than the control group to perceive basic research as a driver of innovation.

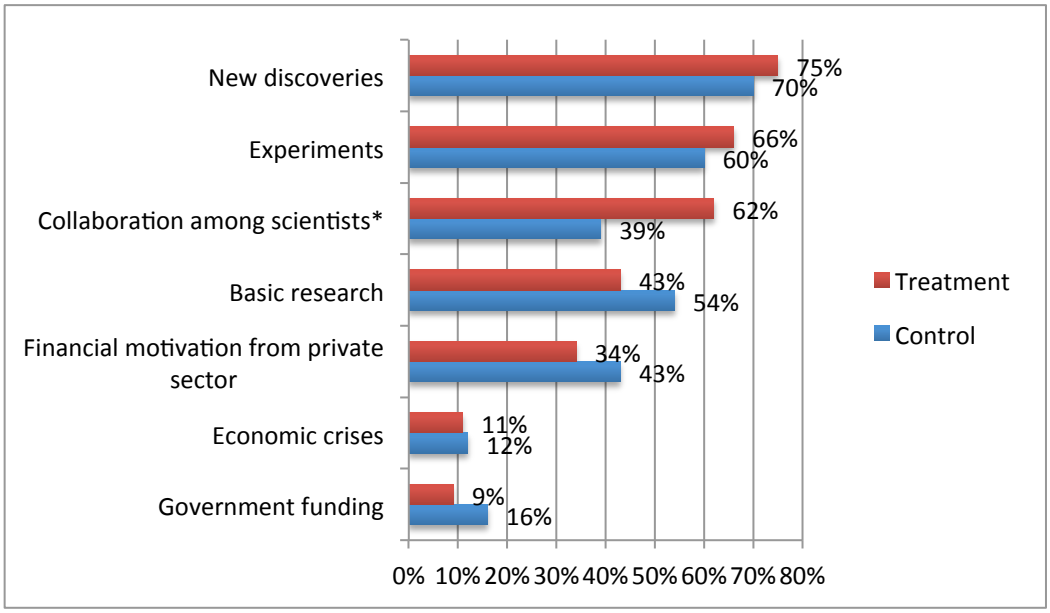

Figure 1. Factors considered most important to driving innovation.

* Chi-square (df=2) = 8.842, p = .003. We ran each analysis separately, controlling for demographic differences between the groups, but the findings did not change.

We asked participants to describe what "scientific innovation" meant to them. While members of the treatment and control groups all tended to recognize innovation as something new or different, treatment group members' responses were longer, more detailed, and included more factors related to innovation. For example, typical responses from the control group members included:

- *New ideas.*
- *Something new and exciting.*
- *Change for the better.*

Typical responses from the treatment group included:

- *Really thinking out of the box. Innovative is that hasn't yet been done; use of the imagination and experience to further something.*
- *Innovation means introducing something new. I think of improving upon past creations. I also think of inventing something new that is advantageous to people.*
- *By use of technology; making or designing something new which did not used to be there in the past--Something which is useful to the society and is used in a completely different way than the previous technologies we used.*

Impact #2: Increasing Public Awareness of and Excitement about Scientific Innovation

Public Awareness of Scientific Innovation

We asked participants to report the extent to which they felt they were aware of scientific or technological innovation. **Treatment group members were significantly more likely to report that they were aware than were control group members, even when controlling for key differences between the two groups.** The average "awareness" score on a scale of 1 to 5 (5 = highest level) was 4.22 (sd = .72) for the treatment group and 3.95 (sd = .73) for the control group, when controlling for differences in science-TV viewing, age, and race ($F_{(df=8, 20.816)} = 5.679$, p = .000; effect size = .37).

To further gauge the participants' awareness of innovation, we asked them to describe the ways in which they innovate in their own lives. Their responses indicate that participants in both groups had a generally clear understanding of what innovation is. An example response for the control group was:

- *I use my husband's walker to take the newspapers and garbage to the waste disposal site in our building. I added a 3 foot length of cardboard to the plant stand by bending it so the plants would hold it in place and the*

upturned part would protect them from the draft of the heater. I need and want to exercise so I do balance exercises on my way down to eat--and back. May look a bit funny but gives me about ten minutes of extra exercise a day.

A typical response from the treatment group was:

- *I try to innovate in the kitchen most. I have kids so it's always a challenge coming up with new ways to get my kids to eat their meals by making new recipes; combining old with new and making food look exciting and nutritious.*

Public Excitement about Scientific Innovation

To assess participants' excitement about scientific and technological innovation, we asked them a series of questions and asked them to indicate the extent to which they agreed or disagreed with them. Participants responded on a scale of 1 (Strongly disagree) to 5 (Strongly agree).

As summarized in the table below, **we found that individuals who watched the MS2 series were significantly more likely than non-viewers to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation.** These analyses controlled for differences in science-TV viewing, age, and race between the two groups.

Table 3: Participants' Excitement and Interest in Innovation

Statements	Treatment Group Average Agreement (sd)	Control Group Average Agreement (sd)	Statistics (If significant difference)
The connections between scientific research and innovation are new and exciting to me.	4.55 (.65)	4.07 (.80)	$F_{(df=8,28.379)}$ = 7.515, p .000; effect size = .66
I enjoy thinking about how scientific innovations can change or improve our lives.	4.64 (.59)	4.13 (.85)	$F_{(df=8,28.595)}$ = 7.524, p .000; effect size = .71
I am interested in learning about science and innovation.	4.70 (.50)	4.11 (.88)	$F_{(df=8,37.594)}$ = 10.847, p .000; effect size = .86

To further gauge excitement, we asked participants how likely they were to engage in a number of activities that were indicative of people who were interested in science. Participants responded on a scale of 1 (Highly unlikely) to 5 (Highly likely). As summarized in the table below, **we found that individuals who watched the MS2 series were significantly more likely than non-viewers to report that they would likely discuss science and innovation with their friends and peers, look into news about innovation, watch science programs on TV, and attend or participate in other science-related events or activities.** These analyses controlled for differences in science-TV viewing, age, and race between the two groups.

Table 4:
Participants' Interest in Engaging in Science-Related Behaviors

Behaviors	Treatment Group Average Agreement (sd)	Control Group Average Agreement (sd)	Statistics (If significant difference)
Discuss science and innovation topics with family, friends, or colleagues.	4.51 (.66)	4.09 (.93)	$F_{(df=8,22.526)}$ = 4.751, p .000; effect size = .53
Look into news about science, innovation, or new technologies.	4.57 (.66)	4.27 (.84)	$F_{(df=8,14.822)}$ = 3.479, p .001; effect size = .40
Watch science programs on television.	4.75 (.56)	4.39 (.69)	$F_{(df=8,15.236)}$ = 5.242, p .000; effect size = .58
Attend or participate in other science-related activities.	4.20 (.97)	3.69 (1.25)	$F_{(df=8,44.578)}$ = 5.310, p .000; effect size = .46

In fact, when we asked treatment group participants specifically about the impact of MS2 on their interest levels, most (84%) confirmed that MS2 made them more interested in science and technology activities:

- The series made me more interested = 87 out of 105 (83.9%)
- The series did not change my interest level because I was already interested = 17 out of 105 (16.2%)
- The series did not change my interest level because I remain disinterested = 1 out of 105 (1.0%)

We asked participants to indicate which of the following other, science-related activities they were likely to participate in. **Participants who viewed MS2 were significantly more likely than non-viewers to report that they were likely to**

attend a science lecture or talk (55% versus 38%). These analyses controlled for differences in science-TV viewing, age, and race between the two groups. Nearly all participants (91% of treatment group and 81% of control group) reported that they were likely to someday visit a museum.

Table 5:
Other Science-Related Activities that Participants Might Engage In

Activities	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
Visit a museum	95 (90.5%)	84 (80.8%)	Not significant
Attend a science lecture or talk	58 (55.2%)	39 (37.5%)	Chi-square $_{(df=1)}$ = 5.916, p = .000
Take a class on a science topic	25 (23.8%)	33 (31.7%)	Not significant
Research science on the Web[2]	2 (1.9%)	7 (6.7%)	Not significant
Don't plan to participate in any	3 (2.9%)	6 (5.8%)	Not significant

Several participants across both groups also reported other types of activities they were likely to do.[3] These included:

- Reading about science (n = 2).
- Doing science activities with their kids or kids they teach (n = 2).
- Joining a local science center (n = 1).
- Attending "Nerd Nite" in their local city (n = 1).
- Sharing science-related information with local governments (n = 1).
- Taking a cooking class (n = 1).

For those participants who reported that they intended to engage in any of these science-related behaviors, we explored the motivations behind those intentions. We did not, however, have any expectations that the groups would differ in their motivations. We were merely interested in describing people's motivations. We asked participants to report on what motivates them to stay informed about topics related to science and innovation. The most common motivation, across both groups was personal interest (91% of treatment group and 88% of control group). The next most common motivation was "to talk with my friends and family" (47% of treatment group and 38% of control group). As expected, there were no statistically significant differences between the groups with respect to motivations.

[2] We added this activity because of the number of individuals providing this response in the Other category.
[3] The sample sizes were not large enough to compare differences between the groups.

One participant reported that they stay informed “to educate my boys and foster a love of science.” Another reported that they stay informed “to educate my children for future careers.” A third added, “It’s just so interesting to see what will happen next (I’m 93)!”

Table 6:
Motivations for Staying Informed about Science and Technology

Motivations	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
For personal interest	96 (91.4%)	91 (87.5%)	Not significant
To talk with my friends and family	49 (46.7%)	39 (37.5%)	Not significant
I need to for my job/career	20 (19.0%)	23 (22.1%)	Not significant
For financial or business purposes	17 (16.2%)	12 (11.5%)	Not significant
Not applicable – Don’t stay informed	1 (1.0%)	6 (5.8%)	Not significant

Finally, we asked participants to report what resources they relied on most to get information on the latest advancements in science and innovation. The top answer from both groups was science documentaries and programs (35% of treatment group and 23% of control group), followed by science-based websites, national news broadcasts, and online news sources.

Table 7:
Resources for Staying Informed about Science and Technology

Resources	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
Science documentaries and programs	37 (35.2%)	24 (23.1%)	Not significant
Science-based website	17 (16.2%)	16 (15.4%)	Not significant
National news broadcast	16 (15.2%)	11 (10.6%)	Not significant
An online news source	14 (13.3%)	25 (24.0%)	Not significant
Public radio news	5 (4.8%)	7 (6.7%)	Not significant
Regional/local newspaper	3 (2.9%)	0 (0.0%)	Not significant
Weekly newspaper such as The Science Times	3 (2.9%)	0 (0.0%)	Not significant
Local news broadcast	2 (1.9%)	4 (3.8%)	Not significant
National newspaper	2 (1.9%)	1 (1.0%)	Not significant
Radio programs such as	1 (1.0%)	4 (3.8%)	Not significant

Resources	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
Science Friday			
Not applicable	1 (1.0%)	3 (2.9%)	Not significant
Other	3 (2.9%)	6 (5.8%)	Not significant

Other resources mentioned by participants included:

- Science magazines like Scientific American, Popular Mechanics, and National Geographic (n = 4).
- Professional, peer-reviewed journals (n = 3).
- Family and friends (n = 1).
- Facebook (n = 1).

Treatment Group Feedback on Making Stuff Season 2

To gather feedback on the MS2 series, we asked treatment group participants what grade they would give the program, ranging from an "A" to a "D or F." Most participants gave MS2 an A (71%) or a B (26%):

- A = 74 out of 105 (70.5%)
- B = 27 out of 105 (25.7%)
- C = 2 out of 105 (1.9%)
- D or F = 2 out of 105 (1.9%)

We asked treatment group participants how appropriate the series was for their own level of knowledge about science and innovation. The majority of participants reported that the series achieved the right balance between basic and challenging (84%).

- The series achieved the right balance between basic and challenging = 88 out of 105 (83.8%)
- Some of the series was too basic for me = 10 out of 105 (9.5%)
- All or most of the series was too basic for me = 4 out of 105 (3.8%)
- Some of the series was too challenging for me = 3 out of 105 (2.9%)

Finally, we asked treatment group participants how likely they were to recommend the MS2 series to their friends or family. The majority of participants reported that they were likely or highly likely to recommend the series (93%).

- Highly likely = 65 out of 105 (61.9%)
- Likely = 33 out of 105 (31.4%)

- Neutral = 5 out of 105 (4.8%)
- Highly unlikely = 1 out of 105 (1.0%)

Study 2: Web User Experiment

Study Design

Objectives

The Web User Experiment was designed to gather evidence related to Impacts #1 and #2:

1. To increase public understanding that basic research leads to technological innovation; and
2. To increase and sustain public awareness and excitement about innovation and its impact on society.

Recruitment

We invited participants from CEG's national panel of study participants to participate in the study at the same time we recruited participants for the TV Viewing Experiment. Participants were offered modest honoraria of $30 each to participate in the study. Interested individuals completed a recruitment screener online (Appendix A).

From the pool of interested individuals who responded to the recruitment screener, we invited a random sample of approximately 200 individuals to participate in the study (we recruited several extra participants to compensate for anyone who did not fully complete the study). Our goal was to recruit a sample of 100 individuals for the control group and 100 individuals for the treatment group. Potential participants were randomly assigned to either a control group or a treatment group upon enrollment in the study.

Methods and Procedures

Before enrollment in the study, we contacted potential control group members to ask whether they had used the MS2 website. Those who had used it were disqualified from the study. The remaining control group members were instructed to respond to a web-based survey only (Appendix B).

Treatment group members were instructed to use the MS2 website at their leisure, and then respond to a web-based survey (Appendix D).

Participants

A total of 207 individuals participated in the Web User Experiment; 104 in the control group and 103 in the treatment group. The table below summarizes the participants' demographic characteristics.

There were slightly more women in both groups (63% of the treatment group and 53% of the control group). Both groups contained a range of individuals across the lifespan, from 18 years old to over 60 years old. There were significantly more White individuals in the control group.

Both groups contained individuals with a range of educational backgrounds, from high school graduates to doctorates. The most common degree in both groups was a bachelor's degree (48% of the treatment group and 32% of the control group had a bachelor's degree).

Table 8:
Participant Characteristics

Participant Characteristics	Treatment Group Count and Percent (n = 103)	Control Group Count and Percent (n = 104)
Gender		
Female	65 (63.1%)	55 (52.9%)
Male	38 (36.9%)	49 (47.1%)
Age		
18-29 years old	17 (16.5%)	13 (12.5%)
30-39 years old	25 (24.3%)	22 (21.2%)
40-49 years old	32 (31.1%)	22 (21.2%)
50-59 years old	21 (20.4%)	27 (26.0%)
60 years old+	8 (7.8%)	20 (19.2%)
Race / Ethnicity		
White or Caucasian*	71 (68.9%)	89 (85.6%)
Hispanic, Spanish or Latino/a	16 (15.5%)	8 (7.7%)
Black or African-American	13 (12.6%)	5 (4.8%)
Asian	4 (3.9%)	4 (3.8%)
Native American or Alaskan Native	0 (0.0%)	1 (1.0%)
Native Hawaiian or Other Pacific Islander	2 (1.9%)	2 (1.9%)
Highest Education Level Attained		
High School Diploma or GED	5 (4.9%)	11 (10.6%)
Some College, No Degree	13 (12.6%)	18 (17.3%)
Currently Enrolled in College	3 (2.9%)	7 (6.7%)
Associate's Degree	13 (12.6%)	8 (7.7%)
Bachelor's Degree	49 (47.6%)	33 (31.7%)

Participant Characteristics	Treatment Group Count and Percent (n = 103)	Control Group Count and Percent (n = 104)
Master's Degree	17 (16.5%)	21 (20.2%)
Doctorate or Other Professional Degree	2 (1.9%)	6 (5.8%)

* Chi-square $_{(df=1)}$ = 7.248, p = .007.

To gauge participants' prior experience with, and interest in, science-related information, we asked participants to report whether they were a scientist and whether they worked or studied in a science-related field. The results are summarized in the table below. Most participants in both groups reported that they were not scientists, did not work in science-related fields, and were not studying in a science-related field. There were no statistically significant differences between the groups with respect to any of these measures.

We also asked participants which science-related television shows they regularly watched, if any. The treatment and control group members were equally likely to be NOVA viewers and viewers of other science-related shows, except Discovery Curiosity.

Table 9:
Participants' Prior Experiences with Science-Related Information

Participant Experiences	Treatment Group Count and Percent (n = 103)	Control Group Count and Percent (n = 104)
Are you a scientist?		
No	100 (97.1%)	100 (96.2%)
Yes	3 (2.9%)	4 (3.8%)
Do you work in a science-related field?		
No	92 (89.3%)	87 (83.7%)
Yes	11 (10.7%)	17 (16.3%)
Are you studying a science-related field?		
No	97 (94.2%)	92 (88.5%)
Yes	6 (5.8%)	12 (11.5%)
Science-related television shows watched		
Discovery Curiosity*	54 (52.4%)	38 (36.5%)
MythBusters	77 (74.8%)	64 (61.5%)
National Geographic Explorer	81 (78.6%)	70 (67.3%)
NOVA	73 (70.9%)	65 (62.5%)
Through the Wormhole	40 (38.8%)	29 (27.9%)

* Chi-square $_{(df=1)}$ = 4.667, p = .031.

Findings

Impact #1: Linking Basic Research to Scientific Innovation

We asked participants to report the extent to which they agreed or disagreed that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society. **We found evidence that viewing the MS2 website helped individuals understand the importance of basic research to innovation.** Treatment group members reported statistically higher levels of agreement (average = 4.86, sd = .40) than control group members (average = 4.52, sd = .67) ($t_{(df=168.056)} = 4.519$, p = .000; effect size = .64).

We also asked participants to express their opinion of the top three factors that lead to innovation. As summarized in the figure below, participants from both groups were most likely to perceive new discoveries and experiments as the top factors driving innovation today. **Treatment group participants were statistically more likely than control group members to choose "collaboration among scientists" as a "top 3" factor (65% versus 39%).**

However, related to NOVA's Impact #1, the treatment group was not more likely than the control group to perceive basic research as a driver of innovation.

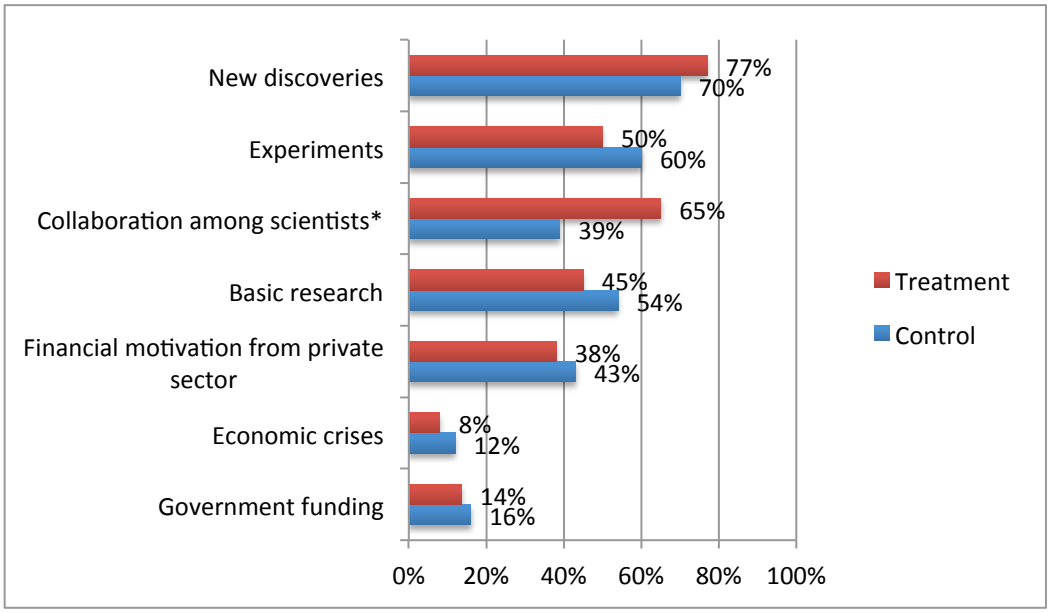

Figure 2. Factors considered most important to driving innovation.

* Chi-square (df = 1) = 5.181, p = .023.

We asked participants to describe what "scientific innovation" meant to them. **While members of the treatment and control groups all tended to recognize innovation as something new or different, treatment group members' responses were longer, more detailed, and included more factors related to innovation.**

For example, typical responses from the control group members included:

- *To make a positive change or improvement.*
- *The drive to make something more efficient through a method not established before.*
- *Progressive adaptation.*

Typical responses from the treatment group included:

- *Taking something that is existing and makes changes to it that allow that object/practice to perform in a different way. Generally, I think of this change as being something that provides positive results.*
- *Innovation has a two-fold meaning to me. It either means creating something that wasn't there before (a perfect example is Apple; we didn't know we needed an ipod; ipad or iphone) but once we saw it, we had to have it. The second meaning is making an existing item better. Keeping on the Apple theme; they took a cd player and made it better (the ipod) a regular cell phone and created the iphone and basically reworked the laptop.*

Impact #2: Increasing Public Awareness of and Excitement about Scientific Innovation

Public Awareness of Scientific Innovation

We asked participants to report the extent to which they felt they were aware of scientific or technological innovation. **Treatment group members were significantly more likely to report that they were aware than were control group members.** The average "awareness" score on a scale of 1 to 5 (5 = highest level) was 4.27 (sd = .75) for the treatment group and 3.95 (sd = .73) for the control group ($t_{(df=204)} = 3.137$, $p = .002$; effect size = .43).

To further gauge the participants' awareness of innovation, we asked them to describe the ways in which they innovate in their own lives. Their responses indicate that participants in both groups had a generally clear understanding of what innovation is.

To assess participants' excitement about scientific and technological innovation, we asked them a series of questions and asked them to indicate the extent to which they agreed or disagreed with them. Participants responded on a scale of 1 (Strongly disagree) to 5 (Strongly agree).

As summarized in the table below, **we found that individuals who used the MS2 website were significantly more likely than non-users to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation.**

Table 10:
Participants' Excitement and Interest in Innovation

Statements	Treatment Group Average Agreement (sd)	Control Group Average Agreement (sd)	Statistics (If significant difference)
The connections between scientific research and innovation are new and exciting to me.	4.47 (.86)	4.07 (.80)	$t_{(df=205)} = 3.444$, p .001; effect size = .48
I enjoy thinking about how scientific innovations can change or improve our lives.	4.55 (.74)	4.13 (.85)	$t_{(df=205)} = 3.789$, p .000; effect size = .53
I am interested in learning about science and innovation.	4.62 (.60)	4.11 (.88)	$t_{(df=205)} = 4.929$, p .000; effect size = .69

To further gauge excitement, we asked participants how likely they were to engage in a number of activities that were indicative of people who were interested in science. Participants responded on a scale of 1 (Highly unlikely) to 5 (Highly likely). As summarized in the table below, **we found that individuals who used the MS2 website were significantly more likely than non-users to report that they would likely discuss science and innovation with their friends and peers, look into news about innovation, watch science programs on TV, and attend or participate in other science-related events or activities.**

Table 11:
Participants' Interest in Engaging in Science-Related Behaviors

Behaviors	Treatment Group Average Agreement (sd)	Control Group Average Agreement (sd)	Statistics (If significant difference)
Discuss science and innovation topics with family, friends, or colleagues.	4.58 (.50)	4.09 (.93)	$t_{(df=190)}$ = 4.621, p .000; effect size = .69
Look into news about science, innovation, or new technologies.	4.58 (.56)	4.27 (.84)	$t_{(df=189)}$ = 2.999, p .003; effect size = .44
Watch science programs on television.	4.63 (.54)	4.39 (.69)	$t_{(df=200)}$ = 2.708, p .007; effect size = .39
Attend or participate in other science-related activities.	4.21 (.90)	3.69 (1.25)	$t_{(df=124.485)}$ = 2.938, p .004; effect size = .48

In fact, when we asked treatment group participants specifically about the impact of MS2 on their interest levels, most (97%) confirmed that MS2 made them more interested in science and technology activities:

- The website made me more interested = 75 out of 103 (72.8%)
- The website did not change my interest level because I was already interested = 25 out of 103 (24.3%)
- The website did not change my interest level because I remain disinterested = 2 out of 103 (1.9%)
- The website made me less interested = 1 out of 103 (1.0%)

We asked participants to indicate which of the following other, science-related activities they were likely to participate in. **Participants who viewed MS2 were significantly more likely than non-viewers to report that they were likely to attend a science lecture or talk (60% versus 38%).** Nearly all participants (89% of treatment group and 81% of control group) reported that they were likely to someday visit a museum.

Table 12:
Other Science-Related Activities that Participants Might Engage In

Activities	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
Visit a museum	92 (89.3%)	84 (80.8%)	Not significant
Attend a science lecture or talk	62 (60.2%)	39 (37.5%)	Chi-square $_{(df=1)}$ = 9.778, p = .002
Take a class on a science topic	34 (33.0%)	33 (31.7%)	Not significant
Research science on the Web[4]	3 (2.9%)	7 (6.7%)	Not significant
Don't plan to participate in any	2 (1.9%)	6 (5.8%)	Not significant

Several participants across both groups also reported other types of activities they were likely to do.[5] These included:

- Reading about science (n = 3).
- Doing science activities with their kids or kids they teach (n = 3).
- Digging for fossils (n = 1).

For those participants who reported that they intended to engage in any of these science-related behaviors, we explored the motivations behind those intentions. We asked participants to report on what motivates them to stay informed about topics related to science and innovation. The most common motivation, across both groups was personal interest (90% of treatment group and 88% of control group). The next most common motivation was "to talk with my friends and family" (47% of treatment group and 38% of control group). There were no statistically significant differences between the groups with respect to motivations (and none were expected – we did not hypothesize that there would be any significant differences between the groups with respect to these motivations).

Table 13:
Motivations for Staying Informed about Science and Technology

Motivations	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
For personal interest	93 (90.3%)	91 (87.5%)	Not significant
To talk with my friends and family	48 (46.6%)	39 (37.5%)	Not significant

[4] We added this activity because of the number of individuals providing this response in the Other category.
[5] The sample sizes were not large enough to compare differences between the groups.

Motivations	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
I need to for my job/career	32 (31.1%)	23 (22.1%)	Not significant
For financial or business purposes	12 (11.7%)	12 (11.5%)	Not significant
Not applicable – Don't stay informed	1 (1.0%)	6 (5.8%)	Not significant

Finally, we asked participants to report what resources they relied on most to get information on the latest advancements in science and innovation. The top answer from both groups was science documentaries and programs (31% of treatment group and 23% of control group), followed by science-based websites, online news sources, and national news broadcasts. There were no expected or observed differences between the groups with respect to the resources individuals reported using.

Table 14:
Resources for Staying Informed about Science and Technology

Resources	Treatment Group Count and Percent	Control Group Count and Percent	Statistics (If significant difference)
Science documentaries and programs	31 (30.1%)	24 (23.1%)	Not significant
Science-based website	20 (19.4%)	16 (15.4%)	Not significant
An online news source	20 (19.4%)	25 (24.0%)	Not significant
National news broadcast	10 (9.7%)	11 (10.6%)	Not significant
Public radio news	3 (2.9%)	7 (6.7%)	Not significant
Regional/local newspaper	3 (2.9%)	0 (0.0%)	Not significant
Weekly newspaper such as The Science Times	1 (1.0%)	0 (0.0%)	Not significant
Local news broadcast	6 (5.8%)	4 (3.8%)	Not significant
National newspaper	2 (1.9%)	1 (1.0%)	Not significant
Radio programs such as Science Friday	3 (2.9%)	4 (3.8%)	Not significant
Not applicable	0 (0.0%)	3 (2.9%)	Not significant
Other	2 (1.9%)	6 (5.8%)	Not significant

Other resources mentioned by participants included:

- Science magazines like Scientific American, Popular Mechanics, and National Geographic (n = 3).
- Professional, peer-reviewed journals (n = 3).
- Family and friends (n = 1).

Treatment Group Feedback on Making Stuff Season 2

To gather feedback on the MS2 website, we asked treatment group participants what grade they would give the website, ranging from an "A" to a "D or F." Most participants gave MS2 an A (75%) or a B (20%):

- A = 77 out of 103 (74.8%)
- B = 21 out of 103 (20.4%)
- C = 2 out of 103 (1.9%)
- D or F = 3 out of 103 (2.9%)

From the 5 participants who gave the website a D or F, a few reported:

- *It was all over the place. It was hard to find what I wanted to see.*
- *Most items would not open.*

We asked treatment group participants how appropriate the website was for their own level of knowledge about science and innovation. The majority of participants reported that the website achieved the right balance between basic and challenging (85%).

- The website achieved the right balance between basic and challenging = 88 out of 103 (85.4%)
- All or most of the website was too basic for me = 7 out of 103 (6.8%)
- Some of the website was too basic for me = 5 out of 103 (4.9%)
- Some of the website was too challenging for me = 3 out of 103 (2.9%)

We asked participants how interesting they found the topics covered on the website. Most reported that they found the website topics to be very interesting (65%):

- Very interesting = 67 out of 103 (65.0%)
- Interesting = 33 out of 103 (32.0%)
- A little interesting = 3 out of 103 (2.9%)

We asked participants how the extent to which they liked the images used on the website. Most reported that they liked the images a lot (57%):

- I liked the images a lot = 59 out of 103 (57.3%)
- I liked the images = 38 out of 103 (36.9%)
- I liked the images a little = 5 out of 103 (4.9%)
- I did not like the images at all = 1 out of 103 (1.0%)

We asked participants to report the extent to which they enjoyed different aspects of the website. The most popular features were the video shorts (97%), full NOVA episodes (94%), NOVA scienceNOW (91%), and NOVA Education (91%). Their responses are summarized in the table below.

Table 15:
Treatment Group Satisfaction with Website Features

Features	Proportion that "Enjoyed" it or "Enjoyed it Very Much" (n = 103)
Video shorts	97 out of 100 (97.0%)
Full NOVA episodes	84 out of 89 (94.4%)
NOVA scienceNOW	83 out of 91 (91.2%)
NOVA Education	77 out of 85 (90.6%)
Articles	91 out of 103 (88.3%)
NOVA quiz	69 out of 82 (84.1%)
NOVA Next blog	60 out of 72 (83.3%)
The Secret Life of Scientists and Engineers	66 out of 80 (82.5%)
NOVA Labs	67 out of 82 (81.7%)
The Nature of Reality blog	51 out of 68 (75.0%)

Finally, we asked treatment group participants how likely they were to recommend the MS2 website to their friends or family. The majority of participants reported that they were likely or highly likely to recommend the website (90%).

- Highly likely = 57 out of 103 (55.3%)
- Likely = 36 out of 103 (35.0%)
- Neutral = 8 out of 103 (7.8%)
- Unlikely = 2 out of 103 (1.9%)

Study 3: Longitudinal Study

Study Design

Objectives

The Longitudinal Study was designed to gather evidence related to Impact #2:

2. To increase and sustain public awareness and excitement about innovation and its impact on society.

Recruitment

After we received final surveys from participants in the TV Viewing Experiment and the Web User Experiment (Studies 1 and 2), we randomly chose participants from the Treatment Groups only to invite to the Longitudinal Study. Participants were offered honoraria of $100 to participate in the study, which required them to complete a survey at 3 months and 6 months following their enrollment in the study.

We invited a random sample of slightly more than 100 individuals to participate in the study (we recruited several extra participants to compensate for anyone who did not fully complete the study). Half were recruited from the TV Viewing Experiment and half from the Web User Experiment. Our goal was to recruit a sample of 100 individuals total.

Study participants were not necessarily initially NOVA viewers before their participation in the study, so any observed sustained interest in the NOVA series or website is not like attributed to their previous engagement with the material.

Methods and Procedures

The surveys completed at the end of the TV Viewing Experiment and the Web User Experiment served as the Month 0 (or baseline) survey for the Longitudinal Study (Appendices E-G). The same core questions were included in the surveys administered at Months 3 and 6 to track changes in response patterns over time, if any, and to look for evidence of *sustained* public awareness and excitement (Impact #2).

Participants

A total of 108 individuals participated in the Longitudinal Study. The table below summarizes the participants' demographic characteristics.

There was more representation from women in the sample (69% women versus 32% men). The sample contained a range of individuals across the lifespan, from 18 years old to over 60 years old. There were significantly more White individuals in the sample than any other racial or ethnic group.

The sample contained individuals with a range of educational backgrounds, from high school graduates to doctorates. The most common degree was a bachelor's degree (45%).

Table 16:
Participant Characteristics

Participant Characteristics	Count and Percent (n = 108)
Gender	
Female	74 (68.5%)
Male	34 (31.5%)
Age	
18-29 years old	18 (16.7%)
30-39 years old	26 (24.1%)
40-49 years old	34 (31.5%)
50-59 years old	24 (22.2%)
60 years old+	6 (5.6%)
Race / Ethnicity	
White or Caucasian	82 (76.0%)
Black or African-American	14 (13.0%)
Hispanic, Spanish or Latino/a	13 (12.0%)
Asian	3 (2.8%)
Native Hawaiian or Other Pacific Islander	2 (1.9%)
Native American or Alaskan Native	1 (0.9%)
Highest Education Level Attained	
High School Diploma or GED	7 (6.5%)
Some College, No Degree	9 (8.3%)
Currently Enrolled in College	4 (3.7%)
Associate's Degree	18 (16.7%)
Bachelor's Degree	49 (45.4%)
Master's Degree	16 (14.8%)
Doctorate or Other Professional Degree	5 (4.6%)

To gauge participants' prior experience with, and interest in, science-related information, we asked participants to report whether they were a scientist and whether they worked or studied in a science-related field. Most participants reported that they were not scientists (n =104, 96.3%), did not work in science-related fields (n = 96, 88.9%), and were not studying in a science-related field (n = 102, 94.4%).

Findings

At three points in time, we asked participants to report on their awareness and beliefs related to scientific or technological innovation. Specifically, we asked participants to report on the extent to which they agreed or disagreed that

- They were aware of scientific or technological innovation,
- They believed that scientific research and innovations can lead to discoveries that can be important to society,
- The connections between scientific research and innovation were new and exciting to them,
- They enjoyed thinking about how scientific innovations can change or improve our lives, and
- They were interested in learning about science and innovation.

We observed that interest and awareness were sustained over time and even grew in some cases.

As summarized in the figure below, we found that, over time (6 months), participants' self-reported awareness of scientific or technological innovation grew. While 83% of respondents agreed that they were aware of such innovation at the start of the study, by the end, the proportion grew to 94%.[6]

Likewise, by the end of the study, the proportion of respondents who reported that they agreed that the connections between scientific research and innovation were new and exciting to them also increased significantly, from 93% to 95%.[7]

As summarized below, at the outset of the study, nearly all (98%) participants reported that they believed that scientific research and innovations can lead to discoveries that can be important to society. This proportion did not change significantly over time; 99% of participants held this belief by the end of the six months. Thus, the belief was sustained.

The proportion of participants who reported that they enjoyed thinking about how scientific innovations can change or improve our lives grew over time. It increased from baseline to the six month point (91% to 95%).

Participants also remained very interested in learning about science and innovation over time (94% to 95%).

[6] This effect was statistically significant (F (1.686, 180.369) = 3.146, p = .000).
[7] This effect was statistically significant (F (1.819, 194.616) = 4.027, p = .022).

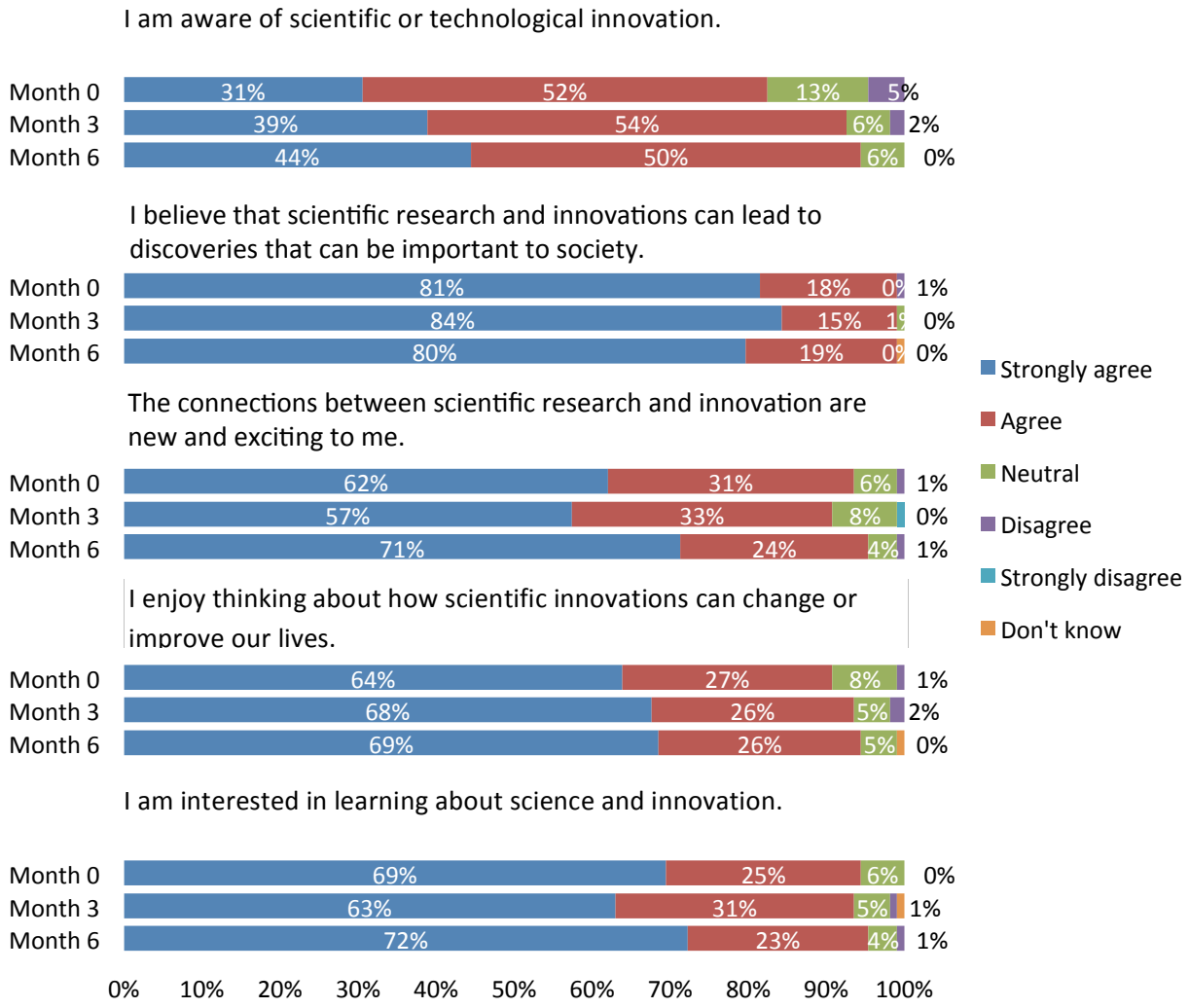

Figure 3. Interest in and awareness of scientific and technological innovation (N = 108).

At baseline, we asked participants to report predict how likely they were to engage in the following types of behaviors related to science. At Month 3 and Month 6, we asked participants to report how frequently during the previous 3 months they actually engaged in these behaviors:

- Discussing science and innovation topics with family, friends, or colleagues;
- Looking into news about science, innovation, or new technologies; and
- Watching science programs on television.

While 90% of participants predicted that they were likely to discuss science and innovation topic with others in the coming month, by Month 3, 84% reported that they had done so, at least a few times per month, and by Month 6, 88% reported that they had done so, at least a few times per month.

Some behaviors exceeded participants' expectations. For example, 89% of participants predicted that they were likely to look into news about science, innovation, or new technologies. By Month 3, 95% reported that they had done this, at least a few times per month, and by Month 6, 89% reported that they did this, at least a few times per month.

Likewise, 97% of participants predicted that they were likely to watch science programs on television. By Month 3, 95% reported that they did this, at least a few times per month, and by Month 6, 89% reported that they had.

For the charts below, perhaps Month 0 should be starred and set apart as *predicted* or *anticipated* future activity? This might help in interpreting the findings a bit more.

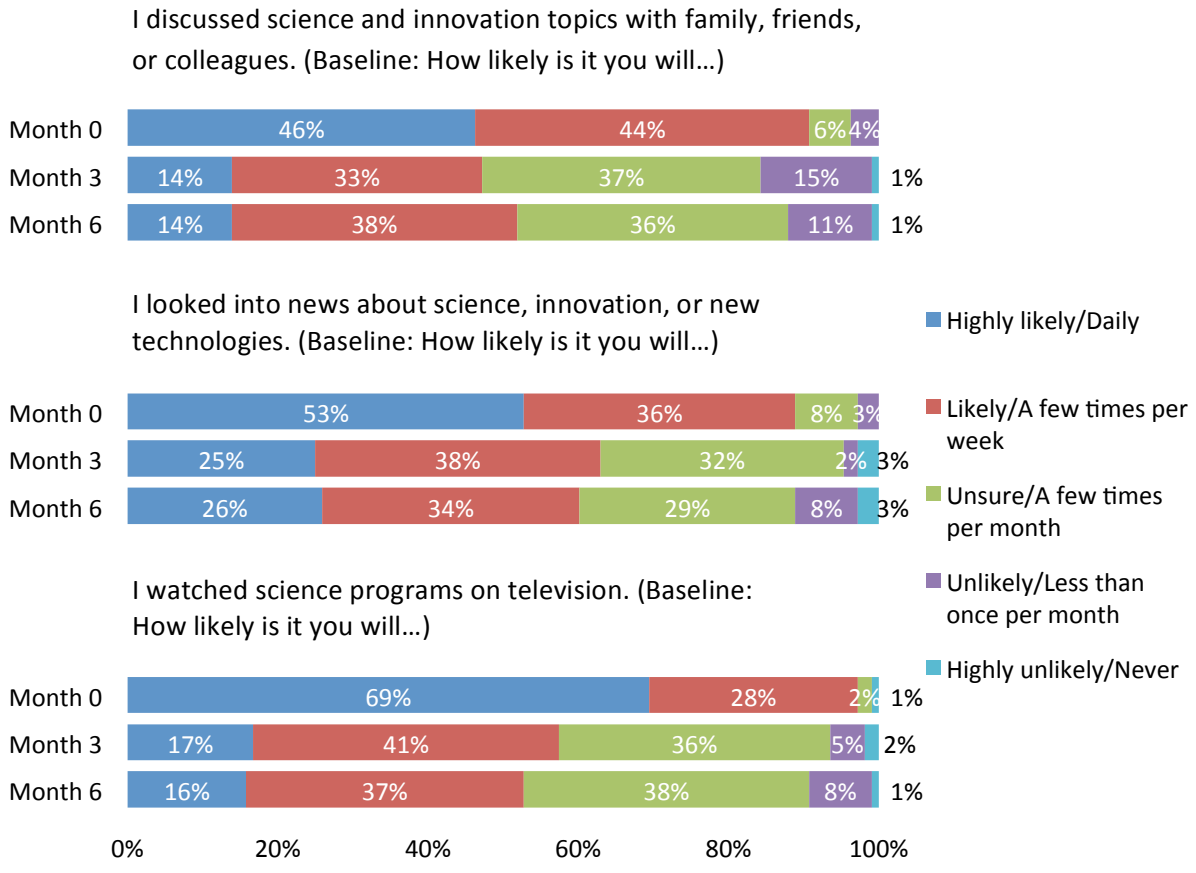

Figure 4. Engagement in science-related activities (N = 108).

We asked participants to report whether they had participated in any science-related activities during the previous six months. Participants were most likely to report they had visited a museum during the previous six months, but these visits became less frequent over time (91% at Month 0 versus 74% at Month 6).

The next activity reported by half of the sample was attending a science lecture or talk. At baseline, 51% reported that they had done so recently. But, by Month 6, this proportion dropped to 25%. Also decreasing over time was the proportion of participants who reported that they had recently taken a class on a science topic (from 31% at baseline to 16% by Month 6).[8]

The proportion of participants who reported engaging in other science-related activities (e.g., attending "Nerd Nights") stayed consistent from baseline to Month 6 (11% versus 14%).

Finally, the proportion of participants reporting that they did not engage in any science-related activities grew over time, from 3% to 13%.

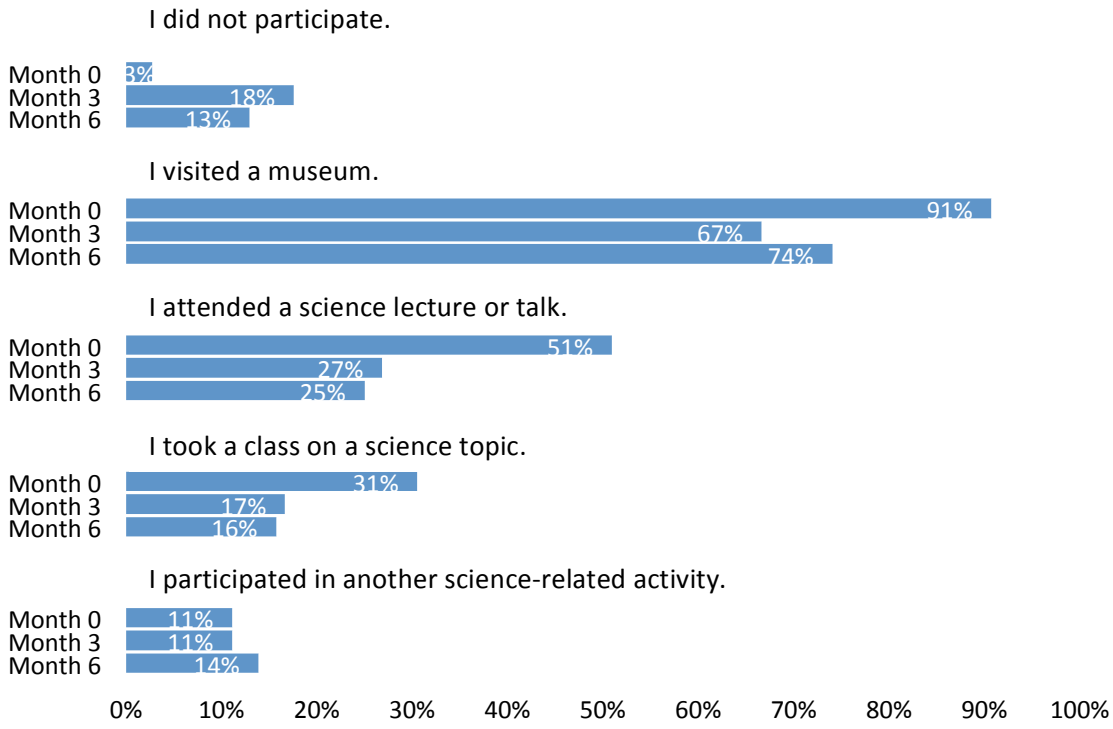

Figure 5. Participation in science-related activities (N = 108).

[8] The study took place during the academic year, so time of year should not be a factor.

NOVA was interested in learning how many participants sustained their interest in watching NOVA over time. Half of the sample (51%) reported that they watched NOVA a few times per month. By the 6-month point, that proportion had been sustained. The proportion of people who reported watching NOVA on a more frequent basis decreased over time, from 29% to 20%.

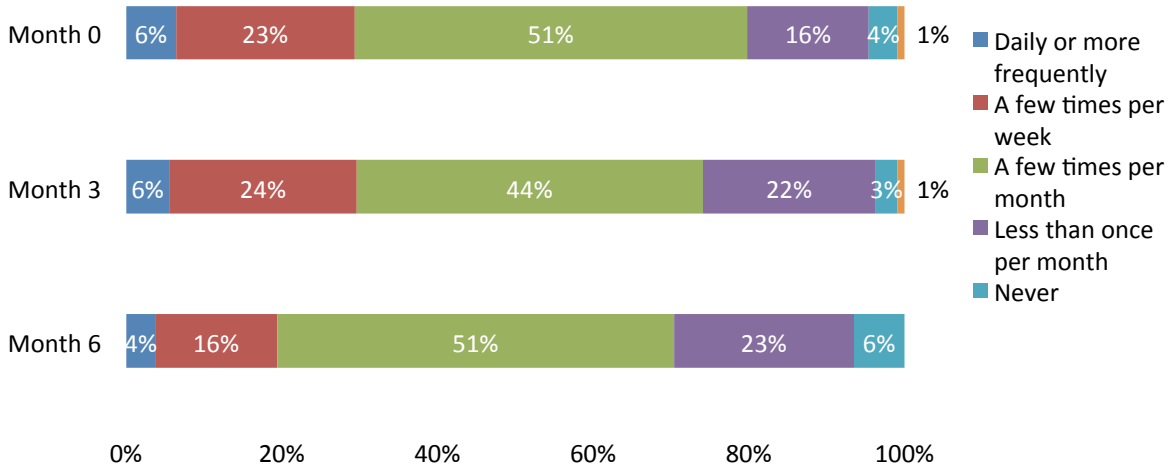

Figure 6. Frequency of NOVA viewing over time (N = 108).

We asked participants who did view NOVA at least occasionally to report their favorite ways of viewing the series. The most popular method was to view the broadcast series live on TV (75% at baseline). This method remained the most popular by Month 6 (reported by 70%).

The next most popular way to view NOVA episodes was streaming them online from the Web. The proportion of participants who reported that they liked to stream NOVA online increased over the study timeline, from 43% to 56%.

Finally, the proportion of participants who reported that they enjoyed watching older episodes of NOVA actually increased over the 6-month period, from 35% to 42%.

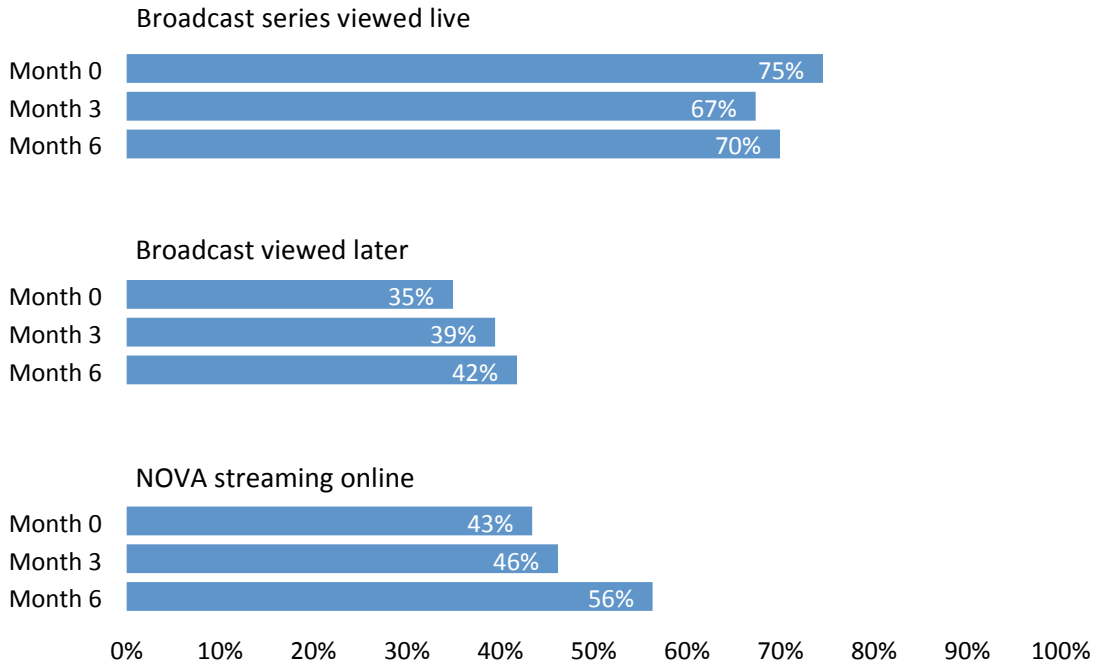

Figure 7. Methods of viewing NOVA (N = 108).

In addition to assessing viewership of NOVA, we also assessed use of the NOVA website by participants over time. We found that use of the NOVA website actually increased over time. Four percent of participants reported using the NOVA website on a daily basis and this increased to 6% by Month 6. Participants who reported using the website a few times per week also steadily increased between baseline (7%), Month 3 (12%), and Month 6 (19%).

Figure 8. Frequency of visiting NOVA website (N = 108).

We were interested in exploring which areas of the NOVA website were most popular with participants over time. At the start of the study, articles were the most popular area of the website (78%) and the NOVA quiz was the least popular (35%). Use of the quiz did not change at all over the course of the study. But, the proportion of website users who reported watching full NOVA episodes increased over time, from 64% at the start to 74% by Month 6. The use of video shorts did not change over time – roughly two-thirds of the partcipants continued watching those. By the end of the study, the proportion of users who reported reading articles on the website descreased to about two-thirds.

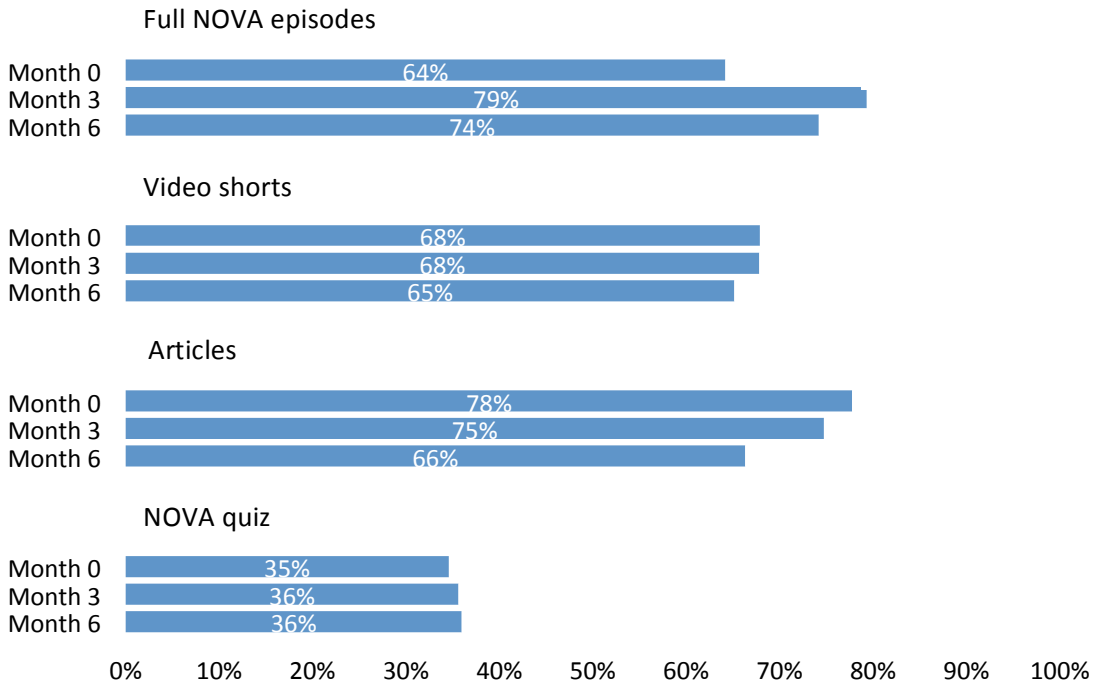

Figure 9: Areas of the NOVA website used most. Month 0 (n = 81); Month 3 (n = 87); Month 6 (n = 89).

Another aspect of the NOVA website is that it contains several other, related sub-sites. We asked participants which of these sites they visited over the life of the study. The most popular site visited was NOVA scienceNOW, visited by 73% of the sample at the start of the study and 78% by the end of the study.

The next most popular was NOVA Education, visited by 57% at the outset and 48% by Month 6. The remaining sites, NOVA Next blog, NOVA Labs, Nature of Reality blog, and the Secret Life of Scientists and Engineers were visited by a core of roughly one-third of the sample and this level of interest was sustained over the 6-month period of the study.

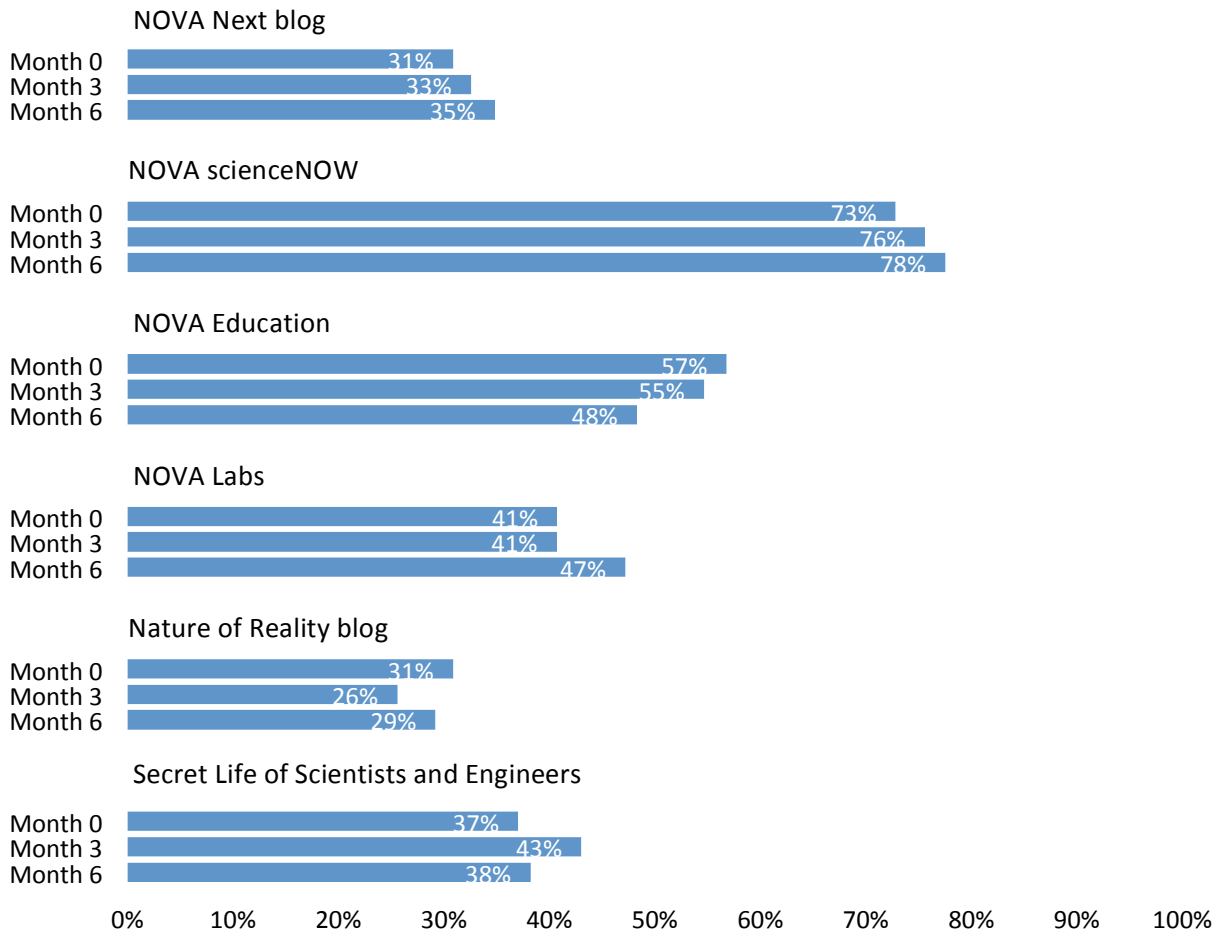

Figure 10. Use of NOVA websites. Month 0 (n = 81); Month 3 (n = 86); Month 6 (n = 89).

NOVA also has a social media presence. We asked participants how often they access NOVA using social media (like Facebook or Twitter). About 5% of the sample reported that they used social media to access NOVA and this proportion was sustained over time. Another 8% reported that they used social media several times a week to access NOVA at the study start. This proportion increased to 15% by the end of the study. Another 15% reported that they used social media several times a month to access NOVA. This proportion decreased to 9% by the end of the study. Roughly half reported that they never used social media to connect to NOVA. This didn't change over the course of the study.

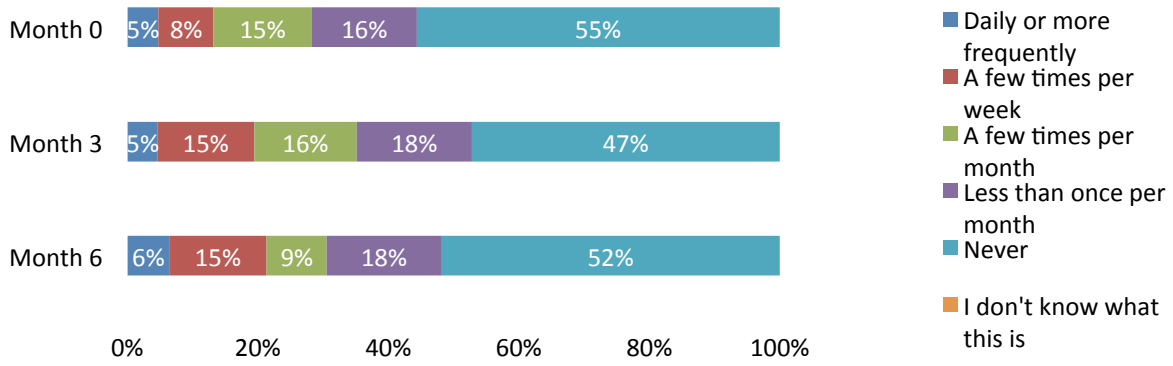

Figure 11. How often do you access NOVA using social media? (N = 108)

The social media platform most commonly used to access NOVA, at the study start and by the end, was Facebook, used by more than three-quarters of the sample. YouTube was the next most popular platform, used by 69% of the sample at the outset and dropping to 62% of the sample by Month 6. Twitter use was sustained over time, used by 38% of the sample at the beginning of the study and 40% by the end. Finally, Google+ was reportedly used by 27% of the sample at the beginning of the study, but increased to 37% of the sample by the Month 6.

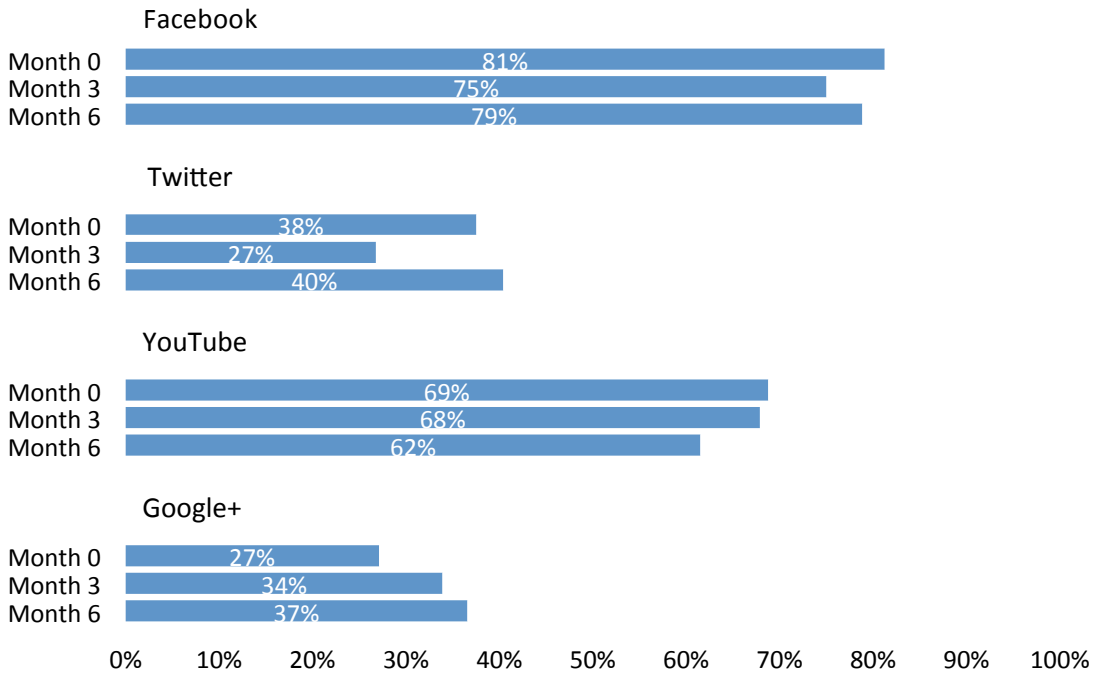

Figure 12. Social media platforms used to access NOVA. Month 0 (n = 48); Month 3 (n = 56); Month 6 (n = 52).

We asked participants how frequently they used the NOVA Education website, if at all. Six percent reported using the site daily at the start of the study and this was sustained over time. Eleven percent of the sample reported using the website a few times per week and this proportion increased over time to 15% by Month 6. Likewise, 20% of the sample reported using the website a few times per month, and this proportion jumped to 28% by Month 6, although that was a light decrease from a Month 3 high of 31%.

Figure 13. Frequency of visits to NOVA Education (N = 108).

Among those participants who did report using NOVA Education, we asked respondents to indicate which of the resources they used. The most commonly used resource was the Engaging Science blog – used by the majority of people who visited the website at the start (78%) and at the end (74%). Roughly half of website users reported using the Spark newsletter at the start and finish of the study (56% and 49%). Teacher resources were used by roughly one-third of website users from start to finish (30% and 35%), although there was a significant decrease from Month 3 (44%) to Month 6 (35%).

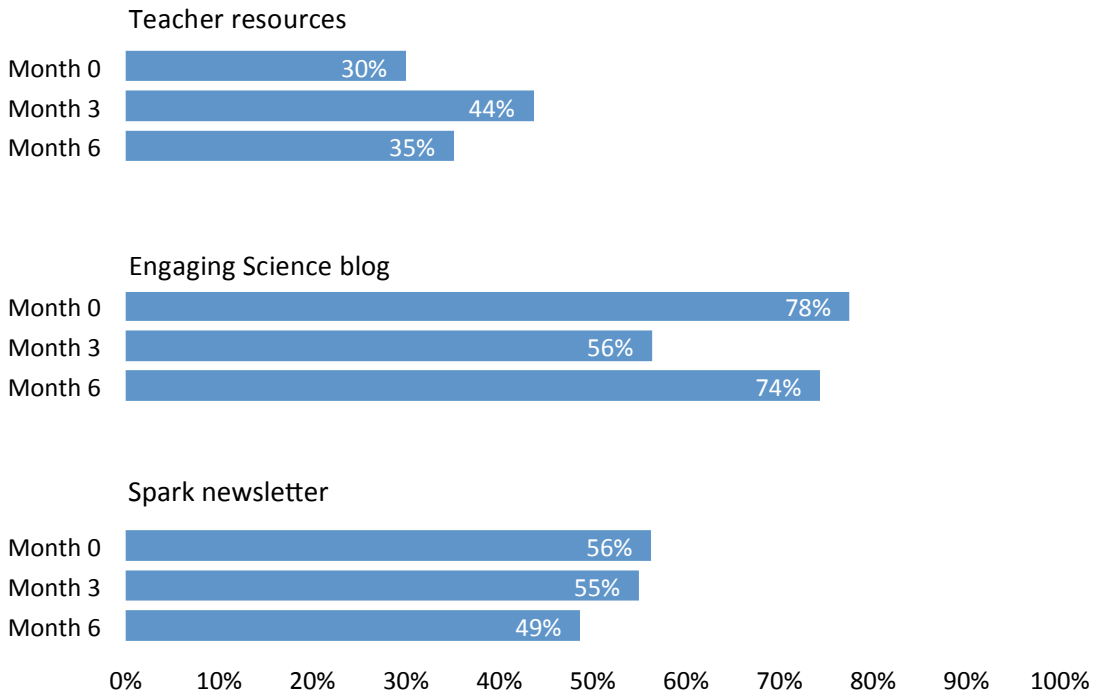

Figure 14. Reported use of NOVA Education resources. Month 0 (n = 80); Month 3 (n = 71); Month 6 (n = 74).

Study 4: Community of Practice Evaluation

Study Design

The Community of Practice (CoP) evaluation was designed to evaluate the extent to which NOVA met its third objective:

3. To establish a community of practice that enhances the frequency and quality of collaboration among STEM researchers and informal educators.

The evaluation included three activities:

- A web-based survey of all CoP members in late spring 2014.
- A network analysis and online community observations to explore the frequency and types of CoP member interactions.
- Interviews with a sample of the most active CoP members in spring of 2014.

Participants

The total number of participants in the CoP evaluation included 113 informal and formal educators and STEM researchers who joined the online CoP community hosted by NOVA.

Network Analysis

We analyzed all of the online posts made by members of the CoP community. Out of 113 members, 107 individuals posted at least one comment, so the network analysis sample represents approximately 95% of the total membership. We also observed one of the NOVA-hosted office hours sessions and all of the live or recorded hangouts, including:

- *What You Need to Know About MAKING STUFF Community Outreach*
- *MAKING STUFF Project Hangout on Air: SAFER*
- *DiscoverE and Engineers Week, what you need to know!*
- *MAKING STUFF Project Hangout on Air: COLDER*
- *MAKING STUFF Project Hangout on Air: WILDER*
- *Designing Great Maker Experiences: A Conversation with David Wells*
- *Hangout on Air with Tony DeRose of Pixar & Young Makers*
- *The Pedagogy of Making w/ Steve Davee of Maker Education*

- *Making STEAM: The Role of The Arts in STEM Education*

Survey

All CoP members were invited to participate in the evaluation survey (Appendix H). We received responses from 54 individuals (a response rate of 39%), including representatives from:

- Afterschool clubs
- Colleges and universities
- Libraries
- Makerspaces
- Museums
- Science centers
- Professional engineering societies
- School districts

Interviews

We conducted telephone interviews (Appendix I) with ten CoP members representing eight different institutions, including:

- A children's museum
- An antique aeroplane and automobile museum
- A museum of industry and innovation
- A STEM-focused public school
- An informal math and science program for girls
- A professional society for engineers
- A materials research laboratory
- A college-based community partnership

Findings

Network Analysis

We tracked the number of and types of posts to the online community from October 2013 to April 2014 when the CoP was most active online.[9] We found that the CoP was active online for about one-third of the project time (peaking for two out of seven months), and that a small proportion of the community regularly interacted with others in the CoP (the average CoP member interacted only four times over seven months).

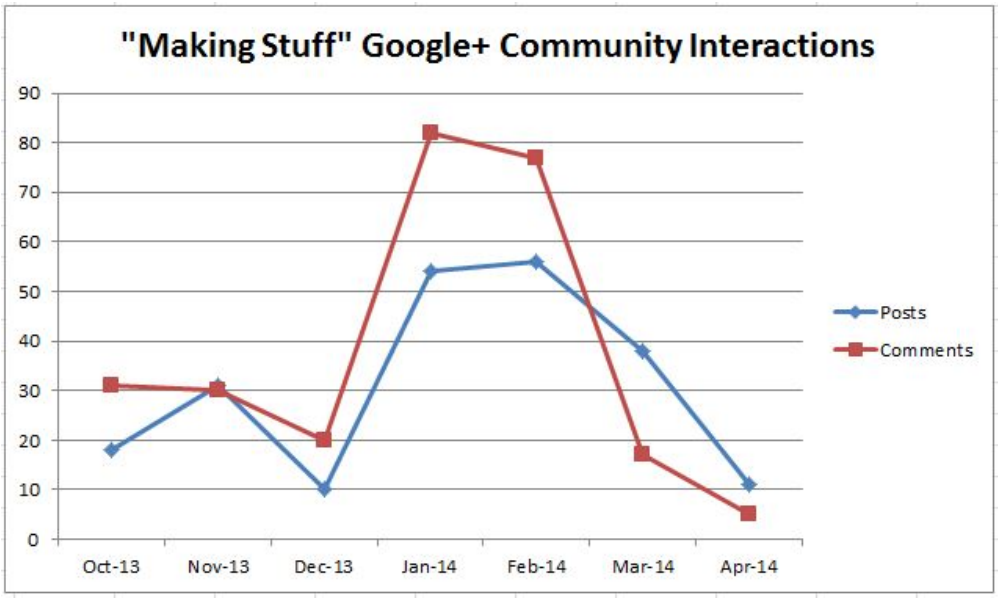

Figure 15. Number of posts and comments made on website during project.

From October 2013 to December 2013, most of the posts and comments were made on the 'I have a question' and 'Introduce yourself' pages, which made sense since most CoP members were new to the community at that time.

In December 2013, we observed a decrease in posts and comments, which was likely due to the holiday season. From January 2014 to February 2014, a majority of the posts and comments pertained to the different projects happening at CoP member sites.

After February 2014, the posts and comments decreased significantly. The number of comments decreased and the number of posts decreased steadily, which indicates that the members may no longer have been checking in with the online community regularly.

[9] As of the writing of this report, there have only been three posts since April.

Seventy (64%) of the CoP members posted or commented at least once between the months of October 2013 and April 2014.[10] A total of 37 people were non-active community members, never posting or commenting at all.

Although the posts and comments increased during the months of February and March 2014, the posts and comments were mainly made by a small group of active people: 13 members posted and commented ten or more times during the seven months of the study. Only five members were highly active, meaning they commented and posted twenty or more times. The most active CoP member commented and posted a total of 45 times.

Survey

Outreach Experiences with the Maker Project Boxes

We asked CoP members to describe the extent of their outreach efforts using the Maker Project Boxes. Members reported reaching anywhere from four people to 6,000 people with their outreach activities. The median number reached was 73 people (the average was 252 people, standard deviation = 825). Outreach members reported that they held between one and 25 events. The average and median number of events was four (standard deviation = 4).

Fifty-one members described the typical users of their Maker Project Boxes. The most common type of users were students and museum visitors of all ages:

- Students: 23 (45.10%)
- Museum visitors of all ages: 13 (25.49%)
- Community members: 8 (15.86%)
- Young children: 3 (5.88%)
- Library patrons, general: 2 (3.92%)
- Adults, unspecified: 1 (1.96%)
- Other, unspecified: 1 (1.96%)

We asked members to report whether the DVD resources and videos clips provided by NOVA were helpful to them in facilitating program delivery to their audiences. Most (more than 84%) reported that the resources were helpful to them, at least somewhat (see table below).

[10] This excludes NOVA and CEG staff.

Table 17:
Helpfulness of the NOVA Resources for Facilitating Program Delivery

Degree of Helpfulness	DVD Resources (n = 52)	Video Clips (n = 53)
A great deal	30 (58%)	31 (59%)
Only somewhat	16 (31%)	13 (25%)
Not sure	3 (6%)	5 (9%)
Not at all	3 (6%)	4 (8%)

Most CoP members (81%) reported that they planned to continue using the Maker Project Boxes. Only one individual reported that they would not use them. Of the respondents who reported they would or might continue using the Maker Project Boxes, nearly all reported that they were useful and engaging. For example, some members reported: [11]

- *These inquiry-based programs were a brilliant way to engage our visitors. I can definitely see us using these programs again in the future, either for workshop-style programming in our lab space or as future programs for our STEM and Camp groups.*

- *They're a great resource and we can continue to use them by integrating the activities into our other programs, including summer camps, after-school programs, etc.*

- *The hands-on nature of the activities can really get students to think about materials, which aligns with our mission.*

- *They were great problem solving projects and the supplies can be used in many other projects too.*

However, five respondents reported that they experienced challenges with the activities, including several concerns that tools included in the boxes were perceived as unsafe to work with under certain conditions or with children who were younger than the NOVA guidelines and safety warnings indicated (e.g., saws, hot glue guns, and box cutters).[12] NOVA strategically did not accept certain schools into the CoP that were elementary schools without the capacity to support these types of building projects. Moreover, in developing the activities, NOVA's partner, the New York Hall of Science (NYSCI), conducted extensive user testing with middle and high school students (the intended audiences) prior to launching the project.

[11] A more comprehensive list of responses is included in Appendix J.
[12] CEG delivered a separate memorandum to NOVA describing specific comments related to safety so that the team could make changes immediately.

Despite selecting an appropriate audience of middle and high school students and testing the activities through NYSCI, communicating safety warnings to CoP members ahead of using the boxes, and publishing safety guidelines on the NOVA website, there were some CoP members who implemented the activities with young children regardless (younger than the intended audience). Since becoming aware of these situations, the NOVA team has taken the feedback very seriously and has removed any tools that might be inappropriate for younger audiences and has a plan for communicating safety warnings even more clearly in future through the activity guidelines and the community of practice outreach group.

Others reported that the science content could be enhanced to better reflect the concepts being covered. For example, some members reported:

- *Some of the video clips didn't really match the project principles very well. For instance, in Faster the video talks about torque as the key to speed, whereas the project itself really has to do with friction, weight, and momentum. Wilder was closer, as was Safer if you used the Shake Table (which could've used better construction guidance). Colder was ok, although 1) some people were startled at the mention of a rectal temp probe, and 2) it was about circulating liquid. Still, it made sense to be making a personal cooling unit given what the video talked about.*

- *The Wilder activity was too far removed from our perception of materials science and engineering. We currently have a structural color activity involving butterfly wings that we feel better aligns with our department's focus.*

- *The one area I see for improvement is the "safer" activity. Although the content is good (the discussion of shapes and their strengths/weaknesses, the connection to the real world with the earthquake table), you might consider a new activity to illustrate this concept. Most kids have done some variation of building with gumdrops and toothpicks in school, camps, etc. I would have liked to see a fresh take on how to "make stuff safer."*

Others reported that the activities were not appropriate for their specific audiences:

- *The car activity is too hard for a classroom setting. One time we did vegetable cars. They could use a specific number of other elements like skewers and rubber bands.*

- *I don't think the pinewood derby or gum drop/toothpick structure activity were anything many people in this community hadn't seen before.*

- *I found the bio inspired claw did not work as well as similar "robotic hand" type projects we currently do and the material cost to be prohibitive for reuse in a museum setting. I felt the vinyl tubing could have been put to better use to build a pneumatic robotic arm which would have also gone with the segment from the Making Stuff series as their arm was also pneumatic.*

- *Some of the activities were much better suited for smaller class sizes with instructor-facilitated programming, and were less conducive to a large community outreach event. We had to modify several activities in order to make sure that they were feasible in that setting with a large number of people.*

Other CoP members reported that they needed more information or that they need the information in a more timely manner:

- *For Making Stuff Colder materials it would have helped to have more practical advice on using and setting up the "experiment".*

- *Not all materials detailed in packaging list were included: I would be careful about that, especially when sending to schools or organizations with funding challenges.*

- *The boxes were great. It would've been nice to get them a little earlier, although I'm sure fulfillment was filled with challenges. That said, the community was great, as were Rachel and Scott, at adapting and exploring different approaches.*

Experiences with the Online Community

We asked CoP members to report whether it was helpful to interact with the online community. Out of 54 members who responded to this question, most (42, 78%) reported that interacting with the online community was helpful to them. Only six (11%) reported that it was not helpful. Those who reported that the online community was not helpful told us that there was not enough interaction between members (4 out of 6) and that the online community was simply too large (2 out of 6).

We asked members to report their favorite ways to interact with the outreach community. The most common ways were the NOVA hosted online hangouts and online live guest hangouts:

- NOVA hosted online live “hangouts:” n = 24 out of 54 (44.44%)
- Online live “hangouts” featuring guests from the maker movement: n = 19 out of 54 (35.19%)
- Interactions with other related network sites: n = 17 out of 54 (31.48%)
- NOVA hosted “office hours:” n = 13 out of 54 (24.07%)

We asked CoP members about the perceived benefits to belonging to the online outreach community. As the table below summarizes, half of members reported that the MS2 outreach community has provided them with more opportunities to interact with others who shared their professional interests. Roughly half also reported that the information they received from the online community was helpful to them in facilitating program delivery to their own audiences.

Table 18:
Perceived Benefits to Participating in the Online Community

Degree of Benefit	Did being a part of the MAKING STUFF Outreach community give you more opportunities to interact with others who share your professional interests? (n = 53)	Was the information you received from the online community helpful to you in facilitating program delivery to your audiences? (n = 52)
A great deal	27 (50%)	24 (46%)
Only somewhat	21 (40%)	19 (37%)
Not sure	4 (7%)	3 (6%)
Not at all	1 (2%)	0 (0%)
Didn’t need extra support	Not applicable	6 (12%)

As summarized in the table below, most members (83%) agreed or strongly agreed that the CoP made them feel like they were part of a larger community. Most members (85%) also agreed or strongly agreed that they enjoyed hearing from others about their Maker Project Box experiences.

CoP members reported they were less motivated or interested in sharing their own experiences with the online community. Only 63% reported that they enjoyed sharing their own experiences, and only 55% reported that they were motivated to share because others would want to hear from them.

Table 19:
Engagement with the CoP

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Engaging with others on Google+ made me feel as if I was part of a larger MAKING STUFF community. (n = 52)	26 (50%)	17 (33%)	6 (12%)	3 (6%)	0 (0%)
I enjoyed hearing from others about their experiences with the Maker Project Boxes. (n = 53)	25 (47%)	20 (38%)	8 (15%)	0 (0%)	0 (0%)
I enjoyed sharing my experiences with the Maker Project Boxes with others. (n =53)	14 (27%)	19 (36%)	19 (36%)	1 (2%)	0 (0%)
I was motivated to share because I felt there was an active community of other educators who wanted to hear from me. (n = 53)	10 (19%)	19 (36%)	21 (40%)	3 (6%)	0 (0%)

We asked CoP members to report on their favorite aspects of the MS2 outreach community. Thirty-two (62.75%) respondents reported that interacting with peers and sharing information with each other was their favorite aspect. For example, some members reported that they enjoyed…

- *…Others' ideas allowed for one to riff on projects and to build upwards and outwards.*

- *I liked that we were connecting our small organization to a larger, national community of informal STEM educators and Makers.*

- *I think that having the Google+ as a resource was really great. I was able to ask general questions about demos or ask people for ideas and opinions and also able to search other conversations for any suggestions and answers. I got to see how many people are out there doing the same things that we are!*

- *It was great way to connect with others around a common interest in a way that felt "informal," in that it was a comfortable conversation to have. It did not have the dry, rigid structure that many professional community networks suffer from. Kudos, NOVA team!*

- *The sharing of "lessons learned" from individuals or groups who encountered challenges in implementation. For example, one of the members created worksheets to help facilitate the learning for each of the*

units. They were excellent ways to help focus students & families on the science & design embedded in the activity rather than "just" having fun!

Other respondents (n = 14, 27.45%) reported that the boxes and hands-on activities were their favorite aspect. For example, some members reported:

- *I teach high school Chemistry. Making Stuff Colder was the most impactful for my group of students. I showed / streamed the video and many students said that "It blew their minds". The hands-on activity deeply engaged the students.*

- *My favorite thing was seeing how kids took ownership over the materials and made it their own, straying somewhat from the directions in the kits.*

- *The lesson plans are very well developed and documented. The Maker Box was very neatly organized and inventoried. The videos were a very good complement to the lessons. The t-shirts and banner were a nice touch, and helped enhance the environment while presenting the activities.*

- *My favorite part was receiving free, high quality materials that were interesting for kids. The curriculum provided, including the slideshows and video clips on the DVD, were very well thought out and easy to teach.*

- *I enjoyed getting families involved with STEM at our school. My students had a great time showing their families how "science works" and building together. Our most successful events included using our wood shop to shape the cars and working with circuits. We had two fathers who happen to be electricians show up and they ended up leading the event! Our girls were empowered as they experienced a risk free learning environment.*

Some respondents reported that they were not fully satisfied with the Google+ platform:

- *I did feel a bit buried in emails occasionally. Perhaps a way to cut those down so that we don't get one every time someone holds and event would be helpful.*

- *Although the content and the participants in the community were great and beneficial, I did not find that the platform used for the community allowed me to participate to the fullest degree.*

- *I honestly didn't really participate in the community aspect much because it was hosted by Google+ which is not a platform I'm a big fan of. To get*

into the community required setting up a whole new account and it was difficult to feel my privacy was secure from the web at large while still sharing enough information to be a contributor within the community itself. Also, I just don't like Google+, it's why I got rid of my personal account.

- *Maybe I'm not technologically advanced enough, but I had a lot of difficulty posting things on the Making Stuff site. It seemed very complicated and not intuitive to me.*

Most CoP members (91%) reported that they would continue to be involved in the Maker Movement or to use the Maker Pedagogy. Only one member reported that they would not. Many respondents reported that their institutions would continue to be involved in the Maker Movement because it fit squarely with their institutional missions. For example, some members reported:

- *The Free Library is dedicated to Maker programming, and will be continuing at least through the rest of the year with dedicated maker workshops in ten branches.*

- *We love the open-ended, creative approach that is inherent to these types of activities. We are always looking for fun, new, creative ways to use cheap, recycled materials and maker pedagogy is a perfect fit for us. Although we are based in a very science-rich area, kids still do not get many opportunities to tinker and explore, and we want to be able to provide them with that opportunity.*

- *This is a great way for kids and adults to learn concepts by making and it fits well with our museum's current goal of integrating STEM activities for and older (3rd grade and up) audience.*

Others reported that they would continue to use Maker pedagogy because it is so engaging and effective as an educational outreach tool:

- *We have found that the maker activities hold the attention of our visitors.*

- *Hands-on is engaging for kids; making something to take home is always a hit!*

- *The Maker Movement helps us to focus students on "lost skills" generationally. Most students aren't allowed or don't have access to simple tools. Students and parents are excited about creating & designing something on their own.*

- *I think the Maker Movement is a powerful tool that museums can (and should!) leverage to reach new audiences and offer unique educational experiences that they are not getting in school or anywhere else.*

Some respondents reported that their institutions were interested in continuing their involvement in the Maker Movement, but they weren't sure what their involvement would be:

- *We are trying to figure out how we are going to be involved in the Maker Movement at this time. It will be included in our institution in the future but we are still working out what that looks like.*

- *Maker Movement is still new for me!*

- *The mission of our center is more about the "stuff" (the new materials) than the "making" (the engineering). We have participated in some Makers Faires, but it's always a bit of a stretch for what we do.*

- *I think the library is a natural place for children to learn creatively, and I hope our district will allow us to make space upgrades down the road that make this an even better possibility.*

Interviews

To gain a deeper understanding of the issues covered in the CoP survey, we interviewed, via telephone, a group of ten of the most active CoP members. A comprehensive set of interviewee comments is available in Appendix J. Below, we have provided example comments.

Activities

Interviewees echoed the comments received from survey respondents about the activities. They were mostly pleased with the activities, with a few exceptions in which materials were considered inappropriate for use. For example, some members reported:

- *…Another favorite was the making things safer activity, building the structures out of the gum drops. For that activity, we always have things in our Maker Space that the kids can use so we decided to make like independent little shake tables using a box set motor inside of like a plastic butter tub. And that made it really awesome because then the kids could just, they, they got to build their own shake table as opposed to us building a larger one that everybody got to experiment on. And then they could hook up different electrical voltages to it to increase you know the*

earthquake effect to make it stronger or lesser to see how well their structure could work. They were able to take that home with them so they could continue experimenting and exploring that structures and trying to make them stronger. I was so impressed with the way that it went I'm actually looking at adapting that into a full in-house workshop. The kids loved it.

- *I most enjoyed seeing it come together on the floor of the museum and watch parents and kids working together on the projects and seeing them get excited.*

- *It really was nice to have it all planned out and have all the lessons there and you could choose what you wanted but it was well done. To have 90% of the supplies come to your door was just such a gift.*

Materials

Interviewees reported that they were mostly satisfied with the materials provided by NOVA. For example, some members reported:

- *I was really impressed with the quality of the materials and the things that they sent. However, for the pinewood derby cars, the saw that they had sent was not the proper saw for cutting those types of things….I really prefer to use the Japanese style pull saws because they cut both on the forward motion and the backward motion.*

- *The box itself is great. As educators, we love opening up a box and the materials are there and we can find them -- even down to the hammer and the saw. That was excellent. Being able to open the box and just start sorting supplies and knowing that the majority of it was there for what we were going to need was excellent. That saves us on the prep time and leaves us for the thinking time we don't have to worry about the materials aspect of it.*

DVDs and PowerPoint Slides

Interviewees echoed the survey findings regarding the usefulness of the DVDs and the PowerPoint slides. For example, some members reported:

- *I loved all those resources and I hope it's okay if I keep using them. The video clips were good as was having the PowerPoint presentation to follow up the video clips that was short -- enough even with the younger kids.*

- *The presentation materials were a little hard to work with. They should test these things next time around if they're going to provide presentation materials just make sure it's something that somebody who's not part of the organization can open it up.*

- *There was a little disconnect between the Wilder video clip and the project, although it was relatively close. And, there was a pretty big disconnect between the Faster video clip and the project itself because the Faster video clip really dealt with torque.*

- *I thought that the slide show (the PowerPoints) that accompanied each activity this year were honestly pretty weak. There is some science background that could be a little more fleshed out. There could be better pictures. Season 1 was better….*

Some participants wished that the boxes had come with a handout guide that was provided by NOVA during Season 1 outreach:

- *This is the first year we've done NOVA Making Stuff outreach, but I was pleasantly surprised when I saw the handout guide they did in Season 1. That was really amazing. I understand we don't want to waste materials and printing costs can be kind of high, but that guide was really cool. I was bummed that one of those didn't come with this year's stuff.*

- *There's a gentleman who's been posting a lot on the community who made up some really good questioning worksheets to go along with the activities. It is great to hand to the facilitators and to the parents and say, "Ask these questions." His resources were tremendous and I'd actually printed off all of those to stick inside my NOVA folder to use the next time that we do this. So things like that within the facilitator's guide would be excellent.*

- *I got the Making Stuff info from Season 1. They certainly did a really nice job in Season 1 in preparing us clearly and cleanly for the demonstration and for the activity and I had no complaints. This year, I don't feel the same way. In fact, a couple of people had to come up with their own.*

CoP members reported that there was information missing from the materials that they received:

- *One of the things that's really important to somebody like me (because I'll go out and do workshops) is timing. I did not see any timing information in the NOVA guide to give us an idea of how much time would be good. So, on member had that experience and he gave it that to me.*

- *We need a real materials list with part numbers.*

Online Community

Members reported that they enjoyed learning from others in the online community. For example, some members reported:

- *There were definitely parts of it that I found very useful, like a lot of the hangouts, even if I wasn't able to like catch them live I tried to go back and watch all of them. I'm a big fan of the community and I'm a big fan of the Google plus side.*

- *I was not able to attend a lot of the webinar sessions or the hangouts because of scheduling conflicts. I was able to go back to a lot of the comments to see what people had made suggestions about -- just to scan through and to see how people had set up theirs and just compare it with what we were getting ready to do. That was very useful to be able to see that.*

- *It was helpful when people would post things, pictures or questions. There was definitely a critical mass there. I felt like there was enough people that I felt like I was part of a community.*

- *The most useful thing about the online community was the problem solving with specific problems.*

Members also reported that they felt like they were able to be helpful resources for other members:

- *I felt like I was a good resource for a few people. I had a couple of people that were emailing and asking me, "Hey, we're trying to do this…" or "I see that you use these types of tools in your space a lot. How does that work for you?" So that was really great.*

- *I felt like I was a good contributor when I posted materials that we had created or feedback on the projects and answering other people's questions.*

- *I felt like I could contribute because we chose to do the cars and the Colder and some people had not done that yet and I could say, "This is what worked for us and this was what I would not do next time." Not only did it support me, but I could support others.*

Three members reported that their interactions with others as part of the MS2 outreach community led to relationships outside of the community:

- *It was great to make the connections with Steve Davy with the Maker Education Initiative. That started a whole conversation with us and then we were selected as a Maker core host sight. They provided a lot of other excellent opportunities for us outside of the NOVA Making stuff outreach that are allowing us to just continue developing and building our program.*

- *I did go to one of the other partner's events. The Children's Museum in Boston had an event that I went to. It was nice to know about what other people are doing.*

- *The community has just made a lot of connections and opportunities with each other. There's a lot of communication, a lot of information going back and forth and I think it's just really helpful.*

Others were disappointed that more individuals did not participate actively in the online community:

- *I was very disappointed that more people didn't participate. We had 75 sites, so we should have had at least 75 people, but we only had three or four you know involved in the discussions. In fact, I haven't seen 75 people that have posted anything on the website about what they've actually done or anything like that. That was kind of disappointing. I figured everybody would be more actively involved than that.*

- *It's too bad, but we never had a lot of people trying to participate in office hours or hangouts, so I don't know what it would be like if there was 20 people online. The ones where it felt like it was sparse were the office hours or hangouts on air. There just weren't that many people watching live to ask questions or to have any sort of exchange.*

Others reported experiencing some initial challenges with the Google Plus format:

- *I still don't understand what Google Plus is, but I figured out what buttons to push and (laugh) I don't know why I pushed those buttons but they got me to where I wanted to go. It was all new to us. But, I eventually managed. I was able to listen to everything and actually participate.*

- *Google Plus was familiar to me, although I had never done it with a large group before. There were things about the platform that took me a while to understand and still don't seem too natural to me (like the way it*

displays information)….So, it was a little hard to navigate but I think every platform has its own little quirks.

One member commented on the lack of advertising help from NOVA:

- *A lot of people were posting on the site what they were doing and what they were planning on doing and the moderators were saying that NOVA would help to advertise or sort of help publicize these events and I don't know if anything came of that -- other than publicizing it to other people who are outreach partners. If NOVA ever put it on Twitter, I don't know if that ever happened. So, I don't know how much publicity help we got from NOVA or how much I should have hoped for. That was the only thing that I wish maybe we could have gotten a little more leverage on just because we've sort of felt like NOVA's got much more reach than we're able to generate ourselves as a small museum.*

Another member expressed a need for more information sooner in the process:

- *Some of the conversations and the hangouts online would have been great to have a little bit earlier. As people were starting to think about how they would do the activities there was a little bit of radio silence early on. Also, I don't know if they were late shipping out, or what logistics were going on behind the scenes that were difficult to manage, but there was a period when I was ready to start planning stuff but NOVA didn't give us as much lead time as I would have liked. It seemed like it could have been frontloaded a little more. But, everything picked up speed pretty well and there was a lot of momentum and good energy once things did get going. In the end, it worked out well.*

Finally, some members commented on how the Making Stuff outreach activities bolstered their own local outreach activities:

- *When we share this program with students and parents we say, "These are NOVA activities from PBS. Students across the entire nation are doing these same activities with you. So if you're traveling and you see a Maker Fair and they've got some NOVA Maker events, they might be the same things that we've done here." We do that so that they now know the culture, they know what to expect if they're traveling -- even in the summer – and they run across a Maker Fair so that they won't be afraid to go. They'll say, "Oh yeah that's what we did at our school."*

- *The museum director was certainly impressed. They want to us to do something every second Saturday now.*

Recommendations

- Some Community of Practice (CoP) members reported that they experienced challenges with the Maker Project Box activities, including several concerns that tools included in the boxes were unsafe to work with (specifically, American hand saws, hot glue guns, and box cutters). **We strongly recommend that NOVA remove these potentially dangerous materials from the Maker Project Boxes before distributing any more of the boxes and that NOVA continue to develop plans for communicating about safety in the future.**[13]

- Some CoP members reported that the science content in the Maker Project Boxes and MS2 resources (DVDs) could be enhanced to better reflect the concepts being covered. **We recommend that NOVA review the science content with a sample of CoP members to address these concerns and strengthen the connection between the science content and the activities, if possible.**

- Some CoP members reported that they were not fully satisfied with the Google+ platform. **For future efforts like this, we recommend exploring other options in addition to Google+.**

- Some CoP members reported that the presentation materials provided by NOVA were challenging to work with. The materials were not customizable to the extent that participants expected they would be. In reaction, one CoP member created new, more usable materials and shared them with the CoP. **We recommend that NOVA review the compatibility of the presentation materials with the most common software programs and revise the materials to enhance their usability.**

- Some participants reported that they wished that the Maker Project Boxes had come with a handout (facilitator guide) similar to one that was provided by NOVA during Season 1 outreach. Again, in response to the perceived need for such a tool, a couple CoP members developed handouts and shared them with the community. **For future efforts, we recommend that NOVA consider creating one-page handouts similar to those that were provided in Season 1.**

- Some members reported that it would have been helpful to have information on activity timing (how long an activity should take) and a

[13] As of this report date, NOVA has already removed these items from the boxes.

complete list of materials. **We recommend providing this information in future efforts.**

- One CoP member commented on the lack of advertising help from NOVA. **We recommend that, for future efforts, NOVA consider whether it wants to offer this type of support and to be clear with members about whether or not this support is provided.**

Summary of Findings

Findings Organized by Impact

We found empirical evidence for each of MS2's intended impacts, suggesting the series accomplished what it set out to achieve. Each of the three intended impacts is reviewed here, presented with a summary of main findings to support each impact.

Impact #1: Linking Basic Research to Scientific Innovation

The first goal of MS2 was to help shape public perception that basic research leads to scientific innovation. To determine whether this was achieved, CEG explored what a sample of the public though were the primary drivers of scientific innovation. Data from two separate, rigorous, experimental studies indicated that NOVA's MS2 project was successful at changing public perceptions of the factors driving scientific innovation; this was particularly evident for the television series.

- **We found evidence that viewing the MS2 series helped individuals understand the importance of basic research to innovation.** Treatment group members reported statistically higher levels of agreement (average = 4.80, sd = .49) than control group members (average = 4.52, sd = .67), when controlling for differences in science-TV viewing, age, and race ($F_{(df=8,\ 7.394)} = 2.739$, p = .007; effect size = .48).

- **We also found evidence that viewing the MS2 website helped individuals understand the importance of basic research to innovation.** Treatment group members reported statistically higher levels of agreement (average = 4.86, sd = .40) than control group members (average = 4.52, sd = .67) ($t_{(df=168.056)} = 4.519$, p = .000; effect size = .64).

- **Treatment group participants were statistically more likely than control group members to choose "collaboration among scientists" as a "top 3" factor related to driving innovation (62% versus 39% in the TV Viewing Experiment and 65% versus 39% in the Web User Experiment).** However, related to NOVA's Impact #1, the treatment group was not more likely than the control group to perceive basic research as a driver of innovation in either experiment.

Impact #2: Increasing Public Awareness of and Excitement about Scientific Innovation

Public Awareness of Scientific Innovation

We also found evidence, across two separate, rigorous, experimental studies that NOVA's MS2 project was successful at improving public awareness of scientific innovation.

- **Treatment group members in the TV Viewing Experiment were significantly more likely to report that they were aware of scientific or technological innovation than were control group members, even when controlling for key differences between the two groups.** The average "awareness" score on a scale of 1 to 5 (5 = highest level) was 4.22 (sd = .72) for the treatment group and 3.95 (sd = .73) for the control group, when controlling for differences in science-TV viewing, age, and race ($F_{(df=8, 20.816)} = 5.679$, p = .000; effect size = .37).

- **Treatment group members in the Web User Experiment were also significantly more likely to report that they were aware of scientific innovation than were control group members.** The average "awareness" score on a scale of 1 to 5 (5 = highest level) was 4.27 (sd = .75) for the treatment group and 3.95 (sd = .73) for the control group ($t_{(df=204)} = 3.137$, p = .002; effect size = .43).

Public Excitement about Scientific Innovation

NOVA's MS2 project was also successful at enhancing public excitement about scientific innovation.

- **We found that individuals who watched the MS2 series or used the MS2 website were significantly more likely than non-viewers/non-users to report that research and innovation were exciting to them, that they enjoyed thinking about the impact of innovation on our lives, and that they were interested in learning about science and innovation.** These analyses controlled for differences in science-TV viewing, age, and race between the two groups.

- **We found that individuals who watched the MS2 series or used the MS2 website were significantly more likely than non-viewers/non-users to report that they would likely discuss science and innovation with their friends and peers, look into news about innovation, watch science programs on TV, and attend or participate in other science-related events or activities.** These analyses controlled

for differences in science-TV viewing, age, and race between the two groups.

- When we asked treatment group participants specifically about the impact of MS2 on their interest levels, **most (84% of those who viewed the MS2 TV series and 97% of those who used the MS2 website) confirmed that MS2 made them more interested in science and technology activities.**

- **Participants who viewed MS2 were significantly more likely than non-viewers to report that they were likely to attend a science lecture or talk (55% versus 38%).** These analyses controlled for differences in science-TV viewing, age, and race between the two groups.

Sustained Public Awareness and Excitement about Scientific Innovation

Through a rigorous, six-month longitudinal study, we found evidence that NOVA was able to achieve sustained and, in some cases, growing public awareness and excitement about scientific innovation over a period of six months.

- We observed that **interest and awareness in scientific and technological innovation were sustained over time and even grew in some cases.**

- While 83% of respondents agreed that they were aware of scientific or technological innovation at the start of the study, six months later, the proportion grew significantly to 94%.

- Likewise, after a period of six months, the proportion of respondents who reported that they agreed that the connections between scientific research and innovation were new and exciting to them also increased significantly, from 93% to 95%.

- The proportion of participants who reported that they enjoyed thinking about how scientific innovations can change or improve our lives also increased over time. It grew from baseline (91%) to the six month point (95%).

- At the outset of the study, nearly all (98%) participants reported that they believed that scientific research and innovations can lead to discoveries that can be important to society. This proportion did not change significantly over time; 99% of participants held this belief by the end of the six months. Thus, the belief was sustained.

- Participants also reported that they remained very interested in learning about science and innovation over time (94% to 95%).

- Ninety percent of participants predicted that they were likely to discuss science and innovation topic with others in the coming month. By Month 6, 88% reported that they had done so, at least a few times per month.

- Some behaviors exceeded participants' expectations. For example, 89% of participants predicted that they were likely to look into news about science, innovation, or new technologies in the coming month. By Month 3, 95% reported that they had done this, at least a few times per month, and by Month 6, 89% reported that they did this, at least a few times per month.

- Likewise, 97% of participants predicted that they were likely to watch science programs on television in the coming month. By Month 3, 95% reported that they did this, at least a few times per month, and by Month 6, 89% reported that they had.

- Some science-related activities were sustained through the six-month study. The proportion of participants who reported engaging in activities such as "Nerd Nights" stayed consistent from baseline to Month 6 (11% versus 14%).

- Half of the sample (51%) reported that they watched NOVA a few times per month. By the 6-month point, that proportion had been sustained.

- The proportion of participants who reported that they enjoyed watching older episodes of NOVA actually increased over the 6-month period, from 35% to 42%.

- For participants in the Longitudinal Study, use of the NOVA website actually increased over time. Four percent of participants reported using the NOVA website on a daily basis and this increased to 6% by Month 6. Participants who reported using the website a few times per week also steadily increased between baseline (7%), Month 3 (12%), and Month 6 (19%).

- The use of video shorts did not change over time – roughly two-thirds of the partcipants continued watching those.

- About 5% of the sample reported that they used social media to access NOVA and this proportion was sustained over time. Another 8% reported

that they used social media several times a week to access NOVA at the study start. This proportion increased to 15% by the end of the study.

- Other science-related activities decreased over time.
    - Throughout the six-month study, participants were most likely to report they had visited a museum during the previous six months, but these visits became less frequent over time (91% at Month 0 versus 74% at Month 6).
    - The next activity reported by half of the sample was attending a science lecture or talk. At baseline, 51% reported that they had done so recently. But, by Month 6, this proportion dropped to 25%.
    - Also decreasing over time was the proportion of participants who reported that they had recently taken a class on a science topic (from 31% at baseline to 16% by Month 6).[14]

Impact #3: Establishing a Community of Practice

We found evidence that NOVA's MS2 Community of Practice enhanced the quality of collaboration among members and encouraged members to continue using Maker pedagogy. The Community also enhanced the frequency of collaboration for some, but not all, of the project period.

- **Community of Practice (CoP) members reported that their involvement in the project was valuable to their own outreach efforts.**
    - CoP members reported reaching anywhere from four people to 6,000 people with their outreach activities.
    - The median number reached was 73 people (the average was 252 people, standard deviation = 825).
    - Outreach members reported that they held between one and 25 events. The average and median number of events was four (standard deviation = 4).
    - Most CoP members (81%) reported that they planned to continue using the Maker Project Boxes.

[14] The study took place during the academic year, so time of year should not be a factor.

- Nearly all reported that the Boxes were useful and engaging, for example.

- CoP members saw value in learning from others in the CoP, but they were less motivated to share their own experiences with the community. **Thus, the CoP was a valuable resource, but was used mostly as a passive way to learn from others' experiences rather than a collaborative experience in which everyone shared their experiences.**

    - Most CoP members (42 out of 54, 78%) reported that interacting with the MS2 online community was helpful to them.

    - CoP members' favorite ways to interact with the online outreach community were the NOVA hosted online hangouts (44%) and the online live guest hangouts (35%).

    - Half of CoP members reported that the MS2 outreach community has provided them more opportunities to interact with others who shared their professional interests.

    - Roughly half also reported that the information they received from the online community was helpful to them in facilitating program delivery to their own audiences.

    - Most CoP members (83%) agreed or strongly agreed that the CoP made them feel like they were part of a larger community.

    - Most members (85%) also agreed or strongly agreed that they enjoyed hearing from others about their Maker Project Box experiences.

    - Thirty-two (63%) CoP members reported that interacting with peers and sharing information with each other was their favorite aspect of the MS2 online community.

    - We found that the CoP was active online for about one-third of the project time period (peaking for two out of seven months) and that a small proportion of the community regularly interacted with others in the CoP (the average CoP member interacted only four times over seven months).

    - While 70 (64%) of the CoP members posted or commented at least once between the months of October 2013 and April 2014,

total of 37 people were non-active community members, never posting or commenting at all.

  - Although the posts and comments increased during the months of February and March 2014, the posts and comments were mainly made by a small group of active people: 13 members posted and commented ten or more times during the seven months of the study. Only five members were very active, meaning they commented and posted twenty or more times. One CoP member was the most active member of the community commenting and posting a total of 45 times.

  - CoP members reported they were less motivated or interested in sharing their own experiences with the online community than they were in learning from others. Only 63% reported that they enjoyed sharing their own experiences, and only 55% reported that they were motivated to share because others would want to hear from them.

  - Only three of the 10 most active CoP members reported that their interactions with others as part of the MS2 outreach community led to relationships outside of the community.

  - Others were disappointed that more individuals did not participate actively in the online community. When we observed online hangouts and office hours, only a handful of people ever attended.

- **Most CoP members (91%) reported that they would continue to be involved in the Maker Movement or to use the Maker Pedagogy.**

  - Many respondents reported that their institutions would continue to be involved in the Maker Movement because it fit squarely with their institutional missions.

  - Others reported that they would continue to use Maker pedagogy because it is so engaging and effective as an educational outreach tool.

Other Findings

- **The NOVA *Making More Stuff* TV series was rated highly by study participants.**

- Most participants gave MS2 an A (71%) or a B (26%).
- The majority of participants reported that the series achieved the right balance between basic and challenging (84%).
- The majority of participants reported that they were likely or highly likely to recommend the series to others (93%).
- The most popular method for viewing NOVA was to view the broadcast series live on TV (75% at baseline). This method remained the most popular by Month 6 (reported by 70%).
- The next most popular way to view NOVA episodes was streaming them online from the Web. The proportion of participants who reported that they liked to stream NOVA online increased over the study timeline, from 43% to 56%.

- **The NOVA *Making More Stuff* website was rated highly by study participants.**
  - Most participants gave MS2 an A (75%) or a B (20%).
  - The majority of participants reported that the website achieved the right balance between basic and challenging (85%).
  - Most participants reported that they found the website topics to be very interesting (65%).
  - Most participants reported that they liked the images used on the website “a lot” (57%).
  - The most popular website features were the video shorts (97%), full NOVA episodes (94%), NOVA scienceNOW (91%), and NOVA Education (91%).
  - The majority of participants reported that they were likely or highly likely to recommend the website to others (90%).
  - At the start of the study, articles were the most popular area of the website (78%) and the NOVA quiz was the least popular (35%). Use of the quiz did not change at all over the course of the study. But, the proportion of website users who reported watching full NOVA episodes increased over time, from 64% at the start to 74% by Month 6.

- The most popular NOVA website visited was NOVA scienceNOW, visited by 73% of the sample at the start of the study and 78% by the end of the study.

- The next most popular was NOVA Education, visited by 57% at the outset and 48% by Month 6. The remaining sites, NOVA Next blog, NOVA Labs, Nature of Reality blog, and the Secret Life of Scientists and Engineers were visited by a core of roughly one-third of the sample and this level of interest was sustained over the 6-month period of the study.

- The social media platform most commonly used to access NOVA, at the study start and by the end, was Facebook, used by more than three-quarters of the sample. YouTube was the next most popular platform, used by 69% of the sample at the outset and dropping to 62% of the sample by Month 6. Twitter use was sustained over time, used by 38% of the sample at the beginning of the study and 40% by the end. Finally, Google+ was reportedly used by 27% of the sample at the beginning of the study, but increased to 37% of the sample by the Month 6.

Appendix A: Recruitment Screener (Studies 1 & 2)

TV and Web Study Recruitment Form

*1. Contact information

Name:

State:

Email Address:

*2. Do you have reliable access to a computer that can access the Internet and stream videos?

- ◯ Yes
- ◯ No
- ◯ Not sure

3. Which of the following science television shows do you watch? (Choose all that apply)

- ☐ Discovery Curiosity
- ☐ MythBusters
- ☐ National Geographic Explorer
- ☐ NOVA
- ☐ Through the Wormhole: Science Channel
- ☐ None of these
- ☐ Other (please specify)

4. Are you a:

- ◯ Male
- ◯ Female

5. How old are you?

- ◯ Under 18
- ◯ 18-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60-69
- ◯ Over 70

TV and Web Study Recruitment Form

6. It's important to us that we reach a diverse audience. How would you describe yourself? (Please choose all that apply)

- [ ] White or European American
- [ ] Hispanic, Latin, or Spanish American
- [ ] Black or African American
- [ ] Asian American
- [ ] Middle Eastern American
- [ ] Native American or Alaskan Native
- [ ] Native Hawaiian or Other Pacific Islander
- [ ] Other (please specify)

7. What is the highest level of education you have attained?

- ◯ Some high school, no diploma
- ◯ High school diploma or GED
- ◯ Some college, no degree
- ◯ Currently enrolled in college
- ◯ Associate's Degree
- ◯ Bachelor's Degree
- ◯ Master's Degree
- ◯ Doctorate or other professional degree

8. Are any of the following true of your current situation?

	Yes	No
Are you a scientist?	◯	◯
Do you work in a science-related field?	◯	◯
Are you studying a science-related field?	◯	◯

Appendix B: Control Group Survey (Studies 1 & 2)

1. What does "innovation" mean to you?

2. In your opinion, what are the TOP 3 things that lead to innovation? (Check only 3)

- [ ] Economic crises
- [ ] Basic research
- [ ] Collaboration among scientists
- [ ] New discoveries
- [ ] Government funding
- [ ] Financial motivation in the private sector
- [ ] Experiments

3. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
I am aware of scientific or technological innovation.	◯	◯	◯	◯	◯	◯
I believe that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society.	◯	◯	◯	◯	◯	◯

4. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
The connections between scientific research and innovation are new and exciting to me.	◯	◯	◯	◯	◯	◯
I enjoy thinking about how scientific innovations can change or improve our lives.	◯	◯	◯	◯	◯	◯
I am interested in learning about science and innovation.	◯	◯	◯	◯	◯	◯

5. In what ways do you innovate in your own life?

6. How likely is it that you will do any of the following?

	Highly likely	Likely	Unsure	Unlikely	Highly unlikely
Discuss science and innovation topics with family, friends, or colleagues.	◯	◯	◯	◯	◯
Look into news about science, innovation, or new technologies.	◯	◯	◯	◯	◯
Watch science programs on television.	◯	◯	◯	◯	◯
Attend or participate in other science-related activities.	◯	◯	◯	◯	◯

7. If you are likely to attend or participate in science-related activities, which ones are you likely to participate in? (Choose all that apply)

- ☐ Museum visit
- ☐ Attend a science lecture or talk
- ☐ Take a class on a science topic
- ☐ Don't plan to participate in science-related activities
- ☐ Other (please specify)

8. If you are likely to do any of the above, what motivates you to keep-up with topics of science and innovation? (Choose all that apply)

- [ ] I need to for my job/career
- [ ] To talk with my family and friends
- [ ] For financial or business purposes
- [ ] For personal interest
- [ ] Not applicable, I don't keep-up
- [ ] Other (please specify)

9. What resource do you rely on the *most* to get information on the latest advancements in science and innovation?

- ◯ National news broadcast
- ◯ Local news broadcast
- ◯ An online news source
- ◯ Public radio news
- ◯ Science documentaries and programs
- ◯ National newspaper
- ◯ Regional/local newspaper
- ◯ Weekly newspaper science pieces such as The Science Times
- ◯ Science-based Web site
- ◯ Radio programs such as Science Friday
- ◯ Not applicable
- ◯ Other (please specify)

Appendix C: TV Viewer Survey (Study 1)

1. What does "innovation" mean to you?

2. In your opinion, what are the TOP 3 things that lead to innovation? (Check only 3)

- [ ] Financial motivation in the private sector
- [ ] Basic research
- [ ] Collaboration among scientists
- [ ] Government funding
- [ ] New discoveries
- [ ] Economic crises
- [ ] Experiments

3. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
I am aware of scientific or technological innovation.	◯	◯	◯	◯	◯	◯
I believe that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society.	◯	◯	◯	◯	◯	◯

4. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
The connections between scientific research and innovation are new and exciting to me.	◯	◯	◯	◯	◯	◯
I enjoy thinking about how scientific innovations can change or improve our lives.	◯	◯	◯	◯	◯	◯
I am interested in learning about science and innovation.	◯	◯	◯	◯	◯	◯

5. In what ways do you innovate in your own life?

6. How likely is it that you will do any of the following?

	Highly likely	Likely	Unsure	Unlikely	Highly unlikely
Discuss science and innovation topics with family, friends, or colleagues.	◯	◯	◯	◯	◯
Look into news about science, innovation, or new technologies.	◯	◯	◯	◯	◯
Watch science programs on television.	◯	◯	◯	◯	◯
Attend or participate in other science-related activities.	◯	◯	◯	◯	◯

7. If you are likely to attend or participate in science-related activities, which ones are you likely to participate in? (Choose all that apply)

- ☐ Museum visit
- ☐ Attend a science lecture or talk
- ☐ Take a class on a science topic
- ☐ Don't plan to participate in science-related activities
- ☐ Other (please specify)

8. If you are likely to do any of the above, what motivates you to keep-up with topics of science and innovation? (Choose all that apply)

- [ ] I need to for my job/career
- [ ] To talk with my family and friends
- [ ] For financial or business purposes
- [ ] For personal interest
- [ ] Not applicable, I don't keep-up
- [ ] Other (please specify)

9. What resource do you rely on the *most* to get information on the latest advancements in science and innovation?

- ◯ National news broadcast
- ◯ Local news broadcast
- ◯ An online news source
- ◯ Public radio news
- ◯ Science documentaries and programs
- ◯ National newspaper
- ◯ Regional/local newspaper
- ◯ Weekly newspaper science pieces such as The Science Times
- ◯ Science-based Web site
- ◯ Radio programs such as Science Friday
- ◯ Not applicable
- ◯ Other (please specify)

Now, we just have a few questions about the Making Stuff, Season 2 series.

10. Overall, what did you think of the Making Stuff, Season 2 series? Did you enjoy viewing it? Please give it a grade.

- ◯ I would give it an "A"
- ◯ I would give it a "B"
- ◯ I would give it a "C"
- ◯ I would give it a "D" or "F" (please explain)

11. Overall, how appropriate was the series for your level of knowledge?

- ◯ All or most of the series was too basic for me
- ◯ Some of the series was too basic for me
- ◯ The series achieved the right balance between basic and challenging
- ◯ Some of the series was too challenging for me
- ◯ All or most of the series was too challenging for me

12. Would you say the Making Stuff, Season 2 series changed your interest in learning about science and innovation?

- ◯ Yes, the series made me more interested
- ◯ No, the series did not change my interest level – I was already interested
- ◯ No, the series did not change my interest level – I remain disinterested
- ◯ Yes, the series made me less interested
- ◯ I don't know

13. How likely are you to recommend the series to your friends or family?

- ◯ Highly likely
- ◯ Likely
- ◯ Neutral
- ◯ Unlikely
- ◯ Highly unlikely

Appendix D: Web User Survey (Study 2)

1. What does "innovation" mean to you?

2. In your opinion, what are the TOP 3 things that lead to innovation? (Check only 3)

- [ ] Government funding
- [ ] Collaboration among scientists
- [ ] Economic crises
- [ ] Financial motivation in the private sector
- [ ] Basic research
- [ ] New discoveries
- [ ] Experiments

3. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
I am aware of scientific or technological innovation.	◯	◯	◯	◯	◯	◯
I believe that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society.	◯	◯	◯	◯	◯	◯

4. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
The connections between scientific research and innovation are new and exciting to me.	◯	◯	◯	◯	◯	◯
I enjoy thinking about how scientific innovations can change or improve our lives.	◯	◯	◯	◯	◯	◯
I am interested in learning about science and innovation.	◯	◯	◯	◯	◯	◯

5. In what ways do you innovate in your own life?

6. How likely is it that you will do any of the following?

	Highly likely	Likely	Unsure	Unlikely	Highly unlikely
Discuss science and innovation topics with family, friends, or colleagues.	◯	◯	◯	◯	◯
Look into news about science, innovation, or new technologies.	◯	◯	◯	◯	◯
Watch science programs on television.	◯	◯	◯	◯	◯
Attend or participate in other science-related activities.	◯	◯	◯	◯	◯

7. If you are likely to attend or participate in science-related activities, which ones are you likely to participate in? (Choose all that apply)

- ☐ Museum visit
- ☐ Attend a science lecture or talk
- ☐ Take a class on a science topic
- ☐ Don't plan to participate in science-related activities
- ☐ Other (please specify)

8. If you are likely to do any of the above, what motivates you to keep-up with topics of science and innovation? (Choose all that apply)

- [ ] I need to for my job/career
- [ ] To talk with my family and friends
- [ ] For financial or business purposes
- [ ] For personal interest
- [ ] Not applicable, I don't keep-up
- [ ] Other (please specify)

9. What resource do you rely on the *most* to get information on the latest advancements in science and innovation?

- ◯ National news broadcast
- ◯ Local news broadcast
- ◯ An online news source
- ◯ Public radio news
- ◯ Science documentaries and programs
- ◯ National newspaper
- ◯ Regional/local newspaper
- ◯ Weekly newspaper science pieces such as The Science Times
- ◯ Science-based Web site
- ◯ Radio programs such as Science Friday
- ◯ Not applicable
- ◯ Other (please specify)

Now, we just have a few questions about the NOVA "Making More Stuff" website.

10. Overall, what did you think of the NOVA website? Did you enjoy using it? Please give it a grade.

- ◯ I would give it an "A"
- ◯ I would give it a "B"
- ◯ I would give it a "C"
- ◯ I would give it a "D" or "F" (please explain)

11. Overall, how appropriate was the website for your level of knowledge?

- ◯ All or most of the website was too basic for me
- ◯ Some of the website was too basic for me
- ◯ The website achieved the right balance between basic and challenging
- ◯ Some of the website was too challenging for me
- ◯ All or most of the website was too challenging for me

12. How interesting did you find the topics covered in the website?

- ◯ Very interesting
- ◯ Interesting
- ◯ A little interesting
- ◯ Not interesting at all

13. Did you like the images presented on the website?

- ◯ I liked the images a lot
- ◯ I liked the images
- ◯ I liked the images a little
- ◯ I did not like the images at all

14. Please tell us how much you enjoyed or did not enjoy the following website features:

	Enjoyed Very Much	Enjoyed	Enjoyed a Little	Did Not Enjoy	Did Not Use
Full NOVA episodes	◯	◯	◯	◯	◯
Video shorts	◯	◯	◯	◯	◯
Articles	◯	◯	◯	◯	◯
NOVA quiz	◯	◯	◯	◯	◯

15. Please tell us how much you enjoyed or did not enjoy the following, additional NOVA websites:

	Enjoyed Very Much	Enjoyed	Enjoyed a Little	Did Not Enjoy	Did Not Use
NOVA Next Blog	◯	◯	◯	◯	◯
NOVA scienceNOW	◯	◯	◯	◯	◯
NOVA Education	◯	◯	◯	◯	◯
NOVA Labs	◯	◯	◯	◯	◯
The Nature of Reality Blog	◯	◯	◯	◯	◯
The Secret Life of Scientists and Engineers	◯	◯	◯	◯	◯

16. Would you say the website changed your interest in learning about science and innovation?

- ◯ Yes, the website made me more interested
- ◯ No, the website did not change my interest level – I was already interested
- ◯ No, the website did not change my interest level – I remain disinterested
- ◯ Yes, the website made me less interested
- ◯ I don't know

17. How likely are you to recommend the website to your friends or family?

- ◯ Highly likely
- ◯ Likely
- ◯ Neutral
- ◯ Unlikely
- ◯ Highly unlikely

Appendix E: Longitudinal Study, Baseline Survey (Study 3)

*1. Please provide your contact information.

Your Name:

State:

Your Email Address:

2. How often do you watch the NOVA television series, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

3. How do you watch NOVA? (Choose all that apply)

- ☐ Broadcast TV series live
- ☐ NOVA broadcast series viewed "later" (i.e. DVR)
- ☐ NOVA streaming online TV series (website)

4. How often do you visit the NOVA website, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

5. Which NOVA website resources do you use? (Choose all that apply)

- ☐ Full NOVA episodes
- ☐ Video shorts
- ☐ Articles
- ☐ NOVA quiz

6. Which NOVA sites do you visit? (Choose all that apply)

- [ ] NOVA Next Blog
- [ ] NOVA scienceNOW
- [ ] NOVA Education
- [ ] NOVA Labs
- [ ] The Nature of Reality Blog
- [ ] The Secret Life of Scientists and Engineers

7. How often do you access NOVA using social media, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

8. Which platforms do you use to access NOVA? (Choose all that apply)

- [ ] Facebook
- [ ] Twitter
- [ ] YouTube
- [ ] Google Plus
- [ ] Other platforms you would like to see NOVA on? (please specify)

9. How often do you visit the NOVA Education website, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

10. Which of the following NOVA Education website resources do you use? (Choose all that apply)

- [ ] Teacher resources
- [ ] “Engaging Science” blog
- [ ] SPARK newsletter

Appendix F: Longitudinal Study, 3-Month Survey (Study 3)

*1. Please provide your contact information.

Your Name:

State:

Your Email Address:

2. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
I am aware of scientific or technological innovation.	○	○	○	○	○	○
I believe that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society.	○	○	○	○	○	○
The connections between scientific research and innovation are new and exciting to me.	○	○	○	○	○	○
I enjoy thinking about how scientific innovations can change or improve our lives.	○	○	○	○	○	○
I am interested in learning about science and innovation.	○	○	○	○	○	○

3. During the past three months, how frequently did you do any of the following:

	Never	Less than once per month	A few times per month	A few times per week	Daily or more frequently
Discussed science and innovation topics with family, friends, or colleagues.	○	○	○	○	○
Looked into news about science, innovation, or new technologies.	○	○	○	○	○
Watched science programs on television.	○	○	○	○	○

4. During the past three months, did you attend or participate in any science-related activities? (Choose all that apply)

- [ ] Museum visit
- [ ] Attended a science lecture or talk
- [ ] Took a class on a science topic
- [ ] Other (please specify)

5. How often do you watch the *NOVA television series*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

6. How do you watch NOVA? (Choose all that apply)

- [ ] Broadcast TV series live
- [ ] NOVA broadcast series viewed "later" (i.e. DVR)
- [ ] NOVA streaming online TV series (website)

7. How often do you visit the *NOVA website*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

8. Which NOVA website resources do you use? (Choose all that apply)

- [ ] Full NOVA episodes
- [ ] Video shorts
- [ ] Articles
- [ ] NOVA quiz

9. Which NOVA sites do you visit? (Choose all that apply)

- [ ] NOVA Next Blog
- [ ] NOVA scienceNOW
- [ ] NOVA Education
- [ ] NOVA Labs
- [ ] The Nature of Reality Blog
- [ ] The Secret Life of Scientists and Engineers

10. How often do you access *NOVA using social media*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

11. Which platforms do you use to access NOVA? (Choose all that apply)

- [ ] Facebook
- [ ] Twitter
- [ ] YouTube
- [ ] Google Plus
- [ ] Other platforms you would like to see NOVA on? (please specify)

12. How often do you visit the *NOVA Education website*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

13. Which of the following NOVA Education website resources do you use? (Choose all that apply)

- [ ] Teacher resources
- [ ] “Engaging Science” blog
- [ ] SPARK newsletter

Appendix G: Longitudinal Study, 6-Month Survey (Study 3)

*1. Please provide your contact information.

Your Name:

State:

Your Email Address:

2. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Don't know
I am aware of scientific or technological innovation.	○	○	○	○	○	○
I believe that scientific research and innovation (such as lab experiments and tests) can lead to discoveries that can be important to society.	○	○	○	○	○	○
The connections between scientific research and innovation are new and exciting to me.	○	○	○	○	○	○
I enjoy thinking about how scientific innovations can change or improve our lives.	○	○	○	○	○	○
I am interested in learning about science and innovation.	○	○	○	○	○	○

3. During the past three months, how frequently did you do any of the following:

	Never	Less than once per month	A few times per month	A few times per week	Daily or more frequently
Discussed science and innovation topics with family, friends, or colleagues.	○	○	○	○	○
Looked into news about science, innovation, or new technologies.	○	○	○	○	○
Watched science programs on television.	○	○	○	○	○

4. During the past three months, did you attend or participate in any science-related activities? (Choose all that apply)

- [ ] Museum visit
- [ ] Attended a science lecture or talk
- [ ] Took a class on a science topic
- [ ] Other (please specify)

5. How often do you watch the *NOVA television series*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

6. How do you watch NOVA? (Choose all that apply)

- [ ] Broadcast TV series live
- [ ] NOVA broadcast series viewed "later" (i.e. DVR)
- [ ] NOVA streaming online TV series (website)

7. How often do you visit the *NOVA website*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

8. Which NOVA website resources do you use? (Choose all that apply)

- [ ] Full NOVA episodes
- [ ] Video shorts
- [ ] Articles
- [ ] NOVA quiz

9. Which NOVA sites do you visit? (Choose all that apply)

- [ ] NOVA Next Blog
- [ ] NOVA scienceNOW
- [ ] NOVA Education
- [ ] NOVA Labs
- [ ] The Nature of Reality Blog
- [ ] The Secret Life of Scientists and Engineers

10. How often do you access *NOVA using social media*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

11. Which platforms do you use to access NOVA? (Choose all that apply)

- [ ] Facebook
- [ ] Twitter
- [ ] YouTube
- [ ] Google Plus
- [ ] Other platforms you would like to see NOVA on? (please specify)

12. How often do you visit the *NOVA Education website*, if at all?

- ◯ Never
- ◯ Less than once per month
- ◯ A few times per month
- ◯ A few times per week
- ◯ Daily or more frequently
- ◯ I don't know what this is

13. Which of the following NOVA Education website resources do you use? (Choose all that apply)

- [ ] Teacher resources
- [ ] "Engaging Science" blog
- [ ] SPARK newsletter

14. What resource do you rely on the most to get information on the latest advancements in science and innovation?

- ◯ National news broadcast
- ◯ Local news broadcast
- ◯ An online news source
- ◯ Public radio news
- ◯ Science documentaries and programs
- ◯ National newspaper
- ◯ Regional/local newspaper
- ◯ Weekly newspaper science pieces such as The Science Times
- ◯ Science-based Web site
- ◯ Radio programs such as Science Friday
- ◯ Not applicable

Appendix H: Community of Practice Interview Protocol (Study 4)

Maker Project Box Community of Practice
INTERVIEW SCRIPT

Overview

Thanks for your involvement with the Maker Project Boxes and the *MAKING STUFF* Outreach Community. Your participation was essential to fostering a sense of community and helping others learn best practices on how to bring the maker movement to their local communities.

NOVA is interested in learning more about your experiences with the *MAKING STUFF* Outreach Community, and I have some questions that would be great to get your feedback on.

General Questions

1. What inspired you to become involved with this project and request a Maker Project Box?
2. Who is your primary audience? Where do you facilitate your Maker Project Box activities?
3. Overall, what was your favorite part of being involved in this project?
4. Which areas stand out as needing more development, or where you'd like to see NOVA place more of its efforts in the future?

Outreach Community

First I'm going to ask you some questions about your experiences with the *MAKING STUFF* Outreach Community on Google+

5. Did the online Outreach Community help you feel supported as a Project Box facilitator?
    a. Did you feel you received all the resources you need?
    b. If not, which additional resources would you have liked to receive?

6. Overall, was the Outreach Community useful to you? Why or why not?

7. Did you like the format of Google+? Why or why not? If not, is there another platform that you feel would have been more appropriate?

8. What was your favorite way to interact with the NOVA *MAKING STUFF* Outreach Community? For example, office hours, Hangouts on Air either hosted by NOVA or featuring a guest, or interactions with other related network sites? Can you please tell us more about this?

9. Did your experiences with the Outreach Community give you the opportunity to interact *more* with others who share your professional interests?
    a. Were these exchanges helpful to you? Why or why not?

b. Can you give an example of one particularly helpful interaction? (if applicable?

10. Do you feel that working with others in the Outreach Community made you feel as if you were part of a larger community? Why or why not?
    a. If so, was this helpful to you? How?

Maker Project Boxes

Now I'd like to get a sense of your experiences with the Maker Project Boxes themselves.

11. Did the DVD resources and video clips help you successfully deliver the Maker projects to your audience? Did they enrich the experience for you? Why or why not? Please explain.

12. In our online survey, you told us that you will/will not continue to use the Maker Project Boxes. Please tell us more about that. (or, rephrase to ask, "Will you continue to use the Maker Project Boxes?")

13. In our online survey, you told us you will/will not continue to be involved in the "Maker Movement" or use the "Maker Pedagogy." Please tell us more about that. (or, rephrase to ask, "Will you continue to be involved in the 'Maker Movement' or use the 'Maker Pedagogy?'")

Concluding Thoughts

14. Please share any additional ideas, comments, or suggestions about the Maker Project Boxes and/or your experience with the NOVA Outreach Community.

Thank you for your time and involvement, we appreciate it!

Appendix I: Community of Practice Survey (Study 4)

NOVA MAKING STUFF Community of Practice Survey

Thanks so much for being part of the NOVA *MAKING STUFF* Outreach Community, using the Maker Kit Project Box, and for sharing your experiences with NOVA and your fellow community members. We had a great time working with you and seeing how you and your students enjoyed learning about the engineering and design process.

We'd love for you to take a just few moments to evaluate your experiences with us through this brief survey. We've already learned so much by interacting with you online, but these few final questions will help us to better understand this project as a whole. Thanks for your time, it is very much appreciated!

1. Your name:

2. Your organization:

General Questions

***3. About how many people used your Maker Project Box in total, including all the events you held?**

***4. Approximately how many events did you host with your Maker Project Box? / At how many events did you use the Maker Project Boxes?**

***5. Please describe the typical user of your Maker Project Box (e.g. after-school program students, museum visitors, other community members).**

MAKING STUFF Outreach Community (Google+ Online Community)

6. Was it helpful to interact with the NOVA *MAKING STUFF* Outreach Community?

- [ ] Yes
- [ ] Not sure
- [ ] No (If not, please explain why not):

MAKING STUFF Outreach Community (Google+ Online Community)

7. What was your favorite way to interact with the NOVA *MAKING STUFF* Outreach Community? (select all that apply)

- [ ] NOVA hosted “office hours”
- [ ] Online live “hang outs” (NOVA hosted)
- [ ] Online live “hang outs” (featuring guests from the Maker Movement)
- [ ] Interactions with other related network sites (please specify which sites):

MAKING STUFF Outreach Community (Google+ Online Community)

8. Did being a part of the *MAKING STUFF* Outreach Community give you more opportunities to interact with others who share your professional interests?

- ◯ Yes, a great deal
- ◯ Yes, but only somewhat
- ◯ No, not at all
- ◯ Not sure

NOVA MAKING STUFF Community of Practice Survey

9. Was the information you received from the online community helpful to you in facilitating program delivery to your audiences?

- ◯ Yes, a great deal
- ◯ Yes, but only somewhat
- ◯ No, I didn't need extra support so didn't use the online community
- ◯ No, I needed support but didn't receive it
- ◯ Not sure

MAKING STUFF Outreach Community (Google+ Online Community)

10. How much would you say you agree or disagree with the following statements:

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Engaging with others on Google+ made me feel as if I was part of a larger *MAKING STUFF* community.	◯	◯	◯	◯	◯
I enjoyed hearing from others about their experiences with the Maker Project Boxes.	◯	◯	◯	◯	◯
I enjoyed sharing my experiences with the Maker Project Boxes with others.	◯	◯	◯	◯	◯
I was motivated to share because I felt there was an active community of other educators who wanted to hear from me.	◯	◯	◯	◯	◯

MAKING STUFF Outreach Community (Google+ Online Community)

11. What was your favorite aspect of the *MAKING STUFF* Outreach Community? Do do you have any thoughts or suggestions you'd like to share with NOVA?

NOVA MAKING STUFF Community of Practice Survey

Maker Project Boxes

12. Were the DVD resources helpful to you in facilitating program delivery to your audiences?

- ◯ Yes, a great deal
- ◯ Yes, but only somewhat
- ◯ No, not at all
- ◯ Not sure

13. Did the video clips provided by NOVA help enrich the experience of the Maker projects?

- ◯ Yes, a great deal
- ◯ Yes, but only somewhat
- ◯ No, not at all
- ◯ Not sure

Maker Project Boxes

***14. Will you continue to use the Maker Project Boxes?**

- ◯ Yes
- ◯ No
- ◯ Not sure

***15. Why or why not?**

Maker Project Boxes

NOVA MAKING STUFF Community of Practice Survey

***16. Will you continue to be involved in the "Maker Movement" or use the "Maker Pedagogy?"**

- ◯ Yes
- ◯ No
- ◯ Not sure

***17. Why or why not?**

Maker Project Boxes

18. Please share any additional thoughts or comments about the Maker Project Boxes.

19. You were listed as the main contact for your organization. If there is someone else at your organization you think might like to complete the survey, please ask them to email Christine at cpaulsen@concordevaluation.com or provide their email address below and we will contact them.

Appendix J: Respondents' Comments from the Community of Practice Study (Study 4)

Of the respondents who reported they would or might continue using the Maker Project Boxes, nearly all reported that they were useful and engaging:

- *It is a great way to help teens learn about science in a fun way.*
- *They are good hands-on materials.*
- *Because they are very useful in interacting with others and getting them interested in science.*
- *The materials are fantastic, and mostly reusable!*
- *These inquiry-based programs were a brilliant way to engage our visitors. We got so much positive feedback from parents especially. It was awesome to see adults and children working together towards a common goal where we typically don't see that sort of interaction in the science center gallery spaces. We were told that the adults had just as much fun as the kids. I can definitely see us using these programs again in the future, either for workshop-style programming in our lab space or as future programs for our STEM and Camp groups.*
- *They're a great resource and we can continue to use them by integrating the activities into our other programs, including summer camps, after-school programs, etc.*
- *Some of the online resources we've been connected to through this project will be very useful.*
- *We are going to use them this summer for the summer reading program for the local library.*
- *The demo kits were very popular at our outreach events. Kids loved the idea of being in charge of their own ideas and having the ability to see their work in action. I think these are a great way to get kids more excited about science and engineering!*
- *They are a great basis from which to work.*
- *The Museum was skeptical at first, but now want to integrate Maker activities into their monthly Second Saturday events and also in their annual Summer camps for kids. We will continue to use the material from the Project Boxes.*
- *We're about to roll out a summer of "Making" at our museum, and looking to integrate our Maker Project Box to that project.*
- *Our outreach programs are continuing to grow. It is great to have some "new" ideas to add to our activities.*
- *It's great to have a variety of activity options for us to offer at the museum in various contexts. We currently have enough supplies for 10-15 participants in each project. We probably won't try to replace the Colder supplies, particularly the fans. That project went fine, but I'm not sure we'll have much demand for it in the future. We will probably do the Safer project most (in fact, we're planning on having it, complete with Shake Table at a Gala at the museum next month), followed by Faster, then Wilder. Wilder is a little tricky with all of the cutting, although the results*

are great. The other consideration with what projects we run is how creative kids can be. Colder and Wilder don't have many design choices, Faster has more (especially if kids decorate the cars), while Safer has the greatest opportunity for creative thinking.

- *The resources are great! I will use them next year in my club and also in my science classroom.*
- *We are trying to build more interactions with the community and it will be great for our festivals where younger students are present.*
- *Because it is such a great learning project that encourages creativity, and meets all learning styles.*
- *The Wave team has made a vacuum former that we will use with our next Science Saturday at our local YMCA. I love the maker movement and plan to include more into my classroom. I had students make cardboard games (Caine's Arcade inspired) for a classroom of their choice. I had one young lady say "I have never made anything before. This is cool."*
- *The ideas are great. I have passed along the ideas to another library.*
- *We have a Fab Lab that will be enriched by the materials, especially the reusable ones. Thank you!*
- *I will continue to use the materials and projects for other program until they are depleted and hopefully secure funding to restock the kit. The projects were great and the kids and parents loved them! The staff loved working with this content as well.*
- *They are great lessons, and you provided some wonderful supplies that we may not have been able to purchase at this time otherwise.*
- *Yes! Since we built the Pinewood Derby track, complete with speed sensors, we'll be using this as a regular activity for kids!*
- *Excellent materials! At our KITE Festival, we have over 100 families attend, and we could not allow families to take the items home. Therefore, we made the activities were they were "reusable", and we will use them again next fall at the PSES - CSI STEM Night.*
- *The hands-on nature of the activities can really get students to think about materials, which aligns with our mission. We were reluctant to use the project that involved hammers and saws at our community event, but plan to have the activity in a smaller group setting for older students.*
- *Definitely will -- seems like I go to the box weekly for something that is in it and will be planning outreach activities for the 2014-15 based on materials from the project box.*
- *The majority of the projects were similar to stuff we already do. The "cool" project was unique and it would probably be the only one we would save from the 4 projects.*
- *The projects were engaging for kids. Many of my male students have made pinewood derby cars with Scouts, so I would probably not use that particular project in the future. The other projects were brand new to kids.*

- *We are going to remake over the summer so that those who were unable to come the first time can make things faster, cooler, safer and wilder!*
- *The gumdrop activity and the cooling unit were both open-ended enough to work with our audience, and the former is simple and inexpensive to replicate. The other activities were much more structured, and not really the sort of thing we prefer to do here.*
- *They were great problem solving projects and the supplies can be used in many other projects too.*
- *I will be transferring to a new school in the district that has a higher external community involvement and I hope to hold after school events at the new school. I felt like I am finally getting the support from administrators on using STEM in the classroom because of this experience! THANK YOU!*
- *They add to many of the activities we have been doing; we probably won't use the making stuff faster project except with very young audiences. It is most suitable for elementary and even pre-schoolers.*
- *Activities can easily be aligned to other programs and initiatives at our museum.*
- *We will definitely continue to use the Making Stuff Wilder project and possibly Making Stuff Colder--both of these projects are relevant to our center and what we do here.*
- *Great resources and great ideas. We will modify some things, like buy different plastic containers and such, we really loved all the activities and have bought lots more stuff for Wilder activities and soon will buy more to add to Safer activities. The cars were great, but I think we will need to go in a different direction here at the museum. (The kids really loved them though.) We really appreciate the tools and the step-by-step instructions. Having the tubing was helpful, so now we know what to look for in the future.*
- *They are a great support to promote science and invention.*
- *We have already been in touch with a local homeschool group who would like to try to present some of the projects as group activities. In addition, many of the tools can be used for all sorts of purposes beyond the activities.*
- *This was a great resource! Even though we weren't able to take advantage of all of the multi-media because of our space - the kids loved being able to build something with actual materials, to invent and re-engineer, and just be creative! These were supplies we also would not have been able to afford and ideas we probably would not have had, if it weren't for being involved with Making Stuff.*
- *They are awesome! We have restocked the making stuff safer and wild.*
- *We are just starting to run evening/weekend workshops for families. It takes a great deal of work to develop engaging, relevant, and science-rich curriculum for these events. The Maker Project Boxes and accompanying*

curriculum really have helped us with this program. We are interspersing these workshops in with other workshops that we develop (in house or with collaborators). These kits allow us to run workshops more often while our program grows. The curriculum is wonderful and our visitors really enjoy the content - the video and the creative projects are the highlight. So, we will continue to use these as we run many more workshops in the future.

- *I am most excited about the small quake tables we developed for the Safer activity and plan on using the activity we created with the materials from Nova as an in house workshop experience for fieldtrips as well as rotating curriculum in our Makerspace.*
- *I'm already looking for local sources for some of the supplies. From the kits and with the ideas from the Google network I got enough inspiration for new summer camp themes and STEM workshops for the next several years. I hope there will be another round of Maker Boxes next year!*
- *I have new program getting online for next school year, which related to aviation. They are grant funded, which takes prior for our museum.*
- *The making stuff colder and wilder activities were interesting and may be used again.*
- *The activities will be utilized during summer workshops and most likely at upcoming camp-ins.*

Others reported that the science content could be enhanced to better reflect the concepts being covered:

- *Some of the video clips didn't really match the project principles very well. For instance, in Faster the video talks about torque as the key to speed, whereas the project itself really has to do with friction, weight, and momentum. Wilder was closer, as was Safer if you used the Shake Table (which could've used better construction guidance). Colder was ok, although 1) some people were startled at the mention of a rectal temp probe, and 2) it was about circulating liquid. Still, it made sense to be making a personal cooling unit given what the video talked about.*
- *The Wilder activity was too far removed from our perception of materials science and engineering. We currently have a structural color activity involving butterfly wings that we feel better aligns with our department's focus.*
- *The Ingenuity Lab is a drop-in program offering monthly rotating engineering design challenges for visitors of all ages. The Making Stuff activities offered some variables to explore, but not enough divergent solutions for us to comfortably call the activities what our visitors have come to expect as "design challenges". We modified the activities - some less, some more to make them work for a drop-in audience on the exhibit floor. We will continue to use elements of the activities. I passed some of*

the activities and materials on to our camp teachers as they work better in a workshop environment.

- *The one area I see for improvement is the "safer" activity. Although the content is good (the discussion of shapes and their strengths/weaknesses, the connection to the real world with the earthquake table), you might consider a new activity to illustrate this concept. Most kids have done some variation of building with gumdrops and toothpicks in school, camps, etc. I would have liked to see a fresh take on how to "make stuff safer."*

Others reported that the activities were not appropriate for their specific audiences:

- *I think more open-ended questions should be included. The car activity is too hard for a classroom setting. One time we did vegetable cars. They could use a specific number of other elements like skewers and rubber bands.*
- *In the timeframe that we had, it was difficult to truly evaluate what the kids had created.*
- *I thought some of the activities were very basic. Too basic for a program that required an application to demonstrate your experience and capacity for hosting and presenting making activities. I don't think the pinewood derby or gum drop/toothpick structure activity were anything many people in this community hadn't seen before.*
- *I found the bio inspired claw did not work as well as similar "robotic hand" type projects we currently do and the material cost to be prohibitive for reuse in a museum setting. I felt the vinyl tubing could have been put to better use to build a pneumatic robotic arm which would have also gone with the segment from the Making Stuff series as their arm was also pneumatic.*
- *Some of the activities were too basic and not unique enough for a museum experience.*
- *The activities did need to be modified somewhat for a "drop in" science center visitor experience.*
- *The projects were not interesting enough. The students had fun doing them, but I was not sure if they were challenging enough for our students who participate in a lot of STEM activities.*
- *Some of the activities were much better suited for smaller class sizes with instructor-facilitated programming, and were less conducive to a large community outreach event. We had to modify several activities in order to make sure that they were feasible in that setting with a large number of people.*
- *Thank you for all the great "stuff"! The one comment I have is that future boxes have a different vehicle for 'Making Stuff Faster" -- the pinewood*

derby cars are great for longer term activities, but usually outreach events don't have the time available to make great cars. I am thinking of sending them home with teachers at one meeting and having their class design one and having a competition among some classes and a later meeting.

- *The pinewood derby cars were not new to some kids, so I would consider not using them again, depending upon my audience.*
- *In general, the activities weren't open-ended enough. There was very little opportunity for kids to mess around and create their own designs, with the exception of the gumdrop activity. It was great to get materials all ready to go, although in some cases there weren't enough We had to acquire more of certain other materials--gumdrops, hammers, and alligator clips ("making stuff colder") come to mind I'm not sure if we will repeat the workshops because some of the materials would be expensive to buy in the quantities we use them here at BCM.*

Other CoP members reported that they needed more information or that they need the information in a more timely manner:

- *For Making Stuff Colder materials it would have helped to have more practical advice on using and setting up the "experiment".*
- *Not all materials detailed in packaging list were included: I would be careful about that, especially when sending to schools or organizations with funding challenges.*
- *The boxes were great. It would've been nice to get them a little earlier, although I'm sure fulfillment was filled with challenges. That said, the community was great, as were Rachel and Scott, at adapting and exploring different approaches.*

We asked CoP members to report on their favorite aspects of the MS2 outreach community. Thirty-two (62.75%) respondents reported that interacting with peers and sharing information with each other was their favorite aspect. They reported that they enjoyed…

- *Others' ideas allowed for one to riff on projects and to build upwards and outwards.*
- *I think that using Google+ was a brilliant move to build the community. It was easy to use and a great way to share photos from the events. Using the Hangouts for updates and such was pretty cool too, although I never really had the occasion to use the office hours. It was nice to see that it was an option.*
- *I liked that we were connecting our small organization to a larger, national community of informal STEM educators and Makers. I think it also helped us market our event to the community, by tying into a larger, nationwide event. I enjoyed seeing photos from other Making Stuff host sites,*

exchanging ideas with others, troubleshooting some of the activities, etc. This was our first large community outreach event (we typically run a LOT of smaller summer camps and in-school and after-school programs) and we were blown away by the community response. We had hundreds of people RSVP within the first few hours after we sent out the announcement! People REALLY enjoyed the event and especially liked the open-ended, hands-on nature of all the activity stations. Kids could take a long time if they wanted to design and re-engineer their products, and I think that families really appreciated that aspect of the event. We are already planning to do something similar next year! :)

- *I think that having the Google+ as a resource was really great. I was able to ask general questions about demos or ask people for ideas and opinions and also able to search other conversations for any suggestions and answers. I got to see how many people are out there doing the same things that we are!*
- *Having all those people out there to call on if I needed help. I am putting together a community for outreach in our Society of Women Engineers, SWE, Region based on my experiences. I hope it works half as well.*
- *It was great way to connect with others around a common interest in a way that felt "informal," in that it was a comfortable conversation to have. It did not have the dry, rigid structure that many professional community networks suffer from. Kudos, NOVA team!*
- *Hearing about how others actually used the materials in their programs was extremely helpful. NOVA did a great job providing the materials and basic guidance, but there's nothing like hearing about, and in some cases seeing, what worked and what didn't when people actually ran the projects. Google+ was the primary forum for this, although some of the live hangouts also supported this exchange. I also really enjoyed hearing from others involved in the "maker movement" and related fields (e.g., Steve Davee, Tony DeRose, and David Wells). Those helped me think about creating experiences like these, and not just running the ones that were part of this program, so they have lasting value for me.*
- *The community was a nice touch.*
- *I like hearing from other how they approached it. It builds an instant set of ideas for the next time we do this.*
- *It was great to see the broad scope of educators and institutions interested in making.*
- *There was a lot of support from the MAKING STUFF Outreach Community. It was inspiring and helpful.*
- *The sharing of "lessons learned" from individuals or groups who encountered challenges in implementation. For example, one of the members created worksheets to help facilitate the learning for each of the units. They were excellent ways to help focus students & families on the science & design embedded in the activity rather than "just" having fun!*

- *The idea that there is a larger making stuff community and that if I had needed to, there was some place I could go for information and advice.*
- *I liked the community feel - the diversity of the venues where we were using our STUFF and the sharing of experiences and modifications to the activities we all made to make them "our own". I was also glad the hangouts were recorded as most times I was not able to join live, but watched at a later time.*
- *Being able to see what worked or did not work for other event organizers.*
- *The collaboration and file share of handouts.*
- *I appreciated people who shared tips and suggestions for the different activities, though if someone posed a specific question, it didn't always get answered. It all depended on people who just voluntarily shared info.*
- *I especially liked the fact that a large group from all around the county was working on the same project and we were all putting our own spin on getting it done. In the end we got it done.*
- *I liked the idea of the community.*
- *The Google+ website was a very active forum. The online community was a great resource to share our work, ask questions and get immediate response. NOVA invited great inspiring speakers for online trainings.*
- *I enjoyed seeing how others adapted the making stuff activities and how they conducted their outreach.*
- *I loved the opportunities to receive clarification on implementation of the programs and use of the materials.*
- *Seeing how other groups actually used the projects. A couple of the projects had issues that made them impractical to use in our setting and it was helpful to see how other groups adapted them.*
- *I did feel like we - the museum - was really a part of a bigger community.*
- *I enjoyed seeing how other museums handled their events -- particularly those who developed worksheets/handouts/guides beyond what was sent by NOVA.*
- *Reading and seeing the latest posts.*
- *I really liked being able to read through all the different ideas and formats people used. I (and my museum) are just starting to implement "maker" projects in a significant way and this really gave us the jump start we needed. I was able to get some great advice for how to take the workshops and turn them into table-top activities. Though I didn't share my experiences very much, I really loved hearing about what others were doing and learning from them.*
- *I loved the way this all came together. The NOVA facilitators made themselves very accessible and I found the projects to be very engaging and easy to modify or use as inspiration for other projects down the road. I felt that participating in this community really helped me assess the level and quality of programing I am currently doing in our space and it also*

showed me how small workshop formats can be very successful. Having the activities and then the information (slide shows and video clips) to correspond the activity to a larger idea was awesome.

- *Reading about the many "hacks" of the different activities. Getting a heads-up on difficulties with the materials in particular settings.*
- *I thought the community on the Google+ site was active and I kept coming back for comments and suggestions from other host sites.*

Other respondents (n = 14, 27.45%) reported that the boxes and hands-on activities were their favorite aspect:

- *I teach high school Chemistry. Making Stuff Colder was the most impactful for my group of students. I showed /streamed the video and many students said that "It blew their minds". The hands-on activity deeply engaged the students.*
- *My favorite thing was seeing how kids took ownership over the materials and made it their own, straying somewhat from the directions in the kits.*
- *Receiving the boxes was obviously my favorite! I was able to fully use 3 out of the 4 kits for programs at my museum (I did not use the "Faster" kit yet). I wish I had been able to link my work email with the Google community so I could participate more during work hours.*
- *The lesson plans are very well developed and documented. The Maker Box was very neatly organized and inventoried. The videos were a very good complement to the lessons. The t-shirts and banner were a nice touch, and helped enhance the environment while presenting the activities.*
- *My favorite part was receiving free, high quality materials that were interesting for kids. The curriculum provided, including the slideshows and video clips on the DVD, were very well thought out and easy to teach.*
- *I enjoyed getting families involved with STEM at our school. My students had a great time showing their families how "science works" and building together. Our most successful events included using our wood shop to shape the cars and working with circuits. We had two fathers who happen to be electricians show up and they ended up leading the event! Our girls were empowered as they experienced a risk free learning environment.*
- *Because it's NOVA, there was buy in from the local Community, we were able to learn so much, we will be implementing much of what we learned over the coming year. I felt a lot more comfortable in the making environment and in discussing topics with other "more advanced" sites which were also part of the Making Stuff Outreach Community. We would love to do this again. The resources were really great.*
- *The kids enjoyed the hands on aspect of the each project!*

Some respondents reported that they were not fully satisfied with the Google+ platform:

- *Too bad there's no good way to save the online posts from the community, apart from me taking as many notes as possible. (I'm assuming that this Outreach platform will go away at some point.)*
- *I did feel a bit buried in emails occasionally. Perhaps a way to cut those down so that we don't get one every time someone holds and event would be helpful.*
- *Although the content and the participants in the community were great and beneficial, I did not find that the platform used for the community allowed me to participate to the fullest degree.*
- *I honestly didn't really participate in the community aspect much because it was hosted by Google+ which is not a platform I'm a big fan of. To get into the community required setting up a whole new account and it was difficult to feel my privacy was secure from the web at large while still sharing enough information to be a contributor within the community itself. Also, I just don't like Google+, it's why I got rid of my personal account.*
- *Maybe I'm not technologically advanced enough, but I had a lot of difficulty posting things on the Making Stuff site. It seemed very complicated and not intuitive to me.*

Most CoP members (91%) reported that they would continue to be involved in the Maker Movement or to use the Maker Pedagogy. Only one member reported that they would not. Many respondents reported that their institutions would continue to be involved in the Maker Movement because it fit squarely with their institutional missions:

- *The Free Library is dedicated to Maker programming, and will be continuing at least through the rest of the year with dedicated maker workshops in ten branches.*
- *We love the open-ended, creative approach that is inherent to these types of activities. We are always looking for fun, new, creative ways to use cheap, recycled materials and maker pedagogy is a perfect fit for us. Although we are based in a very science-rich area, kids still do not get many opportunities to tinker and explore, and we want to be able to provide them with that opportunity.*
- *I am intrigued with the Maker movement, but also think a lot of what we already do in a museum setting makes sense and fits.*
- *It's fun, and it's right up our alley!*
- *It is a natural fit for introducing Engineering concepts.*
- *"Maker" fits perfectly with the basic point of the Charles River Museum of Industry and Innovation.*
- *We believe in experiential learning!*

- *It's encouraged students to make the learning process their own.*
- *We are very committed to STEAM learning and in offering informal science learning opportunities.*
- *This is a great way for kids and adults to learn concepts by making and it fits well with our museum's current goal of integrating STEM activities for and older (3rd grade and up) audience.*
- *SLO MakerSpace is the hub for makers in the Central Coast and we want to continue to develop and use similar curricula for students and community members.*
- *We have a variety of hands-on activities beyond the Making Stuff kit that we use in outreach activities. We plan to incorporate the Making Stuff activities into our suite of demos.*
- *It is important for kids to have the opportunity to create, succeed, fail, and revise while learning. The Makers Movement is a perfect fit for kids to grow.*
- *Because I am a Maker Corp Mentor and I love Making. We also started a Young Makers Club at our library!*
- *We had already been planning Maker Workshops when the NOVA opportunity came along; it tied in nicely with the direction we were heading anyway.*
- *We are deeply committed to the idea of tinkering.*
- *Maker and tinkering spaces are part of a growing movement of hands-on, mentor-led learning environments to make and remake the physical and digital worlds and to collaborate with one another.*
- *Maker Spaces foster experimentation, invention, creation, exploration, and STEM learning. The Lawrence Hall of Science has actively participated in the growing Maker Movement for many years by developing design-based programs and exhibits to inspire the next generation of innovators and engineers. Partnerships with Maker community members and groups have created many open-ended design challenges, like those in the Hall's Ingenuity Programs and the Design Quest exhibit. Ingenuity Programs build on the best of "tinkering" and "maker" content in science centers, but emphasize the engineering design process and engineering careers. The basis of our work in the Ingenuity Programs at the Hall is "constructivist" learning which asserts that knowledge is not simply transmitted from teacher to learner, but actively constructed by the mind of the learner. "Constructionism" takes it even further and suggests learning happens more effectively and new ideas emerge when people are actively engaged in making an external and tangible object.*
- *We've been doing some form of this for a long time and cannot imagine not including this in any of our future events/programs.*
- *This is exactly where we want to be. We may be moving slowly, but we are moving in the right direction and the community seems to be following*

along with us. This was a really good first step and it will take us a bit to add more steps to our path, but we are doing it.

- *For the last three years I have avidly been involved with the "Maker Movement" creating a Makerspace for children as well as being part of our local "grown up" maker space and group. I am very passionate and strong in my beliefs and power of the S.T.E.A.M. movement and project based learning as a whole and plan to dedicate my career to both of these ideals.*
- *The Maker movement allows children access to STEM subjects from their own skill level and interests. Instead of a prescribed, theoretical curriculum the Maker Pedagogy connects STEM to every day problems and their solutions. There is no better way to help children understand that STEM is relevant for their everyday lives, is a valid career prospect, can be approached by everyone (not just scientists in a lab) and is FUN! This also aligns with our own mission and our push to increase STEM programs and exhibits but make them hands-on.*
- *This is a community and a movement we have been involved with for over 10 years. We are committed to providing opportunities for kids to think like engineer, work through the design process, and gain materials literacy/creative confidence.*
- *As a science center that utilizes inquiry and hands-on, interactive learning, the philosophy of the maker movement is a perfect fit for what we attempt to do every day.*

Others reported that they would continue to use Maker pedagogy because it is so engaging and effective as an educational outreach tool:

- *Because it works in outreach.*
- *We have found that the maker activities hold the attention of our visitors. For our typical table top activities, visitors stay with one activity for up to 5 minutes. With the maker activities, most visitors stay with the activity for 15+ minutes. This level of engagement is wonderful! We also really like how easy it is to flex the maker style activities to different ages. We often have 3 year olds and 10 year olds working on the same challenge side-by-side and both are getting a lot out of the activity.*
- *I believe it is growing in importance as a library program, and the popularity is increasing as well. With students not getting as much hands-on experience in school, it is imperative that they get it somewhere, and where better than the public library?*
- *We have a great community with interest in this area.*
- *We are already looking for ways to implement the demos in other outreach events.*
- *Hands-on is engaging for kids; making something to take home is always a hit!*

- *Too many kids don't do enough with their hands. I feel that being a Maker gives them a gut understanding that they will not get otherwise.*
- *We also very much enjoy doing our little bit to give the visitors to WAAAM a learning experience.*
- *So many people don't have a basic understanding of the STEM field or how we need to prepare students for them.*
- *The Maker Movement helps us to focus students on "lost skills" generationally. Most students aren't allowed or don't have access to simple tools. Students and parents are excited about creating & designing something on their own.*
- *I think the Maker Movement is a powerful tool that museums can (and should!) leverage to reach new audiences and offer unique educational experiences that they are not getting in school or anywhere else.*

Some respondents reported that their institutions were interested in continuing their involvement in the Maker Movement, but they weren't sure what their involvement would be:

- *We are trying to figure out how we are going to be involved in the Maker Movement at this time. It will be included in our institution in the future but we are still working out what that looks like.*
- *Maker Movement is still new for me!*
- *The mission of our center is more about the "stuff" (the new materials) than the "making" (the engineering). We have participated in some Makers Faires, but it's always a bit of a stretch for what we do.*
- *I think the library is a natural place for children to learn creatively, and I hope our district will allow us to make space upgrades down the road that make this an even better possibility.*

Interviewees echoed the comments received from survey respondents about the activities. They were mostly pleased with the activities, with a few exceptions in which materials were considered too dangerous to use:

- *I thought that the hand gripper that they had us build had more of a wow factor in the way that it looked but it didn't quite function as well as the other ones I've built in the past. But the kids really, really loved it.*
- *I would say probably my favorite activity of the ones that we did were the little air conditioning units. I felt like that was perhaps more open-ended in the approach to the activity. It really gave the kids an opportunity to do some problem solving and really look at what made the best solution. Another favorite was the making things safer activity, building the structures out of the gum drops. For that activity, we always have things in our Maker Space that the kids can use so we decided to make like independent little shake tables using a box set motor inside of like a*

plastic butter tub. And that made it really awesome because then the kids could just, they, they got to build their own shake table as opposed to us building a larger one that everybody got to experiment on. And then they could hook up different electrical voltages to it to increase you know the earthquake effect to make it stronger or lesser to see how well their structure could work. They were able to take that home with them so they could continue experimenting and exploring that structures and trying to make them stronger. I was so impressed with the way that it went I'm actually looking at adapting that into a full in-house workshop. The kids loved it.

- *The only project that we had to modify was the pine box derby cars. To actually shape the box, the hand saw was not going to do it. We did not have a proper workshop. We did this in our lab space. So we did not have vice to hold it, to be able to reshape it, nor did we have the time to get to that point. What we did is send it home and asked the parents, "Do you have the tools at home to continue this project?" And they indicated that they did and the parents were excited to go ahead and do that. So, in our space we were able to put on the wheels. We were able to do the design and talk about it and tested it going down the ramp. But we were not able to actually shape the car out of the block of wood.*

- *I most enjoyed seeing it come together on the floor of the museum and watch parents and kids working together on the projects and seeing them get excited.*

- *In the Colder activity, during the second stage where you're actually creating a little cooling box, that's really an assembly activity. There's not a lot of creativity or flexibility around how the kids are going to go about that. You can play with the insulation a little bit but I don't think that really matters a tremendous amount. The Wilder activity has the same challenge. Basically the project is to create a specific thing -- basically it's a building activity. Which is fine. There's nothing wrong with that as long as that's the intent of the activity. It's just not learning how to do something. In the future, I'll probably gravitate more towards the activities that have a little more creativity and more degrees of freedom in what the outcome should look like.*

- *It really was nice to have it all planned out and have all the lessons there and you could choose what you wanted but it was well done. To have 90% of the supplies come to your door was just such a gift.*

Materials

- *I was really impressed with the quality of the materials and the things that they sent. However, for the pinewood derby cars, the saw that they had sent was not the proper saw for cutting those types of things. I find that kids usually don't have the muscle strength that a full-grown adult's going to have and American style hand saws only cut when you push forward. They don't cut when you pull back. So, if you're sitting there sawing back and forth you're wasting half of the work you do. So, I really prefer to use the Japanese style pull saws because they cut both on the forward motion and the backward motion. And I just find that that makes it a lot easier for kids to manage that experience because they're cutting when they go forward, they cut when they go back so there's not as much likelihood of the saw binding or getting caught in the wood and it doesn't take as long for a kid to complete that task.*

- *The box itself is great. As educators, we love opening up a box and the materials are there and we can find them -- even down to the hammer and the saw. That was excellent. Being able to open the box and just start sorting supplies and knowing that the majority of it was there for what we were going to need was excellent. That saves us on the prep time and leaves us for the thinking time we don't have to worry about the materials aspect of it.*

- *There was a guide that had like little typos or something. Also, there was discussion about the earthquake table, the shake table, and not a lot of guidance on what it was supposed to look like or how you were supposed to do it. There were a couple of links, but it took some digging to figure out what I was supposed to do. So some things were a little unclear. But, the materials that were provided were really good.*

- *The saw wasn't very good. I get the feeling that nobody's ever done much with a regular handsaw there because it's not an appropriate tool at all for anything. That's just an experience thing.*

DVDs and PowerPoint Slides

- *I loved all those resources and I hope it's okay if I keep using them. The video clips were good as was having the PowerPoint presentation to follow up the video clips that was short -- enough even with the younger kids. The 5-6 years olds were able to sit there and maintain and engage in those discussions. A lot of times when I'm Making with the younger kids, I like to sit down and talk to them first. I encourage them to grab a piece of paper and come with an idea, even if they're only five or six and*

it's just going to be scribbles. I have them sketch out a design and talk about it before we run this straight to the tools and start grabbing and building.

- *The DVD resource -- leading me also to the website to get access to all of the other stuff from NOVA -- has been tremendous. We have a school grade level meeting every other week so 5th grade teachers can all meet together to plan. Simultaneously, all of our 5th grade students end up in our auditorium for about an hour, where they're supposed to do homework and other engaging activities. Once I received the NOVA activities, I went to show the students in the auditorium. We showed video clips. They enjoyed watching in that large group setting. It really sparked the kids' interest. And, so, the DVDs have been a tremendous resource, not only for the program itself, but for the whole rest of the school.*

- *The first thing we did was we set-up the DVD on my computer monitor and did a slide show. We had a discussion and then I took them out into the museum and filed them into a 1948 DeSoto four door sedan and I said, "Okay what's the difference in this car? Would you feel safe riding in this car? What's the difference between this car and your parents' car?" And first, "Oh, no seatbelts" you know? And then we went all the big things that makes you feel safer are and how things have developed and how engineers had developed making you safe. Then we went back and watched a video on the buildings and then we started in on the gumdrops and fix them. The kids came up with some pretty good, very strong structures. We had a little shaker table and, and we piled cans of you know vegetables and cat food. They piled them up pretty high and shook that table and those structures really held. So, that was a lot of fun. And our youngest member, a little three year old, was so proud of the fact that she was able to stick two toothpicks in the gumdrop. She went around saying, "Look. I did this. I did this."*

- *The presentation materials were a little hard to work with. I think it may have had to with fonts that they used that not everybody has, for instance. When I was trying to customize the PowerPoint presentation I was working with it in both PowerPoint and Key Note. It was nice that they provided a PDF version of it, which is what I ended up using just because it was a consistent. I was trying to customize it some on the PowerPoint version and also in the Key Note version. It wasn't cooperating. It was doing weird things for me. So, I just gave up on that. They should test these things next time around if they're going to provide presentation materials just make sure it's something that somebody who's not part of the organization can open it up.*

- *There was a little disconnect between the Wilder video clip and the project, although it was relatively close. And, there was a pretty big disconnect between the Faster video clip and the project itself because the Faster video clip really dealt with torque. But the project itself really didn't explore any of that at all because the project itself was much more about the structure of the vehicle and if the kids wanted to play around with things usually what they ended up playing with was shape to some extent, although that really didn't have an impact on the outcome. Or weight, which is much more about inertia, momentum, and things like that. So if the project had been about creating a rubber band powered car then I think you can get into discussing torque.*

- *I appreciated them sending the DVD because I was never sure what our wireless was going to be. What I did end up doing, however, is going back to the video parts that were on YouTube and pulling out different sections. It was also nice to know that I didn't need to worry about that if the wireless went down. It's very calming when you know you have a hard copy of something to use.*

- *I thought that the slide show (the PowerPoints) that accompanied each activity this year were honestly pretty weak. There is some science background that could be a little more fleshed out. There could be better pictures. Wilder has a lot to do with nature inspired science. They started to maybe pose some introductory questions but they're not really leading us really to where we want to go with talking about bio inspired science or materials. And I think that happened for a couple of the other activities as well. I get the feeling that two years ago it was all about the stuff, Making Stuff. And the stuff meaning materials. Stuff meaning science in term, pushing forward this really interesting materials revolution that's really happening now. This year's effort was more making and less about the stuff. And that's not a bad thing because I've presented at small Maker's Fairs locally and I'm tuned into all of that world, but it also ties into some of my more mature feelings about the movement now that I've been engaged in it for a couple of years. I think that it's only as useful as the science that you tie into. It's not like we can just engineer. We've got to tie it into science all the time or the teachers can't find a place for it. Season 1 was better at doing that.*

- *The Faster video didn't really have much to do with the activity. If you were to shape the car it, it wasn't about aerodynamics. It was about power.*

Some participants wished that the boxes had come with a handout guide that was provided by NOVA during Season 1 outreach:

- *This is the first year we've done NOVA Making Stuff outreach, but I was pleasantly surprised when I saw the handout guide they did in Season 1. That was really amazing. I understand we don't want to waste materials and printing costs can be kind of high, but that guide was really cool. I was bummed that one of those didn't come with this year's stuff.*

- *There's a gentleman who's been posting a lot on the community who made up some really good questioning worksheets to go along with the activities. It is great to hand to the facilitators and to the parents and say, "Ask these questions." His resources were tremendous and I'd actually printed off all of those to stick inside my NOVA folder to use the next time that we do this. So things like that within the facilitator's guide would be excellent.*

- *I ended up making and I think a couple of other people ended up making some kind of handout versions of the project materials. So, what I made was two other documents and I posted them on the site. I created a facilitator's guide or, basically, a volunteer's guide because I had a couple of other people helping me with the activity. So, instead of having them read through the 15-20 pages of the books that were provided by NOVA, I boiled it down to some of the key things that are going to happen, including some questions for you to ask as you walk around. Most of that material was already in the book, but it was just a one to two page version of what a non-primary facilitator might need. The other thing I did was create handouts for the participants so that they would have a page on each activity so they can have something at their station when they're going through just to remind them of what it is they're trying to do and what are the steps. So, that might be something that could be relatively easy for NOVA to create as part of their packaging -- a hand-out version. I know other people did it too because they posted them online.*

- *I got the Making Stuff info from Season 1. I'm referring to the activity sheets themselves. They were actually broken into two parts where it was a demonstration sheet and it had a nice introduction to some of the science. It was actually titled Science Background. There was an overview based on some science in it. Then there was the materials list. It was really clear. Then there was a quick video clip and then you have an advance preparation for this particular one I'm looking at and they were all very similar to this. They certainly did a really nice job in Season 1 in preparing us clearly and cleanly for the demonstration and for the activity and I had no complaints. This year, I don't feel the same way. In fact, a*

couple of people had to come up with their own. These are wonderful. One person came up with his own activity sheet that made me say, "I've got to take this and actually make my own from this." I'm not trying to trash anybody's work at NOVA. I'm just saying that I think that there could be progress in making this a little clearer, more organized. And it's not like you have to reinvent the wheel. It's right here. Like the ones from Season 1. The sections are nice.

CoP members reported that there was information missing from the materials that they received:

- *One of the things that's really important to somebody like me (because I'll go out and do workshops) is timing. I did not see any timing information in the NOVA guide to give us an idea of how much time would be good. So, on member had that experience and he gave it that to me.*

- *We need a real materials list with part numbers.*

Online Community

Members reported that they enjoyed learning from others in the online community:

- *There were definitely parts of it that I found very useful, like a lot of the hangouts, even if I wasn't able to like catch them live I tried to go back and watch all of them. I enjoyed the hangout with David Wells. I've met David Wells several times and I just think he's an amazing resource. So, that was really cool and fun. I don't know how much the community necessarily helped me just because I've been so ingrained in this kind of Maker movement for the last two years and I'm really active on the other communities, but it was really great and enlightening to see a lot of the work and stuff that other people were doing. I'm a big fan of the community and I'm a big fan of the Google plus side.*

- *I was not able to attend a lot of the webinar sessions or the hangouts because of scheduling conflicts. I was able to go back to a lot of the comments to see what people had made suggestions about -- just to scan through and to see how people had set up theirs and just compare it with what we were getting ready to do. That was very useful to be able to see that.*

- *I've certainly done these kinds of programs before, but, what was most fun for me or most interesting for me -- apart from just doing the actual projects -- was learning from what the other outreach partners were*

doing, the advice that NOVA gave, the hangouts on air, and some of that support really enriched the experience for me. I thought that the hangout approach worked well.

- *It was helpful when people would post things, pictures or questions. There was definitely a critical mass there. I felt like there was enough people that I felt like I was part of a community. There was something like 70 outreach partners and obviously they weren't all on the website -- 10 to 20% of them actually were active. I think that was enough. It seemed like the community was relatively robust and there seemed to be things getting posted on there on a pretty regular basis. Inevitably, some people posted a lot and some people posted once in a while, but, that seemed to be fine.*

- *It was just a lot of fun to talk to people and to see what people were doing. One member did some guides for people that was really nice because it helped the learning curve for those of us who weren't doing everything at once but were doing things one at a time over a period. And that was really nice of him and it was helpful. Different people have different talents and it's great to be able to take advantage of those talents and that kind of free sharing environment.*

- *The most useful thing about the online community was the problem solving with specific problems. Like, you realize that you need to hold the tubing this way so you don't cut yourself. I hate to get really nitty-gritty but you just can't have this many activities that need anyone, even an adult wield like a utility knife because it's just too gnarly. People are going to get hurt. I actually got cut just barely on my finger but it could have been deeper. But, I can't give a kid that. And then, related to the pinewood derby cars, we hit upon the potato thing as a group. You cut a potato and then you put the wheels on the potato and that was a savior for that activity. And with that we came up with that just in the Google group.*

Members also reported that they felt like they were able to be helpful resources for other members:

- *I felt like I was a good resource for a few people. I had a couple of people that were emailing and asking me, "Hey, we're trying to do this…" or "I see that you use these types of tools in your space a lot. How does that work for you?" So that was really great.*

- *Being able to post about what we were doing and showing it to others was helpful. I like the community part of it.*

- *I felt like I was a good contributor when I posted materials that we had created or feedback on the projects and answering other people's questions. So, if I was doing the Faster Project and I had created some materials for that, or I had questions about it, it was nice to have a tag or subcategory of Faster stuff in one place. I definitely dipped into what other people had posted and that was helpful to see either how they were approaching things or what sort of challenges they were finding. It felt good to me to be able to put stuff out there.*

- *I felt like I could contribute because we chose to do the cars and the Colder and some people had not done that yet and I could say, "This is what worked for us and this was what I would not do next time." Not only did it support me, but I could support others.*

- *I posted a question about the earthquake shaking table and I ended up just having to come up with researching it on my own. I posted a question you know like, "Is there just a simple picture of what I'm trying to make here?" And I never heard anything from anybody. I just made up my own thing that I liked. But, I posted a picture of it.*

Three members reported that their interactions with others as part of the MS2 outreach community led to relationships outside of the community:

- *It was great to make the connections with Steve Davy with the Maker Education Initiative. That started a whole conversation with us and then we were selected as a Maker core host sight. They provided a lot of other excellent opportunities for us outside of the NOVA Making stuff outreach that are allowing us to just continue developing and building our program. Beyond that, I predominately use my Google plus account for work networking. I've added several people from the Making stuff outreach community to my Google plus. We talk pretty often. It's been really beneficial and I think there are several of them that I'll continue talking to afterwards.*

- *I did go to one of the other partner's events. The Children's Museum in Boston had an event that I went to. It was nice to know about what other people are doing.*

- *The community has just made a lot of connections and opportunities with each other. There's a lot of communication, a lot of information going back and forth and I think it's just really helpful.*

Others were disappointed that more individuals did not participate actively in the online community:

- *I was very disappointed that more people didn't participate. We had 75 sites, so we should have had at least 75 people, but we only had three or four you know involved in the discussions. In fact, I haven't seen 75 people that have posted anything on the website about what they've actually done or anything like that. That was kind of disappointing. I figured everybody would be more actively involved than that.*

- *It's too bad, but we never had a lot of people trying to participate in office hours or hangouts, so I don't know what it would be like if there was 20 people online. The ones where it felt like it was sparse were the office hours or hangouts on air. There just weren't that many people watching live to ask questions or to have any sort of exchange.*

Others reported experiencing some initial challenges with the Google Plus format:

- *I still don't understand what Google Plus is, but I figured out what buttons to push and (laugh) I don't know why I pushed those buttons but they got me to where I wanted to go. It was all new to us. But, I eventually managed. I was able to listen to everything and actually participate.*

- *Google Plus was familiar to me, although I had never done it with a large group before. There were things about the platform that took me a while to understand and still don't seem too natural to me (like the way it displays information). So, for instance, if I'm looking at this screen, it's not clear to me exactly why the things that appear on the top of the screen are there. Some of the posts are there because it's the most recent comment or posting, but others are not recent. So, it was a little hard to navigate but I think every platform has its own little quirks.*

One member commented on the lack of advertising help from NOVA:

- *A lot of people were posting on the site what they were doing and what they were planning on doing and the moderators were saying that NOVA would help to advertise or sort of help publicize these events and I don't know if anything came of that -- other than publicizing it to other people who are outreach partners. If NOVA ever put it on Twitter, I don't know if that ever happened. So, I don't know how much publicity help we got from NOVA or how much I should have hoped for. That was the only thing that I wish maybe we could have gotten a little more leverage on just because*

we've sort of felt like NOVA's got much more reach than we're able to generate ourselves as a small museum.

Another member expressed a need for more information sooner in the process:

- *Some of the conversations and the hangouts online would have been great to have a little bit earlier. As people were starting to think about how they would do the activities there was a little bit of radio silence early on. Also, I don't know if they were late shipping out, or what logistics were going on behind the scenes that were difficult to manage, but there was a period when I was ready to start planning stuff but NOVA didn't give us as much lead time as I would have liked. It seemed like it could have been frontloaded a little more. But, everything picked up speed pretty well and there was a lot of momentum and good energy once things did get going. In the end, it worked out well.*

General Comments

- *I really loved the experience. We're very excited about it. I'm planning on adapting several of the activities to kids' workshops and I really hope NOVA does it again next year. I'd like to see them get more in-depth and get some different tools out there. But it's a really great program so I really appreciate you guys putting it all together and finding the funding to do it.*

Some members commented on how the Making Stuff outreach activities bolstered their own local outreach activities:

- *When we share this program with students and parents we say, "These are NOVA activities from PBS. Students across the entire nation are doing these same activities with you. So if you're traveling and you see a Maker Fair and they've got some NOVA Maker events, they might be the same things that we've done here." We do that so that they now know the culture, they know what to expect if they're traveling -- even in the summer – and they run across a Maker Fair so that they won't be afraid to go. They'll say, "Oh yeah that's what we did at our school."*

- *The museum director was certainly impressed. They want to us to do something every second Saturday now.*