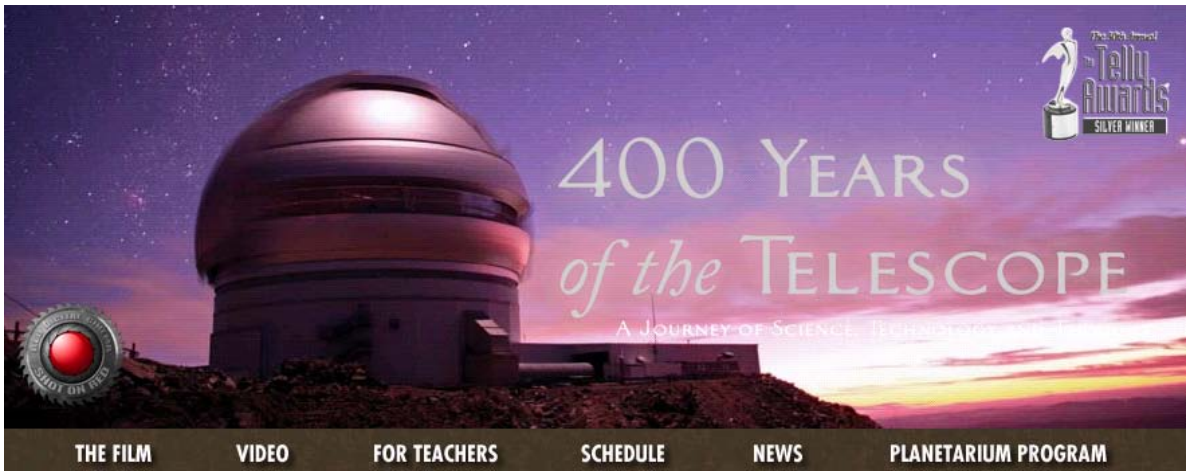
400 Years of the Telescope: Summative Evaluation



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About the Institute for Learning Innovation:

Established in 1986 as an independent non-governmental not-for-profit learning research and development organization, the Institute for Learning Innovation is dedicated to changing the world of education and learning by understanding, facilitating, advocating and communicating about free-choice learning across the life span. The Institute provides leadership in this area by collaborating with a variety of free-choice learning institutions such as museums, other cultural institutions, public television stations, libraries, community-based organizations such as scouts and the YWCA, scientific societies and humanities councils, as well as schools and universities. These collaborations strive to advance understanding, facilitate and improve the learning potential of these organizations by incorporating free-choice learning principles in their work.

EXECUTIVE SUMMARY

INTRODUCTION

The *400 Years of the Telescope* project, funded by the National Science Foundation (DRL #0813414), celebrated the International Year of Astronomy in 2009 and was a unique partnership among a public television station, a production studio, two planetariums and a leading astronomical society in the United States. The main project partners who developed the project's chief components were Interstellar Studios, Southern Oregon Public Television, I'miloa Planetarium in Hawai'i, the Buhl Planetarium in Pittsburgh, and the Astronomical Society of the Pacific. The Institute for Learning Innovation (ILI) was also a partner and served as the project evaluator.

400 Years of the Telescope included five main components:

1. A one-hour PBS documentary
2. A 22-minute planetarium program
3. A website with astronomical information
4. "Star parties" (nighttime astronomical viewing events)
5. Promotional events hosted by PBS affiliate stations

The project aimed at engaging the public in astronomy, and encouraged them to look up at the night sky. It also provided learning opportunities that support a more science-literate, science-engaged public by presenting linked choices for engaging in observational astronomy.

PURPOSE OF THE EVALUATION AND METHODS

The purpose of the summative evaluation of *400 Years of the Telescope* was to see to what degree the project's linked experiences increased active engagement in astronomy through three evaluation questions:

1. What are the individual and cumulative impacts of the menu of deliverables?
2. Which path(s) did people take when engaging in the activities?
3. What is the most effective way of getting people to look up at the night sky?

Multiple methods were used to answer the above questions. The chief method was online surveys (n=848) with audiences for the five deliverables included in a variety of ways: through PBS email distribution lists for the documentary, by distributing cards with the survey link at the planetarium program and star parties, and through online links for the website. Telephone interviews were conducted with a subset of the online survey respondents a few months after the online surveys (n=34). Complementary methods included focus groups discussing the planetarium program (n=34) and surveys at PBS station events to introduce the project (n=244).

For the online survey, four main markets presenting both the PBS documentary and planetarium program were selected and included in the summative evaluation: 28% from Lincoln, Nebraska (Nebraska Educational Television), 15% from Portland, Oregon (OPB), 14% from Philadelphia, Pennsylvania (WHYY) and 8% from Baltimore, Maryland (Maryland Public Television). The online survey

sample included a relatively equal split between males (58%) and females (42%), were mostly Caucasian (84%), had a household makeup of either one adult (26%) or multiple adults without children (49%), a college degree (30%) or graduate degree (41%), and about half (52%) were PBS members.

When interpreting the results, it is important to keep in mind that three quarters of the sample (n=749) viewed the documentary, which served as the project's entry point for almost two-thirds (64%) of respondents. Since the majority of this group was reached through the PBS member email lists, this sample may be skewed by the fact that the list included a higher proportion of PBS members than exists among the general public who engaged in the *400 Years* deliverables.

MAIN FINDINGS

An important aspect of the evaluation appeared in the benefits offered by multiple paths for engagement with the *400 Years* project. While each deliverable achieved positive outcomes on its own, for the majority of the main outcomes measured in this study, participation in more deliverables resulted in higher outcomes. This means not only that the different deliverables complemented each other but also that each of them delivered something additional to the experience that positively impacted astronomy-related outcomes. Furthermore, participants interviewed by telephone several months after their involvement stated that engaging in the *400 Years* project changed the way that they think about astronomy, at least to some degree. Overall, there is evidence to support the model that providing multiple entry points was effective in engaging multiple public audiences in astronomy.

Engagement with the *400* Year project: The majority of survey participants (71%) engaged in one of the *400 Years* deliverables, with almost one-third (29%) engaged in more than one. One in five (19%) engaged in two deliverables, 7% in three and 2% in all four. Those who entered through a star party had the highest average number of deliverables (2.0), followed by those entering through the website (1.8). Individuals entering through the planetarium and documentary had the lowest average (1.3). The documentary included the highest proportion of participants (76%), followed by the planetarium program (22%), website (20%) and star parties (15%).

The documentary attracted a larger proportion of men, PBS members, and those with no children in the household. In contrast, the planetarium program attracted non-PBS members, and those with children in the household. Both the website and the star parties attracted non-PBS members and those who had previously looked through a telescope. The star parties also proved more likely to attract those with children in the household. When asked why individuals did not participate in more of the deliverables, the most common responses included not knowing about them, logistics (e.g., location, transportation) or a busy schedule.

Awareness of the *400 Years* project: Lack of awareness of the project's multiple components seemed to be an issue, since even for those who participated only 15% were aware that it was part of the larger *400 Years of the Telescope* project. The entry point to the project was related to project awareness, with the highest level of awareness found for the star party (54%) compared to awareness of the other three deliverables: the planetarium program (13%), website (12%) and documentary (10%). Those entering through the documentary had approximately equal awareness of the other main deliverables, while those entering through the planetarium program, the star parties, and website had a wide range of awareness of the other deliverables. Overall, those sufficiently engaged with astronomy and telescopes

to attend a star party proved much more likely to be aware of the project in general than those entering through the other deliverables.

Impact of the Deliverables: The survey included nine items dealing with project participation that covered the areas of interest, attitudes, affect, intentions and self-efficacy (i.e., feeling there are tools they can use to do astronomy). The highest impacts appeared in awareness of the ongoing discoveries in astronomy, of the conclusion that science is interesting, and of the fact that looking through a telescope is an awe-inspiring experience. Which deliverables someone engaged in did have an impact on these overall project outcomes. The documentary yielded differences in the interest and attitude categories, while the planetarium impacted self-efficacy and intentions. The website and star parties impacted most of the categories, so that those two deliverables tended to produce multiple impacts in different areas. One hypothesis to explain these differences suggests that visiting a website and attending a star party can be tailored toward the experiences and interests of the participant, whereas a documentary or planetarium program remains more fixed in their delivery. In any case, these findings suggest that the four deliverables complemented each other well. The documentary proved particularly effective in encouraging the realization that astronomers are constantly discovering new things, since only this deliverable had a significant impact on responses in this area, in comparison to those who didn't view the documentary.

In addition to answering questions about the overall project, respondents also answered a set of questions about the impact of each deliverable in which they participated, in order to determine which deliverables had an impact in specific areas, such as learning, awareness, attitudes and intentions. Each of the deliverables seemed to have a good self-reported impact on those who engaged in them, with the average ratings (across deliverables) ranging from 5.0 to 6.6 on a 7-point scale. The documentary had the highest average ratings for the specific deliverable outcome statements, and the greatest impact among specific items involved in the realization that there is still so much more to learn about the universe, helping participants to perceive the beauty of the universe, and motivating participants to look up at the night sky. Each of the deliverables, based on these items, seemed to have a measurable impact on participants' astronomy-related appreciation, awareness, learning, inspiration and intentions.

Respondents were also asked to complete the following sentence for each deliverable in which they engaged: "*I never realized that…"* Responses were categorized, and these were grouped into three main areas: learning, awareness and satisfaction. The distribution of these open-ended responses among these three categories depended greatly upon the deliverable engaged in. As a proportion of total responses to this item, learning was highest for the documentary (69%) and the planetarium program (57%), followed by the website (36%) and the star party (11%). For awareness, the distribution reversed, and it was highest for the star party (75%) and the website (48%), followed by the planetarium program (33%) and the documentary (29%). The satisfaction responses were much more consistent, ranging from 8% for the documentary to 13% for the website. Again, the deliverables seemed to complement each other nicely on these outcomes.

Participating in Multiple Deliverables: As mentioned above, roughly one-third (29%) of respondents participated in more than one deliverable. Some patterns appeared in the specific paths by which these respondents entered the project and which deliverables were most likely to engage them after the first. Those who first engaged in the documentary were most likely to engage next in the website, then the planetarium program. Those engaging in the planetarium program first were about equally likely to attend a star party or watch the documentary next. Those who attended a star party first were most likely to watch the documentary next. Lastly, those visiting the website first were equally likely to see

the planetarium program or to attend a star party. Men were slightly more likely to engage in multiple deliverables, and non-PBS members were more likely than PBS members to engage in multiple deliverables. Participants who had recently looked through a telescope also engaged in more deliverables, which is not surprising since this group may be the most likely of all of them to engage in the *400 Years* deliverables.

A series of statistical analyses, using stepwise linear regression, were run to see which groups of variables were the most predictive of the main outcome measures. These were run for the overall project, combining the impact of multiple deliverables, as well as with an examination of each deliverable on its own.

Inspired to Learn More About Astronomy: For each of the **specific deliverables**, feeling inspired to learn more about astronomy partly resulted from gaining an appreciation about the work that astronomers are doing. For each of the four deliverables, being inspired to look up at the night sky was also a good predictor of being inspired to learn more about astronomy. That is, being inspired to learn about astronomy included both appreciating astronomer's work and being inspired to look up. For three of the four deliverables, being inspired to learn more about astronomy also included saying there's still so much to learn about the universe. This indicates that the more affective factors such as being inspired and appreciating astronomical work have a greater impact on being inspired to learn more about astronomy than saying you actually learned about astronomy (there were other "learning" factors not included as important factors for this statement). In other words, learning something doesn't always lead to being inspired to learn more; other factors trump learning, at least for these deliverables.

Inspired to Look Up at the Night Sky: For the **overall project outcomes**, being inspired to look up at the night sky was best predicted by how much participants thought looking up at the night sky offers a way to feel more connected to the universe, and whether or not they felt there were tools they could use to do astronomy. Basically, being inspired came down to feeling connected and feeling like they could do astronomy.

In examining being inspired to look up at the night sky for the **specific deliverables**, some consistency appeared across all four deliverables. For all four, the best predictor of being inspired to look up was feeling inspired to learn more about astronomy. That is, the more someone was inspired to learn about astronomy the more they were inspired to look up, and vice-versa. The next best predictors for being inspired to look up varied by deliverable, although being inspired included both cognitive (thinking) and affective (feeling) factors. For the planetarium program and website, learning about the history of astronomy was included next, followed by more affective variables such as seeing how beautiful the universe is and gaining an appreciation for what's out there. For the documentary and star parties, seeing how beautiful the universe is was included next, followed by more cognitive measures like learning about how telescopes work.

Longer-term Impacts: To further understand participants' experiences and astronomy-related behaviors since engaging with the project's deliverables, a sub-set of participants (n=34) were interviewed by phone a few months after their participation. Not only did nearly all of the respondents state that engaging in the project changed to some degree how they think about astronomy, but four fifths of them also said that the project influenced them to seek out other astronomy-related experiences; two fifths said it had a great deal of influence.

As many of the participants were already interested in astronomy and telescopes before engaging with *400 Years*, many of the longer-term impact involved the reinforcement of thoughts about astronomy, or encouraging them to do activities they were already engaging in. For example, while many respondents were already looking up at the night sky, half of them reported looking up at the sky more often. A few individuals reported looking up at the night sky more purposefully for the first time after engaging in *400 Years.* Meanwhile, two-thirds of those who reported already owning a telescope said they used their telescope more often after engaging the project, with some specifically saying they were more inspired as a result of their participation. One positive and unanticipated outcome was the fact that nearly a quarter of those interviewed said that in the months after their engagement, they were helping others to look up or learn more about astronomy. In some cases this activity involved family members, while others helped people they didn't know prior to the outreach activities.

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INTRODUCTION

400 Years of the Telescope was an NSF-funded project celebrating the International Year of Astronomy in 2009 with a unique partnership between public television, a production studio, planetariums and an astronomical society. The main project partners developing these components were Interstellar Studios, Southern Oregon Public Television, I'miloa Planetarium in Hawai'I, the Buhl Planetarium in Pittsburgh, and the Astronomical Society of the Pacific.

The project's is a project with multiple components included the *400 Years of the Telescope* PBS documentary, a planetarium program called *Two Small Pieces of Glass*, a website (www.400years.org) and a tool kit for amateur astronomers. These components were released during the International Year of Astronomy in 2009 to coincide with the 400th anniversary of Galileo looking through a telescope at the night sky. The purpose of the activities was to provide the general public with a menu of linked choices for engaging in observational astronomy. In other words, the project hoped to inspire people to look up at the night sky by engaging them with media-centered deliverables like the documentary and the planetarium program, as well as by activity-centered deliverables like the astronomy club events and the interactive website.

The various components of the project launched in the spring and summer of 2009, starting with the launch of the PBS documentary. The documentary was launched in April, 2009 and rebroadcast on slightly fewer stations in October 2009 and April 2010. The planetarium program was shown in planetariums starting in May 2009 with some of the planetariums still showing the program at the time this report is being written. The star parties were hosted by members of the Night Sky Network (NSN) and were planned independently of other *400 Years* activities; data collection for these events occurred during the summer of 2009. The website launched in March 2009 and is still active at the time this report is being written. While most components were launched within a few months of each other, people could have experienced the four main project components together over a period of 4 to 6 months.

In addition, there were eight markets that were chose to be "enhanced" so that all four of the main components, plus the station events, would be available in the market. In this manner, the evaluation could focus on these areas to look at the cumulative impact of participating in multiple components. The public television stations in these areas received some funding to defray the cost of participating in the project and also coordinated launch parties at local informal science institutions such as museums and planetariums. The sites included the following stations: WTTW (Chicago), WHYY (Philadelphia), NPT (Nashville), NET (Nebraska), WQED (Pittsburgh), RMPBS (Colorado), OPB (Oregon), and MPT (Maryland).

A theory of action was developed, describing the project and showing the multiple paths at which people could enter and experience *400 Years* (Appendix I).

EVALUATION PURPOSE AND QUESTIONS

The purpose of this summative evaluation was to see to what degree the menu of linked experiences contributed to sustained and active engagement in astronomy.

The main evaluation questions were the following:

1. What are the individual and cumulative impacts of the menu of deliverables?
2. Which path(s) were people taking when engaging in the activities?
3. What is the most effective way of getting people to look up at the night sky?

In general, the evaluation sought to gather detailed information about the project's components and how successful they were. This included looking at each component on its own, and also to see how the components may have worked together to reach the project's objectives. This last part was extremely important since the project's theory of action included the assumption that people engaging in more than one component should have more positive outcomes than those engaging in just one component by itself.

Limitations

As with any study, in planning and carrying out the study there were limitations in what was possible. So that the results may be interpreted in the proper context, below are reported a number of circumstances that likely affected the results of the study. Sometimes this was due to the scope of the study, other times the methods being used, and other times the ability to reach the target audiences. The main areas identified as limitations in this particular study are the methods chosen for the study, who was included in the study, and the sample sizes.

1. Methods chosen for the study – To be able to compare across the various components, and to ensure that data collection methods didn't impact results a single method, online surveys, was chosen as the main data collection method across all four components. While this method in general worked well, it worked better for some components compared to others. For example, it proved very successful as a means for including PBS members who had seen the documentary. However, there were challenges getting people who had viewed the website, planetarium program and attended the star parties to fill out the survey.

2. Who was included in the study – The study focused on eight specific markets (Chicago, Philadelphia, Nashville, Nebraska, Pittsburgh, Colorado, Oregon, and Maryland) that were showing the documentary and planetarium program, and had astronomy clubs using the materials developed by the Astronomical Society of the Pacific. There is a chance that the audiences in these areas interacted differently with the components than other markets would have. However, the web sample was not sampled using a geographic approach so this limitation does not apply to the web sample. Additionally, the online survey sample was heavily skewed to the documentary audience, which was made up of many PBS members.

3. Astronomy experience – Many of those included in the study had a sizable amount of previous experience with astronomy. This means that the results may not be representative of the

general public who engaged with *400 Years*, and may overestimate the overall impact of the project. Additionally, the more times we talked with people, the more likely they were to have increased past experience in astronomy. Therefore, in the T2 online survey and the telephone follow-up interviews, the likelihood of having people relatively unfamiliar with astronomy was low.

4. Sample sizes – As mentioned above, sample sizes for some of the methods were small, and as such, these groups may be underrepresented in the analysis. In addition, since they were smaller it was more difficult to break these methods down by which market they were in or other factors. Originally, it was hoped that sample sizes would be large enough to allow for meaningful comparisons along multiple dimensions.

METHODS

To answer the evaluation questions above, a mix of quantitative and qualitative methods were employed, including the following:

Table 1: Summative Evaluation Sample, by Method

Method	Number of Individuals Surveyed	Percentage of Total Surveyed
Online survey	848	75%
Follow-up phone interviews (subgroup, online survey)	34	3%
Focus groups	34	3%
Station event surveys	244	22%
Total	1,126	100%

Online survey: While a multitude of methods were considered for the main data collection approach, it was ultimately determined that using an online survey would accommodate multiple entry points (e.g., PBS documentary, planetarium program, star parties hosted by members of the NSN and website) while still ensuring that the same method was being used for all entry points. There were a number of ways the invitation to the online survey was distributed:

1. PBS documentary – local PBS affiliates either sent an email or included an announcement in their e-newsletter with a link to the web survey.
2. Planetarium program – cards were handed out to visitors viewing a planetarium program, with a link to the web survey printed on the card.
3. Star parties – cards were handed out to those attending amateur astronomy events in coordination with the Astronomical Society of the Pacific (ASP), with a link to web survey printed on the card.
4. Website – for the *400 Years* website, a link was placed on the main page inviting viewers of the site to participate in the web survey.

After completing the survey participants were eligible to be entered into a drawing for a gift card. More details are provided below for how various groups were recruited as participants.

Online Surveys

The primary method used in the summative evaluation was an online survey completed by members of the public who had engaged in at least one the project deliverables. The survey was designed to gather information on participants' familiarity with the project as a whole, which deliverable(s) they had engaged in, the order in which they had engaged in them, impacts of the deliverables individually and in conjunction with one another, experience with telescopes and planetarium programs, and basic demographics (gender, education level, household make-up, PBS affiliate membership, and zip code). The survey included Likert-type ratings scales, open-ended questions, and forced-choice questions.

One of the challenges of administering the survey was figuring out when to ask people to fill out the survey, given that as explained above the different components were launching at different times. To make sure that PBS documentary viewers could answer questions within a few weeks after they may have seen the documentary it was necessary to send out the survey to PBS members in early spring. Given that some of these viewers would not have an opportunity to participate in the other components until after they had filled out the survey, a second survey was sent to those who were willing to be contacted again. This was done for each of the deliverables, so that there was an original time when they filled out the Time 1 (T1) survey and a second follow-up survey allowing them to report any additional interaction with the *400 Years* components in the Time 2 (T2) survey. For analysis purposes, if a participant had completed both T1 and T2 surveys, the T2 survey was used in the analyses since it had the more complete picture of the participant's interaction with the *400 Years* activities. However, having both T1 and T2 surveys allowed for some understanding of when people engaged with specific project components.

The Time 2 (T2) survey largely mirrored the Time 1 (T1) survey; questions regarding familiarity with the project were eliminated in T2 to avoid redundancy and questions regarding engagement with telescopes and planetarium programs were updated to reflect the passage of time (See Appendix A for the T1 survey instrument and Appendix B for the T2 survey instrument). The total sample for the T1 survey was n=849, with n=135 of those respondents (16%) filling out the T2 survey.

Both versions of the primary survey (T1 and T2) were hosted online using vovici.com[1] and surveys were completed by a total of 849 respondents (see Table 2). The majority of respondents entered the study through their viewing of the PBS documentary (64%), followed almost equally though the website (15%) and planetarium program (14%), then the star parties (8%).

Table 2: Online Survey Sample, by Component

Component	Number of Individuals Surveyed	Percentage of Total Surveyed
PBS Documentary	540	64%
Website	123	15%
Planetarium Program	116	14%
Star parties	69	8%
Book insert	1	<1%
Total	848	100%

[1] A paper version of the T1 survey also was used at the Buhl Planetarium. See the section below entitled "Recruitment for the T1 Survey via Planetariums Showing *Two Small Pieces of Glass*" for more information.

As mentioned above, there were a variety of different methods used to recruit participants for the online T1 and T2 surveys. These recruitment methods are detailed below.[2]

Completed survey data were downloaded into Excel for data cleaning and then transferred into SPSS (Statistical Package for the Social Sciences) quantitative analysis software for analysis. Quantitative data were analyzed using descriptive and inferential statistics. Qualitative responses were reviewed using an inductive approach to create general coding categories. Qualitative data were then coded according to this rubric, and descriptive statistics were performed, as appropriate.

Recruitment for the T1 Survey via PBS Affiliates

The primary distribution method for the T1 survey was recruitment through PBS affiliates who were part of the project; 64% of all T1 survey sample were from participants recruited by PBS affiliates. A total of seven affiliates participated in the T1 recruitment: DPTV (Detroit), MPT (Maryland), NET (Nebraska), OPB (Oregon), RMPTV (Colorado), WHYY (Philadelphia), and WTTW (Chicago). Recruitment via the PBS affiliates was tied to the original air date of the documentary (April 2009) and re-broadcast dates (October 2009 and April 2010). See the Findings section for the sample size from each affiliate and when the data were collected. The sampling frame used to recruit participants was including members of the affiliate who had active email addresses and members of the public who visited affiliate-related sites online, including social media sites (e.g., Facebook). To accommodate the affiliates, different methods were used to distribute the link of the web survey to members or the general public. Recruitment methods included stand-alone emails that were only about the survey, e-newsletters to members that included multiple topics, posting a link to the survey on the station's "community" page, posting a short story and the survey link on Facebook. The methods used were chosen by staff at each affiliate with input and review of recruitment materials by ILI researchers.

The incentive for completing the T1 survey was a chance to win a $100 gift certificate to Amazon.com. Participants who completed the survey were eligible to enter a drawing for the gift certificate; one winner from each affiliate was selected randomly from these entries (a total of eight gift certificates)[3]. The gift certificate was then emailed to the winner.

Recruitment for the T1 Survey via 400years.org

The second largest sub-sample of T1 survey respondents was recruited through the *400 Years of the Telescope* website; 15% of all T1 survey sample were drawn from the project's website. To recruit visitors to website, a link to the primary survey and brief language introducing the survey was posted on the project's home page as a banner ad. Recruitment via this link occurred from April to October 2009 and April to June 2010.

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[2] In addition to the methods detailed, one respondent to the online survey was recruited from an insert in the *4oo Years* book, distributed by Interstellar Studios.

[3] Six of the seven affiliates participated in one round of recruitment. MPT participated in two rounds of recruitment (April 2009 and April 2010); one gift certificate was distributed during each round of recruitment to MPT participants.

The incentive for completing the T1 survey was a chance to win a $100 gift certificate to Amazon.com. Participants who completed the survey could choose to enter a drawing for the gift certificate; three winners were drawn at random, one each from the entries collected during the following time periods: April to August 2009, September to October 2009, and April to June 2010 (a total of three gift certificates). The gift certificate was then emailed to the winner.

Recruitment for the T1 Survey via Planetariums showing *Two Small Pieces of Glass*

The third largest sub-sample of T1 survey respondents was recruited from viewers of *Two Small Pieces of Glass*; 14% of all T1 survey sample were from participants recruited at planetariums showing the program. There were two methods of distributing the T1 survey to viewers of *Two Small Pieces of Glass:* 1) postcards directing viewers to a web-based survey, and 2) paper versions of the survey. Postcards developed by ILI researchers were distributed to a total of six planetariums that were showing the planetarium program, three in 2009 and three in 2010 (See Table 3 for a list of the participating planetariums). Each planetarium was provided with a set of postcards, directions for distributing the postcards, and a script for introducing the postcards and the related survey to viewers. The postcards asked viewers to visit a link and participate in a web-based survey (See Appendix C for a sample of the postcards). Recruitment via the postcards occurred from July to September 2009 and April to May 2010. Planetarium staff were asked to estimate the number of cards they distributed; three of the six planetariums did not offer an estimate. This makes it impossible to calculate a response rate for the planetarium card recruitment method.

The incentive for completing the T1 survey was a chance to win a $100 gift certificate to Amazon.com. Participants who completed the survey could choose to enter a drawing for the gift certificate; two winners were drawn at random, one each from the entries collected during the following time periods: July to September 2009 and April to May 2010 (a total of two gift certificates). The gift certificate was then emailed to the winner.

Table 3: Planetariums that Participated in the T1 Survey Recruitment by Distributing Postcards

Planetarium/Location	**Number of Postcards Distributed (estimated by planetariums)[4]**
Participants in 2009 Recruitment	
Davis Planetarium, Maryland Science Center	400
Kendall Planetarium, Oregon Museum of Science and Industry (OMSI)	No estimate available
Mueller Planetarium, University of Nebraska State Museum	No estimate available
Participants in the 2010 Recruitment	
Ask Jeeves Planetarium, Chabot Space & Science Center	No estimate available
Detroit Science Center	163
Miami Planetarium, Miami Science Museum	188

[4] For planetariums with no estimate available, multiple attempts were made but no estimate of the number of cards distributed was provided to ILI.

Paper versions of the T1 survey were also used with viewers of *Two Small Pieces of Glass.* Data collection using the paper-based survey was conducted by an ILI researcher at the Buhl Planetarium at the Carnegie Science Center on October 3 and 4, 2009. An announcement was made before and after the program to alert viewers of the opportunity to complete a survey. The incentives provided to respondents were tickets to a laser-light show or Omnimax movie for the respondent and the group they were visiting with (value of $8 per ticket). Of the planetarium program respondents, 46% completed a paper version of the survey, and 54% completed the online version.

Recruitment for the T1 Survey via Night Sky Network (NSN) Events

The smallest sub-sample of T1 survey respondents was recruited at star parties hosted by members of the NSN; 8% of all T1 survey sample participants were recruited from this source. Postcards developed by ILI researchers were distributed to astronomy clubs partnered with PBS affiliates on the project (See Table 4 for the club names and locations). The postcards were designed for distribution by club members at events held during summer of 2009. Each club was provided with a set of postcards, directions for distributing the postcards, and a script for introducing the postcards and the related survey to event attendees. The postcards asked attendees to visit a link and participate in online T1 survey (See Appendix C for a sample of the postcards). Approximately 1400 postcards were distributed by club members for an estimated response rate of 5%.

A personal celestial object finder, Celestron SkyScout (valued at $200), was offered as an incentive for completing the survey. Participants who completed the survey could choose to enter a drawing for the SkyScout; one winner was selected randomly from all entries of participants at NSN events. The winner was contacted via email for a mailing address for the SkyScout; the SkyScout was purchased by ILI staff online and shipped directly to the winner. The astronomy clubs also received an incentive for their participation in the distribution of the postcards. Each club was sent a moon globe (valued at $49) at the end of the postcard distribution period.

Table 4: NSN Clubs that Participated in the T1 Survey Recruitment

Club/Location	Number of Postcards Distributed (Estimated by clubs) [5]
Amateur Astronomers Association of Pittsburgh; Pittsburgh, PA	150
Barnard-Seyfert Astronomical Society; Nashville, TN	255
Darien O'Brien Astronomy Club; Lakewood, CO	300
Delaware Valley Amateur Astronomers; the greater Philadelphia, PA area	30
Chicago Astronomical Society; Chicago, IL	218
Prairie Astronomy Club; Lincoln, NE	175
Rose City Astronomers; Portland, OR	No estimate available
Westminster Astronomical Society; Westminster, MD	275

[5] For NSN clubs with no estimate available, multiple attempts were made but no estimate of the number of cards distributed was provided to ILI.

Recruitment for the T2 Survey

Participants for the T2 survey were recruited from respondents who completed the T1 survey and indicated they would be willing to participate in a follow-up survey. Participants who indicated they would be willing to participate in a follow-up survey were recruited via email approximately four months after their completion of the T1 survey. This four month window necessitated a rolling recruitment strategy. For example, all eligible participants who completed the T1 survey in April 2009 were recruited for the T2 survey in August 2009; participants who completed the T1 survey in May 2009 were recruited for the T2 survey in September 2009, and so on. The T2 rolling recruitment was conducted from August 2009 through March 2010. A total of 135 participants completed the T2 survey. The response rate was 52%.

The recruitment email for T2 contained an invitation to complete the T2 survey, a survey link, and mention of the incentive; those who did not complete the survey within two weeks of the invitation were sent a reminder email (See Appendix D for the invitation and reminder emails). The incentive for completing the T2 survey was a $100 gift certificate to Amazon.com. Participants who completed the survey were entered into a drawing for the gift certificate; one winner was selected randomly from all the completed T2 surveys. The gift certificate was then emailed to the winner.

Station Event Surveys

ILI researchers attended three different "400 Years of the Telescope" themed events hosted by MPT, WHYY, and OPB (See Table 5). Each event included a unique mix of project activities for attendees to participate in, which could include the planetarium program, a trailer for the documentary, facilitated star gazing with telescopes, a question and answer session with Kris Koenig (the PBS document's Director), and/or a talk by a Galileo re-enactor. At each event, researchers distributed paper versions of a survey to event attendees; surveys were tailored to include ratings for activities available at each site. Data from a fourth event, hosted by NPT, were collected by station staff members in a similar manner. The survey included Likert-type rating scales on activities offered at the event and other astronomy-related free-choice learning opportunities, an open-ended question designed to elicit what attendees learned at the event, and basic demographics (affiliate/museum membership, age, group size, zip code) (see Appendix H for a sample of the station event survey used at the MPT event). Station event survey data were entered into Excel and then transferred to SPSS for analysis. Using an inductive approach, qualitative responses were reviewed to create general coding categories. Qualitative data were then coded according to this rubric, and descriptive statistics were run on all data.

Table 5: Details of the Event Data Collection

Station/Location	Event Location	Event Date	Attendees	Incentive for Completing Survey
NPT/Nashville	Adventure Science Center	April 3, 2009	Station and Museum members	None
OPB/Oregon	Oregon Museum of Science and Industry (OMSI)	April 19, 2009	Station and Museum members	Planisphere
WHYY/Philadelphia	The Franklin Institute	April 7, 2009	Station members	None
MPT/Maryland	Maryland Science Center	June 30, 2009	Station and Museum members	None

Follow-up Telephone Interviews

A follow-up telephone interview was designed by ILI researchers to gather qualitative data on project impacts and how project participation was integrated into the person's life roughly one year after participating in their first *400 Years* deliverable. The semi-structured interview took approximately 15 minutes and consisted of questions on astronomy activities, telescope ownership and use, reasons for choosing to engage or not engage in the project's deliverables, and cognitive and behavioral impacts of the project. The interview drew on the online survey data already submitted, which allowed the researcher to refer back to the data as a way of engaging the participant in a discussion of the project deliverables (See Appendix E for the protocol and instrument).

Participants who had completed both the T1 and T2 online surveys were emailed an invitation to participate in a follow-up telephone interview. The email invitation asked participants to email the researcher to schedule a phone call appointment at a time of their convenience; a $30 gift certificate was offered to all participants who scheduled and completed an interview. A total of 34 in-depth telephone interviews were completed between June 21 and August 18, 2010. ILI researchers invited 133 individuals to participate; the response rate was 26%. Data from the interviews were entered into SPSS for analysis. Using an inductive approach, responses were reviewed to create general coding categories. All data were then coded according to this rubric and descriptive statistics were performed.

Focus Groups

Focus groups were designed to gather in-depth, qualitative data from viewers of the documentary and the planetarium program. The focus groups included questions on participants' astronomy interest and prior experience, knowledge of and participation in the 400 Years project, reaction to and comprehension of the deliverable, and the potential for behavioral impacts based on participant intentions. An attempt was made to conduct focus groups with Maryland Public Television (MPT) members who had viewed the documentary, but despite multiple recruitment efforts and vehicles (direct email, Facebook posts, etc.) the focus groups did not have enough members to be held. Recruiting for the documentary-related focus groups was also attempted from the website; a pop-up recruitment tool was used to screen website visitors for interest in participating in a telephone focus group; this method also did not yield enough members to be held.

However, recruiting for the focus groups on *Two Small Pieces of Glass* planetarium program was more successful. Two focus groups on the planetarium program were held on November 8, 2009 at the Carnegie Science Center. Members of the science center were invited via an e-newsletter to view the program and then participate in a 45-60 minute discussion facilitated by an ILI researcher. A $30 gift certificate to the museum store was offered as an incentive for each focus group participant. Because of group size and the need to limit the focus group to one hour, not all questions were asked in both focus groups (See Appendix F for the focus group instrument and Appendix G for the focus group recruitment advertisement).

DESCRIPTION OF THE SAMPLES

This section describes the demographics and additional information of the various methods, splitting the online sample down into its four subgroups of the PBS documentary, planetarium program, website and night sky network events (star parties).

Sample for the T1 Online Survey (all deliverables)

Respondents to the T1 online survey were slightly more likely to be male (58%), were typically Caucasian (84%), and well-educated (Table 6). The majority of the respondents (74%) did not have children living at home, and 49% overall lived in a multiple-adult household without children. Most of the respondents lived in the US (95%), with the Midwest and West regions (determined by zip code) heavily represented in the sample. By state, respondents tended to live in states where a participating PBS affiliate was found; 28% of all respondents were from Michigan (home of DPTV), 15% from Oregon (OPB), 14% from Pennsylvania (WHYY), and 8% from Maryland (MPT). A little more than half of all respondents (52%) were PBS members, which explains the high level of education and other factors.

Table 6: Demographics for the Respondents to the T1 Online Survey

Demographic Category	Percent of Sample
Sex (n=835)	
Male	58%
Female	42%
Race/Ethnicity (check all that apply)* (n=849)	
Caucasian	84%
Asian/Pacific Islander	6%
African American	5%
Hispanic/Latino	3%
Native American	2%
Other	3%
Mean Household Size (n=800)	2.5 people
Household Make-up (n=800)	
One Adult (no children)	26%
Multiple Adults (no children)	49%
Adults and Children	26%
Education (n=835)	
Some high school	3%
High school graduate	4%
Some college	22%
Bachelor's degree	21%
Some graduate school	9%
Graduate degree or higher	41%
Country (n=839)	
Living in the US	95%
Living in Canada	4%
Living in a country other than US or Canada	1%
Living in the US by Region (n=798)	
Northeast	19%
Midwest	37%
South	19%
West	25%
PBS Member (n=842)	52%

*Multiple responses allowed. Percentages total more than 100%.

Nearly half of all respondents (47%) first heard about 400 Years as a result of watching the documentary, while another 16% heard about it from a PBS source (such as an on-air ad or a station guide) (Table 7). This trend is a result of the sample being largely drawn from PBS members and documentary watchers; the degree to which this reflects the general population of people who participated in the *400* Years deliverables is unknown.

Table 7: Ways by which Respondents Became Aware of the *400 Years* project (n=839)

Source	n	Percent
Watching the documentary	390	47%
Non-documentary PBS source	136	16%
Watching the planetarium program	127	15%
A star party	63	8%
Other media	33	4%
A member event	22	3%
Word of Mouth	21	3%
Astronomy-related media	17	2%
400years.org	13	2%
Science center/museum	8	1%
Other	9	1%

Similar to previous comments, the results were likely influenced by the fact that the sample was predominantly made up of those who entered the study through the documentary.

Documentary: 400 Years of the Telescope

A total of 602 respondents or 71% of all respondents to the online survey indicated that they had watched the documentary. A small portion of respondents (2% or 20 respondents) were unsure whether they had watched the documentary. Of those who indicated when they had watched the documentary, 45% watched it in April 2009 and 39% in April 2010; the majority of respondents (63%) indicated they first watched the documentary in 2009.

Respondents who had watched the documentary were more likely to be male (61%), were typically Caucasian (87%), and well-educated (Table 8). The majority of the respondents (73%) did not have children living at home, and 53% overall lived in a multiple-adult household without children. Most of the respondents lived in the US (94%), with the Midwest and West regions (determined by zip code) heavily represented in the sample. The majority of respondents were PBS members (63%), a result of the sampling method where views of the documentary were recruited from member-lists of partnering PBS affiliates.

Table 8: Demographics for Respondents who Watched the Documentary

Demographic Category	Percent of Sample
Sex (n=592)	
Male	61%
Female	39%
Race/Ethnicity (check all that apply)* (n=602)	
Caucasian	87%
Asian/Pacific Islander	4%
African American	4%
Hispanic/Latino	2%
Native American	3%
Other	2%
Mean Household Size (n=565)	2.2 people
Household Make-up (n=586)	
One Adult (no children)	30%
Multiple Adults (no children)	53%
Adults and Children	16%
Education (n=596)	
Some high school	1%
High school graduate	1$
Some college	24%
Bachelor's degree	21%
Some graduate school	10%
Graduate degree or higher	41%
Country (n=595)	
Living in the US	94%
Living in Canada	5%
Living in a country other than US or Canada	1%
Living in the US by Region (n=561)	
Northeast	15%
Midwest	44%
South	15%
West	26%
PBS Member (n=598)	63%

*Multiple responses allowed. Percentages total more than 100%.

Planetarium Program: Two Small Pieces of Glass (Online survey)

A total of 192 respondents or 23% of all respondents to the online survey indicated that they had watched the planetarium program. A small portion of respondents (2% or 16 respondents) were unsure whether they had watched the planetarium program. Of those who indicated when they had watched the planetarium program, 32% watched it in April 2009, 27% in October 2009, and 12% in April 2010; the majority of respondents (84%) indicated they first watched the planetarium program in 2009. The majority of respondents who had watched the planetarium program indicated they had done so at an institution connected with the 400 Years project (86%) (Table 9). Nearly a third of respondents (29%) indicated they had seen the program at the Buhl Planetarium; this was a result of the sampling procedure where ILI researchers facilitated paper-based surveys at the Buhl (see the Methods section).

Table 9: Where Respondents saw the Planetarium Program (n=184)

Source	n	Percent
Buhl Planetarium, Carnegie Science Center	53	29%
Kendall Planetarium, OMSI	31	17%
Davis Planetarium, Maryland Science Center	18	10%
Detroit Science Center	13	7%
Ask Jeeves Planetarium, Chabot Space & Science Center	11	6%
Fels Planetarium, The Franklin Institute	9	5%
Nashville, Various planetariums	9	5%
Nebraska, Various planetariums	8	4%
Miami Planetarium, Miami Science Museum	7	4%
Non-400 Years Partner Museum	9	5%
"Planetarium" or "Museum" (unspecified)	16	9%

Respondents who had watched the planetarium program were evenly split between male and female viewers, were typically Caucasian (77%), and well-educated (Table 10). Nearly half of all respondents (48%) had children living at home. Most of the respondents lived in the US (97%), with the Northeast and West regions (determined by zip code) heavily represented in the sample.

Table 10: Demographics for Respondents who Watched the Planetarium Program

Demographic Category	Percent of Sample
Sex (n=191)	
Male	53%
Female	47%
Race/Ethnicity (check all that apply)* (n=199)	
Caucasian	77%
Asian/Pacific Islander	8%
African American	5%
Hispanic/Latino	5%
Native American	3%
Other	5%
Mean Household Size (n=185)	3.2 people
Household Make-up (n=189)	
One Adult (no children)	15%
Multiple Adults (no children)	37%
Adults and Children	48%
Education (n=187)	
Some high school	6%
High school graduate	6%
Some college	18%
Bachelor's degree	22%
Some graduate school	4%
Graduate degree or higher	45%
Country (n=193)	
Living in the US	97%
Living in Canada	1%
Living in a country other than US or Canada	2%
Living in the US by Region (n=188)	
Northeast	33%
Midwest	17%
South	22%
West	29%
PBS Member (n=192)	32%

*Multiple responses allowed. Percentages total more than 100%.

Planetarium Program: Two Small Pieces of Glass (Focus Group)

Two focus groups with views of *Two Small Pieces of Glass* were held, both at the Buhl Planetarium in Pittsburgh. One focus group consisted of 15 people, with ten adults and two children (three children under eight and two teenagers). The other focus group consisted of 19 people, including children from ages seven to fifteen. The majority of participants in both groups had prior experience with using telescopes and viewing planetarium programs. A few participants had seen *Two Small Pieces of Glass* before viewing it for focus group, but none recalled seeing the documentary on television.

Website: 400years.org

A total of 159 respondents or 19% of all respondents to the online survey indicated that they had visited the website 400Years.org. A small portion of respondents (2% or 17 respondents) were unsure whether they had visited the website. Of those who indicated when they had visited it, 34% visited in April 2009,

14% on May 2009, and 12% in April 2010; the majority of respondents (83%) indicated they first visited the website in 2009.

Respondents who had visited the website were more likely to be male (65%), were typically Caucasian (82%), and well-educated (Table 11). The majority of the respondents (70%) did not have children living at home, and 47% overall lived in a household with more than one adult and no children. Most of the respondents lived in the US (94%), with respondents evenly distributed by region. More than one-third (39%) of respondents who visited the website were PBS members.

Table 11: Demographics for Respondents who Visited the Website

Demographic Category	Percent of Sample
Sex (n=157)	
Male	65%
Female	35%
Race/Ethnicity (check all that apply)* (n=159)	
Caucasian	82%
Asian/Pacific Islander	10%
African American	4%
Hispanic/Latino	1%
Native American	3%
Other	3%
Mean Household Size (n=151)	2.6 people
Household Make-up (n=154)	
One Adult (no children)	23%
Multiple Adults (no children)	47%
Adults and Children	30%
Education (n=158)	
Some high school	4%
High school graduate	2%
Some college	17%
Bachelor's degree	17%
Some graduate school	13%
Graduate degree or higher	48%
Country (n=158)	
Living in the US	94%
Living in Canada	3%
Living in a country other than US or Canada	3%
Living in the US by Region (n=148)	
Northeast	20%
Midwest	26%
South	24%
West	30%
PBS Member (n=158)	39%

*Multiple responses allowed. Percentages total more than 100%.

A total of 120 respondents or 14% of all respondents to the online survey indicated that they had gone to a star party since April 2009 (the launch date of the 400 Years events). A small portion of respondents (2% or 13 respondents) were unsure whether they had gone to a star party in that time period. Of those who indicated when they had gone to a star party, 23% went in April 2009, 21% in June 2009, and 14% in August 2009; the majority of respondents (99%) indicated they gone to a star party in 2009. The largest group of respondents indicated they had gone to a star party in Tennessee (21%), followed by Pennsylvania (15%) (Table 12). It is important to note that cards were handed out at the star parties, so the sampling greatly affected where people were from.

Table 12: State Where Respondents Attended the Star Party (n=119)

Source	n	Percent
Tennessee	25	21%
Pennsylvania	18	15%
Oregon	12	10%
Maryland	10	8%
Colorado	9	8%
California	8	7%
Nebraska	8	7%
Michigan	7	6%
Florida	2	2%
New Jersey	2	2%
New York	2	2%
Other US State (1 response per state)	10	8%
Non-US	6	5%

Respondents who had attended a star party were more likely to be male (62%), were typically Caucasian (86%), and well-educated (Table 13). Two-fifths of respondents (40%) had children living at home. Most of the respondents lived in the US (93%), with the South (determined by zip code) heavily represented in the sample.

Table 13: Demographics for Respondents who Attended a Star Party

Demographic Category	Percent of Sample
Sex (n=117)	
Male	62%
Female	38%
Race/Ethnicity (check all that apply)* (n=120)	
Caucasian	86%
Asian/Pacific Islander	8%
African American	4%
Hispanic/Latino	3%
Native American	2%
Other	3%
Mean Household Size (n=113)	2.9 people
Household Make-up (n=116)	
One Adult (no children)	14%
Multiple Adults (no children)	47%
Adults and Children	40%
Education (n=119)	
Some high school	6%
High school graduate	3%
Some college	19%
Bachelor's degree	25%
Some graduate school	8%
Graduate degree or higher	38%
Country (n=120)	
Living in the US	93%
Living in Canada	4%
Living in a country other than US or Canada	3%
Living in the US by Region (n=112)	
Northeast	21%
Midwest	14%
South	38%
West	26%
PBS Member (n=119)	21%

*Multiple responses allowed. Percentages total more than 100%.

Who participated in which deliverables?

The following section describes the demographic and psychographic differences between who participated in the four main deliverables. The deliverables were compared by gender, level of education, whether someone was a PBS member, whether someone had children under 18 in the household and when the last time someone had looked through a telescope. For each statement below, only statistically significant differences are reported.

There were differences between the various deliverables and who they attracted. The documentary was more likely to attract PBS members, men, those with more than a high school degree, and those without children in their household. The planetarium program was more likely to attract non-PBS members,

those with lower levels of education, and with children in their household. Meanwhile, both the website and star parties attracted more non-PBS members, and those who had looked through a telescope more often or more frequently were most likely they were to go to the website or attend a star party. However, the star parties also attracted those with children in their household.

Documentary

- **Gender**: Men were more likely to see the documentary than women (79% compared to 69%, $X^2(1, n=812)=5.01, p<.05$).
- **PBS Membership**: PBS members were more likely to see the documentary than non-members (87% compared to 58%, $X^2(1, n=819)=85.63, p<.001$).
- **Education**: Those with a high school degree or higher were more likely to have seen the documentary than respondents with only some high school (Some high school: 30%, High school graduate: 68%, Some college: 78%, Bachelor's degree: 70%, Some graduate school: 84%, Graduate degree of higher: 74%; $X^2(5, n=812)=26.62, p<.001$).
- **Household Make-up**: Those with no children in the household (1 adult with no children: 86%; multiple adults with no children: 79%) were more likely to see the documentary than those with children in the household (47%; $X^2(2, n=802)=95.03, p<.001$).
- **Telescope Usage**: There was no obvious or predictable pattern for telescope usage and watching the documentary.
    - **Prior Telescope Experience**: Those who had never looked through a telescope previously (72%) and those who had looked 6 or more times (77%) before engaging with the *400 Years* project were most likely to have seen the documentary, compared to those with moderate telescope usage (1 time: 64%; 2-3 times: 69%; 4-5 times: 66%; $X^2(4, n=824)=10.62, p<.05$)
    - **Telescope Usage Since Becoming Aware of *400 Years***: Those with the lowest and highest amounts of telescope usage since learning about *400 Years* were most likely to have watched the documentary (0 times: 76%; 1 time: 64%; 2-3 times: 60%; 4-5 times: 73%; 6 or more times: 78%; $X^2(4, n=819)=14.85, p<.005$)

Planetarium program

- **PBS Membership**: Non-PBS members were more likely to see the planetarium program than PBS members (3379% compared to 14%, $X^2(1, n=826)=41.25, p<.001$).
- **Education**: In general, those with a lower level of education were more likely to have seen the planetarium program. Those with some high school (55%) and a high school degree (32%) were most likely to see the planetarium program, followed by graduate degree (25%) and bachelor's degree (24%). The least likely groups were those with some college (18%) or some graduate school (10%; $X^2(5, n=819)=24.26, p<.001$).
- **Household Make-up**: Those with children in the household (45%) were more likely to see the planetarium program than those with no children in the household (1 adult with no children: 14%; multiple adults with no children: 18%; $X^2(2, n=810)=70.15, p<.001$).
- **Telescope Usage**: There was no obvious or predictable pattern for telescope usage and viewing the planetarium program.
    - **Prior Telescope Experience:** Those who had never looked through a telescope previously (30%) and those who had looked through a telescopes 4-5 times before engaging with *400 Years* (39%) were the most likely to have seen the planetarium program compared to others (1 time: 23%; 2-3 times: 26%; 6 or more times: 17%; $X^2(4, n=832)=27.65, p<.001$).

- **Telescope Usage Since Becoming Aware of *400 Years***: Those lower amounts of telescope usage since learning about *400 Years* were most likely to have watched the planetarium program (0 times: 20%; 1 time: 30%; 2-3 times: 35%; 4-5 times: 22%; 6 or more times: 22%; X^2(4, n=826)=11.72, p<.05).
- **Most Recent Telescope Usage**: There were no clear patterns in terms of when someone had last used a telescope and whether they had seen the planetarium program (Within the past month: 30%; 1-5 months ago: 24%; 6-11 months ago: 14%; 1-2 years ago: 24%; 3 or more years ago: 20%; Never: 25%; X^2(5, n=829)=12.15, p<.05).

Website

- **PBS Membership**: Non-PBS members were more likely to go to the website than PBS members (25% compared to 14%, X^2(1, n=824)=14.67, p<.001).
- **Education**: There was no obvious or predictable pattern for level of education and visiting the website. Those with some higher school (35%) and some graduate school (27%) or a graduate school degree (22%) were most likely to have visited the website. High school graduates (10%), those with some college (14%), and those with bachelor's degrees (15%) were less likely to visit with website (X^2(5, n=817)=13.99, p<.05).
- **Telescope Usage**: Higher and more frequent telescope usage were factors in visiting the website.
  - **Prior Telescope Experience:** Those with the most telescope experience prior to their engagement with the *400 Years* project were the more likely to have visited the website (0 times: 13%; 1 time: 13%; 2-3 times: 12%; 4-5 times: 9%; 6 or more times: 26%; X^2(4, n=830)=27.60, p<.001).
  - **Telescope Usage Since Becoming Aware of *400 Years:*** The more often someone had looked through a telescope since becoming engaged with *400 Years*, the more likely they were to have visited the website (0 times: 12%; 1 time: 23%; 2-3 times: 25%; 4-5 times: 27%; 6 or more times: 38%; X^2(4, n=824)=45.762, p<.001).
  - **Most Recent Telescope Usage**: The more recently a participant had used a telescope, the more likely they were to use the website (Within the past month: 37%; 1-5 months ago: 23%; 6-11 months ago: 15%; 1-2 years ago: 10%; 3 or more years ago: 9%; Never: 12%; X^2(5, n=827)=70.64, p<.001).

Star Parties

- **PBS Membership**: Non-PBS members were more likely to go to a star party than PBS members (24% compared to 6%, X^2(1, n=826)=55.44, p<.001).
- **Household Make-up**: Those who had children in their household (22%) more likely to have gone to a star party than those without children (1 adult with no children: 8%; multiple adults with no children: 14%;; X^2(2, n=810)=18.32, p<.001.
- **Telescope Usage**: Higher and more frequent telescope usage were factors in attending star parties.
  - **Prior Telescope Experience:** Those with the most telescope experience prior to their engagement with the *400 Years* project were the more likely to have gone to a start party (0 times: 6%; 1 time: 15%; 2-3 times: 11%; 4-5 times: 9%; 6 or more times: 18%; X^2(4, n=832)=14.01, p<.01).
  - **Telescope Usage Since Becoming Aware of *400 Years:*** The more often someone had looked through a telescope since becoming engaged with *400 Years*, the more likely they were to have gone to a star party (0 times: 3%; 1 time: 16%; 2-3 times: 26%; 4-5 times: 20%; 6 or more times: 53%; X^2(4, n=826)=200.79, p<.001).

- **Most Recent Telescope Usage**: The more recently a participant had used a telescope, the more likely they were to have been to a star party (Within the past month: 43%; 1-5 months ago: 17%; 6-11 months ago: 4%; 1-2 years ago: 1%; 3 or more years ago: 1%; Never: 0%; $X^2(5, n=829)=12.15$, $p<.05$).

Station Events

Station events occurred at the beginning of the *400 Years* projected and typically consisted of a PBS affiliate station partnering with a local informal science education facility, such as a museum or planetarium, to host an evening event about *400 Years of the Telescope*. A total of 60 respondents or 7% of all respondents to the online survey indicated that they had participated in a station event. A small portion of respondents (2% or 13 respondents) were unsure whether they had attended a station event. Of those who indicated when they had attended the event, the majority (85%) had gone in April 2009.

Specific Station Events that were evaluated as part of the summative evaluation were organized by four stations, in different parts of the country: WHYY in Philadelphia, OPB in Oregon, MPT in Maryland, and NPT in Nashville. At the Station Events attendees were asked to fill out a paper-based questionnaire; a total of 244 surveys were collected (Table 14).

Table 14: Distribution of Responses based on Station Event Location (n=244)

Station Event Location	n	Percent
WHYY event at the Franklin Institute	90	37%
OPB event at OMSI	66	27%
MPT event at the Maryland Science Center	30	12%
NPT at Adventure Science Center	58	24%
Total	244	100%

While about 68% of respondents to the station event surveys indicated they were PBS members (Table 15), only 20% overall were members of the museum or institution where the event took place. At the WHYY and OPB Events, the majority of surveyed participants were PBS members; however, these same PBS members were not very likely to be members of the host museums (12% at WHYY and 27% at OPB). Approximately 30% of participants of the MPT and NPT Events were PBS members; while 53% of the MPT Event participants were members of the Maryland Science Center, only 7% of NPT Event participants were members of their event museum (Table 15).

In terms of characteristics of respondents, the most common group attending the Station Events were groups of multiple adults and no child (53%); only 25% of the respondent groups were visiting with children. Across stations, MPT Events had the largest attendance by groups with both children and adults (43%) and WHYY Events had the lowest (8%). The typical group, across all stations, had two people (median), while group size ranged from one to seven individuals. The Events at NPT had a four larger groups (15 and above), which were outliers and thus were eliminated from the calculation of means and medians (Table 15).

Most survey participants were aged 50 to 59, followed by those 40 to 49 years of age. Participants at the WHYY and MPT Events skewed slightly older— 68% and 57% were 50 and older, respectively. OPB Event respondents were split, with half under 50 and half 50 and older. NPT Events had the youngest participants with only 46% 50 and over (Table 15).

Table 15: Demographic Breakdown by Station and Overall

Demographic Category	OVERALL (n=244)		WHYY (n=90)	OPB (n=66)	MPT (n=30)	NPT (n=58)
	n	Percent	Percent	Percent	Percent	Percent
PBS Member	166	68%	97%	78%	30%	33%
Museum Member	49	20%	12%	27%	53%	7%
Group Composition						
One Adult (no child)	54	22%	32%	11%	20%	21%
Multiple Adults (no child)	129	53%	60%	59%	37%	43%
Adults and Children	61	25%	8%	30%	43%	36%
Group Size						
Mean		2.64	1.88	2.50	2.87	3.88
Median		2.00	2.00	2.00	2.50	2.00
Respondents' Age	(n=229)		(n=81)	(n=64)	(n=28)	(n=56)
Under 18	5	2%	0%	0%	0%	9%
18-29	16	7%	4%	9%	4%	11%
30-39	26	11%	11%	11%	14%	11%
40-49	53	23%	17%	30%	25%	23%
50-59	65	28%	32%	25%	25%	29%
60-69	47	20%	27%	20%	21%	11%
70 and older	17	7%	9%	5%	11%	7%

When asked how they were made aware of the Station Event, the majority indicated a form of communication coming from their Station or Affiliate (83%). The form of communication most frequently mentioned was email or email newsletter (40%), especially by those who attended the WHYY Event. A large proportion of those attending the OPB Event heard about the event from the radio, whereas none of the MPT Event attendees did so. Fewer than three attendees heard about the events through television, magazine or newspaper, or their local astronomy clubs (Table 16).

Table 16: Ways by which Respondents Became Aware of Station Events, by Station and Overall**

	OVERALL		WHYY	OPB	MPT
	n	Percent*	Percent*	Percent*	Percent*
Source		n=132	n=58	n=58	n=16
Station of Affiliate	110	83%	95%	83%	44%
Museum/ University	22	17%	5%	17%	56%
Type		n=138	n=66	n=48	n=24
Email or email newsletter/announcement	66	40%	67%	25%	42%
Radio	20	12%	2%	40%	0%
Friend or family member	13	8%	8%	10%	12%
Website	12	7%	12%	2%	12%
Member program/service	11	7%	9%	4%	12%
Regular mail (e.g., postcard, program, etc.)	6	4%	2%	4%	12%
Television	3	2%	0%	6%	0%
Magazine or newspaper (printed publication)	3	2%	0%	6%	0%
Local astronomy club	2	1%	0%	4%	0%
Other	4	2%	3%	0%	8%

*Multiple responses allowed. Percentages total more than 100%.
**NPT did not collect these data.

FINDINGS

PARTICIPATION IN DELIVERABLES

The study focused on only those who had participated in at least one *400 Years* deliverable and completed a survey (Table 17), and therefore was not meant to estimate the proportion of the general public who engaged in the deliverables. As such, and based on the methods and recruiting mentioned above, the large majority had viewed the documentary (76%), while roughly one in five had participated in the remaining deliverables of the planetarium program (22%), website (20%) and star parties (15%).

Table 17: Participation in *400 Years* deliverables (only those who participated in the *400 Years* survey)

Component	Number of Individuals	Percentage
PBS Documentary	570	76%
Planetarium Program	163	22%
Web site	152	20%
Star parties	110	15%
Total individuals	749	133%*

*Multiple responses allowed. Percentages total more than 100%.
Note: Only those who participated in at least one *400 Years* deliverable are included.

FINDINGS BY DELIVERABLE

The T1 and T2 online surveys asked respondents whether they had participated in each deliverable. If they indicated they had participated in the documentary, planetarium program, website, or star parties, respondents were asked the following set of question about each deliverable they participated in:

1) When they participated in the deliverable,
2) Where they participated for the place-based deliverables (e.g., the planetarium program and star parties),
3) To complete a sentence based on the deliverable (e.g., "I never realized that…"), and
4) To rate their agreement with ten outcome statements (see Appendix A).

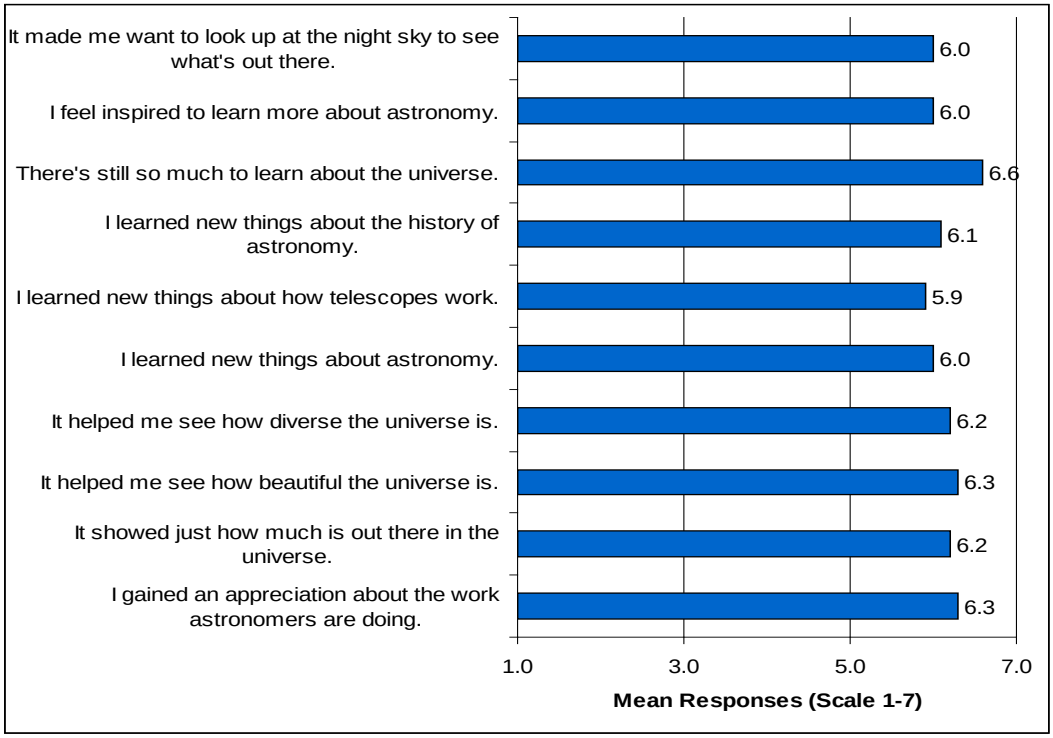
Respondents who indicated they had participated in the member event were asked when and where they attended the event; the impact data on the events was collected at the events themselves using a paper-based survey.

Given that some participants participated in the online survey at two different times, the second survey data (T2) was used for analysis for these participants. This was so that the most complete picture of participants' experiences with the deliverables would be included. As such, the following data uses T1 data for those respondents who completed only the T1 survey, and T2 data for those who completed both surveys. To provide a more complete picture and use all of the data collected for the online survey, a comparison of the T1 and T2 data for individuals who completed both is included in the Longitudinal Findings section below.

Impacts of the Documentary: 400 Years of the Telescope

The documentary seemed to be effective at achieving the outcomes defined for the deliverables, based on the self-perceived ratings of documentary viewers (Figure 1). When rating the ten outcome statements, respondents who watched the documentary rated all statements a mean of 5.9 or higher (where the scale was 1="strongly disagree" and 7="strongly agree"). The highest rated statement about the documentary, higher than most of the other ratings, was *There is still so much to learn about the universe,* with a mean rating of 6.6 (Figure 1).

Figure 1: Outcome Ratings for the Documentary (Means) Scale from 1 to 7



Respondents of the T1 and T2 online surveys were asked to complete the following statement "*Thinking about the Documentary, please complete the following question: I never realized that…*" Data were coded within three broad categories that emerged from open coding: learning, awareness, and satisfaction/affect.

The majority of the responses from those 458 respondents who responded to the question fit into the Learning category (69%), followed Awareness (29%), and Satisfaction/affect (8%) (Table 18).

- **Learning (69%)**: About one quarter of respondents indicated learning about the technology and use of modern telescopes, especially *"that telescopes could be so huge,"* and that the telescope development currently going on involves a large number of individuals working in several parts of the world. Other respondents learned about the early history of telescopes, including how old telescopes are, the roles of Galileo, Newton and other early astronomers in the development of telescopes, or how *"past astronomers accomplished so much with so little."* Some of those watching the documentary also learned scientific concepts, such as the expansion of the universe and *"that dark energy exists."*
- **Awareness (29%)**: For about one third of respondents, the documentary helped raise awareness about astronomy and telescopes. For example, some respondents indicated never realizing the impact or importance of telescopes *"to the advancement of knowledge"* in general, but even to *"the history of mankind"* or how *"the invention of the telescope changed the world as we know it."* Other respondents became aware of the depth of the topic: how they personally *"knew so little about the telescope"* or that *"there was so much to astronomy! There are so many questions, so much left to know!"*

- **Satisfaction/Affect (8%)**: A smaller proportion of respondents indicated an enjoyment of the documentary or the topic, a few stating that they never realized *"that such a technical subject could be so wonderfully interesting."*

Table 18: Responses to "*I never realized that…*" from those who watched the documentary (n=458)

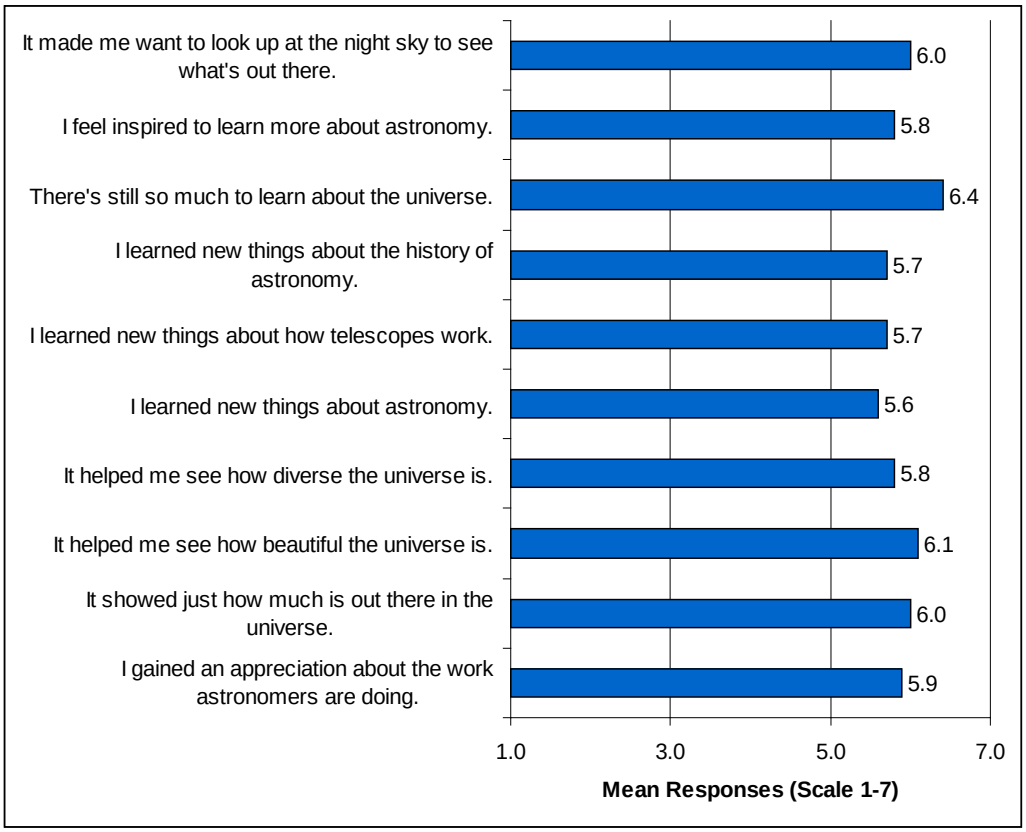
	n	Percent*
Learning	314	69%
Technology and use of modern telescopes	117	26%
Early history of telescopes and their users	78	17%
Advances in telescopes over time	62	14%
Scientific concepts and discoveries	64	14%
Diversity of telescopes and differences between them	26	6%
Awareness	132	29%
Impact or importance of astronomy on society	42	9%
Overall depth of the topic	31	7%
Beauty, awe	20	4%
Self-efficacy (e.g., the tools within their reach)	20	4%
Awareness of 400 Years programs and locations	16	3%
Prior extensive knowledge	10	2%
Nature of star parties and amateur astronomers	1	0%
Satisfaction/Affect	36	8%
Interesting/fascinating topic	20	4%
Satisfaction with content	12	3%
Dissatisfied with content	4	1%
Other	9	2%
Don't know/don't remember	8	2%

*Multiple responses allowed. Percentages total more than 100%.

Impacts of the Planetarium Program: T1 and T2 Online Survey Results

The planetarium program was effective at achieving the outcomes defined for the deliverables, based on the self-perceived ratings of planetarium program viewers (Figure 2). When rating the ten outcome statements, respondents who watched the planetarium program rated all statements a mean of 5.6 or higher (where the scale was 1="strongly disagree" and 7="strongly agree"). The highest rated statement was *There is still so much to learn about the universe* with a mean rating of 6.4 (Figure 2).

Figure 2: Outcome Ratings for the Planetarium Program (Means) Scale from 1 to 7



Participants of the planetarium show were asked to indicate what they had "*never realized*" before watching the program. Their responses were coded using the same emergent codes used for documentary respondents, and were also grouped in three broader categories: learning, awareness, and satisfaction/affect. Over half of the 152 respondents had answers indicating learning (57%), whereas about one third referred to awareness (33%), and 11% to satisfaction/affect (Table 19).

- **Learning (57%)**: As the largest category, more than half mentioned learning. About 10-15% of all respondents indicated learning about one of the main subcategories about learning. For example, some respondents indicated learning about the early history of telescopes, especially who invented the telescope and that *"the telescope was invented so long ago."* Others learned about the technology and use of modern telescopes, including how large and complex they can be, as well as how *"some land-based telescopes are now able to correct for atmospheric distortions."* Respondents also learned scientific concepts, including the expansion of the universe, aberration, or black holes.
- **Awareness (33%)**: For about one third of respondents, the planetarium program helped raise awareness about astronomy and telescopes. For some respondents, the program made them more aware about the nature of star parties and amateur astronomers. Some of them had never realized *"star parties existed"* or that *"there were so many stargazer programs"* in their cities. Others increased their awareness about the impact or importance of telescopes for humanity and science. For example, one respondent had never realized that *"viewing other planets and universes could change how we see ourselves so much,"* while another had never

realized that *"the telescope played such a central role in discovering the nature of the solar system / universe."*

- **Satisfaction/Affect (11%)**: A smaller proportion of respondents indicated an enjoyment of the planetarium or the topic. For most, this was a self-enjoyment. For others, it extended to their children, as reflected by this respondent who had never realized that *"even my young grandsons (ages 6) could be so fascinated with telescopes and the stars. This program was excellent!"*

Table 19: Responses to "*I never realized that…*" from those who watched the Planetarium (n=152)

	n	Percent*
Learning	87	57%
Early history of telescopes and their users	22	14%
Technology and use of modern telescopes	19	13%
Scientific concepts and discoveries	18	12%
Diversity of telescopes and differences between them	16	11%
Advances in telescopes over time	14	9%
Awareness	50	33%
Nature of star parties and amateur astronomers	12	8%
Impact or importance of astronomy on society	9	6%
Overall depth of the topic	8	5%
Prior extensive knowledge	7	5%
Self-efficacy (e.g., the tools within their reach)	8	5%
Awareness of 400 Years programs and locations	6	4%
Beauty, awe	2	1%
Satisfaction/Affect	17	11%
Satisfaction with content	15	10%
Interesting/fascinating topic	3	2%
Dissatisfied with content	1	1%
Other	6	4%
Don't know/don't remember	0	0

*Multiple responses allowed. Percentages total more than 100%.

Impacts of the Planetarium Program: Focus Group Results

The overall response to the planetarium program in the two focus groups was positive. When asked to rate the show on a scale of 1 to 10 (with 1="poor" and 10="excellent") the average rating was a 7, with a few people giving it a 10. Participants appreciated a variety of elements of the program including:

- **Appropriateness for engaging children in the topic**: Participants felt the content of the program and its main message were well designed to engage children. Adults felt the show was a good

way to inspire children to become interested in astronomy. *"I think that if I was a kid, I think it would really make me want to study astronomy. It makes me want to study now."* Another adult responded, *"One thing I liked was at the end, is that they present sort of like an invitation, saying, 'Hey, these are areas in astronomy still to be studied ... You might be interested. You might want to go for that kind of thing.' That will perk the interest of kids."*

- **Inspiring artistic elements**: Focus group participants appreciated some of the visuals and the music, appreciating elements that were inspiring and that fostered a sense of awe. *"I'm there to have my sense of wonder and curiosity stimulated, and to come away feeling satisfied that that was a very entertaining and mind-expanding experience,"* said one adult who felt the program did just that. Another responded that *"the use of computer simulation and graphic imagery is just incredibly effective"* in the show. Visual elements that were appealing included the opening sequence and the sequences in space that were immersive. *"I have to say, I really liked the pictures,"* said one participant. *"It makes you actually feel like you're really there, seeing the stuff, though you're really not."* The music was also singled out by a few participants: *"I just wanted to say the music was great...it'll make you more interested in what you're watching when you have music like that …That makes you feel inspired, that kind of music."*
- **Main message of the program**: Many adults appreciated the big idea of the program, talking about how the history of the telescope is an interesting topic. *"I thought it was well-done,"* concluded one participant, *"that there was a historical perspective to just sort of suggest to people that science is a human activity, and everything we know now was discovered by somebody else who was a real human being."* Other participants appreciated how the a relatively complex message was conveyed in a way that all members of the audience could understand:

  > *"You know, you guys did a good job on, you know, explaining, you know, the history of the telescope, and just kind of like shedding light on what a wonderful tool it is to use, to expand your knowledge of astronomy. So if you can get that point across to kids and still be interesting to adults—and you guys have achieved that—you did a good job."*

Suggestions for improving the program were mostly related to issues that could be described as the "dualistic nature" of the program, or that it seemed to be trying to do two things. Some participants were frustrated by what they perceived to be the interspersed scenes of actors with the more impressive imagery of stars, planets, and the universe. *"There's too much talking of the people that are like the kids,"* said one participant who appreciated the CGI, "*Less talking [by the actors] and more of seeing stars and planets."* Others felt these different pieces did not fit together:

> *"It was almost like two different people produced it or something, like the first part seemed completely different, and it didn't seem to go together. Now it did a good job describing the telescopes and explaining the history of that, but I really felt like it – visually, it didn't go together."*

> *"Completely lost me like towards the end. I was like, what's – it was really pretty, sort of the sparkly type thing, but I didn't see how that fit together with the star – with the kids at the beginning and all that, so I would rather that it either have been all the kids or one or the other or something."*

Another concern of some participants was that program tried to cover too much ground by including the history of the telescope, types of telescopes and the potential for future discoveries. With one adult

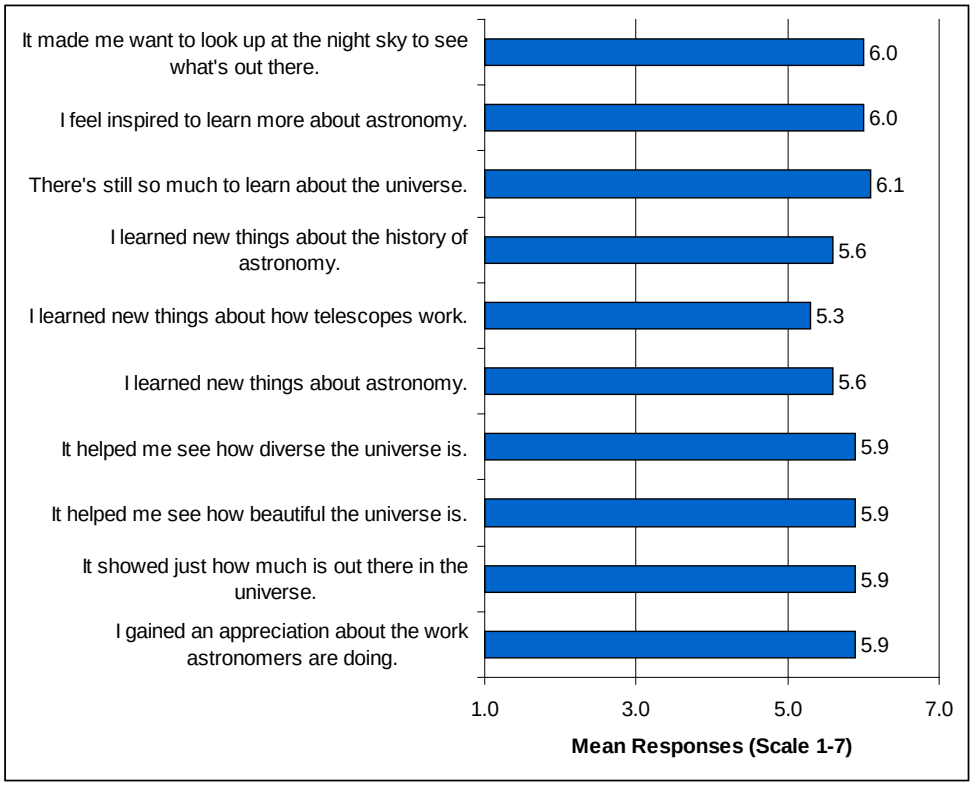
suggesting *"narrowing down how much information is really given in the movie, to really have more visual aids."* Another agreed, saying, *"It was just trying to, like, cover too many topics."*

The program did have an impact on participants' behavioral intentions. As a result of seeing the program, participants in the focus group agreed that they were interested in looking up at the stars, either with or without a telescope. The majority expressed interest in attending a star party as a result of seeing the program; they felt a star party would be good way to experience astronomy first-hand rather than on TV or online. One person who owned a telescope said, *"I don't know how to use it, so I think the star party would be a good place to go to learn."* Parents especially seemed to appreciate the family-friendly, activity-oriented nature of star parties. One parent responded positively to the idea of going to a star party, saying, *"I just look for things to get the kids off the computer and away from the television always first."* Some focus group participants expressed interest in watching the documentary, indicating that they felt they would learn a lot.

Impacts of 400Years.org Website

The website was effective at achieving the outcomes defined for the deliverables , based on the self-perceived ratings of website visitors (Figure 3). When rating the ten outcome statements, respondents who visited the website rated all statements a mean of 5.3 or higher (where the scale was 1="strongly disagree" and 7="strongly agree"). The highest rated statement was *There is still so much to learn about the universe* with a mean rating of 6.1 (Figure 3). The lowest rated statement *I learned new things about how telescopes work* (mean rating of 5.3) could have been affected because visitors to the website were already somewhat more knowledgeable about telescopes.

Figure 3: Outcome Ratings for the Website (Means) Scale from 1 to 7



Those respondents who used 400years.org were also asked to indicate what they had *"never realized"* before their visit to the website. As with previous deliverables, the responses were analyzed based on emergent codes within broad categories of learning, awareness, and satisfaction/affect. Almost half of the 107 respondents' answers were categorized as awareness (48%), followed by learning (36%), and satisfaction (13%) (Table 20). This is different from the documentary and planetarium program in that for those two learning was higher than awareness, compared to the other way around for the website.

- **Learning (36%)**: For website respondents learning seemed to have happened more frequently around the areas of early history of telescopes and scientific concepts. Those learning about the early history of telescopes commented on how long telescopes have been around, inventors, or that *"there was such a history to telescopes."* The scientific concepts mentioned by website respondents included the expansion and acceleration of the universe, dark energy, and so forth.
- **Awareness (48%)**: For about one third of respondents, the website helped raise awareness about *400 Years* programs and locations, more specifically, that there were *"so many prime websites to visit"* or that *"it was great to find such information gathered into one place."*
- **Satisfaction/ Affect (13%)**: A smaller proportion of respondents indicated an enjoyment of the website or the topic. This satisfaction sometimes reflected an appreciation for the delivery of child-friendly content, as exemplified by the respondent who stated never realizing that *"a website could so elegantly convey complex science to kids."*

Table 20: Responses to "*I never realized that…*" from those who used the Website (n=107)

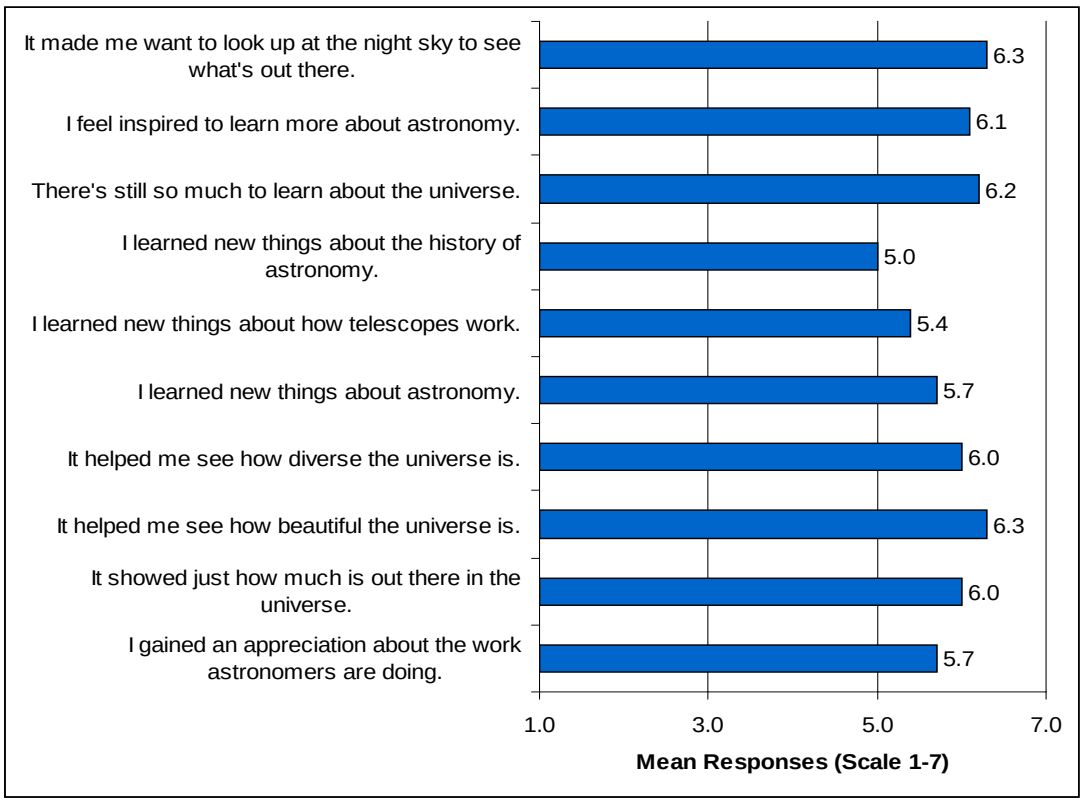
	n	Percent*
Learning	38	36%
Early history of telescopes and their users	14	13%
Scientific concepts and discoveries	13	12%
Technology and use of modern telescopes	9	8%
Advances in telescopes over time	2	2%
Diversity of telescopes and differences between them	0	0
Awareness	51	48%
Awareness of 400 Years programs and locations	35	33%
Impact or importance of astronomy on society	5	5%
Overall depth of the topic	5	5%
Prior extensive knowledge	3	3%
Self-efficacy (e.g., the tools within their reach)	2	2%
Beauty, awe	1	1%
Nature of star parties and amateur astronomers	1	1%
Satisfaction/Affect	14	13%
Satisfaction with content	10	9%
Interesting/fascinating topic	2	2%
Dissatisfied with content	2	2%
Other	10	9%
Don't know/don't remember	3	3%

*Multiple responses allowed. Percentages total more than 100%.

Impacts of Star Parties hosted by Astronomy Clubs in the Night Sky Network

The star parties were effective at achieving the outcomes defined for the deliverables, based on the self-perceived ratings of star party participants (Figure 4). When rating the ten outcome statements, all of them had a mean of 5.0 or higher (where the scale was 1="strongly disagree" and 7="strongly agree"). The highest rated statements were *It made me want to look up at the night sky to see what's out there* and *It helped me see how beautiful the universe is*, both rated at a mean of 6.3 (Figure x). The lowest rated statement, *I learned new things about the history of astronomy* (with a mean of 5.0), was probably rated lower in comparison to the other outcomes statements because the star parties focused less on history than on the mechanics of telescopes and actually star gazing.

Figure 4: Outcome Ratings for the Star Party (Means) **Scale from 1 to 7**



Those attending star parties also indicated what they learned about from attending the star parties by completing the sentence "*I never realized that…"* Their responses were also coded within the three broad categories of learning, awareness, and satisfaction. About three quarters of the 85 respondents suggested the start party had raised their awareness related to astronomy and telescopes (75%), followed by those responses related to learning (11%) and satisfaction/affect (11%) (Table 21).

- **Awareness (75%)**: Forty percent of respondents indicated increased awareness of self-efficacy related to astronomy. Some of these respondents never realized that *"a[n] astronomy club would have such cool equipment"* and that *"the telescopes were easy to handle."* Others had never realized *"how many objects were visible through a telescope,"* or *"the problems with light pollution."* For some respondents, the star party helped raise awareness about the nature of star parties and amateur astronomers. Some of these participants had never realized star parties were going on in their neighborhoods, or that *"so many people are generous with their time and interested in teaching others about astronomy."*
- **Learning (11%)**: Only a small group of star party participants' answers suggested learning. The most frequently mentioned topic learned at a star party was scientific concepts and discoveries, including how vast the universe is, and the large amount of existing galaxies.
- **Satisfaction/Affect (11%)**: Another small proportion of respondents indicated an enjoyment of star parties. These respondents talked about star parties as being *"awesome," "a wonderful experience,"* and *"fun."*

Table 21: Responses to "*I never realized that…*" from those who went to a Star Party (n=85)

	n	Percent*
Learning	9	11%
Scientific concepts and discoveries	6	7%
Advances in telescopes over time	1	1%
Diversity of telescopes and differences between them	1	1%
Technology and use of modern telescopes	1	1%
Early history of telescopes and their users	0	0
Awareness	64	75%
Self-efficacy (e.g., the tools within their reach)	34	40%
Nature of star parties and amateur astronomers	13	15%
Overall depth of the topic	9	11%
Prior extensive knowledge	6	7%
Beauty, awe	4	5%
Awareness of 400 Years programs and locations	2	2%
Impact or importance of astronomy on society	0	0
Satisfaction/Affect	9	11%
Satisfaction with content	8	9%
Interesting/fascinating topic	1	1%
Dissatisfied with content	0	0
Other	7	8%
Don't know/don't remember	0	0

*Multiple responses allowed. Percentages total more than 100%.

Impacts of the Station Events

Respondents were asked to rate their enjoyment of various aspects of the Station Event on a scale from 1 to 7, where 1 was "not at all enjoyable" and 7 was "extremely enjoyable." In general, respondents enjoyed the event and its components: the rating of the event as a whole was a mean=6.27 and the lowest mean for an individual activity was 5.75, for using a planisphere (Figure 5). Only two individual activities were offered in all Stations participating in the survey: the planetarium show *"Two Small Pieces of Glass"* and looking through/ working with real telescopes. Of these two activities, the opportunity to look through/ work with real telescopes received higher ratings (Table 22). At the other two stations, WHYY (Philadelphia) and NPT (Nashville), other individual activities that were unique to those events seemed slightly more enjoyable. For example, the WHYY Event was the only one offering Galileo's Telescope (one of the original ones he used), which received the highest enjoyment rating for that station; NPT was one of two stations with star gazing opportunities, which were rated high for that station and overall. Preview of the PBS show was among the lowest rating overall and for the two stations that offered it (WHYY and NPT).

Figure 5: Overall Enjoyment Scores for Each Program Component (means) Scale from 1 to 7

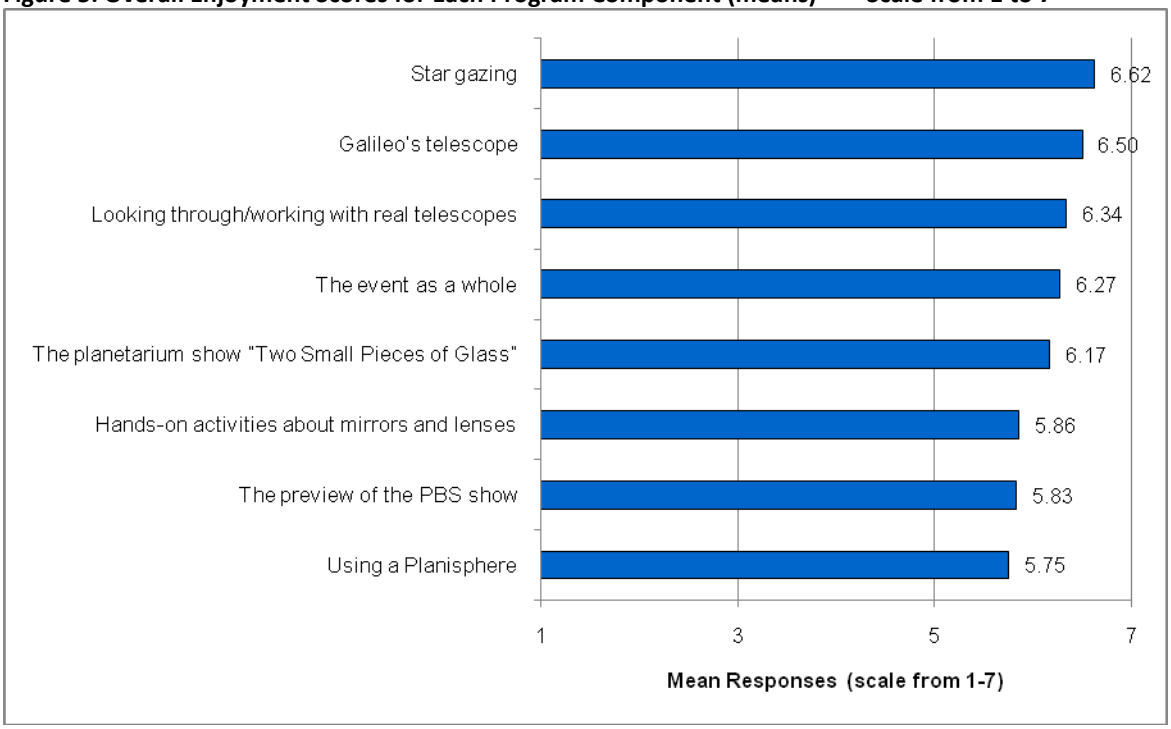


Table 22: Respondents' Enjoyment of Station Events, by Station and Overall (Scale 1 to 7, where 1 is "not at all enjoyable" and 7 is "extremely enjoyable")

Program Component	OVERALL		WHYY		OPB		MPT		NPT	
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean
The event as a whole	241	6.27	89	6.26	65	5.97	30	6.23	57	6.65
The planetarium show *"Two Small Pieces of Glass"*	236	6.17	88	6.13	65	5.91	30	6.47	53	6.40
The preview of the PBS show	139	5.83	88	5.64	--	--	--	--	51	6.18
Galileo's telescope	80	6.50	80	6.50	--	--	--	--	--	--
Star gazing	60	6.62	--	--	--	--	14	6.36	46	6.70
Looking through/working with real telescopes	119	6.34	39	5.90	19	6.21	17	6.47	44	6.75
Hands-on activities about mirrors and lenses	76	5.86	52	5.77	12	5.50	12	6.58	--	--
Using a Planisphere	40	5.75	--	--	40	5.75	--	--	--	--

Respondents were asked to rate their likelihood of participating in other astronomy-related activities during 2009 - the International Year of Astronomy - on a scale from 1 to 7, where 1 was "definitely won't participate" and 7 "definitely will participate." In general, respondents indicated a high intention to watch a documentary about telescopes and astronomy on PBS (highest mean overall and at three of

the four stations; OPB respondents, instead, seemed slightly more likely to get a book or magazine from the library about astronomy) (Figure 6 and Table 23). Respondents also indicated an intention to go to a Planetarium show about telescopes (second highest mean overall and by MPT and NPT respondents; OPB respondents, instead, seemed slightly more likely to watch a documentary about telescopes and WHYY respondents slightly more inclined to go to a related website).

The activity respondents were least likely to take part in a local astronomy club event to learn about how telescopes work (lowest rating overall and at each of the stations). This is interesting because, as described earlier, "looking through/working with real telescopes" was the most enjoyable of the activities that were held at all Station Events. It is possible that respondents' low interest in attending an astronomy club event was due to the fact that they had just participated in an entire event where they could find out about how telescopes work, or that the other options simply sounded more appealing. The fact that the two local astronomy club options were the lowest is interesting, and could suggest that people were less interested in group activities or getting to a more active level of participation like going or joining a club.

Figure 6: Overall Likelihood of Participating in Other Astronomy-Related Activities (means) Scale from 1 to 7

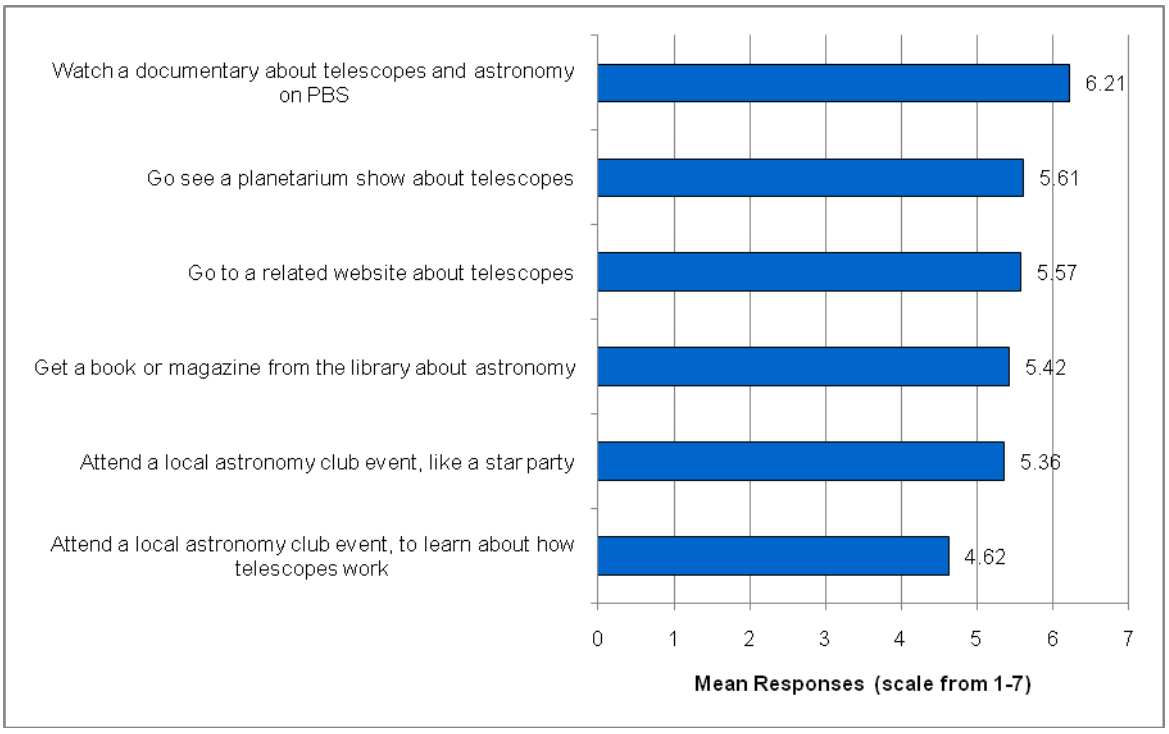


Table 23: Respondents' Likelihood of Participating in Other Astronomy-related Activity, by Station and Overall (Scale 1 to 7, where 1 is "definitely won't" and 7 is "definitely will")

Astronomy-related activities	OVERALL		WHYY		OPB		MPT		NPT		Sig. Differences between Sites?
	n	Mean	n	Mean	n	Mean	n	Mean	n	Mean	
Go see a planetarium show about telescopes	238	5.61	85	5.16	65	5.26	30	6.53	58	6.19	Yes, F=12.03, p<.001
Watch a documentary about telescopes and astronomy on PBS	242	6.21	89	6.24	66	6.00	29	6.55	58	6.24	No
Go to a related website about telescopes	242	5.57	88	5.51	66	5.05	30	5.97	58	6.05	Yes, F=5.32, p<.001
Attend a local astronomy club event, to learn about how telescopes work	239	4.62	86	4.31	65	4.05	30	5.03	58	5.48	Yes, F=8.36, p<.001
Attend a local astronomy club event, like a star party	240	5.36	86	4.77	66	5.48	30	5.60	58	5.98	Yes, F=8.02, p<.001
Get a book or magazine from the library about astronomy	239	5.42	85	4.75	66	6.14	30	5.23	58	5.67	No

Those attending the Station Events were also asked to indicate what they learned by participating in the Station Event. Their responses were coded within learning, awareness, and satisfaction/affect categories that were used to analyze the responses to this question for each deliverables. About two-thirds (64%) of responses fell under the learning category, followed by awareness (24%), and satisfaction (8%) (Table 24). A similar proportion of responses was obtained in each of station responses, except for NPT. However, at the NPT event only five individuals responded to this question; the differences were more likely due to a very small sample size and will not be described.

- **Learning (64%)**: About 20% of responses referred to learning about a scientific concept and discoveries in the field. Some responses referred to concepts seen in other deliverables, such as how "the Universe was expanding at an increasing rate" or how "the galaxies are moving away from each other increasingly fast." However, a larger number of responses talked about "the concept of telescopes as time machines" or how "looking at objects father away is the same as looking further back in time." This was likely due to how the speakers at the events framed the topic. Another group of responses referred to learning about modern telescopes (17%), such as how "we could now filter out effects of the atmosphere on our images" and "telescopes were so large." Another set of responses referred to learning about the early history of telescopes (16%);

for example, that "the telescope has been around for 400 years" or that "Galileo was persecuted for his advanced ideas that were contrary to religious perceptions of the heaven bodies."

- **Awareness (24%)**: Respondents indicated increasing their awareness of 400 Years of Telescopes programs, especially that the Event Stations carried out such programs or were involved in collaborations, and also about the topic of astronomy.
- **Satisfaction/ Affect (10%)**: Another small proportion of respondents indicated an enjoyment of the Station Events. These respondents talked about them as being "neat" or "cool."

Table 24: Responses to "*I never realized that…*" from those who went to a Station Event

	OVERALL (n=130)		WHYY (n=58)	OPB (n=44)	MPT (n=23)	NPT (n=5)
	n	Percent*	Percent*	Percent*	Percent*	Percent*
Learning	83	64%	62%	66%	61%	80%
Scientific concepts and discoveries	29	22%	19%	34%	9%	20%
Technology and use of modern telescopes	22	17%	12%	18%	30%	0%
Early history of telescopes and their users	21	16%	19%	11%	17%	20%
Advances in telescopes over time	13	10%	14%	5%	9%	20%
Diversity of telescopes and differences between them	4	3%	0%	2%	9%	20%
Awareness	31	24%	28%	20%	26%	0%
Awareness of 400 Years programs and locations	10	8%	9%	2%	17%	0%
Overall depth of the topic	6	5%	5%	5%	4%	0%
Nature of star parties and amateur astronomers	5	4%	2%	9%	0%	0%
Beauty, awe	4	3%	5%	0%	4%	0%
Self-efficacy (e.g., the tools within their reach)	3	2%	3%	2%	0%	0%
Impact or importance of astronomy on society	0	0%	0%	0%	0%	0%
Prior extensive knowledge	0	0%	0%	0%	0%	0%
Satisfaction/Affect	10	8%	10%	5%	9%	0%
Satisfaction with content	7	5%	7%	5%	4%	0%
Dissatisfied with content	2	2%	3%	0%	0%	0%
Interesting/fascinating topic	1	1%	0%	0%	4%	0%
Other	17	13%	10%	11%	22%	20%
Don't know/don't remember	0	0%	0%	0%	0%	0%

*Multiple responses allowed. Percentages total more than 100%.

FINDINGS ACROSS DELIVERABLES

Whereas the previous section focused on each deliverable by itself, this section looks at either the deliverables combined or makes comparisons across deliverables. This provides information about the overall project as well as being able to compare across each of the deliverables.

Use of Telescopes

A series of items tried to get at the extent to which people had experiences with telescopes, and also the extent to which they used telescopes after being exposed to the *400 Years* deliverables.

It can be said that many of the participants in this study had a decent amount of experience with telescopes (Table 25). In fact, 87% of participants had looked through a telescope at least twice before engaging with the deliverables, and only 7% had never looked through a telescope before engaging with the project. For most people, this meant that the project would not be able to introduce them to looking through telescopes; however, it could certainly have the potential to increase the number of times they had looked through a telescope.

As can be seen in Table 25, the majority of people hadn't necessarily looked through a telescope since engaging with the deliverables; for many, it was only a month or two. However, more than one third (36%) had looked through a telescope since engaging with *400 Years*. Given the amount of experience the respondents had with telescopes prior to engaging with the project, it is difficult to know whether these additional views through telescopes could be attributed to the project.

Table 25: Frequency of telescope use, both before and after engaging *400 Years*

Frequency of telescope use (# of times looked through)	Lifetime before *400 Years*		Since *400 Years*	
	n	%	n	%
0	24	7%	218	64%
1 time	21	6%	39	12%
2-3 times	74	22%	29	9%
4-5 times	48	14%	20	6%
6 or more times	175	51%	33	10%
Total	342	100%	339	100%

As can be seen in Table 26, the one third (33%) of people had looked at a telescope in the past five months. This is important because for most of the respondents this would have fallen with the period during which they engaged in the *400 Years* deliverables. Again, it is difficult to know whether this was done as a result of engaging the project or not, since the number of times they had engaged in the project during that time period was not recorded.

Table 26: Last time they looked through a telescope (n=340)

Deliverable	n	Percent
Have never looked	20	7%
Within the past month	57	17%
1-5 months ago	32	9%
6 to 11 months ago	40	12%
1 to 2 years ago	56	17%
3 or more years ago	135	40%
Total	340	100%

Overall Outcomes by Deliverable

As mentioned previously, there were a set of items that were meant to serve as overall project outcomes (see Table 27 below for the list of overall project outcomes). These items were asked regardless of which deliverable(s) someone engaged in and related most directly to the overall project's goals and objectives. It is important to note that these are agreement items, which may or may not have been influenced by the deliverables. However, they are important to include so that one can compare the extent to which these ratings change based on the number of deliverables or for whether they engaged in specific deliverables, which are addressed in other sections of the report.

Of the nine items, the highest items were "Astronomers are discovering new things all the time," "Science is interesting to me," and "Looking through a telescope is an awe-inspiring experience." These items ranged across the different types of outcomes: affect, interest and attitude, respectively. The two lowest items related to being inspired and self-efficacy, or feeling that they have the abilities to do something like astronomy.

Table 27: Ratings for overall project outcome statements, all respondents (scale is 1 to 7, from lowest to highest agreement)

Overall Project Outcomes	Category	n	Mean	Standard Deviation
Science is interesting to me.	Interest	833	6.31	1.22
Astronomy is interesting to me.	Interest	833	6.16	1.24
Astronomers are discovering new things all the time.	Attitude	823	6.37	1.13
Astronomy is a science that both professionals and everyday people can contribute to.	Attitude	834	6.07	1.31
Astronomy is exciting to me.	Affect	818	6.00	1.35
Looking through a telescope is an awe-inspiring experience.	Affect	828	6.24	1.24
Looking up at the night sky is a way to feel more connected to the universe.	Affect	832	6.08	1.36
There are resources and tools that I can use to do astronomy.	Self-Efficacy	824	5.80	1.42
I want to look up at the night sky right now, or as soon as it's dark.	Intention	830	5.43	1.59

Analyses were run to determine whether those who participated in a specific deliverable were more likely to experience specific overall project outcomes. Some deliverables were, in fact, more likely to occur for certain outcomes than others (see Table 28). In reading the table, for example, the highlighted blue box in the top left corner, under Documentary and for the "Astronomy is interesting to me" says that those who viewed the documentary were more likely to agree that astronomy was interesting to them, compared to a group who did not view the documentary.

The statistically significant differences are highlighted in blue in Table 28. A statistically significant difference means that if a box is not highlighted, any differences in the ratings on the project outcomes statements were not different enough to warrant further discussion. Also important to mention is the direction in which the differences occurred; if there is a statistically significant difference, there was a higher rating on that particular outcome statement for those who engaged in the deliverable than those who did not.

It is interesting to note that each of the deliverables did not result in the same kinds of differences in outcome measures and categories. That is, the documentary and planetarium program did not overlap at all in terms of which types of outcomes they were related to. The documentary yielded differences in the interest and attitude categories, while viewing the planetarium program impacted self-efficacy and intentions. Equally interesting is that the website and star parties were related to the largest number of outcomes, nearly all of them in fact. Since we did not gather specific information from respondents about why certain outcomes occurred more than others based on deliverables, one can only speculate that the website and the star parties may have offered a more individualized experience that may have

impacted these results. Additionally, the amount of time someone could have spent on the website was limitless, and star parties typically last one to two hours. Further research into why this might be the case would be useful, and some hints are provided when examining the individual outcomes for the deliverables in the sections below entitled "Respondents Learning and Increased Awareness by Deliverable" and "Impact of Multiple Deliverables."

Table 28: Comparison of overall project outcomes by participation in each deliverable

Outcome Category	Overall Project Outcome Statements	Statistically Significant Difference with Participation in a Specific Deliverable?			
		Docu-mentary	Planet-arium	Website	Star Party
Interest	Astronomy is interesting to me.	Yes, t=-1.98, p<.05	No	Yes, t=-4.49, p<.001	Yes, t=-4.42, p<.001
	Science is interesting to me.	Yes, t=-2.09, p<.05	No	Yes, t=-3.25, p<.001	No
Affect	Astronomy is exciting to me.	No	No	Yes, t=-5.33, p<.001	Yes, t=-3.79, p<.001
	Looking up at the night sky is a way to feel more connected to the universe.	No	No	Yes, t=-3.33, p<.001	Yes, t=-2.26, p<.05
	Looking through a telescope is an awe-inspiring experience	No	No	Yes, t=-2.99, p<.005	Yes, t=-2.60, p<.05
Attitude	Astronomers are discovering new things all the time.	Yes, t=-2.77, p<.05	No	No	No
	Astronomy is a science that both professionals and everyday people can contribute to.	No	No	Yes, t=-2.50, p<.05	Yes, t=-3.09, p<.005
Self-Efficacy	There are resources and tools that I can use to do astronomy.	No	Yes, t=-2.51, p<.05	Yes, t=-4.41, p<.001	Yes, t=-3.26, p<.001
Intention	I want to look up at the night sky right now, or as soon as it's dark.	No	Yes, t=-2.59, p<.05	Yes, t=-4.92, p<.001	Yes, t=-5.54, p<.001

Outcomes for Specific Deliverables

A second set of outcome statements were included in the study, this time asked about each of the specific deliverables. That is, the same set of questions (Table 29) was asked for each of the deliverables someone engaged with. Unlike the overall items, however, the items for the deliverables asked specifically about the impact that engaging with that deliverable had on the individual.

There were some differences in the average ratings, with the documentary having the highest average rating compared to the other three deliverables (Table 29). The biggest impacts, across deliverables, were the following items: “There’s still so much to learn about the universe,” “It helped me see how beautiful the universe is,” and “It made me want to look up at the night sky.” In terms of the outcome categories represented, these included Learning, Awareness and Intention. This first set of items was followed by the following items: “I gained an appreciation about the work astronomers are doing,” “It showed just how much is out there in the universe,” “It helped me see how diverse the universe is,” and “I feel inspired to learn more about astronomy.” In summary, each of the deliverables had a high impact on participants’ astronomy appreciation, awareness, learning, inspiration, and intentions.

Table 29: Mean ratings of deliverable-specific outcomes for each deliverable (Scale: 1 is "strongly disagree" and 7 is "strongly agree").

Outcome Category	Specific Deliverable Outcome Statements	Mean Ratings on Deliverables				Across All Deliverables
		Docu-mentary	Planet-arium	Website	Star Party	
Appreciation	I gained an appreciation about the work astronomers are doing.	6.3	5.9	5.9	5.7	6.0
Awareness	It showed just how much is out there in the universe.	6.2	6.0	5.9	6.0	6.0
	It helped me see how beautiful the universe is.	6.3	6.1	5.9	6.3	6.2
	It helped me see how diverse the universe is.	6.2	5.8	5.9	6.0	6.0
Learning	I learned new things about astronomy.	6.0	5.6	5.6	5.7	5.7
	I learned new things about how telescopes work.	5.9	5.7	5.3	5.4	5.6
	I learned new things about the history of astronomy.	6.1	5.7	5.6	5.0	5.6
	There's still so much to learn about the universe.	6.6	6.4	6.1	6.2	6.3
Inspiration	I feel inspired to learn more about astronomy.	6.0	5.8	6.0	6.1	6.0
Intention	It made me want to look up at the night sky to see what's out there.	6.0	6.0	6.0	6.3	6.1
	Mean For Each Deliverable	6.2	5.9	5.8	5.9	5.9

Outcomes by Demographics / Psychographics

The overall project outcome statements were compared based on the demographic and psychographic characteristics of the respondents, as can be seen below. These outcomes were compared by gender, level of education, whether someone was a PBS member, whether someone had children under 18 in the household and when the last time someone had looked through a telescope. For each statement below, only statistically significant differences are reported.

The variable that made the biggest difference on these items was how recently someone had looked through a telescope. This makes some intuitive sense, given that those who have most recently looked

through a telescope likely have a higher interest in and engagement with astronomy. While men were more likely to say they found astronomy and science interesting, women were more likely to say astronomy was a way to feel more connected to the universe. Those with kids under 18 in the household were more likely to say astronomy was exciting to them, and that there were resources and tools they could use to do astronomy. Interestingly, level of education made no difference in these items.

Astronomy is interesting to me.

- **Gender**: Men had higher ratings on this item compared to women (6.3 compared to 6.0, $t(818)=2.44$, $p<.05$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

Science is interesting to me.

- **Gender**: Men had higher ratings on this item compared to women (6.4 compared to 6.2, $t(700.58)=2.96$, $p<.005$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

Astronomy is exciting to me.

- **Household Make-up**: Those who had children in the household (6.1) or lived in a multiple adult household with no children (6.1) had higher ratings than those whol lived alone (5.8; $F(2,794)=3.70$, $p<.05$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

Astronomers are discovering new things all the time.

- **PBS Membership**: PBS members had higher ratings than non-PBS members (6.5 compared to 6.3, $t(758.55)=2.44$, $p<.05$).
- **Telescope Usage**: Those who had more experience with telescopes prior to becoming aware of the *400 Years* project rated this item higher (See Table 30).

Astronomy is a science that both professionals and everyday people can contribute to.

- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

Looking up at the night sky is a way to feel more connected to the universe.

- **Gender**: Women had higher ratings on this item compared to men (6.3 compared to 5.9, $t(784.23)=-3.36$, $p<.001$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

Looking through a telescope is an awe-inspiring experience.

- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32).

There are resources and tools that I can use to do astronomy.

- **Household Make-up**: Those who had children in the household (6.0) had higher ratings than those with no children in the house (1 adult with no children: 5.6; multiple adults with no children: 5.8; $F(2,800)=3.19$, $p<.05$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables 30, 31, and 32.

I want to look up at the night sky right now, or as soon as it's dark.

- **Gender**: Women had higher ratings on this item compared to men (5.7 compared to 5.3, $t(779.72)=-3.49$, $p<.001$).
- **Household Make-up**: Those who had children in the household (5.8) had higher ratings than those with no children in the house (1 adult with no children: 5.3; multiple adults with no children: 5.4; $F(2,806)=5.86$, $p<.005$).
- **Telescope Usage**: Those who had more experience with telescopes and who had used a telescope more recently rated this item higher (See Tables xyz).

Table 30: The Role of Prior Telescope Experience on Rating the Project Outcomes (Scale: 1 is "strongly disagree" and 7 is "strongly agree").

Overall Project Outcome Statements	Number of Telescope Usages prior to becoming aware of *400 Years*					Sample Size	*F* value	*p* value
	0	1	2-3	4-5	6			
Astronomy is interesting to me.	5.6	5.7	5.9	5.9	6.5	833	15.27	***
Science is interesting to me.	5.8	6.0	6.0	6.1	6.6	833	10.92	***
Astronomy is exciting to me.	5.6	5.6	5.7	5.7	6.3	818	11.55	***
Astronomers are discovering new things all the time.	6.0	6.1	6.4	6.2	6.5	823	4.45	***
Astronomy is a science that both professionals and everyday people can contribute to.	5.6	5.7	5.9	5.8	6.3	834	8.84	***
Looking up at the night sky is a way to feel more connected to the universe.	5.6	5.5	6.0	5.9	6.3	831	5.76	***
Looking through a telescope is an awe-inspiring experience	5.9	5.6	6.2	6.1	6.4	828	6.43	***
There are resources and tools that I can use to do astronomy.	5.1	5.2	5.5	5.6	6.1	824	14.80	***
I want to look up at the night sky right now, or as soon as it's dark.	4.9	5.0	5.4	5.3	5.6	830	3.62	*

**p<.05*
***p<.005*
****p<.001*

Table 31: The Role of Telescope Usage Since Becoming Aware of *400 Years* on Rating the Project Outcomes (Scale: 1 is "strongly disagree" and 7 is "strongly agree").

Overall Project Outcome Statements	Number of Telescope Usages since becoming aware of *400 Years*					Sample Size	*F* value	*p* value
	0	1	2-3	4-5	6			
Astronomy is interesting to me.	6.0	6.3	6.2	6.1	6.7	827	8.57	***
Science is interesting to me.	6.2	6.4	6.3	6.1	6.6	827	3.22	*
Astronomy is exciting to me.	5.8	6.2	6.1	5.9	6.6	812	10.07	***
Astronomers are discovering new things all the time.	6.3	6.6	6.4	6.3	6.6	817	2.21	n.s.
Astronomy is a science that both professionals and everyday people can contribute to.	5.9	6.4	6.1	6.3	6.4	828	5.35	***
Looking up at the night sky is a way to feel more connected to the universe.	5.9	6.3	6.3	6.4	6.4	826	6.12	***
Looking through a telescope is an awe-inspiring experience	6.1	6.4	6.4	6.5	6.6	822	6.17	***
There are resources and tools that I can use to do astronomy.	5.6	6.0	6.0	6.1	6.5	818	12.65	***
I want to look up at the night sky right now, or as soon as it's dark.	5.1	5.6	5.9	5.9	6.2	824	15.12	***

**p<.05*
***p<.005*
****p<.001*

Table 32: The Role of Recent Telescope Usage on Rating the Project Outcomes (Scale: 1 is "strongly disagree" and 7 is "strongly agree").

Overall Project Outcome Statements	Last Time Looked through a Telescope						Sample Size	*F* value	*p* value
	Within the last month	1-5 months ago	6-11 months ago	1-2 years	3 or more years ago	Never			
Astronomy is interesting to me.	6.5	6.4	6.3	6.2	5.9	5.6	831	8.99	***
Science is interesting to me.	6.4	6.5	6.5	6.3	6.2	5.9	831	25.0	*
Astronomy is exciting to me.	6.3	6.3	6.2	5.9	5.8	5.5	816	7.62	***
Astronomers are discovering new things all the time.	6.4	6.5	6.5	6.4	6.3	6.0	821	1.56	n.s.
Astronomy is a science that both professionals and everyday people can contribute to.	6.3	6.4	6.2	6.2	5.8	5.6	832	6.47	***
Looking up at the night sky is a way to feel more connected to the universe.	6.3	6.3	6.3	6.1	5.8	5.7	830	5.11	***
Looking through a telescope is an awe-inspiring experience	6.5	6.4	6.3	6.2	6.0	5.8	826	5.54	***
There are resources and tools that I can use to do astronomy.	6.2	6.1	5.9	5.8	5.4	5.1	822	11.78	***
I want to look up at the night sky right now, or as soon as it's dark.	6.0	5.7	5.4	5.4	5.0	4.9	829	11.12	***

*p<.05
**p<.005
***p<.001

Respondents Learning and Increased Awareness by Deliverable

An open-ended item was included to find out what visitors were learning from the various deliverables. The item asked visitors to complete the following sentence about their experience for each of the deliverables they experienced: *"I never realized that…."* In a previous section, this item is broken down for each of the deliverables; this section combines those responses.

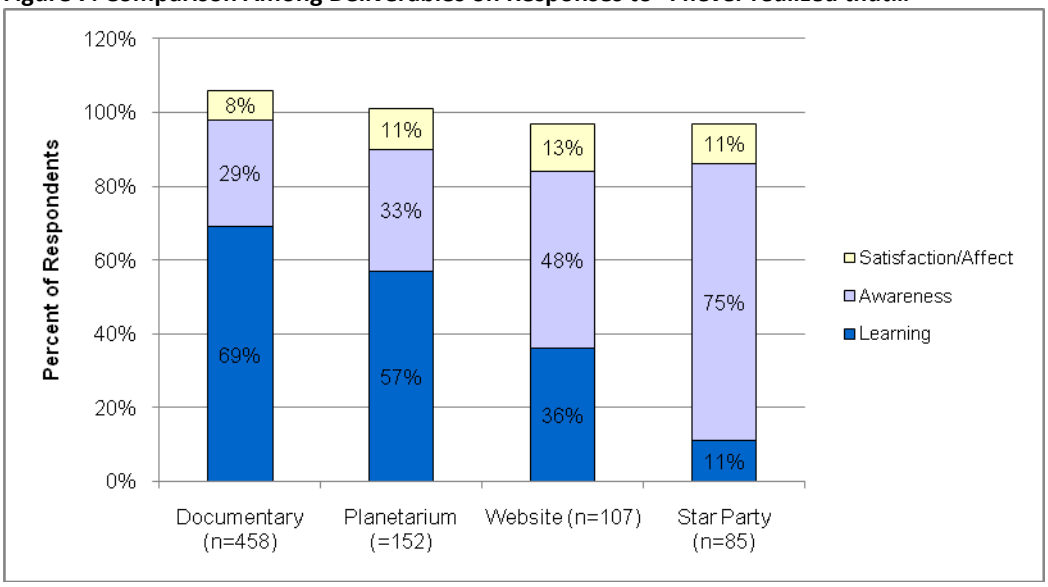
Findings across all deliverables:

Respondents' answers were coded within three broad categories of learning, awareness, and satisfaction/affect.[6] When comparing the responses across deliverables, it is interesting to note that

[6] There were too few open-ended responses in the "satisfaction/affect" category to analyze the broad category in a similar manner as for learning and awareness.

learning content knowledge occurred more frequently for those who watched the documentary (69%), followed by the planetarium program (57%), visiting the website (36%), and attending a star party (11%) (Figure 7).

Figure 7: Comparison Among Deliverables on Responses to "*I never realized that…*"



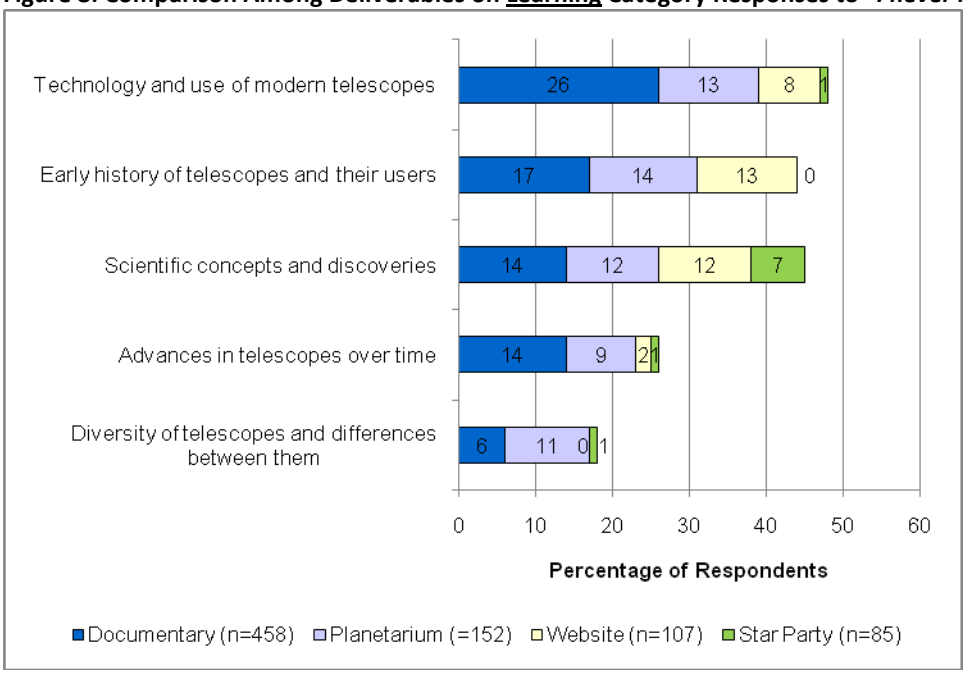
Note: Respondents could provide more than one answer and sometimes more than one code was used for individual responses; therefore, responses can total more than 100%

In order to better understand these findings, it was important to look at the specific codes within the broader **learning** category (Figure 8). From that it was possible to observe the following:

- Those watching the documentary seemed to have learned more about the technology and use of modern telescopes than participants of the other deliverables.
- Conversely, those attending star parties were less likely to gain understanding about the early history of telescopes, advances of telescopes over time, modern telescopes, and/or scientific concepts.
- In general, except for learning about modern telescopes, those attending the planetarium program seemed to have gained understanding of these topics in a similar way as those who watched the documentary.

Those who engaged with the website learned about these topics in a more diversified way: while they gained some understanding about early history of telescopes and scientific concepts, they did not gain as much in terms of advances in telescopes, diversity of telescopes, and modern telescopes.

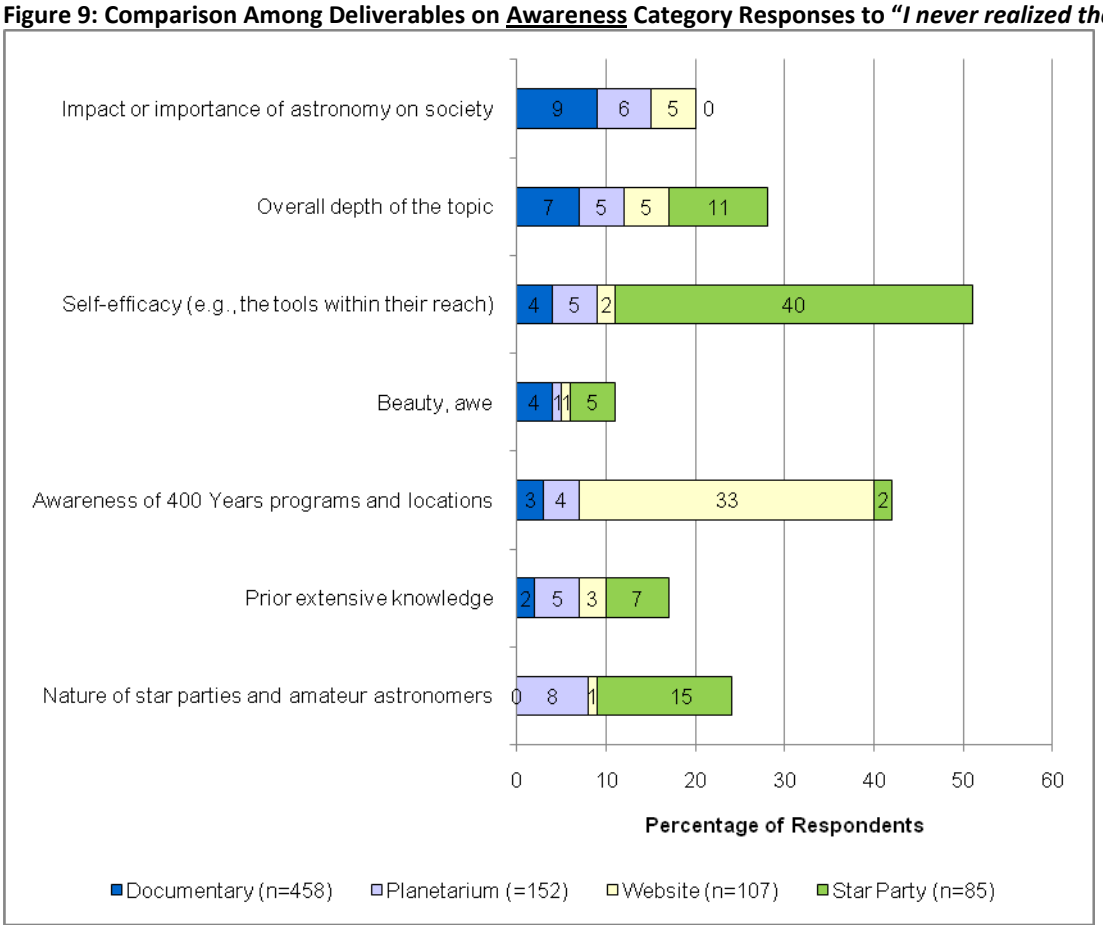
Figure 8: Comparison Among Deliverables on Learning Category Responses to "*I never realized that…*"



On the other hand, an opposing trend was found for **awareness**, which was more frequently reported by those attending star parties (75%), and progressively declined in those visiting the website (48%), watching the planetarium program (33%), and the documentary (29%) (Figure 9). A closer look at the specific codes in this category revealed the following (Figure 9):

- Those attending star parties seemed to have gained more awareness of their self-efficacy (or feeling that they could actually do astronomy), about the nature of star parties and amateur astronomers, and the overall depth of the topic than did respondents from the other deliverables.
- Those watching the documentary, the planetarium program, or viewing the website had similar awareness about the impact of astronomy on society, the depth of the topic, their own prior knowledge, beauty, self efficacy, and about the existence of 400 Years programs. One difference related to the awareness of the nature of star parties and amateur astronomers, which seemed larger for those participating in the planetarium program and probably due to the fact that the storyline of the show focuses on going to a star party.

Figure 9: Comparison Among Deliverables on Awareness Category Responses to "*I never realized that…*"



PARTICIPATING IN MULTIPLE DELIVERABLES

As mentioned previously, there were four main deliverables of the project: PBS documentary, planetarium program, website and NSN events (star parties). Up until this point, the report has treated the different deliverables separately. However, given that the project provides a suite of options that are meant to work together as a whole, it was important to determine whether people were engaging in more than one deliverable and seeing this impacted the participants' experiences with *400 Years*.

One important factor was that many of the respondents were unaware that the deliverable they were participating in was part of the larger *400 Years of the Telescope* project. In fact, only 15% of respondents were aware of the existence of the overarching framework for the project. This should be considered when reading the rest of this section and the report in general.

Number of Deliverables

The mean number of deliverables completed was 1.4 out of 4 per participant, with more than two-thirds (71%) participating in only one deliverable and less than one-third (29%) participating in more than one deliverable (see Table 33). While 19% of all respondents participated in two deliverables, 7% did three and only 2% did all four deliverables.

Table 33: Total number of deliverables participated in (n=749)

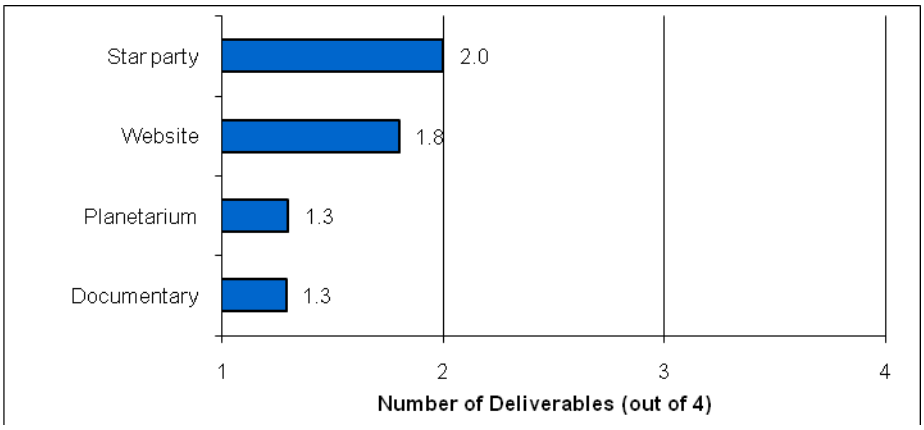
Number of deliverables	n	Percent
One	533	71%
Two	143	19%
Three	55	7%
Four	15	2%
Total	749	100%

Males were slightly more likely to engage in more deliverables (1.4) compared to females (1.3); while this difference was not that large, it was statistically significant ($t(702.66)=2.21, p<.05$). Interestingly, PBS members were actually less likely to engage in more than one deliverable (1.3) compared to non-PBS members (1.5), a statistically significant difference ($t(686.01)=2.82$, $p<.005$). Those participants who had looked through a telescope most recently also engaged in more deliverables ($F(5,741)=28.365$, $p<.01$).

The factor that seemed to have the strongest predictive relationship to the number of deliverables was which of the deliverables was the entry point into their engagement with *400 Years* (Table 31). If the respondent first experienced the project at a star party or the website, they were much more likely to engage in another deliverable, compared to the planetarium program or the documentary. Perhaps this had to do with the fact that those going to a star party, because of their interest in amateur astronomy, were more likely to engage in other astronomy-related activities. Additionally, the website could also

have served to raise awareness of the other activities, or someone may have been going to the website specifically to find out about the *400 Years* activities.

Table 34: Total number of deliverables participated in, by entry point into *400 Years* (n=749)



Order of Deliverables / Pathways

It is important to remember that most people (71%) stopped engaging with *400 Years* after their first deliverable; meaning, for these respondents their *400 Years* project experience was limited to and completely driven by the deliverable they experienced. Given that the deliverables were highly rated, the fact that they did not engage in more activities may have been affected by factors other than their experience with the single deliverable. As mentioned above, awareness was likely a key factor.

As was mentioned earlier, the means by which participants were sampled most likely affected which deliverables people had engaged in and especially which deliverables they first engaged in. That is, the numbers below may not reflect the way in which the general public engaged in the *400 Years* deliverables. That said, for the sample the most common entry point into *400 Years* was the documentary, followed by the website, planetarium program, then the start parties (Table 35).

Table 35: Which deliverable was the entry point into *400 Years* (n=748)

Deliverable	n	Percent
Documentary	479	64%
Website	118	16%
Planetarium program	91	12%
Star party	60	2%
Total	748	100%

The entry point also affected their awareness of the *400 Years* project in general; this was a statistically significant difference. Those who entered through the star parties had the highest awareness (54%),

while the numbers were very similar for the other deliverables: planetarium program (13%), website (12%), and documentary (10%). A participant's entry point also impacted which specific deliverables they were aware of (Table 36). Those who came in through the star party were most aware of the documentary, while those coming in for the website were most aware of the star parties. Respondents entering through the documentary were most aware of the planetarium program. This shows that not only was there not one predictable pattern in terms of awareness of other deliverables, but also that which deliverable you started at affected your rate of awareness for the other deliverables.

Table 36: Entry point and awareness of other deliverables.

Entry Point	**Percent of Sample Answering "Yes" to awareness of that deliverable**			
	Documentary	Planetarium	Website	Star party
Documentary	--	39%	35%	33%
Planetarium	58%	--	42%	26%
Website	69%	25%	--	81%
Star party	81%	69%	38%	--
Significant Difference?	No	Yes; p<.01; Chi sq=11.280	No	Yes; p<.01; Chi sq=14.837
Sample Size	67	131	134	118

Respondents were also asked to list the order in which they engaged in the deliverables, if they engaged in more than one. There were some specific patterns among the order of deliverables engaged in, depending on which one a participant started with.

Deliverables starting with (in order from highest to lowest frequency starting with):

1. Documentary (476 individuals started here) – 120 individuals, or 25% of those who started with the documentary, engaged in another deliverable. If people engaged in another deliverable after the documentary, it was most likely to be the website; the second most common deliverable after the documentary was the planetarium program, followed by the star party.

   Most common paths, after documentary:

   Documentary→Website (61 individuals)

   Documentary→Planetarium program (43 individuals)

   Documentary→Star Party (16 individuals)

2. Planetarium program (126 individuals started here) – 29 individuals, or 23% of those who started with the planetarium program, engaged in at least one other deliverable. For those who engaged in another deliverable, they were most likely to engage in a star party or the documentary, followed by the website.

   Most common paths, after planetarium:

   Planetarium→Star Party (13 individuals)

   Planetarium→Documentary (10 individuals)

Planetarium→Website (6 individuals)

3. Star Party (62 individuals started here) – 29 individuals, or 47% of those who started with the star party, engaged in at least one other deliverable. For those who engaged in another deliverable, the most common second choice was the documentary, followed by the website and the planetarium.

   Most common paths, after star party:

   Star Party →Documentary (13 individuals)

   Star Party →Website (9 individuals)

   Star Party →Planetarium (7 individuals)

4. Website (40 individuals started here) – 21 individuals, or 53% of those who started with the website, engaged in at least one other deliverable. If respondents started with the website they did they were most likely to next watch the documentary or attend a star party.

   Most common paths, after website:

   Website →Documentary (10 individuals)

   Website →Star Party (10 individuals)

   Website →Planetarium (1 individuals)

Which deliverable someone first started with definitely impacted which the next most common deliverable, or path, was taken. There seemed to be a pairing between the documentary and the website; the documentary's second deliverable was most commonly the website, and the website's most common second deliverable was the documentary. Meanwhile, the planetarium program's most common second deliverable was the star party, and the star party's most common second deliverable was the documentary.

Number of Deliverables and Main Project Outcomes

There was a relationship between the number of deliverables someone engaged in and the main project outcomes (Table 37). In fact, there was a statistically significant difference on six out of the nine main project statements between the number of deliverables and the outcomes; the more deliverables you engaged in, the higher the ratings. Of the six items, one was about Interest, all three Affect items were significant, as was the Self-efficacy item and the Intention item. While neither of the Attitude items were significantly different, it is important to note that attitudes can sometimes be very difficult to affect.

Table 37: Main project outcomes by number of deliverables (scale is 1 to 7, from lowest to highest agreement)

Overall Project Outcomes	One (n=526)	Two (n=142)	Three (n=55)	Four (n=15)	Statistically Significant Difference?
Science is interesting to me. (Interest)	6.27	6.35	6.65	6.67	No (p=.083)
Astronomy is interesting to me. (Interest)	6.13	6.30	6.56	6.80	**Yes** (p<.05)
Astronomers are discovering new things all the time. (Attitude)	6.40	6.43	6.45	6.67	No (p=.764)
Astronomy is a science that both professionals and everyday people can contribute to. (Attitude)	6.07	6.19	6.35	6.47	No (p=.215)
Astronomy is exciting to me. (Affect)	5.95	6.19	6.42	6.40	**Yes** (p<.05)
Looking through a telescope is an awe-inspiring experience. (Affect)	6.17	6.44	6.50	6.27	**Yes** (p<.05)
Looking up at the night sky is a way to feel more connected to the universe. (Affect)	5.99	6.32	6.46	6.20	**Yes** (p<.05)
There are resources and tools that I can use to do astronomy. (Self-efficacy)	5.68	6.13	6.34	6.07	**Yes** (p<.05)
I want to look up at the night sky right now, or as soon as it's dark. (Intention)	5.29	5.77	6.04	5.93	**Yes** (p<.05)

IMPACT OF MULTIPLE DELIVERABLES

Given that the deliverables were meant to be experienced as a group, rather than individually, a series of analyses were conducted to look at the collective impact of participating in more than one deliverable. The basic hypothesis was that the more deliverables a person engaged with, the higher the outcomes and impacts would be. However, no specific hypotheses were made about which outcomes would be more or less affected by increasing the number of deliverables participated in.

To do this analysis, a series multiple regressions were run. Multiple regression is a statistical analysis that looks at the individual and cumulative impact of a group of variables on another variable.

The multiple regression analyses[7] included below were intended to answer specific questions. Some questions look at the overall project and included any and all of the four deliverables someone engaged with, while others are run only on a specific deliverable.

The questions guiding the regression analysis were as follows:

1. FOR THE OVERALL PROJECT, which outcomes best predicted whether someone…
    a. Thought astronomy was interesting?
    b. Thought astronomy was exciting?
    c. Was inspired to look up at the night sky?
2. BASED ON EACH DELIVERABLE, which outcomes best predicted whether someone…
    a. Was inspired to look up at the night sky?
    b. Was inspired to learn more about astronomy?

Participants rated the impact of participation in the overall *400 Years* project on nine items:

Astronomy is interesting to me.
Science is interesting to me.
Astronomy is exciting to me.
Astronomers are discovering new things all the time.
Astronomy is a science that both professionals and everyday people can contribute to.
Looking up at the night sky is a way to feel more connected to the universe.
Looking through a telescope is an awe-inspiring experience.
There are resources and tools that I can use to do astronomy.
I want to look up at the night sky right now, or as soon as it's dark.

How Multiple Regression Works

In the analyses below, there is one main variable that is the focus of the regression – this is called the *dependent variable*. Then one or more variables are entered to see how predictive they are of the main variable – these are called the *independent variables*. In a stepwise regression, the type used in the analyses below, the independent variables are entered one by one in the order of their predictive power. That is, the best predictor of the main variable is entered first, the second best predictor is entered next, and so on; correlations are used as the means for knowing how predictive, or how strong of a relationship there is. However, independent variables will not be entered if they do not have any additional predictive power above and beyond the variable or group of variables already entered into the analysis. That is, if an item does not account for any additional variance above and beyond the group of independent variables already included, it is not included.

The measure of the amount of predictive power is called the *R-squared*. It ranges from .000 to 1.000 and represents the amount of variance (as a percentage) the group of independent variables explains about the dependent variable. The R-squared value represents a range from 0% to 100%. The higher the R-

[7] For the analyses in this section, a stepwise linear regression analysis was used, so that variables were only entered into the regression analysis if they accounted for additional variance above and beyond the variables currently entered. As a stepwise model, it entered them in the order of the amount of individual variance accounted for.

square, the better job the independent variables do of predicting the dependent variable. In the social sciences while it is still a subject of much debate, an R-square of .400 or .500 is considered to be a relatively good predictor. The more related the variables, however, the more you would expect strong correlations and thus higher R-square values.

Thinking Astronomy is Interesting (Overall Project)

As can be seen in Table 38, only four of the eight independent variables were included in the regression analysis. In stepwise regression, only variables that contribute predictive power above and beyond those already entered are included in the analysis. Even though only four variables were entered, they had a combined R-squared that was a very good predictor of seeing astronomy as interesting (R^2=.815). While four variables were included, the two items that were most likely to predict whether someone saw astronomy as interesting were whether they thought *astronomy was exciting* and whether they saw *science as interesting*. These two variables together accounted for the large majority of variance (R^2=.806). Also included were saying that *there are resources and tools they could use to do astronomy*, and saying *astronomers are discovering new things all the time*. The total predictive power for these four variables was quite good (R^2=.815; 82% of the variance for the dependent variable was explained).

Table 38: Regression analysis for *"Astronomy is interesting to me"* by main outcomes.

Dependent variable: *Astronomy is interesting to me.*	R-squared	R-squared change
Independent variables included:		
1. *Astronomy is exciting to me.*	.772	N/A
2. *Science is interesting to me.*	.806	.034
3. *There are resources and tools that I can use to do astronomy.*	.813	.007
4. *Astronomers are discovering new things all the time.*	.815	.002

Independent variables not included (excluded) in the regression:

- *Astronomy is a science that both professionals and everyday people can contribute to.*
- *Looking up at the night sky is a way to feel more connected to the universe.*
- *Looking through a telescope is an awe-inspiring experience.*
- *I want to look up at the night sky right now, or as soon as it's dark.*

Thinking Astronomy is Exciting (Overall Project)

As can be seen in Table 39, seven of the eight independent variables were included in the regression analysis; compared to the previous regression, it seems that a larger number of factors influence people thinking of astronomy as exciting. The seven variables entered, as a group, were a very good predictor of people saying astronomy was exciting to them (R^2=.804; 80% of the variance for the dependent variable was explained). A single item, saying *astronomy was interesting* to them, accounted for nearly all of the variance on its own (R^2=.772), although *looking up at the night sky to connect to the universe* added a respectable amount of predictive power (R^2=.020). The only item that was not included was *"Looking through a telescope is an awe-inspiring experience."* According to this analysis, finding astronomy interesting was very much related to finding it exciting as well.

Table 39: Regression analysis for *"Astronomy is exciting to me"* by main outcomes.

Dependent variable: *Astronomy is exciting to me.*	R-squared	R-squared change
Independent variables included:		
1. *Astronomy is interesting to me.*	.772	N/A
2. *Looking up at the night sky is a way to feel more connected to the universe.*	.792	.020
3. *Astronomers are discovering new things all the time.*	.797	.005
4. *I want to look up at the night sky right now, or as soon as it's dark.*	.801	.004
5. *Science is interesting to me.*	.802	.001
6. *Astronomy is a science that both professionals and everyday people can contribute to.*	.803	.001
7. *There are resources and tools that I can use to do astronomy.*	.804	.001

Independent variable not included (excluded) in the regression:

- *Looking through a telescope is an awe-inspiring experience.*

Being Inspired to Look up at the Night Sky (Overall Project)

As can be seen in Table 40, six of the eight independent variables were included in the regression analysis. The six variables entered had an R-square that was a decent predictor of people wanting to look up at the night sky (R^2=.576; 58% of the variance for the dependent variable was explained). The specific items that were most likely to predict whether someone wanted to look up at the night sky was to what extent they thought it was a way to *feel connected to the universe* and whether or not they felt there were *tools available for them to do astronomy*. These two variables together accounted for the large majority of variance (R^2=.533). The only two items that were not included were *"Astronomy is interesting to me"* and *"Astronomy is a science that both professionals and everyday people can contribute to."* For participants, wanting to look up at the night sky was most related to feeling like they have to tools to do this and that it connects them to the universe.

Table 40: Regression analysis for *"I want to look up at the night sky right now, or as soon as it's dark"* by main outcomes.

Dependent variable: *I want to look up at the night sky right now, or as soon as it's dark.*	R-squared	R-squared change
Independent variables included:		
1. *Looking up at the night sky is a way to feel more connected to the universe.*	.477	N/A
2. *There are resources and tools that I can use to do astronomy.*	.533	.056
3. *Looking through a telescope is an awe-inspiring experience.*	.551	.018
4. *Astronomy is exciting to me.*	.559	.008
5. *Science is interesting to me.*	.571	.012
6. *Astronomers are discovering new things all the time.*	.576	.005

Independent variables not included (excluded) in the regression:

- *Astronomy is interesting to me.*
- *Astronomy is a science that both professionals and everyday people can contribute to.*

Inspiring Participation (Based on Each Deliverable)

Participants rated each deliverables based on their agreement with the following ten statements:

I gained an appreciation about the work astronomers are doing.
It showed just how much is out there in the universe.
It helped me see how beautiful the universe is.
It helped me see how diverse the universe is.
I learned new things about astronomy.
I learned new things about how telescopes work.
I learned new things about the history of astronomy.
There's still so much to learn about the universe.
I feel inspired to learn more about astronomy.
It made me want to look up at the night sky to see what's out there.

As a reminder, the following questions were answered for the regression analyses for each deliverable:

2. BASED ON EACH DELIVERABLE, which outcomes best predicted whether someone…
    a. Was inspired to look up at the night sky?
    b. Was inspired to learn more about astronomy?

For Table 41 below, the main variable that was being predicted was *"It made me want to look up at the night sky to see what's out there."* The variables listed under each deliverable is the combination of variables that best predicted whether someone was motivated to look up at the night sky, in order from highest to lowest. These analyses will provide an understanding of which outcomes are most likely to result in people being inspired by the project.

Looking up at the night sky – of the nine possible variables listed above that could be included in the regression analysis, there was some consistency across the four deliverables. For all four of the deliverables (documentary, planetarium program, website, star party) the best predictor of whether someone was inspired to look up at the night sky was feeling *inspired to learn more about astronomy*. While the variables included varied, for each deliverable they were a combination of both cognitive learning and affective variables.

For the planetarium program and website, *learning about the history of astronomy* was included next, followed by more affective variables such as *seeing how beautiful the universe is* and *gaining an appreciation for what's out there.*

For the documentary and star parties *seeing how beautiful the universe is* was included next, followed by more cognitive measures like *learning about how telescopes work*. While the independent variables were specifically selected to fit into the two main categories of cognitive and affective, it is interesting that both of those categories were included when predicting people being inspired to look up. It was much more effective when both outcomes occurred rather than just learning, or just being impacted affectively.

A regression analysis also tells you how well the combination of variables predicts the main variable you are looking at (i.e., in our case the two being inspired variables), by providing an R-squared value. The R-squared values were higher for the star parties (R^2=.752) and the website (R^2=.698), compared to the planetarium program (R^2=.552) and the documentary (R^2=.595). This means that the set of variables was a better predictor of people wanting to look up at the night sky for the star parties and the website.

Table 41: Regression analysis for "It made me want to look up at the night sky to see what's out there" by each outcome statement, by deliverable.

Dependent variable: *It made me want to look up at the night sky to see what's out there.*			
Documentary (n=541)	Planetarium Program (n=179)	Website (n=137)	Star Party (n=105)
R-squared = .595	R-squared = .552	R-squared = .698	R-squared = .752
Independent variables entered:			
1. *I feel inspired to learn more about astronomy. (R^2 = .546)*	1. *I feel inspired to learn more about astronomy. (R^2 = .407)*	1. *I feel inspired to learn more about astronomy. (R^2 = .616)*	1. *I feel inspired to learn more about astronomy. (R^2 = .631)*
2. *It helped me see how beautiful the universe is. (R^2 Change = .041)*	2. *I learned new things about the history of astronomy. (R^2 Change = .085)*	2. *I learned new things about the history of astronomy. (R^2 Change = .056)*	2. *It helped me see how beautiful the universe is. (R^2 Change = .056)*
3. *I learned new things about how telescopes work. (R^2 Change = .008)*	3. *It helped me see how beautiful the universe is. (R^2 Change = .045)*	3. *There's still so much to learn about the universe. (R^2 Change = .026)*	3. *I gained an appreciation about the work astronomers are doing (R^2 Change = .035)*
	4. *I learned new things about astronomy. (R^2 Change = .014)*		4. *I learned new things about how telescopes work. (R^2 Change = .029)*

Feeling Inspired to Learn More about Astronomy (Based on Each Deliverable)

For Table 42 below, the main variable that is being predicted is *"I feel inspired to learn more about astronomy."* The variables listed under each deliverable is the combination of variables that best predicted whether someone was motivated to learn more about astronomy, in order from highest to lowest. While there was also a lot of consistency with being inspired to learn more about astronomy, there were some marked differences from the previous regression analyses. All four of the regression analyses included saying the participant *gained an appreciation about the work astronomers are doing*, and all four also said it *made them want to look up at the night sky*. Three of the four deliverables included saying "*There's still so much to learn about the universe."*

Interestingly, while there were three statements specifically about what people learned, none of these were included in the regression analysis by deliverable. This suggests that while cognitive learning is certainly occurring and is well documented in other parts of the report, it is the more affective measures such as appreciation and increased awareness that best predict feeling inspired to learn more about astronomy, at least for those included in the study. This goes against a commonly held assumption that if people learn something about a topic that it then leads to wanting to learn more.

Table 42: Regression analysis for "I feel inspired to learn more about astronomy" by each outcome statement, by deliverable.

Dependent variable: *I feel inspired to learn more about astronomy.*			
Documentary (n=541)	Planetarium Program (n=179)	Website (n=137)	Star Party (n=105)
R-squared = .644	R-squared = .575	R-squared = .790	R-squared = .813
Independent variables entered:			
1. *It made me want to look up at the night sky to see what's out there. (R^2 = .546)*	1. *I gained an appreciation about the work astronomers are doing. (R^2 =.466)*	1. *There's still so much to learn about the universe. (R^2 =.672)*	1. *It made me want to look up at the night sky to see what's out there. (R^2 = .631)*
2. *There's still so much to learn about the universe. (R^2 Change = .087)*	2. *It made me want to look up at the night sky to see what's out there. (R^2 Change = .095)*	2. *It showed just how much is out there in the universe. (R^2 Change = .083)*	2. *There's still so much to learn about the universe. (R^2 Change = .168)*
3. *I gained an appreciation about the work astronomers are doing. (R^2 Change = .011)*	3. *It helped me see how diverse the universe is. (R^2 Change = .013)*	3. *It made me want to look up at the night sky to see what's out there. (R^2 Change = .024)*	3. *I gained an appreciation about the work astronomers are doing. (R^2 Change = .020)*
		4. *I gained an appreciation about the work astronomers are doing. (R^2 Change = .011)*	

LONGITUDINAL FINDINGS

Two longitudinal studies were undertaken as part of the summative evaluation, both of which were subsets of the original online survey:

1) T2 online survey – this was conducted four months after an individual filled out the T1 online survey. The purpose of this second survey was to allow for those who filled out a survey at the beginning of the project to include other *400 Years* experience they may have engaged in later in the life of the project.
2) Follow-up phone interviews – these were conducted roughly six months after the respondent filled out the online survey. The purpose was to gather to gather qualitative data on project impacts and how project participation was integrated into the person's life after participating in the *400 Years* deliverables.

See the Methods section for further details about recruitment for these studies.

Sample, T2 Online Survey

A total of 135 individuals responded to the T2 online survey (Table 40). The respondents to the T2 survey were very similar to those who responded only to the T1 survey; there were no statistical differences between the two groups on sex, education, race, PBS membership, region, and household size or make up of the household (i.e., number of children and adults). There was evidence, however, that those who responded to the T2 survey may have been more engaged with astronomy as measured by telescope usage. T2 respondents were more likely than T1 respondents to have used a telescope 6 or more times (X^2 (4, N = 506) = 15.660, p < .05) and were more likely to have used a telescope within the past month (X^2 (5, N = 505) = 19.408, p < .05). It is possible that the T2 respondents were overall more interested or engaged with astronomy, leading them to have greater interest or buy-in to completing the T2 survey. This hypothesis was supported by data that indicated that T2 respondents participated in significantly more deliverables than did T1 respondents (a mean of 1.6 deliverables compared to 1.2; t(152.4)=-3.89, p<.001). However, this may also have been influenced by the fact that more time had elapsed and therefore people would have been more exposed to and likely to participate in other *400 Years* deliverables.

Sample, Follow-up Phone Interview

Telephone interviews were completed with 34 individuals (Table 43). The respondents to the telephone interviews were very similar to those who completed the T2 survey; the two groups were comparable on sex, education, race, PBS membership, region, and telescope usage. The groups were not comparable on household make-up; those who participated in the phone interviews were less likely to have children living with them (X^2 (1, N = 133) = 4.303, p < .05) and had a smaller household size (Mann-Whitney U=1249.0, N=131, p<.05) than the T2 respondents. This difference is probably a result of self-selection; parents with minor children may have chosen not to participate in the phone interviews due to their schedules, while those without children at home may have been more willing to make time for the interview. Again, it may also be that those who participated in the phone interviews were more engaged in the project overall; those who completed a phone interview participated in significantly more deliverables than did those only completed a T2 survey but did not participate in the phone interview (Mean number of deliverables at T1: 2.0 (phone interview) compared to 1.4 (no interview), t(121)=-3.10,

p<.005; Mean number of deliverables at T2: 2.3 (phone interview) compared to 1.8 (no interview), *t*(111)=-2.10, *p*<.05). This would indicate that the phone interview respondents were different from the T2 survey population and T1 survey population.

Table 43: Demographics for the Respondents to the Longitudinal Studies

Demographic Category	Percent of Sample	
	T2 Online Survey (n=135)	Follow-up Phone Interview (n=34)
Sex		
Male	57%	56%
Female	43%	44%
Race/Ethnicity (check all that apply)*		
Caucasian	87%	91%
Asian/Pacific Islander	7%	9%
African American	1%	0
Hispanic/Latino	3%	0
Native American	2%	3%
Other	3%	3%
Mean Household Size	2.5 people	2.2 People
Household Make-up **		
One Adult (no children)	25%	44%
Multiple Adults (no children)	46%	41%
Adults and Children	28%	15%
Education**		
Some high school	2%	0
High school graduate	2%	3%
Some college	19%	12%
Bachelor's degree	24%	32%
Some graduate school	13%	15%
Graduate degree or higher	39%	38%
Country**		
Living in the US	98%	97%
Living in Canada	2%	3%
Living in a country other than US or Canada	1%	0
Living in the US by Region		
Northeast	29%	27%
Midwest	12%	6%
South	20%	24%
West	39%	42%
PBS Member	43%	53%
Telescope Owner	n/a	21%
Astronomy Club Member	n/a	53%

*Multiple responses allowed. Percentages total more than 100%.

** Percentages do not total 100% because of rounding.

Experience with the 400 Years Project

The respondents for the T2 online survey did on average 1.6 project activities at T1 and 2.0 at T2, a statistically significant increase ($t(105)=-4.12$, $p<.01$). The documentary was the first *400 Years* activity for half of the respondents (50%, n=58), while one in five (20%, n=23) saw the planetarium program first, slightly less than one in five (15%, n=18) attended a star party first, and more than one in ten (12, n=14) visited the website first, while a small percentage (3%, n=4) attended a member event as their first *400 Years* activity.

Impacts of the 400 Years Project

For each deliverable, respondents rated the impact of that deliverable on a set of ten outcome statements in T1 and T2. Having rating for the same statements in T1 and T2 allowed for analyses that compared the ratings, seeing if the initial impact of the deliverable increased, decreased or stayed the same over time. Many informal science education activities are "one off" experiences that occur with no intentionally planned reinforcement activities after the experience. As such, it is realistic to expect that for many participants the outcomes would decrease over time. The main reason to conduct a T1 and T2 online surveys for *400 Years* is to see whether a suite of intentionally related activities allows for reinforcement and thus maintenance of the outcomes during the *400 Years* project period.

The comparisons of the ratings for each deliverable are presented below.

- **Documentary**: The mean ratings for eight of the ten statements did not change significantly from T1 to T2. The ratings for the statement *I gained an appreciation about the work astronomers are doing* did change significantly, going down over time; the T1 rating was 6.4 and the T2 rating was 6.1 ($t(77)=1.99$, $p=.05$). The ratings for the statement *It showed just how much is out there in the universe* also decreased significantly over time; the T1 rating was 6.4 and the T2 rating was 6.1 ($t(77)=2.02$, $p<.05$).
- **Planetarium Program**: The mean ratings for all ten statements did not change significantly over time.
- **Website:** The mean ratings for five of the ten statements did not change significantly from T1 to T2. The ratings for the other five outcome statements all increased over time.
    - For *It showed just how much is out there in the universe* the T1 rating was 5.4 and the T2 rating was 6.3 ($t(27)=-2.96$, $p<.05$).
    - For *It helped me see how diverse the universe is* the T1 rating was 5.4 and the T2 rating was 6.2 ($t(27)=-2.20$, $p<.05$).
    - For *I learned new things about astronomy* the T1 rating was 5.3 and the T2 rating was 5.9 ($t(27)=-2.18$, $p<.05$).
    - For *I learned new things about how telescopes work* the T1 rating was 4.9 and the T2 rating was 5.4 ($t(27)=-2.65$, $p<.05$).
    - For *It made me want to look up at the night sky to see what's out there* the T1 rating was 5.6 and the T2 rating was 6.3 ($t(27)=-2.42$, $p<.05$).
- **Star Parties**: The mean ratings for nine of the ten statements did not change significantly from T1 to T2. The ratings for the statement *I learned new things about astronomy* did change significantly, going down over time; the T1 rating was 6.2 and the T2 rating was 5.3 ($t(21)=2.57$, $p<.05$).

Given that one might expect some of the impacts to naturally decline without being reinforced, it is interesting that for three of the deliverables (documentary, planetarium program and star parties) some outcome stayed the same. For the website there were greater self-reported impacts for the experience over time. It is possible that this occurred because people were already familiar with and engaged in astronomy and astronomy-related activities; therefore, the outcomes may have had a greater chance to persist as they were reinforced by activities occurring during this time, both for *400 Years* and from other sources.

On both surveys, respondents were asked the degree to which they agreed with a set of nine project-based outcome statements. The mean ratings for eight of the nine statements did not change significantly from T1 to T2. The ratings for the statement *I want to look up at the night sky right now, or as soon as it's dark* did change significantly, going down over time; the T1 rating was 5.9 and the T2 rating was 5.6 ($t(128)=2.68$, $p<.05$).

As a whole, those participants who responded to both the T1 and T2 surveys were quite experienced with telescopes. More than two-thirds of respondents (69%) had looked through a telescope six or more times before they became aware of the 400 Years of the telescope project. For these respondents, who as a whole were already frequent telescope users, the project does not seem to have impacted the amount or frequency of their telescope use. At T1, 46% of the respondents had looked through a telescope in the past month, and another 10% had done so within the past one to five months. At T2, 55% indicated they had looked through a telescope in the past three months, representing no increase from T1. This is not to say that the project might not have increased the telescope use of other participants; those who had less telescope experience before the project may have been more inclined to "look up" with the help of a telescope as a result of the project. However, the study's sample was biased towards those with more telescope experience, making it impossible to infer trends in the general population based on these results.

Follow-up Telephone Interviews

The majority of respondents to the telephone interview (82%, n=28) indicated that they were already very interested in astronomy before engaging in any *400 Years* activities; nearly all these individuals had a long-standing interest in astronomy (n=25). A teacher described her interest in astronomy this way: *"I have always been involved with astronomy. I used to represent NASA aeronautics products in the community so people always associate me with NASA… and I teach astronomy in my 8th grade science class."* Another interviewee said she had been interested in astronomy since childhood, and that an interest in the topic had been *"passed down through the generations"* of her family. The majority of respondents reported regularly engaging in astronomy activities (85%, n=29), with "looking up" (e.g., star gazing, using a telescope, watching satellites pass over) being the most common activity (Table 44).

Table 44: Astronomy Activities Regularly Engaged in by Telephone Interview Respondents (n=29)

Sources	n	Percent
"Looking up"	22	76%
Media (e.g. TV, websites, magazines)	14	48%
Club Events or Star Parties	5	17%
Teaching/Outreach	4	14%
Special Events or Lectures	4	14%
Planetarium Shows	2	7%

*Multiple responses allowed. Percentages total more than 100%.

Experience with the *400 Years* Project

The telephone interview respondents did on average 2.0 project activities at T1 and 2.3 at T2, a statistically significant increase (Z=-2.524, $p<.05$). The documentary was the first 400 Years activity for half of the respondents (50%, n=17), 18% (n=6) visited the website first, 15% (n=5) attended a star party first, 12% (n=4) saw the planetarium program first, and 6% (n=2) attended a member event as their first 400 Years activity. Respondents were asked how they heard about the deliverable they did first (Table 45); 47% (n=16) heard through a PBS-related source, which included member guides and channel surfing. This is not surprising, given that the documentary was the entry point for the majority of respondents.

Table 45: Sources for How Telephone Interview Respondents Heard about the First Deliverable in which They Participated (n=34)

Sources	N	Percent
PBS source	16	47%
Other non-PBS media	8	24%
A club or IYA-related source	3	9%
Word of mouth	2	6%
Other	3	9%
Don't Remember	2	6%

Respondents were motivated to engage with their first deliverable for a variety of reasons including:

- **Astronomy-related interests**: Half of all respondents (50%, n=17) engaged with their first 400 years deliverable because of an astronomy interest. For example, one respondent indicated that she watches anything that is related to the Hubble. Another reported that he is particularly interested in the Big Bang. Others said it was their long-standing interest in astronomy in general that motivated them.
- **Non-science or general interests**: A little less than one-third (30%, n=10) of those interviewed said they were motivated to engage with their first deliverable because of a non-science, or more general interest. For example, one man admitted that he watches very little TV, but *"PBS*

has good programs and this was a good introduction to the subject matter," indicating that it was the quality of programs shown by PBS that was motivating. Another man participated to enhance his "basic knowledge" saying he wanted a *"more comprehensive picture and history to round out his knowledge."*

- **Science-related interests**: A smaller segment of those interviewed (12%, n=4) responded that they chose to participate because of it was a science-topic, not necessarily because it was astronomy. This included individuals who said they enjoy watching NOVA of other science shows generally.

When asked why they pursued subsequent deliverables in the *400 Years* project, some respondents (n=8) indicated that they were motivated by the self-referencing nature of the deliverables. For example, one interviewee said he visited the website after seeing the documentary because *"the show said to check out the web site for more information."* Another reason for pursuing subsequent deliverables was a general feeling that the deliverables fit together or were all on the same topic (n=13); one participant who first found out about the 400 years project at a star party, said it seemed like a "natural progression" to go from the star party to cloudynights.com to 400years.org, then watch the documentary and go to another star party. A few respondents did not remember what motivated them to pursue additional deliverables (n=3) and others did not have any specific reason for choosing to do other deliverables (n=2).

When asked why they chose not to participate in certain deliverables, responses included:

- **Not knowing about the deliverable**: This was especially true for the member events and the planetarium program.
- **Having a barrier to accessing the deliverable** (e.g., it was not offered in the area, too long a distance, lack of transportation): This was true for all location-based deliverables, including the member events, planetarium program, and star parties.
- **Having an already busy schedule** (e.g., "too busy," not at a convenient time): This was especially true for the website and star parties.
- **Not finding deliverable's topic interesting**: This was mentioned by only a few respondents.

Impacts of the *400 Years* Project

An important goal for the *400 Years* project was to influence people to engage in astronomy through the simple act of looking up at the night sky. At least for those who participated in the phone interviews, the project did have an impact on participants' tendencies to "look up," and if they were already a telescope owner, to use their telescope more often. Because many of those interviewed were already interested in astronomy, the project encouraged them to "re-engage" with looking-up.

- **Looking up at the sky more often or for the first time:** More than half (52%, n=18) of those interviewed indicated that as a result of *400 Years* they were looking up at the sky more often or for the first time. *"I travel at night,"* responded one interviewee when asked how they project encouraged her to look up, *"and when I stop at the side of the road I think this is how the sky looks all the time…This opens up more horizons."* Another participant said she now attends star parties and looks through her boyfriend's telescope as a result of the project.
- **Telescopes use:** Nearly two-thirds (61%, n=11) of those who owned telescopes said they used their telescopes more often following their experiences with *400 Years*. Some said they were simply more "inspired" to use their telescopes after their *400 Years* experiences. Others

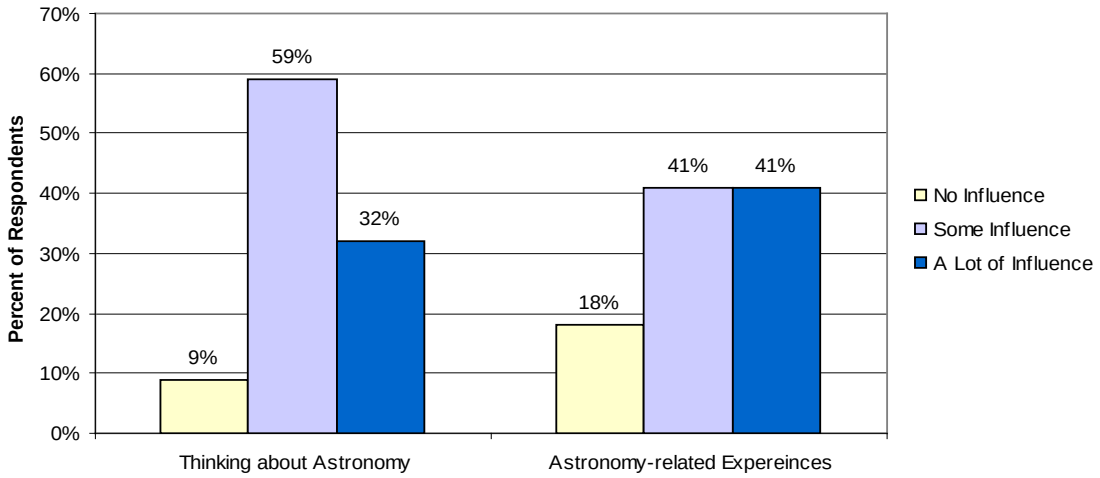
reported that they used their telescope more intensely right after seeing the documentary, but as months went by, their initial enthusiasm waned.

- **Providing access for others:** Nearly a quarter of those interviewed (24%, n=8) said that as a result of *400 Years* they were helping others to look up or learn about astronomy. Some of these were grandparents or engaging their grandchildren in astronomy; others were amateur astronomers who participated in more outreach activities because of the project. Both for participants who said the project had influenced them to look up more often (n=6) and those who felt they were not looking up more (n=2) indicated they were helping to provide access to others.
- **Not looking up:** For those who said they were not looking up more, reasons included already being a regular sky-watcher (n= 13 of 16) or being dissuaded by barriers such as their location or light pollution (n=2 of 16).

Participants replied that engaging in the project did influence "how [they] think about astronomy" with 91% (n=31) responding that their participation had at least some influence (Figure 10). For many of these individuals, the project supported their existing astronomy knowledge (n=16), fostered new knowledge or ways of thinking (n=9), or has led them to become more active in astronomy (n=10). One participant with a long-time interest in astronomy said the project had not changed his ideas*, "just expanded them—when you learn more about it, it adds to the excitement of learning."* Another interviewee talked about how the documentary *"got my imagination going."* Many participants in the phone interviews talked about how the project's deliverables were a good blending of history and science, and that in itself lent a new perspective on astronomy.

When asked if the project had any influence on their "likelihood of seeking out other astronomy-related experiences," 82% responded that it had an influence, with 41% overall indicating that the project had a great deal of influence (Figure 10). Some respondents seemed to be more passively aware of astronomy opportunities, taking advantage of activities if they "happen to see something" (n=6). Others were much more active in their pursuit of additional astronomy activities, specifically seeking out ways to extend the experience begun with *400 Years* (n=10). Still others indicated that they were more active in helping others gain access to astronomy experiences (n=5); this included club-based outreach activities and adults supporting the interests of the younger family members (i.e. children and grandchildren).

Figure 10: Influence of *400 Years* on Telephone Interview Respondents' Thinking about Astronomy and Seeking Out of Astronomy-related Experiences (n=34)



CONCLUSIONS AND RECOMMENDATIONS

The following section includes overall conclusions based on the findings from this study, and recommendations for the field of informal science education. Our overall conclusion from the study is that creating a menu-based project approach where individuals can pick from a suite of options is a useful and successful way to communicate and engage with the general public about astronomy. The different *400 Years* deliverables offered different types of experiences that engaged multiple audiences and resulted in a variety of positive outcomes related to learning about and becoming interested and engaged in astronomy.

Conclusions:

1. Each deliverable was successful in achieving its own objectives, in a number of different areas. While there was some variation in which areas the deliverables had success (i.e., appreciation, awareness, learning, inspiration, behavioral intentions), all the deliverables rated relatively high on each of the categories. In fact, average ratings for these types of items across the deliverables were very consistent, suggesting that each deliverable had a positive impact on its own. For a subset of participants contacted a few months after their participation, there is evidence that participating in *400 Years* seemed to support existing astronomy knowledge, fostered new knowledge or ways of thinking, and led them to become more active in astronomy.

2. The deliverables offered different types of experiences, and often served different sub-groups of the audience. As a result, the menu-based approach achieved its goal of engaging multiple audiences; this broadened accessibility and helped the project reach its objective of reaching a broader audience than if it had only offered one type of experience. Also important to consider is that some of the experiences were more personalized (i.e., star party and website) while others were less able to respond to individual needs (i.e., PBS documentary and planetarium program).

3. Even while the deliverables consistently offered a positive experience across the outcome categories, there were some differences based on whether the audiences saw a PBS documentary, planetarium program, visited the website or went to a star party. This suggests that if projects are interested in achieving certain kinds of outcomes more than others (i.e., increased awareness or inspiration), they would do well to tailor their offerings based on which outcomes they are most likely to encourage.

4. While it was expected that prior experience with telescopes would affect multiple aspects of the participant experience, prior experience had a large impact on participation and many of the outcome categories. Those who had greater prior experience had higher ratings for the overall project outcomes; however, it is difficult to know whether the increased outcomes are based on higher interest in telescopes or whether prior experiences actually impacted the way someone experienced the various deliverables. Further research to investigate this would be very useful.

5. The more activities a participant engaged in, the higher the outcome on most of the study's outcomes. This is perhaps the most compelling evidence that a menu-based approach is effective; offering multiple options that build on each other resulted in significantly more positive project-related outcomes. This included more affective outcomes like excitement and awe, as well as encouraging people to feel they could do astronomy themselves and being inspired to look up at the night sky.

6. While the positive effects of participating in more than one deliverable was well documented, relatively low awareness existed among participants that the deliverable they were participating in was part of the larger *400 Years of the Telescope* project. While it would not be expected that everyone who participated in one *400 Years* deliverable would be motivated to participate in the others, an awareness of the menu of deliverables seems to be necessary for larger numbers of participants to have the experiences build on each other. However, it is important to note that there were sometimes limitations how a particular deliverable was implemented, as with the PBS documentary, where it was not possible to include specific information about the other deliverables due to restrictions that were beyond the project team's control.

7. Lastly, being inspired to learn more about astronomy was not strictly based on cognitive learning. That is, being inspired to learn more about astronomy was not based upon learning content about astronomy; rather, people were inspired to learn when they appreciated the vastness and complexity of the universe. Often, there is an assumption that teaching people concepts and facts will lead to wanting to learn more of this kind of information. Rather, this study confirmed that in fact other non-cognitive outcomes are better predictors of someone being inspired to learn about astronomy.

The recommendations below, while best suited for the areas of Science, Technology, Engineering and Math (STEM), they can certainly be applied to other types of educational and informal learning environments. They will be particularly relevant to project incorporating multiple media-based deliverables to engage multiple audiences.

Recommendations for the field of informal science education, and related fields:

1. There is evidence that a menu of interrelated activities on the same subject, all released within a relatively short period of time seems to be a viable way to achieve multiple project outcomes. These areas included increased awareness, changed attitudes, increased cognitive learning and behavioral intentions. Therefore, it is recommended that projects trying to achieve multiple outcomes consider having multiple offerings released as a group rather than as individual deliverable. Additionally, the project's outcomes should provide outcomes not only for each individual deliverable, but also outcomes for those who engage in more than one deliverable.

2. When providing complementary experiences, it is very important that there is a clear link between the deliverables so that participants who are interested can easily transition from one deliverable to another. Branding is used extensively in marketing, and this approach of having an overall "brand" identity for the project could be included in these types of projects; this

would assist the project team in having a consistent message across deliverables based on the larger project. For more transition of the audience from one deliverable to the next, increased bundling of the activities and greater awareness of the larger project would be extremely beneficial. Another way of increasing the "conversion" rate from one deliverable to another would be to have specific ideas of which deliverables would be most likely to lead to other specific deliverables: this study sheds some light on the kinds of experiences that were most likely to lead to other types of deliverables.

3. This study provides evidence that the best way to encourage people to want to learn more about a topic is not simply teaching them about the topic, but includes a broader range of motivations. In fact, while cognitive learning is occurring in this project and is well documented, other factors such as an increased appreciation and awareness of what is out there and how it is being studied best predict wanting to learn more. This is not to say that cognitive learning cannot engender more cognitive learning, just that there may be a more direct and efficient path to motivating people to want to learn about a topic. It is strongly recommended that similar projects investigate which types of experiences and outcomes have the largest impact on cognitive learning. A related recommendation is that while cognitive learning is an important outcome and should certainly be included in projects, it is important to consider a broader range of outcomes types, such as those included in this study.

4. Lastly, people seemed most inspired by the project and its deliverables when they were both motivated and felt like they were able to connect with and do astronomy themselves. Providing participants with multiple ways to connect with the content is very important, and providing multiple deliverables is one way to allow people to find different avenues to connect with a project. Also important in being inspired to look up at the night sky was having people feel like they could do astronomy, that looking up at the night sky was something they could do on their own. The more hands-on deliverables like the star parties where people actually looked through telescopes seemed to increase self-efficacy the most. Helping people to connect, then providing a way to actively participate in the science was an important part of inspiring people. Investigating more specifically how motivation and self-efficacy interact to inspire people in other scientific areas would be incredibly useful to the field.

End of Report: April 28, 2011

Appendices

Appendix A T1 Online Survey Instrument

400 Years of the Telescope

Main Instrument/Survey as posted for web-surveys

INTRODUCTION

Thank you very much for taking time to share your thoughts with us.

2009 is the International Year of Astronomy (IYA), and the National Science Foundation has funded a project titled *400 Years of the Telescope*.

This project has a variety of components, including the following:

- PBS Documentary – "400 Years of the Telescope"
- Planetarium Program - "Two Small Pieces of Glass"
- Website for *400 Years of the Telescope* – www.400years.org
- Night Sky Network Events – like star parties
- Member Events hosted by local PBS stations

You have received this questionnaire because you have taken part in at least one of the activities listed above. In this survey we will refer to these collective activities as the *400 Years of the Telescope* activities. As the number of individuals being asked to complete the survey is small, it's important you complete the entire survey. Only with your help, can future activities be improved. If you have any questions about this survey, please email Steve Yalowitz at yalowitz@ilinet.org.

To get started, click on "Next Page"

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***400 YEARS OF THE TELESCOPE* ACTIVITIES**

1. How did you first hear about *400 Years of the Telescope*?

- ☐ Watching the PBS documentary "400 Years of the Telescope"
- ☐ At the planetarium program "Two Small Pieces of Glass"
- ☐ On the *400 Years of the Telescope* web site www.400years.org
- ☐ At a Night Sky Network event or star party
- ☐ At a member event hosted by a local PBS station
- ☐ Other: _____

2. Before now, were you aware that the [specific activity] was part of a larger project called *400 Years of the Telescope*?

- ☐ No
- ☐ Yes

3. Did you know that there were other activities related to *400 Years of the Telescope?*

- ☐ No → go to next page
- ☐ Yes → go to Q3a

3a. [If Yes to Q3] Which of the following activities were you aware of?

- ☐ PBS documentary "400 Years of the Telescope"
- ☐ Planetarium program "Two Small Pieces of Glass"
- ☐ *400 Years of the Telescope* web site www.400years.org
- ☐ Night Sky Network event or star party
- ☐ Station event hosted by a local PBS station

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PBS DOCUMENTARY – "400 YEARS OF THE TELESCOPE"

The film "400 Years of the Telescope" is a chronicle of the history of the telescope from the time of Galileo, its profound impact upon the science of astronomy, and how both have shaped the way we view ourselves today in the midst of an infinite universe. It started airing on PBS stations on April 10, 2009 and has been rebroadcast in many markets.

4. Have you watched the PBS Documentary "400 Years of the Telescope?"

- ☐ No → go to next page
- ☐ Yes → go to Q5
- ☐ Don't know → go to next page

5. When did you watch it? [DROP-DOWN MONTH AND YEAR –Apr to Dec 2009]

6. Thinking about the documentary, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

7. Based on WATCHING THE DOCUMENTARY, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

7a. I gained an appreciation about the work astronomers are doing.

7b. It showed just how much is out there in the universe.

7c. It helped me see how beautiful the universe is.

7d. It helped me see how diverse the universe is.

7e. I learned new things about astronomy.

7f. I learned new things about how telescopes work.

7g. I learned new things about the history of astronomy.

7h. There's still so much to learn about the universe.

7i. I feel inspired to learn more about astronomy.

7j. It made me want to look up at the night sky to see what's out there.

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PLANETARIUM PROGRAM – "TWO SMALL PIECES OF GLASS"

The program "Two Small Pieces of Glass" is a planetarium program that presents the story, through people attending a "star party," of the telescope and the astronomers who used them to make their

dramatic discoveries. It follows two teens as they learn from their teacher about telescope types and the work of astronomers.

8. Have you seen the planetarium program "Two Small Pieces of Glass?

- ☐ No → go to next page
- ☐ Yes → go to Q9
- ☐ Don't know → go to next page

9. When did you see it? [DROP-DOWN MONTH AND YEAR – Apr to Dec 2009]

10. Where did you see it (if at a planetarium or museum, please say which one)? [OPEN-ENDED]

11 Thinking about the planetarium program, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

12. Based on SEEING THE PLANETARIUM PROGRAM, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

12a. I gained an appreciation about the work astronomers are doing.

12b. It showed just how much is out there in the universe.

12c. It helped me see how beautiful the universe is.

12d. It helped me see how diverse the universe is.

12e. I learned new things about astronomy.

12f. I learned new things about how telescopes work.

12g. I learned new things about the history of astronomy.

12h. There's still so much to learn about the universe.

12i. I feel inspired to learn more about astronomy.

12j. It made me want to look up at the night sky to see what's out there.

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WEBSITE FOR "400 Years of the Telescope" – WWW.400YEARS.ORG

The website for *400 Years of the Telescope*, pictured below, contains information about all of the various activities for the project, as well as information about International Year of Astronomy (IYA) events.

13. Have you visited the official *400 Years of the Telescope* web site (at www.400years.com) ?

- ☐ No → go to next page
- ☐ Yes → go to Q14
- ☐ Don't know → go to next page

14. When did you go to the web site (if multiple times, please tell us the <u>first</u> time)? [DROP-DOWN MONTH AND YEAR – Jan to Dec 2009]

15. Thinking about the web site, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

16. Based on VISTING THE WEBSITE, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

16a. I gained an appreciation about the work astronomers are doing.

16b. It showed just how much is out there in the universe.

16c. It helped me see how beautiful the universe is.

16d. It helped me see how diverse the universe is.

16e. I learned new things about astronomy.

16f. I learned new things about how telescopes work.

16g. I learned new things about the history of astronomy.

16h. There's still so much to learn about the universe.

16i. I feel inspired to learn more about astronomy.

16j. It made me want to look up at the night sky to see what's out there.

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ASTRONOMY CLUB STARGAZING EVENTS

Many local astronomy clubs host outreach events like star parties, where groups of people meet to look through telescopes at the sky. They also use hands-on activities and demonstrations about astronomy and telescopes. The clubs are supported by the Night Sky Network with activities and resources. A telescope demonstration and observing sheet about Galileo may have been provided for this event.

17. Did you go to local astronomy club events or "star parties" since April?

- ☐ No → go to next page
- ☐ Yes → go to Q18
- ☐ Don't know → go to next page

18. When did you attend a star party? [DROP-DOWN MONTH AND YEAR – Apr to Dec 2009]

19. Where did you attend the party? [OPEN-ENDED]

20. Thinking about the STAR PARTY, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

21. Based on GOING TO THE STAR PARTY, please tell us the degree to which you agree with the following statements.

Strongly	2	3	4	5	6	Strongly

Disagree						Agree
1						7
○	○	○	○	○	○	○

21a. I gained an appreciation about the work astronomers are doing.

21b. It showed just how much is out there in the universe.

21c. It helped me see how beautiful the universe is.

21d. It helped me see how diverse the universe is.

21e. I learned new things about astronomy.

21f. I learned new things about how telescopes work.

21g. I learned new things about the history of astronomy.

21h. There's still so much to learn about the universe.

21i. I feel inspired to learn more about astronomy.

21j. It made me want to look up at the night sky to see what's out there.

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MEMBER EVENTS – HOSTED BY LOCAL PBS STATIONS

Some of the local PBS stations hosted events related to *400 Years of the Telescope*. These may have included showing the "400 Years of the Telescope" documentary, the "Two Small Pieces of Glass" auditorium program, or other activities.

22. Did you go to a member event hosted by your local PBS station as part of *400 Years of the Telescope?*

- ☐ No → go to next page
- ☐ Yes → go to Q23
- ☐ Don't know → go to next page

23. When did you attend the member event? [DROP-DOWN MONTH AND YEAR – April to Dec 2009]

24. Where did you attend the member event (if at a planetarium or museum, please say which one)? [OPEN-ENDED]

[GO TO NEXT PAGE]

Overall

25. Which of the following *400 Years of the Telescope* activities have you participated in? Please put them in the order you have done them, starting with the first activity.

26. Overall impacts (point-in-time)

Please tell us the degree to which you agree with the following statements:

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

26a. Astronomy is interesting to me.

26b. Science is interesting to me.

26c. Astronomy is exciting to me.

26d. Astronomers are discovering new things all the time.

26e. Astronomy is a science that both professionals and everyday people can contribute to.

26f. Looking up at the night sky is a way to feel more connected to the universe.

26g. Looking through a telescope is an awe-inspiring experience.

26h. There are resources and tools that I can use to do astronomy.

26i. I want to look up at the night sky right now.

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EXPERIENCE WITH TELESCOPES

27. Prior to your knowledge of "400 Years of the Telescope" activities, how many times had you looked through a telescope?

☐ 0 (never)

- ☐ 1
- ☐ 2-3
- ☐ 4-5
- ☐ 6 or more

28. Since becoming aware of "400 Years of the Telescope" activities, how many times have you looked through a telescope?

- ☐ 0 (never)
- ☐ 1
- ☐ 2-3
- ☐ 4-5
- ☐ 6 or more

[GO TO NEXT PAGE]

29. When was the last time you looked through a telescope?

- ☐ I never have looked through a telescope
- ☐ Within the past month
- ☐ 1 to 5 months ago
- ☐ 6 months to 11 months ago
- ☐ 1 to 2 years ago
- ☐ 3 or more years ago

30. Where did you look through the telescope the last time? [OPEN-ENDED]

[GO TO NEXT PAGE]

EXPERIENCE WITH PLANETARIUM PROGRAMS

31. How many times have you seen a planetarium program? [DROP-DOWN WITH FOLLOWING CHOICES, INCLUDING NONE]

- ☐ 0 (never)→ go to next page
- ☐ 1 → go to Q32
- ☐ 2-3 → go to Q32
- ☐ 4-5 → go to Q32
- ☐ 6 or more → go to Q32

[GO TO NEXT PAGE]

32. When was the last time you saw a planetarium program?

- ☐ Within the past month
- ☐ 1 to 5 months ago
- ☐ 6 months to 11 months ago

- ☐ 1 to 2 years ago
- ☐ 3 or more years ago

33. Where did you see your last planetarium program? [OPEN-ENDED]

[GO TO NEXT PAGE]

ABOUT YOU

Answering the following questions will help us figure out how well the *400 Years of the Telescope* project is reaching different audiences. Thank you.

34. Which of the following best describes your ethnic origin (CHECK ALL THAT APPLY)? (This lets us know how well the project is serving different communities.)

- ☐ African-American
- ☐ Caucasian
- ☐ Asian/Pacific Islander
- ☐ Hispanic/Latino
- ☐ Native American
- ☐ Other: _____

35. What is your 5-digit United States postal zip code (no ZIP+4, please) ? [OPEN-ENDED]

35a. If from outside the United States, please tell us which country you live in: [OPEN-ENDED]

36. In your household, how many adults are there 18 years and older? [DROP-DOWN WITH FOLLOWING CHOICES]

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10 or more

37. In your household, how many children are there under the age of 18? [DROP-DOWN WITH FOLLOWING CHOICES]

- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3

- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10 or more

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

- ☐ Some high school
- ☐ High school graduate
- ☐ Some college
- ☐ Bachelor's degree
- ☐ Some graduate school
- ☐ Graduate degree or higher

39. What is your gender?

- ☐ Male
- ☐ Female

40. Are you currently a member of your local (or other) PBS member station?

- ☐ No
- ☐ Yes

[GO TO NEXT PAGE]

FOLLOWING UP

As part of this National Science Foundation-funded study we are very interested in finding out whether you will be participating in any other *400 Years of the Telescope* activities. Please provide us with the following information so that we may send you a one-time follow-up web survey in a few months to ask about your future experiences related to 400 Year of the Telescope activities. The information you have provided and your email address will not be used for any other purpose, shared or otherwise provided to any third parties.

Your first name: _____

Email address: _____

- ☐ No, thank you. I do not want to participate in the follow-up survey.

[GO TO NEXT PAGE]

THANK YOU

As a thank you for answering our questions, we'd like to offer you the chance to win a $100 gift certificate for Amazon.com. Please include your email here if you would like to be entered into the drawing. The winner will be notified by email within a couple of months, and the email will only be used for the purpose of the drawing. It will not be used for any other purpose, shared or otherwise provided to any third parties. If you entered your information on the previous page, you have already been entered in the drawing.

Email address: _____

Thank you very much for your help.

Appendix B T2 Online Survey Instrument

400 Years of the Telescope

Main Instrument/Survey as posted for Follow-up web survey

INTRODUCTION

2009 is the International Year of Astronomy (IYA), and the National Science Foundation has funded a project titled *400 Years of the Telescope*. This project has a variety of components, including the following:

- PBS Documentary – "400 Years of the Telescope"
- Planetarium Program - "Two Small Pieces of Glass"
- Website for *400 Years of the Telescope* – www.400years.org
- Night Sky Network Events – like star parties
- Member Events hosted by local PBS stations

In this survey we will refer to these collective activities as the *400 Years of the Telescope* activities. As the number of individuals being asked to complete the survey is small, it's important you complete the entire survey.

Three months ago you were kind enough to complete an online survey about the *400 Years of the Telescope* project and agreed to participate in a follow-up survey. We are conducting the follow-up survey to truly understand how the different activities of the project are being used. Your feedback will help us to better understand the impact this national project is having. You may notice that some of the questions are exactly the same as in the first survey. We realize this might seem a bit repetitive for you, but we would like to find out what you have done since we last contacted you. We appreciate your willingness to participate in the survey.

And remember, by completing the survey you will be entered to win a $100 gift certificate to Amazon.com.

If you have any questions about this survey, please email Steve Yalowitz at yalowitz@ilinet.org.

To get started, click on "Next Page"

[GO TO NEXT PAGE]

PBS DOCUMENTARY – "400 YEARS OF THE TELESCOPE"

The film "400 Years of the Telescope" is a chronicle of the history of the telescope from the time of Galileo, its profound impact upon the science of astronomy, and how both have shaped the way we view ourselves today in the midst of an infinite universe. It started airing on PBS stations on April 10, 2009 and has been rebroadcast in many markets.

1. Have you ever watched the PBS Documentary "400 Years of the Telescope?"

- ☐ No → go to next page
- ☐ Yes → go to Q2
- ☐ Don't know → go to next page

[GO TO NEXT PAGE]

2. When did you watch it? [DROP-DOWN MONTH AND YEAR –Apr to Dec 2009]

3. Thinking about the documentary, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

4. Based on WATCHING THE DOCUMENTARY, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

4a. I gained an appreciation about the work astronomers are doing.

4b. It showed just how much is out there in the universe.

4c. It helped me see how beautiful the universe is.

4d. It helped me see how diverse the universe is.

4e. I learned new things about astronomy.

4f. I learned new things about how telescopes work.

4g. I learned new things about the history of astronomy.

4h. There's still so much to learn about the universe.

4i. I feel inspired to learn more about astronomy.

4j. It made me want to look up at the night sky to see what's out there.

[GO TO NEXT PAGE]

EXPERIENCE WITH PLANETARIUM PROGRAMS

5. Since we last talked to you about "400 Years of the Telescope," which was about 3 months ago, have seen any planetarium programs?
   - ☐ No → go to next page
   - ☐ Yes → go to Q6

[GO TO NEXT PAGE]

6. How many planetarium programs have you seen in the last three months?

   - ☐ 1
   - ☐ 2-3
   - ☐ 4-5
   - ☐ 6 or more

7. Where did you last see a planetarium program? [OPEN-ENDED]

[GO TO NEXT PAGE]

PLANETARIUM PROGRAM – "TWO SMALL PIECES OF GLASS"

The program "Two Small Pieces of Glass" is a planetarium program that presents the story, through people attending a "star party," of the telescope and the astronomers who used them to make their dramatic discoveries. It follows two teens as they learn from their teacher about telescope types and the work of astronomers.

8. Have ever you seen the planetarium program "Two Small Pieces of Glass"?

   - ☐ No → go to next page
   - ☐ Yes → go to Q9
   - ☐ Don't know → go to next page

[GO TO NEXT PAGE]

9. When did you see it? [DROP-DOWN MONTH AND YEAR – Apr to Dec 2009]

10. Where did you see it (if at a planetarium or museum, please say which one)? [OPEN-ENDED]

11. Thinking about the planetarium program, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

12. Based on SEEING THE PLANETARIUM PROGRAM, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

12a. I gained an appreciation about the work astronomers are doing.

12b. It showed just how much is out there in the universe.

12c. It helped me see how beautiful the universe is.

12d. It helped me see how diverse the universe is.

12e. I learned new things about astronomy.

12f. I learned new things about how telescopes work.

12g. I learned new things about the history of astronomy.

12h. There's still so much to learn about the universe.

12i. I feel inspired to learn more about astronomy.

12j. It made me want to look up at the night sky to see what's out there.

[GO TO NEXT PAGE]

WEBSITE FOR "400 Years of the Telescope" – WWW.400YEARS.ORG

The website for *400 Years of the Telescope*, pictured below, contains information about all of the various activities for the project, as well as information about International Year of Astronomy (IYA) events.

13. Have you ever visited the official *400 Years of the Telescope* web site (at www.400years.com)?

- ☐ No → go to next page
- ☐ Yes → go to Q14
- ☐ Don't know → go to next page

[GO TO NEXT PAGE]

14. When did you go to the web site (if multiple times, please tell us the <u>first</u> time)? [DROP-DOWN MONTH AND YEAR – Jan to Dec 2009]

15. Thinking about the web site, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

16. Based on VISTING THE WEBSITE, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

16a. I gained an appreciation about the work astronomers are doing.

16b. It showed just how much is out there in the universe.

16c. It helped me see how beautiful the universe is.

16d. It helped me see how diverse the universe is.

16e. I learned new things about astronomy.

16f. I learned new things about how telescopes work.

16g. I learned new things about the history of astronomy.

16h. There's still so much to learn about the universe.

16i. I feel inspired to learn more about astronomy.

16j. It made me want to look up at the night sky to see what's out there.

[GO TO NEXT PAGE]

EXPERIENCE WITH TELESCOPES

17. Since we last talked to you about "400 Years of the Telescope," which was about 3 months ago, have you looked through a telescope?

☐ No → go to next page

☐ Yes → go to Q18

[GO TO NEXT PAGE]

18. How many times have you looked through a telescope in the last three months?

☐ 1
☐ 2-3
☐ 4-5
☐ 6 or more

19. Where did you lat look through a telescope? [OPEN-ENDED]

ASTRONOMY CLUB STARGAZING EVENTS

Many local astronomy clubs host outreach events like star parties, where groups of people meet to look through telescopes at the sky. They also use hands-on activities and demonstrations about astronomy and telescopes. The clubs are supported by the Night Sky Network with activities and resources. A telescope demonstration and observing sheet about Galileo may have been provided for this event.

20. Did you go to local astronomy club events or "star parties" since April 2009?

- ☐ No → go to next page
- ☐ Yes → go to Q21
- ☐ Don't know → go to next page

[GO TO NEXT PAGE]

21. When did you attend a star party? [DROP-DOWN MONTH AND YEAR – Apr to Dec 2009]

22. Where did you attend the party? [OPEN-ENDED]

23. Thinking about the STAR PARTY, please complete the following sentence: "I never realized that…." [OPEN-ENDED]

24. Based on GOING TO THE STAR PARTY, please tell us the degree to which you agree with the following statements.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

24a. I gained an appreciation about the work astronomers are doing.

24b. It showed just how much is out there in the universe.

24c. It helped me see how beautiful the universe is.

24d. It helped me see how diverse the universe is.

24e. I learned new things about astronomy.

24f. I learned new things about how telescopes work.

24g. I learned new things about the history of astronomy.

24h. There's still so much to learn about the universe.

24i. I feel inspired to learn more about astronomy.

24j. It made me want to look up at the night sky to see what's out there.

[GO TO NEXT PAGE]

MEMBER EVENTS – HOSTED BY LOCAL PBS STATIONS

Some of the local PBS stations hosted events related to *400 Years of the Telescope*. These may have included showing the "400 Years of the Telescope" documentary, the "Two Small Pieces of Glass" auditorium program, or other activities.

25. Did you go to a member event hosted by your local PBS station as part of *400 Years of the Telescope?*

- ☐ No → go to next page
- ☐ Yes → go to Q27
- ☐ Don't know → go to next page

[GO TO NEXT PAGE]

26. When did you attend the member event? [DROP-DOWN MONTH AND YEAR – April to Dec 2009]

27. Where did you attend the member event (if at a planetarium or museum, please say which one)? [OPEN-ENDED]

[GO TO NEXT PAGE]

THINKING ABOUT ALL OF THE 400 YEARS OF THE TELESCOPE ACTIVITIES

28. Which of the following *400 Years of the Telescope* activities have you participated in? Please put them in the order you have done them, starting with the first activity.

29. Overall impacts (point-in-time)

Please tell us the degree to which you agree with the following statements:

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7
○	○	○	○	○	○	○

29a. Astronomy is interesting to me.

29b. Science is interesting to me.

29c. Astronomy is exciting to me.

29d. Astronomers are discovering new things all the time.

29e. Astronomy is a science that both professionals and everyday people can contribute to.

29f. Looking up at the night sky is a way to feel more connected to the universe.

29g. Looking through a telescope is an awe-inspiring experience.

29h. There are resources and tools that I can use to do astronomy.

29i. I want to look up at the night sky right now.

[GO TO NEXT PAGE]

THANK YOU

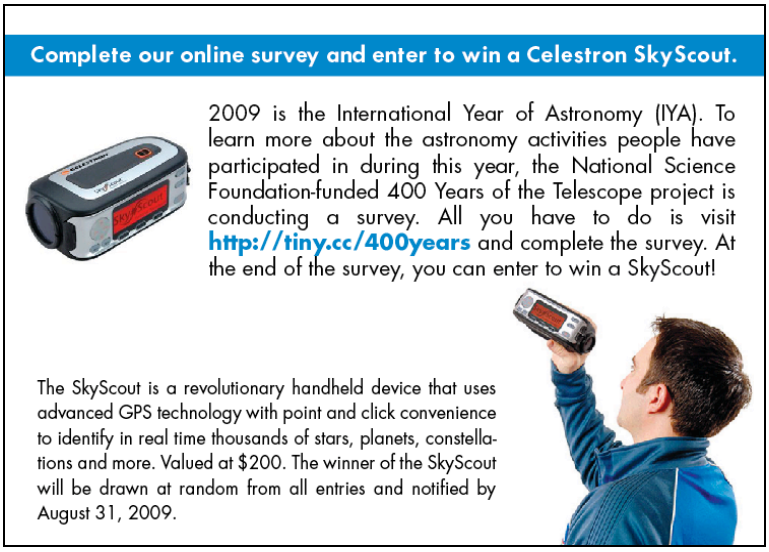
You have been automatically entered into a drawing for a chance to win a $100 gift certificate from Amazon.com. If you are the winner of the drawing, you will be notified at the email address that you previously provided.

Thank you very much for your help! Click “Submit Survey.”

Appendix C Sample Recruitment Post Cards

Front of a planetarium recruitment postcard:

Front of a NSN event recruitment postcard:



Back of all recruitment postcards:

Looking Out for Meteors!

Meteor showers occur when small pieces of comet dust collide with the Earth's atmosphere. The best time to view them is between midnight and dawn and all you need is to keep your eyes open. Grab some warm blankets, find the darkest spot around, and simply look up. A bright Moon can really light up the sky, so try to block it with a tree or telephone pole so that your eyes can better adjust to the darkness.

Meteor Showers

Name	Peak
Lyrids	21/22 April
Perseids	12/13 August
Orionids	21/22 October
Leonids	7/18 November
Geminids	13/14 December
Ursids	22/23 December

For meteor shower information, visit www.spaceweather.com

The survey is hosted by the 400 Years of the Telescope project. The planetarium is not responsible for the survey or the prize drawing.

400 Years of the Telescope Summative Evaluation

Initial email invite for T2 Survey

- Mailed on a Tuesday.
- Sent to visitors who three months previously had agreed to share their email and participate in a follow-up survey.
- Any text in [brackets] denotes a data field used by Vovici to insert text in as a placeholder. For example, since the imported data file includes the [First Name] the individual's first name is inserted into the email message sent.

> *Subject line:* Following-up on *400 Years of the Telescope* feedback
> *Email text:*
> Dear [First Name],
>
> Three months ago you were kind enough to complete an online survey about the *400 Years of the Telescope* project and agreed to participate in a follow-up survey. We are conducting the follow-up survey to truly understand how the different activities of the project are being used. Your feedback will help us to better understand the impact this national project is having.
>
> This link will take you to the follow-up survey [SurveyLink].
>
> This survey takes about 5 to 10 minutes to complete. When you finish the survey, you'll be entered into a drawing to win a $100 gift certificate for Amazon.com. You may notice that some of the questions are exactly the same as in the first survey. We realize this might seem a bit repetitive for you, but we would like to find out what you have done since we last contacted you. We appreciate your willingness to participate in the survey.
>
> Please complete the survey by (researcher will enter a date 7-10 days after email is sent, the 2nd Friday after the initial invite is preferred.)
>
> Thanks so much for your help,
> Steve Yalowitz
> Senior Researcher on the *400 Years of the Telescope* project

"Reminder" email invite for the T2

- Sent 3 days or so after the initial deadline, on a Tuesday.
- Sent only to those who have not completed the T2 survey.

> *Subject line:* Following-up on 400 Years of the Telescope feedback
> *Email text:*
> Dear [First Name],
>
> Last week, we emailed you with an invitation to complete a short web survey about the *400 Years of the Telescope* project. You received the invitation as a result of generously agreeing to participate in the survey three months ago.
>
> We really value your opinion and would appreciate it if you could find 5 to 10 minutes to fill out the survey. When you finish you'll be entered into a drawing to win a $100 gift certificate for Amazon.com.

This link will take you directly to the survey [SurveyLink]. If possible, we would love to hear from you by (researcher will enter, preferably the Friday after the email is sent).

Thanks so much for your help. We realize you are very busy and wanted to give you a chance to fill out the survey in case you ran out of time.

Thanks for your participation,
Steve Yalowitz
Senior Researcher on the *400 Years of the Telescope* project

400 Years of the Telescope
Telephone Interview Protocol and Invitation Email

Interview Protocol

The goal of this portion of the 400 Years of the Telescope is to gather in-depth, qualitative information from participants who completed both the t1 and t2 online surveys. This data will be collected via a telephone interview with participants during June and early July 2010. The sample size will be 20 to 40 interviews. This protocol provides an overview of contacting the participants and conducting the interview.

Invitation to Participate:
We have the participants' names, email addresses, and responses to their prior surveys. To request an interview, all participants will be sent an invitation email (see the text for this email at the end of the protocol). This email will be personalized with the name of the participant. After the initial invitation is sent, the researcher will coordinate participant who respond to set up a time that is convenient for both parties to conduct the interview.

Reminder emails may need to be sent one to two weeks after the initial invitation email based upon the number of responses to the initial email. Please update Susan and Steve on number of participants who respond to the initial email so they can determine whether a follow-up email is needed.

Contacting the Participant:
Only relevant for participants who provide you with a phone number. Please try to set up a specific appointment time to contact the participant. If they are not there/do not pick up their phone at the appointment time, please leave a message such as:

> Hi. This is Liz calling for _____. I'm with the 400 Years of the Telescope project and we were supposed to talk today. Please call me back at {your number}. If I don't hear from you in the next day or so, I'll try back.

In the days after the appointment, call back and if necessary leave another two messages. Please leave a message each time you call. Do not call anyone more than 3 times. After 3 tries with 3 messages, cross them off the list.

Conducting the Interview:
When you get a participant on the phone for an interview, you will have to open the SPSS database and look at their responses to the t2 survey. You will have to have their responses in front of you to complete the interview. Where you need to refer to their data is noted in the interview instrument. Susan will review the SPSS database with you prior to the start of interviewing.

Conduct the interview following the instrument. Be sure to read the introduction section to the participant, especially the third paragraph about 400 Years activities. Probing is essential to this interview instrument. Please try at to probe at least once for each

question. Remember to tell the person you will be recording the interview (if you decide to do so).

After each interview (or set of interviews), review the recording of the interview and enter the data in the SPSS database. At the end of data collection, send the completed SPSS database to Susan via email and burn the recorded interviews on to a CD and mail them to Susan.

Providing the Incentive:
Every participant who completes a telephone interview will receive a $30 gift certificate from Amazon.com. You can order these in batches every day or two OR send them out individually as soon as you finish an interview. Which ever way you choose, please let the participant know when to expect the gift certificate. While they are on the phone, verify that the email address you recently used to contact them for the interview is the one where you should send the gift certificate.

Invitation Email

Hello [name],
In the last year you completed two online surveys about your experience with the *400 Years of the Telescope*. You have been so helpful in telling us about your experience that we are hoping you will help us one last time. As the project comes to a close, we are conducting telephone interviews with people who responded to our previous surveys. We hope to learn more about why you participate in astronomy activities. **Everyone who completes a telephone interview will receive a $30 gift certificate to Amazon.com.**

The interview will take about 10 minutes and will be scheduled at a time that is convenient for you. All you have to do is call me at my number below or reply to this email with your telephone number and a time when I can reach you. After completing the interview, I'll email your gift certificate to you.

Please help us continue to learn more about the impact of *400 Years of the Telescope* and other astronomy activities.

Thank you and I hope to hear from you soon,
Signature of ILI staff person doing the phone interviews, i.e. Liz
Phone number

400 Years of the Telescope
Telephone Interview Guide

To be completed with respondents to the online follow-up (t2) online survey

Date: _____ **Interviewer:** _____

Respondent Name: _____ **Phone #:** _____

Original ID number (from SPSS file): _____

Introduction

Hi, my name is _____, and I'm working with the *400 Years of the Telescope* Project to learn more about the astronomy activities people have done. Is now a good time to talk? (If not, when can I call you back?)

Great! Thanks again for agreeing to talk with me. The conversation should take about 10 minutes. There are no right or wrong answers to any of the questions – we just want your honest opinions. Do you have any questions before we get started? Also I want to get your permission to record this interview before we start. May I begin recording? Great, let's begin…

[Start recording]

So you may remember from our online surveys, the *400 Years of the Telescope* was funded by the National Science Foundation as part of the International Year of Astronomy. The project has a variety of components. I'll just list them quickly to refresh your memory:

- PBS Documentary – "400 Years of the Telescope"
- Planetarium Program - "Two Small Pieces of Glass"
- Website for *400 Years of the Telescope* – www.400years.org
- Night Sky Network Events – like star parties
- Member Events hosted by local PBS stations

Just as a reminder, the purpose of the project is to find out how best to engage people in astronomy.

---

1. What types of astronomy activities do you engage in on a regular basis? [Examples might be star gazing, using a telescope, watching programs on TV, reading about astronomy]

2. Do you belong to an astronomy club? ☐ Yes ☐ No

3. Do you own a telescope? ☐ Yes ☐ No
   - 3a. [If Yes] As a result of the 400 Year of the Telescope activities I listed before, did you find yourself using your telescope more frequently?
     ☐ Yes ☐ No
   - 3b. Tell me a bit about that.

4. I have your previous survey in front of me. So it looks like you did:
   - 4a. *[Look at the order of their activities]* Looks like you did _____ first. How did you hear about _____? *[Write the activity in the blank]*
   - 4b. Why did you decide to do it?

5. *[If they did more than one activity]* Next you did _____ and _____. Can you tell me why you did things in that particular order? *(Probe: How did they hear about it? Did they seek it out because of learning more about the 400 Years project and range of activities? Or where they just seeking out astronomy things in general? Or did they just stumble upon it?)*

6. There were those other activities that we listed that were part of this project, *[list them for the respondent]* but you didn't do them. Was there any particular reason why not? [Probe for a reply for each activity they did not do, rather than a generic one-size fits all. Probes: Was the location where the activity was a held a barrier for you? Were you not interested in that activity? Was it at an inconvenient time?]

7. The activities of the *400 Years of the Telescope* project were designed to increase people's interest in astronomy. How interested would you say you were in astronomy before you did any *400 Years activities*? *[Read the scale]* ☐ Not at all ☐ Some ☐ A lot

7a. Why would you say that?

8. How much did participating in the 400 Years of the Telescope activities influence how you think about astronomy? Would you say they had *[Read the scale]*

☐ No Influence ☐ Some Influence ☐ A lot of Influence

8a. Why would you say that?

9. How much did participating in these activities influence your likelihood of seeking out other astronomy-related experiences? Would you say they had *[Read the scale]*

☐ No Influence ☐ Some Influence ☐ A lot of Influence

9a. Why would you say that?

10. One goal of this project was to get people to look up at the night sky more often or perhaps for the first time. Did that happen for you? ☐ Yes ☐ No

10a. Tell me a bit about that. *(Probe: Can activities like this change something like that? Can they change a behavior/inspire a new behavior for you? Can they change a behavior/inspire a new behavior for other people?)*

11. Do you have any other comments about the 400 Years of the Telescope project or activities?

Thanks so much for your time. We really appreciate your willingness to talk to us. I'll be sending your $30 Amazon.com gift certificate out on _____. Is it ok to send it to the email address I have on file [the one I emailed you at recently]? Keep an eye out for it in your email inbox.

Appendix F Focus Group Instrument

400 Years of Telescope
Summative Focus Groups Guide
November 8, 2009 in Pittsburgh at the Buhl Planetarium

General and 400 Years Experiences

1. Warm up and experience with Astronomy and Science (10 min)
    a. [Introductions]
    b. [Purpose of the focus group]
    c. Have you ever watched any astronomy programs on TV? If yes, which ones have you watch?
    d. As you might have guessed, we'll be talking about telescopes. Have any of you ever looked through a telescope? Can you tell me what that experience was like for you?
    e. Have any of you attended a planetarium show before today? How many would say you see a lot of planetarium programs?
    f. Have you ever seen a planetarium program here or been to the science center's observatory before today?
2. Experience with other *400 Years of the Telescope* activities (15 min)
    a. 2009 is the International Year of Astronomy (IYA), and the National Science Foundation has funded a project titled *400 Years of the Telescope*. This project has a variety of components. For each one, I'm going to ask you to raise your hand if you've done that activity.
        i. **Watched the PBS Documentary – "400 Years of the Telescope."** This film is a chronicle of the history of the telescope from the time of Galileo, its profound impact upon the science of astronomy, and how both have shaped the way we view ourselves today in the midst of an infinite universe. It started airing on PBS stations on April 10, 2009 and has been rebroadcast in many markets. Count of people: _____
        ii. **Gone to the website for 400 Years of the Telescope –** www.400years.org The website for 400 Years of the Telescope contains information about all of the various activities for the project, as well as information about International Year of Astronomy (IYA) events. Count of people: _____
        iii. **Attended a Night Sky Network Events – like star parties.** Many local astronomy clubs host outreach events like star parties, where groups of people meet to look through telescopes at the sky. They also use hands-on activities and demonstrations about astronomy and telescopes. The clubs are supported by the Night Sky Network with activities and resources. A telescope demonstration and observing sheet about Galileo may have been provided for this event. Count of people: _____
        iv. **The member event hosted by WQED at this science center.** Some of the local PBS stations hosted events related to 400 Years of the Telescope. These may have included showing the "400 Years of the Telescope" documentary, the "Two Small Pieces of Glass" auditorium program, or other activities. Count of people: _____

b. For each activity you have done, I'll ask you to complete the sentence "I never realized that…"
c. Sometimes people don't participate in things like these because they either were not that interested in them OR because they didn't know about them. For those of you who didn't participate, which was it for you?
d. Which of the activities would you have done if you had known about them?

Focus on the Program (25 min)

3. Reaction to Planetarium Program: Now we'll be focusing on the planetarium program you just watched, "Two Small Pieces of Glass"
    a. How did you decide to watch this particular planetarium program today? Did you consider other programs?
    b. Which parts of the program were the most interesting to you? What really drew you in?
    c. Which parts weren't as interesting to you? Why weren't they so interesting?
    d. On a scale from 1 to 10, where 1 is poor and 10 is excellent, how would you rate the program? [For each person, if 9 or lower] What would make it a 10?
    e. Were there any times when you were watching the program that you really felt inspired? Tell me about that.
4. Comprehension/Misconceptions
    a. Was most of this information you had heard before or was it kind of new? If yes, Where and Which parts?
    b. Please complete the following sentence about the program you just watched: "I never realized that…" [probe: Was anything surprising?]
    c. What do you think the program was about? OR If you had to describe to a friend what this was about what would you say?
    d. Do you now understand astronomy better than you did before? Can you give me some examples?
    e. Did you learn anything new about telescopes? Can you give me some examples?
    f. Did you learn anything new about the work that astronomers are doing today? Can you give me some examples?
5. Motivated to Do Something
    a. Some people, after watching the program, have said it motivated them to learn more about astronomy. Did you find this to be the case with you? What did this program motivate you to want to learn more about?
    b. Some people, after watching the program, have said it motivated them to want to do something else. Did you find this to be the case with you? What did this program motivate you to want to do?
    c. The people who put this show together want to get people excited about looking up at the night sky. Are you more motivated to look up at the night sky after seeing the program? Why or why not?
6. Final comments, closing thoughts, thank you's.

Appendix G Focus Group Recruitment Advertisement

[The following text was included in a e-newsletter to members of the Carnegie Science Center]

Another Great Opportunity—Just for Members!

Participate in a Focus Group and Get a $30 Gift Certificate to the XPLOR Store!

Provide important feedback to the Buhl Digital Dome as you take part in celebrating the 2009 International Year of Astronomy. Everyone is welcome! See Two Small Pieces of Glass, then spend one hour discussing the show. You will receive more info once you RSVP. Don't miss this chance to help us plan for the future, and each participant will receive a $30 gift certificate to the Science Center's XPLOR Store as a special thank you.

November 8, two sessions: 1 and 3 pm

Email Dan Malerbo at MalerboD@CarnegieScienceCenter.org to register. RSVP deadline is Friday, November 6.

Appendix H Sample Station Event Survey

400 YEARS *of the* TELESCOPE:
A JOURNEY OF SCIENCE, TECHNOLOGY, AND THOUGHT

Where did you hear about this event?

Thinking about this event, please complete the following sentence: "I never realized that..."

For each item below please rate your enjoyment. Mark "n/a" for those activities you did not participate in.

	Not at all Enjoyable						Extremely Enjoyable	
The event as a whole	1	2	3	4	5	6	7	n/a
The planetarium show *Two Small Pieces of Glass*	1	2	3	4	5	6	7	n/a
Hands-on activities about mirrors and lenses	1	2	3	4	5	6	7	n/a
Star gazing	1	2	3	4	5	6	7	n/a
Looking through/working with real telescopes	1	2	3	4	5	6	7	n/a

2009 is the International Year of Astronomy. A lot of astronomy-related activities will be taking place including the ones listed below. For each one, please indicate if you would participate.

How likely would you be to want to...	Definitely Won't						Definitely Will
Go see a planetarium show about telescopes	1	2	3	4	5	6	7
Watch a documentary about telescopes and astronomy on PBS	1	2	3	4	5	6	7
Go to a related web site about telescopes	1	2	3	4	5	6	7
Attend a local astronomy club event, to learn more about how telescopes work	1	2	3	4	5	6	7
Attend a local astronomy club event, like a star party, where you look through telescopes at the night sky	1	2	3	4	5	6	7
Get a book or magazine from the library about astronomy	1	2	3	4	5	6	7

Are you a MPT member? ☐ Yes ☐ No

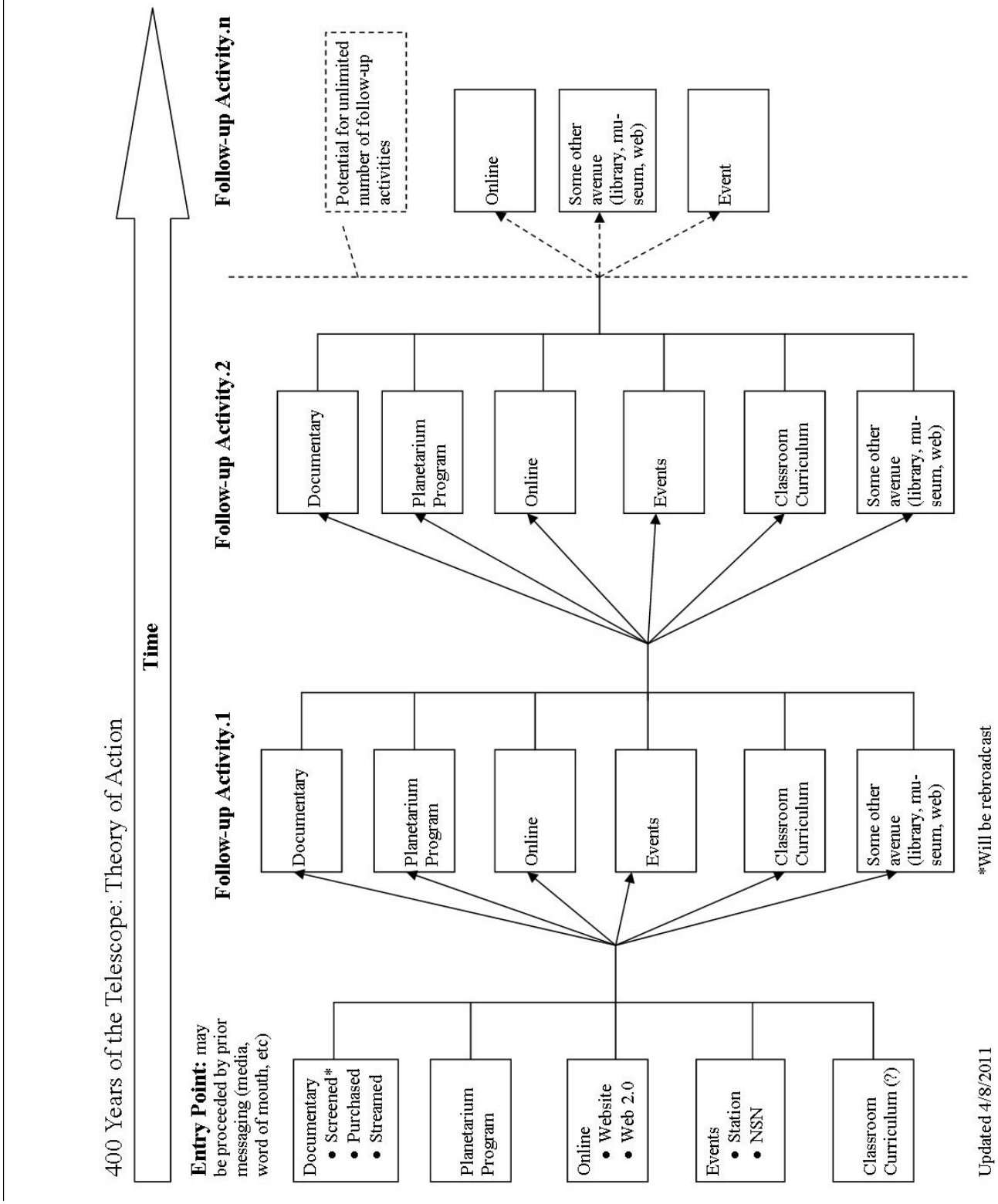
Are you a Maryland Science Center member? ☐ Yes ☐ No

How many people, including yourself, are in your group today?

# of Adults _____ # of Children ____

What year were you born? _____

What is your U.S Postal Zip Code (or if outside U.S., which country are you from?) _____


400 Years of the Telescope: Theory of Action
Time
Entry Point: may be proceeded by prior messaging (media, word of mouth, etc)
Follow-up Activity.1
Follow-up Activity.2
Follow-up Activity.n
Potential for unlimited number of follow-up activities
Documentary
• Screened*
• Purchased
• Streamed
Planetarium Program
Online
• Website
• Web 2.0
Events
• Station
• NSN
Classroom Curriculum (?)
Documentary
Planetarium Program
Online
Events
Classroom Curriculum
Some other avenue (library, museum, web)
Online
Some other avenue (library, museum, web)
Event
*Will be rebroadcast
Updated 4/8/2011