Was the Polar-Palooza *"Stories from a Changing Planet"* Campaign a Transformative Learning Experience for the Participating Scientists?

A Research Project by

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ABSTRACT

The *Stories from a Changing Planet* component of the US-based, International Polar Year education and public outreach effort *Polar-Palooza*, was a multimedia roadshow that married high production value images, HD video and sound with in-person scientist and Native Alaskan presentations. Using an online survey, interviews and other data, this study explores what, if any, lasting impacts participating in the program had on the scientists' attitudes towards science communication. This was done within the framework of *Transformative Learning*. This study concludes that many of the scientists who responded to the survey, and those that were interviewed, displayed the hallmarks of a *Transformative Learning* experience; that is, they reassessed their thinking about science communication and put their new frame of reference into practice.

INTRODUCTION

In the past few decades, scientists have been encouraged to participate in public engagement (Andrews et al., 2005). Researchers have sought to understand scientists' attitudes towards public outreach and the factors that predict whether or not individual scientists will participate in these kinds of activities (Poliakoff and Webb, 2007; Besley et al., 2012). However, very little work has been done on how participating in science communication efforts affects the scientists' attitudes towards these activities or whether or not it changes how they pursue them.

For the most part, outreach activities by scientists are comprised of public talks, media interviews, articles for general interest magazines, and self-published podcasts and videos. These methods of communication employ the information transmission model in which the scientist is the expert and the audience passively receives the information. The scientist has a reasonable degree of control over her message and is not required to critically assess her message or methods of communication. Generally speaking, for the average scientist, these public engagement activities are individual, "one off" experiences.

During the International Polar Year, a select group of U.S. polar scientists had the opportunity to participate in a unique science communication program. "*Stories from a Changing Planet"* (*SfaCP*) was the live, travelling component of the *Polar-Palooza* public outreach program. It combined professionally produced audio-visual material with live

presentations given by groups of scientists and native Alaskans who told stories about their lives and research in the Polar Regions. The composition of these groups changed from venue to venue. The group setting and narrative style of the *SfaCP* presentations represented a new model of science communication for most of the participating scientists and may have had an impact on how they approached their subsequent outreach activities.

BACKGROUND

How scientists view science communication, which ones participate in it and why they participate, are questions that have been the focus of several recent studies (Poliakoff and Webb, 2007; Besley et al., 2012). A small study at a large, mid-western university in the United States confirmed the widely held notion that scientists view science communication as a largely didactic, transmission model, activity also known as the information deficit model. In face-to-face interviews, 12 scientists revealed that they view science communication with the public as a monologic and asymmetric activity (Tanona et al., unpublished). In this scenario, they provide expert information to their audiences but do not really listen to, or learn anything from them. Audience feedback was used solely to assess the fidelity of message reception or gauge the effects of the message. This view of science communication might be explained, in part, by the fact than many scientists engage in this activity because of their commitment to the public good and a sense of professional obligation (Beseley et al., 2012). These reasons for involvement in science communication point to an underlying desire to inform the public about science; neither implies any deeper engagement on the part of the scientist beyond “source of expert information”. In effect, these scientists are content to emulate the lecturer/student format of the classroom in their public outreach presentations.

Professional status, and by implication age, may also play a role in this view of science communication. In their reanalysis of the data from the 2009 survey of American Association for the Advancement of Science (AAAS) members and the 2006 survey of university scientists by the United Kingdom’s Royal Society, Beseley et al. (2012) found that scientists who had reached mid-career status were more likely to engage in outreach. Similarly, Dudo (2012) identified scientist’s status (career level and number of publications) as a key factor contributing to scientists’ public communication activity. These studies imply that many of the scientists participating in public outreach are

successful, well-established professionals. It is reasonable to assume that if they are academics or government scientists, their science communication efforts are primarily simplified versions of their lectures and peer (conference) presentations.

This notion of professional status also helps to explain another factor that predicts a scientist's intention to participate in public engagement activities: control. Both Poliakoff and Webb (2007) and Dudo (2012) identified control issues as important in relation to a scientist's decision to participate in science communication. Scientists are more likely to pursue these activities if they think their participation is under their control (behavioral control), (Poliakoff & Webb, 2007) or if they did not need permission to give the presentation or talk to a journalist (communication autonomy), (Dudo, 2012). Mid-career professionals enjoy a significant level of autonomy and, therefore, are more able to pursue science communication on their own terms.

Even though control over their participation is important to scientists, they are not immune to broader community norms. Poliakoff & Webb (2007) found that one factor that predicted scientists' intentions to participate in public engagement was whether or not their colleagues regarded these activities positively, or as Dudo (2012) described it, "the perceived social pressures to perform [or] not perform a [particular] behavior" (normative beliefs). In addition, scientists can be motivated by their belief that their colleagues participate in these activities (descriptive norms), (Poliakoff & Webb, 2007). In this way, participation in science communication becomes a way of gaining or reinforcing status in a professional cohort that values it.

While it is clear that many scientists engage in science communication activities for primarily professional considerations, some pursue these activities for more personal reasons. Searle (2011) surveyed 1,521 Australian scientists and found that for many of them such communication was personally important and produced positive feelings about themselves, their communication and their work. This included: enjoyment from explaining and sharing what they do; love of sharing their enthusiasm and passion for their work; enjoyment of people being interested and enthused about their work; feelings of pride and self-esteem in making a contribution to society through either their communication or research; enjoyment of helping others; and enjoyment of a two-way exchange.

These studies give new insight into a scientist's motivation for, and predisposition to, engaging in public outreach. Generally speaking, scientists who have achieved a certain degree of status and autonomy (mid-level career) participate in science communication activities due to a combination of commitment to the public good, a sense of professional obligation, and personal efficacy and enrichment. However, none of these studies addresses how, or if, participation in public science communication activities changes a scientist's worldview of herself as a scientist or communicator. *Transformative Learning* Theory offers one model for exploring this possibility.

Transformative Learning Theory

Transformative Learning was proposed nearly 35 years ago as a theoretical description of the steps learners undergo in changing their worldviews (Mezirow, 1978). It offers a theory of learning that is uniquely adult, abstract and idealized, grounded in the nature of human communication and effectively captures the meaning making process of adult learners, particularly the learning process of paradigmatic shifts (Taylor, 2007). From the educator's perspective, *Transformative Learning* occurs when a learner is struck by a new concept or way of thinking and then follows through to make a life change (Brock, 2009).

Theoretically, it consists of 10 steps (Mezirow, 1978):

1. A disorienting dilemma;
2. Self-examination with feelings of guilt or shame;
3. Recognition that one's discontent and the process of transformation are shared and that others have negotiated a similar change;
4. Exploration of options for new roles, relationships, and actions;
5. A critical assessment of assumptions (self reflection that includes premise as well as content and process);
6. Provisional trying of new roles;
7. Planning of a course of action;
8. Acquisition of knowledge and skills for implementing one's plans;
9. Building of competence and self-confidence in new roles and relationships; and
10. A reintegration into one's life on the basis of conditions dictated by one's new perspective

These ten steps represent four levels of: an elaboration of existing frames of reference, learning new frames of reference, transforming a point of view, and transforming "habits of mind" (Mezirow, 2000).

In the *Transformative Learning* framework, a disorienting dilemma is the catalyst for change (Taylor, 2007). While this dilemma can be extreme, for example learning that one is HIV positive (Courtenay et al., 1998), this is not always the case. Taylor (2007) cites two studies of *Transformative Learning* in which students training in palliative care (doctors and nurses) were required to visit hospices, funeral homes and anatomy laboratories. These direct, personally engaging learning experiences stimulated reflection. One can infer from these studies that a very uncomfortable or unfamiliar situation is the emotional and intellectual equivalent of a disorienting dilemma.

In order to determine if all of the precursor steps were necessary to achieve *Transformative Learning*, 256 undergraduate business school students were surveyed (Brock, 2009). The more steps respondents remembered experiencing, the more they also reported *Transformative Learning*. The highest incidence of reporting Transformative Learning was associated with the precursor step of critical reflection (Step 5), followed by disorienting dilemmas (Step 1) and trying on new roles (Step 6). However, most of the respondents who engaged in critical reflection reported not changing their beliefs or role expectations (Step 10).

Mezirow overlooked the role of context in shaping *Transformative Learning* (Taylor, 1998). Research has identified both personal (e.g. prior life experiences) and sociocultural (e.g. historical events) contextual factors as significant in *Transformative Learning*. A number of studies examined the various characteristics of a perspective transformation (outcomes) and demonstrated that many were the product of a particular transformative context. There also seem to be shared transformational characteristics that transcend context, such as greater self-directedness, assertiveness, self-confidence and self-esteem, which support the emphasis of autonomy found in Mezirow's (2000) interpretation of *Transformative Learning*. Context has implications both at the personal and social level (Taylor, 1998).

Research also indicates that establishing relationships with others is one of the essential factors of a transformative experience (Taylor, 1998). Trust, non-evaluative feedback,

nonhierarchical status, voluntary participation and partner selection, shared goals and authenticity are important relational qualities for *Transformative Learning* (Eisen, 2001). In other words, the learning process is dependent on the need for support, trust, friendship and intimacy (Taylor, 1998). These relationships can be manifested in an intense, group experience such as an immersive workshop.

The Banff Center Science Communication Program as a Transformative Learning Experience

Since 2005, the Banff Center Science Communications Program has brought together leading science communicators and individuals working in science and engineering, science communications, journalism, knowledge transfer, science outreach, science policy, and cultural industries. During a two-week, immersive residency experience in August, they explore the use of print, visual, and social media, as well as other communication formats, with the goal of fostering a more engaging role for science in public culture (The Banff Center, 2012).

A survey of past participants in the Banff Science Communications program was undertaken in the fall of 2009 to capture concrete data on short-term and long-term outcomes (The Banff Center, 2009). Of the 72 participants in the program, 61 people (85 percent) completed the survey. The enduring changes are described as improved effectiveness as communicators, increased awareness of the different workplace demands on scientists and communicators, and a desire for expanded activity and excellence in science communication. The survey responses fell into the following themes: workplace approach, workplace activities, workplace role, new projects, career change, talks or presentations, new educational pursuits, change in academic approach, change in academic role, awards or nominations and other. The exact changes are itemized in the report (The Banff Center, 2009, pages 11-18). Many of the participants describe the program as *transformative*. One might interpret the reported fundamental changes in their commitment and approach to science communication as a shift in their "habits of mind".

The International Polar Year Polar-Palooza Campaign

The science communication activity of interest in this research is the International Polar Year *Polar-Palooza* campaign. The International Polar Year (IPY) was a large scientific

program focusing on the Arctic and the Antarctic from March 2007 to March 2009 (IPO, 2012). This fourth IPY involved over 200 projects, with thousands of scientists from over 60 nations examining a wide range of physical, biological and social research topics. This IPY also had an extensive education and outreach component.

Polar-Palooza (*PPZA*) was a multimedia initiative supported by the US National Science Foundation (NSF) and the National Aeronautics and Space Administration (NASA) (Geoff Haines-Stiles Productions, Inc., 2012). Geoff Haines-Stiles was the Principal Investigator (PI); Erna Akuginow was the co-Principal Investigator (co-PI). *PPZA* involved researchers, Alaskan natives, in-person presentations at science centers and natural history museums, a website, video and audio podcasts, and more. The U.S. based portion of this travelling presentation ran from 19 October 2007 to 5 April 2009 and consisted of 25 stops from Fairbanks, AK to Tampa, FL and from San Diego, CA to New York, NY.

Stories from a Changing Planet (*SfaCP*), was the live, multimedia presentation associated with *PPZA*. It consisted of presenters, called *Travelers,* talking about the Poles, their own research, and climate change while standing in front of high-definition video projections of polar scenes. These included profiles, portraits and/or short videos of them engaged in research and daily activities like cooking meals, traveling across snow and ice, and having fun on the job. The *Travelers* were handpicked because of their polar research, presentation skills, and willingness to have their field research and lives captured digitally on film and on tape (Perry, 2010). The *Travelers* were researchers and Alaskan residents who, between them, were expert on ice, Earth history, penguins, polar bears, climate change, the oceans, subsistence living on the coast or in the Alaskan interior (Geoff Haines-Stiles Productions, Inc., 2012).

The preparation of the *SfaCP* live presentations was an iterative process. In its initial phase, the *PPZA* staff provided a storyboard, or general outline of the points that they wanted made, and invited the *Travelers* to elaborate on this outline and include their own thoughts. Once at the *SfaCP* venue, the *Travelers* worked individually with the *PPZA* staff, writing and rewriting their presentations. Then, they rehearsed with the entire group of *Travelers* in order to create a more engaging and coherent multimedia and multi-person experience for the audience (Perry, 2010). All of this implies significant coaching and professional development; that is, an educational experience.

Each *SfaCP* was part of a broader array of outreach activities that highlighted the *Travelers* and their work. These activities included: university seminars and symposia; interviews with local media; educator workshops; presentations for school groups and business and community leaders; and Family Days open to the public (Perry, 2010).

Selinda Research Associates, Inc. evaluated *SfaCP* during its run (Perry, 2010). Although not integral into the evaluation, some information about the *Travelers'* experiences was documented. Data indicated that the *PPZA* experience for most of the *Travelers* was extremely positive as they gained in important ways from their participation. However, there has not been a follow-up study to determine if the *PPZA* experience significantly transformed the *Travelers'* thinking or approaches to science communication and public engagement activities.

RATIONALE FOR THE PRESENT RESEARCH

Studies have shown that scientists engage in science communication for various reasons. There does not appear to be a full-scale study on the lasting impacts that these activities have on the participating scientists, although the internal evaluation done by the Banff Center on its Science Communication Program does point to some intriguing benchmarks. The purpose of this research is to explore what, if any, lasting impacts participating in the International Polar Year *Polar-Palooza* campaign had on the *Travelers*' attitudes towards science communication. In other words: Was participating in the *"Stories from a Changing Planet"* (*SfaCP*) component of *Polar-Palooza* a *Transformative Learning* experience for the *Travelers*?

METHODS

This research involves human subjects. As a consequence, it was submitted, evaluated and approved by the Laurentian University Ethics Approval process before it proceeded.

Sample Population

The sampling population is limited to the scientists, or *Travelers*, who participated in *PPZA*'s *SfaCP* campaign. There are thirty-six *Travelers* listed on the *PPZA* website, three of them are Native Alaskans and one is a science writer for the New York Times newspaper. The Native Alaskans and the New York Times reporter were not invited to

participate: the former were part of *PPZA* to provide the indigenous perspective (not necessarily to communicate science) and the latter is already a professional communicator.

Overall, twenty-seven individuals were contacted. These people appeared on the *PPZA* website and were also listed as 'Presenters' in the *PPZA* Final Report to the National Science Foundation (unpublished, copy provided by Haines-Stiles). It is reasonable to think that a number of these *Travelers* may have "moved on" from their *SfaCP* experience and, as a consequence, would not respond to the survey. Similarly, those that had a less satisfactory experience may decide not to participate. As a result, this study can only yield a partial picture of the effects, or lack of them, that the *PPZA* experience had on the *Travelers'* attitudes towards science communication. In fact, fourteen of these *Travelers* did not respond to the survey. This was taken into consideration when interpreting the findings.

Data Collection Methods

A mixed method approach (primarily survey and interviews) was employed to determine if participation in *PPZA* had any lasting effects (transformative experience) on the *Travelers'* attitudes towards science communication. This method allows for the collection of both quantitative and qualitative data that permit the construction of "a broader picture by adding depth and insights to 'numbers' through inclusion of dialogue and narratives" (O'Leary, 2010, page128). This is especially important given the small size of the sampling population and the fact that the entire population did not participate in this research.

Surveys and interviews are a common tool for determining the motivations and attitudes of scientists towards science communication (for example, Besley et al., 2012; Searle, 2011; and Tanona et al., unpublished). According to Taylor (2007), there is a growing number of studies of *Transformative Learning* that involve the use of surveys and/or open-ended questionnaires. Many of these surveys/questionnaires are used in a mixed methods context, which includes interviews.

Survey

Every person in the target population was sent an introductory e-mail. This communication described the research and emphasized how important each recipient's contribution was to the project. It was hoped that by making this personal contact before sending out the survey more people would fill it out. In due course, a second e-mail was sent to each potential participant. It contained information about the study, a consent form (Appendix 1) and the link to the online survey. This survey was explanatory in nature, that is, its "goal is to build complex understanding that goes beyond description or even correlation … to determine cause and effect" (O'Leary, 2010, page 181).

The survey consisted of closed and open questions (Appendix 2). The closed questions offered multiple responses (i.e. a Likert scale) and yielded quantitative data that were graphed for easy analysis. The open questions yielded qualitative data that were analyzed for emerging themes and information that corroborated the closed question responses.

The survey distributed by the Banff Center to evaluate its Science Communication program provided a model for the current research. That survey was able to provide data on the changes in thinking and behavior of the program participants, hallmarks of a transformative experience. These included: improved effectiveness as communicators; increased awareness of the different workplace demands on scientists and communicators; a desire for expanded activity; and excellence in science communication (The Banff Center, 2009). The survey results pointed to operationalizing changes in behavior by asking questions about changes in: workplace approach, workplace activities, workplace role, new projects, career change, talks or presentations, new educational pursuits, change in academic approach, change in academic role, and awards or nominations. Questions from other surveys, such as *Factors Affecting Science Communication* commissioned by The Royal Society, Research Councils UK and The Wellcome Trust (May 2006) and *Scientific Achievements Less Prominent Than a Decade Ago*: *PUBLIC PRAISES SCIENCE; SCIENTISTS FAULT PUBLIC, MEDIA* conducted by the Pew Research Center and AAAS (released July 2009) were also used as models to determine the *Travelers'* attitudes towards science and science communication.

Interviews

Conducting interviews with a few respondents after the survey added depth to the survey findings (O'Leary, 2010, page 129). One of the last questions on the survey asked if the *Traveler* would be willing to be interviewed. A subsample of those who responded positively was contacted. Some care was taken to include a diversity of respondents. These interviews lasted 20-30 minutes. A separate Consent Form was required for these interviews (Appendix 3).

Each interview was one-on-one. These interviews were conducted via Skype and were recorded and transcribed for later analysis. The interviews were semi-structured (Appendix 4). A number of set questions and follow-up questions were asked but the interviewer took the opportunity to pursue unexpected and promising threads in the conversation as befits the exploratory nature of this project.

Once transcribed, the interviews were analyzed for content. This involved: 1) noting overall impressions from the interviews; 2) reducing and coding the data into themes; 3) searching for patterns and interconnections; 4) mapping and building themes; 5) building and verifying theories; and 6) drawing conclusions (O'Leary, 2010, page 268). Steps 2-4 were iterative.

Ancillary Data

Some other existing data were available for analysis. They were used to add some depth to the understanding of the *Travelers'* attitudes towards science communication before, during or immediately after their *SfaCP* experience or to provide some 'real time' information about the *SfaCP* experience itself. These included:

- Documentation of the *Travelers'* science communication activities before and after his/her *SfaCP* experience (2006-2012);
- A *Traveler's* webpage that described his *SfaCP* experience;
- An article written by one of the *Travelers* about her *SfaCP* experience; and
- An article describing one of the *SfaCP* presentations.

These data were analyzed using the same methods as the interviews.

Thirteen of the twenty-seven *Travelers* responded to the survey. Four interviews were conducted with individuals that were representative of the sample. Together, these

quantitative and qualitative data were analyzed to describe the *SfaCP* experience and determine what impact, it any, it had on the *Travelers'* attitudes towards science communication and outreach.

As with any study that is exploratory, and largely qualitative, it is not possible to generalize the findings beyond the participants. However, the analysis of these data produced a rich and detailed picture of the experiences of particular people participating in particular events. This information might have implications for further studies and contribute to a better understanding of such experiences on scientists' view of communication activities.

RESULTS

The Survey Data

Of the twenty-seven *Travellers* who were contacted, thirteen completed the *SfaCP* survey (48%). This is good result given that self-administered surveys have a relatively low return rates (i.e., Dudo (2012) = 34.5% response rate, Poliakoff and Webb (2007) = 16.9%). From this point on, people who participated in the survey are referred to as the *Respondents.*

The Respondents

The *Respondents* were asked to indicate their level of work experience at the time of *SfaCP*. Four groups emerged: graduate student (GS); mid-level academic - associate professor (MA); senior academic - full professor (SA); and senior government scientists (SGS), (Figure 1). In other words, almost all of the members of this cohort were well along their career paths. No early-career academics - assistant professors (EA) or early or MGS - mid-career government scientists (EGS, MGS) responded to the survey.

Not surprisingly, the *Respondents* have devoted a significant number of years to research. Although this value represents all of the years from graduate research to present day, it is impressive (mean ± standard deviation = 27.1 ± 8.4 years). The graduate student, who has the least amount of research experience, has completed ten years; the most experienced researcher has completed 40 years. One could subtract five years from these totals to estimate the numbers of years of research completed at the time of *SfaCP*.

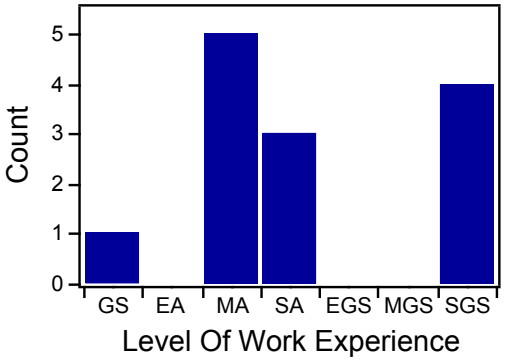

Figure 1. The level of work experience of the *Respondents* at the time of *SfaCP*. (GS = Graduate Student; EA = Early-career Academic; MA = Mid-career Academic; SA = Senior Academic; EGS = Early-career Government Scientist; MGS = Mid-career Government Scientist; SGS = Senior Government Scientist)

The *Respondents* were asked to think about how much time they had devoted to four main activities of their professional life: research; teaching; administration; and science communication and outreach (Figure 2). Most of the *Respondents* performed all of these functions, to varying degrees, as part of their job.

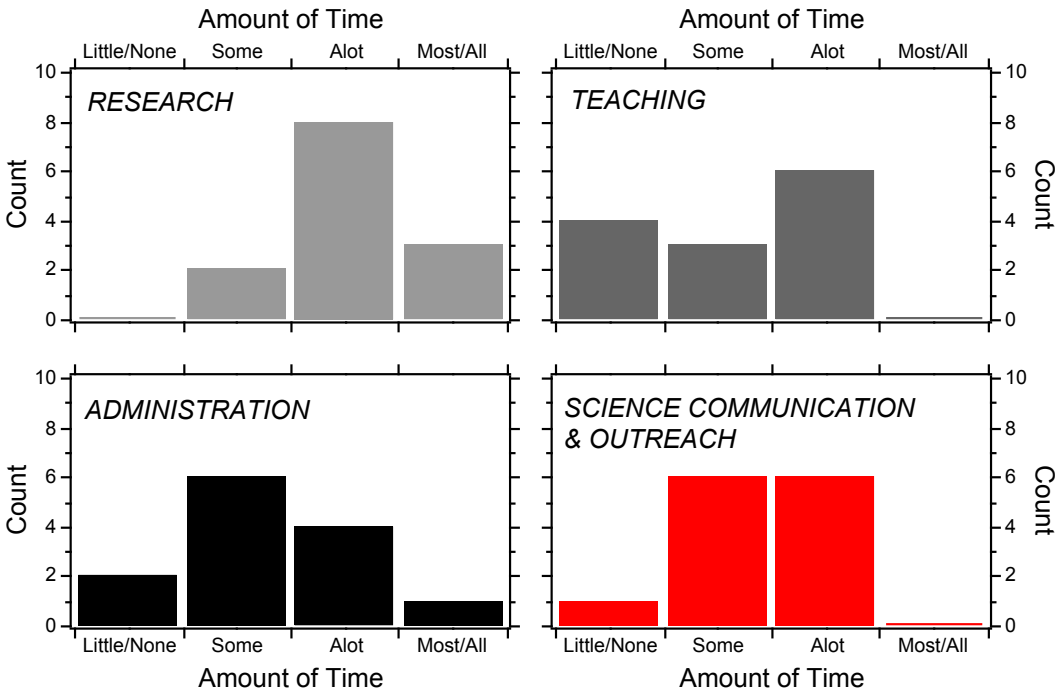

Figure 2. How much time the *Respondents* have spend on four professional activities in the past five years.

All of the *Respondents* spent some time doing research (Little or None = 0). While most spent some of their time teaching, some do little or no teaching at all and none spent all of their time teaching. Only one *Respondent* spent most of his time doing administrative activities; two served no administrative function at all. All but one *Respondent,* spent a notable amount of time engaged in science communication and outreach activities although no one spent most of her time engaged in this activity.

The number of events attended by the *Respondents* ranged widely (Figure 3). Most *Respondents* participated in these events two to three times. Two attended only one event, while another participated in nine events in the US (and others abroad). It is likely that these varying levels of participation had some impact on how the *Respondents* remember their *SfaCP* experiences.

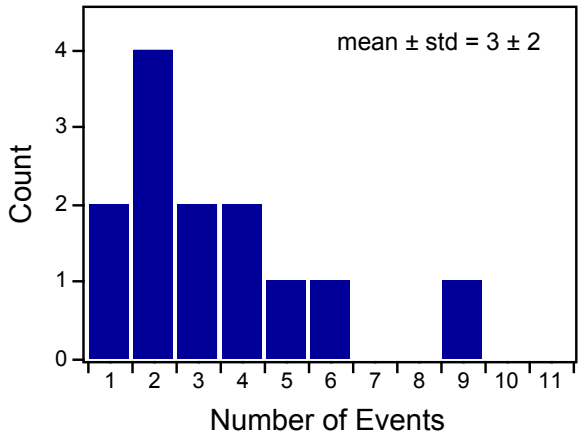

Figure 3. Number of *SfaCP* events attended by the *Respondents.*

Attitudes Toward Science Communication

The *Respondents* identified a variety of audiences that they reached out to through science communication including: family, neighbors, friends, groups, schools, the general public, and policymakers. Many used the word “relevant” when describing their science and the need to communicate it to these broader audiences. For example, “it means making my science relevant to [the public]” or “scientists produce results of high relevance to the society at large”. A variation on this theme was “value”. (“Communicating our science in a manner that is understandable and meaningful to someone like my wife or mother so that they understand its value on their lives.” or

"There is a growing recognition in the general public and media, that there is value to science, and hence an increase in general interest.")

Most *Respondents* talked about educating their various audiences. They spoke of, "explaining the science to students, teachers, policy makers, and the general public" and "sharing understanding of science research." "This means that scientists need to reach out to the general public (who may know very little about science), and convey to them both the importance of the science and the outcomes, and why it is relevant to them." Several *Respondents* specifically identified earth sciences ("our dynamic earth") and climate change as a topic of particular importance. One thought, "all members of the public should have, but often do not have, a sense of climate and environmental literacy." But one *Respondent* cautioned that scientists should not "advocate policies, just give [the audience] the information of what we know we know."

One *Respondent* identified information accessibility as a reason for scientists to communicate directly with the public. He reasoned that scientific results are relevant to "society at large but those results are published in scientific journals which are often not readily available to the non-specialist public, and written specifically for scientists." Finally, one *Respondent* opined that science communication could be used to "justifying our public funding by demonstrating the value of our work to them and to science."

Many *Respondents* recognized that different strategies were needed to talk to the non-scientific audience. They referred to, "talking to the general public about scientific work in a way that is engaging, understandable, and educational" and "explaining the excitement of science." Several *Respondents* recognized that they needed to "cultivate our communication skills, so that these [science communication] opportunities are able to produce the best outcomes." This included, "convey[ing] personal perspectives to the public, to bring the science home." It also meant, "interacting with the public through presentations, demonstrations, and discussions explaining the process and results of science in understandable language."

There was also some recognition that there were new opportunities and venues available to scientists for communicating their science. Said one, "I also think that with social media and the many other sources of information, there are more opportunities for communication on all topics in general. " Another *Respondent* related an experience that

demonstrated how successful exploiting these venues can be: "The greatest acknowledgement I received was when someone who [had] watched some of the *Stories from a Changing Planet*, [expressed] thanks and appreciation for the work we do [and] the sacrifices we make to bring clarity and new information to this issue of climate change."

The Stories from a Changing Planet (*SfaCP*) Experience

The *Respondents* were asked to describe their *SfaCP* experience. In the first instance they chose all the appropriate adjectives from a list; in the second, they described in their own words the most memorable aspects of their *SfaCp* experience.

The *Respondents* overwhelmingly described the *SfaCP* experiences in a positive fashion (Figure 4). All of them described the experience as 'Fun'. The *Respondents* also heavily favored other words with positive connotations ('Inspiring', 'Exciting', 'Rewarding', 'Educational' and 'Challenging'). 'Frustrating' and 'Hard Work' (words with possible negative connotations) were not chosen (with one exception, Figure 4). It should be noted that the *Respondents* had the opportunity to add their own words to the list – none did.

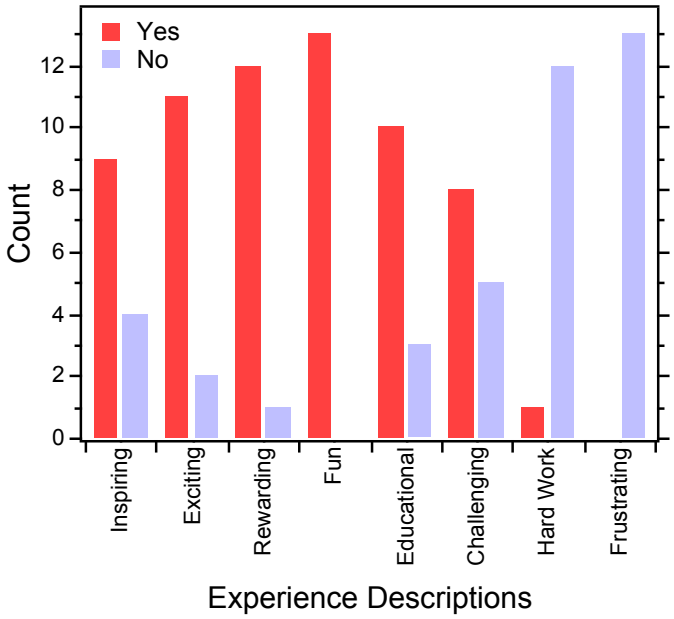

Figure 4. Descriptions of the *SfaCP* experience.

One reason that the *Respondents* may have found the experience so enjoyable was that they felt competent. They all reported that their previous science communication experiences prepared them for their participation in *SfaCP.* All but one thought that they were reasonably well prepared and did not have to modify their approach much to fit into the *SfaCP* model. The other *Respondent* thought that he did not have to change anything at all in his approach.

When describing their *SfacP* experience in their own words, almost all of the *Respondents* talked about the audience. They were impressed by the "enthusiastic" and "positive response of the audience" and enjoyed "sharing science with people unfamiliar with our research." Many commented that the students in the audience had "great questions and great attitudes." For the graduate student, the response of the audience was a revelation: "Until I participated in *SfaCP*, I didn't realize that the public perceived me as a scientist and wanted to hear what I had to say about climate change."

Many *Respondents* commented on the pleasure they got from meeting and working with their fellow *Travelers.* They enjoyed the camaraderie and learning about other scientist's research. As one commented, "We're all passionate people and knowing them as such, rather than names on papers, was great."

Some *Respondents* learned new skills during their *SfaCP* experiences. "It helped me 'up my game' and challenged me to become a more effective communicator", one commented. Said another, "All of my public presentations are many notches higher on a scale of effectiveness now than they were before my involvement in *Polar Palooza*; I've adopted many of the techniques that Geoff and Erna employed." One *Respondent* reported on the challenge of, "trying to figure out how to say anything of substance on TV with only two sentences to work with."

Several *Respondents* expressed their appreciation for the PIs. "Their professionalism is inspiring", said one. Another commented that they "made the 'show' flow smoothly and built up a great sense of purpose and unity to all of our individual efforts." Others commented on the presentation of *SfaCP* as masterminded by the PIs. One was impressed by the "intense, exciting way in which the science was relayed", while others commented on the "visuals" and "production aspects" created by the *PPZA* team.

There were no negative comments about the *SfaCP* experience. The comment that came closest was framed as "least favorite". It "was simply not being in charge of my own 'production'; normally when I talk about my work I do so in presentations of my own construction."

The Impact of the *SfaCP* Experience

When asked if participating in *SfaCP* had an effect on their professional activities (changes implemented in the workplace, on their career, or through projects or initiatives), the *Respondents* were evenly divided. When describing the impact that *SfaCP* had on their professional activities, the comments ranged from "no impact" to a change of vocation. One spoke of utilizing *SfaCP* video segments in his undergraduate classes because they "work well to introduce or wrap up some subject" and "help take the students to Antarctica". Another said he "used material from *SfaCP* in [his] science presentations."

Others spoke of their commitment to, and enthusiasm for, science communication. "It reaffirmed and enhanced my commitment to education, formal and informal", said one *Respondent*. "[It] reinforced my belief in the importance of public outreach about science," said another. A third *Respondent* commented that, "I make as much effort as possible to participate in outreach activities [now]."

For others the changes in their professional activities were more far-reaching. One *Respondent* commented, "I'd say that outreach has become a more important and motivating part of my job since *SfaCP*." Another stated, more dramatically, "By showing me the intense satisfaction of Education and Public Outreach (EPO), I have chosen to continue to be involved in EPO even after retiring from active research."

Furthermore, all of the *Respondents* thought that the *ScaCP* had had an impact on their approach to communicating science (Figure 4). Many of the *Respondents* talked about being more confident in front of audiences after their *SfaCP* experience. They also thought that they were now better communicators. They spoke of:

- "Adding more energy" and being more of a "showman";
- Giving more thought to the language they use in their presentations ("realize that my normal word choices have to be different when talking to the public");

- "Developing the human story along with the science story" ("I make sure to relate to people how I became a scientist and that my path is not only not so unusual, but that they can pursue the same path and feel the joy and excitement of research"); and
- Putting more thought into their presentation material ("When I speak to the public, I pay great attention to the visuals (slides, videos) that they contain as few words as possible but still convey the message.").

One *Respondent* said that the *SfaCP* experience, "raised my awareness about how much the public does NOT know, and each time I speak now to a public audience, I now make a point of mentioning 2-3 points about climate change that I feel everyone should know." Another *Respondent* spoke of "Trying to be more open to more venues (like radio)."

For one *Respondent*, the impacts were more elusive, "All I can say is that it added to my perspective and experiences. Whenever we do something new and in a different way, like *SfaCP*, we take what worked (e.g. the showmanship), and try to carry that forward into our other presentations." Another *Respondent* summarized *SfaCP* this way: "It provides a role model with regards to future outreach efforts."

Only one *Respondent* reported writing a publication that was a direct result of participating in *SfaCP* even though all appeared to view it as a positive experience.

Changes in Science Communication Activities Since *SfaCP*

The *Respondents* described their current science communication efforts and those that pre-dated *SfaCP* by choosing all the appropriate activities from a list (Figure 5). These activities covered many audiences including: the general public, young people and schools, media, policy makers, non-governmental organizations and industry/business.

During both periods, most of the *Respondents* participated in activities that involved schools, young people, the public and the media. In fact, all of the *Respondents* reported current contact with schoolteachers and young people in schools. While there was contact with policy makers, non-governmental organization and industry, these were not as widely pursued.

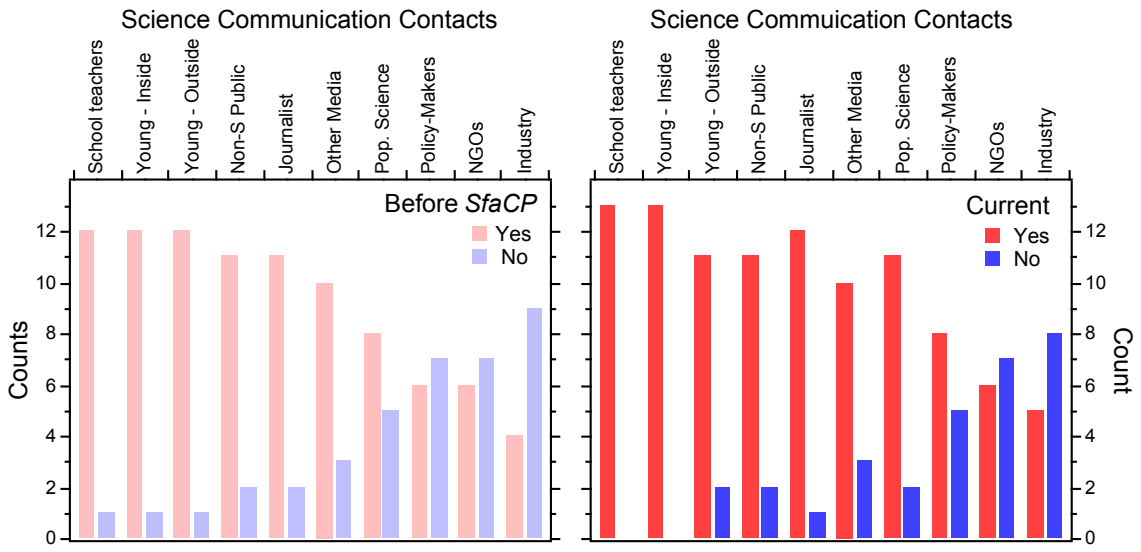

Figure 5. Science communication efforts before and after *SfaCP*.

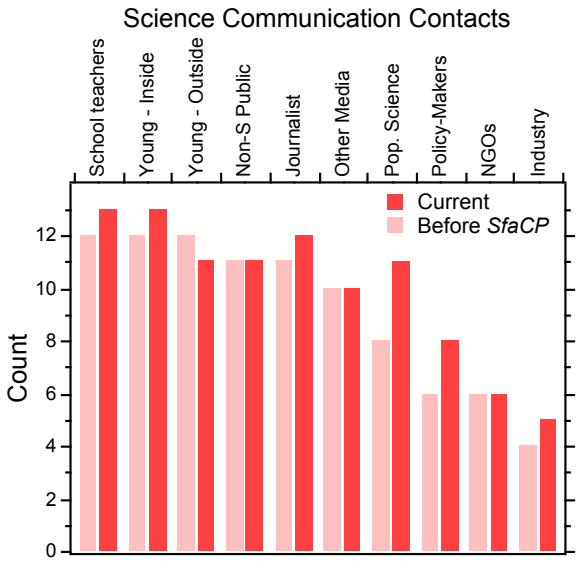

Figure 6. Comparison of science communication efforts before and after *SfaCP*.

The positive responses for pre/post *SfaCP* science communication contacts are shown in Figure 6 (the negative responses are not presented, as they are simply a mirror image). The largest increase in engagement was with popular science journalists and policy makers. Slight increased engagement was experienced with teachers, young people in school, journalists (press, TV, and radio), and industry. There was no change in the interactions with non-specialist public, other media (writers and documentary and

other program makers) and non-governmental organizations (NGOs). The only category that decreased was the interaction with young people outside the classroom, which may be due to lack of opportunity rather than personal preference.

When looking at the *Respondents* as individuals, most of them (8 out of 13) reported no change in their participation in the prescribed activities (either their response was 'yes' for both the 'before *SfaCP*' and 'Current' questions or 'no' for both). Of those that reported changes: four reported only increases in some of the activities (with the other categories remaining unchanged); one reported increases in three activities and a decrease in one other; and one reported a decrease in participation in three of the science communication activities. It is noteworthy that three out of four of the *Respondents* that reported *any* increase in activities held senior positions, while the one that reported multiple decreases was a graduate student.

Having identified which groups they had engaged in science communication, the *Respondents* then indicated how often they met some elements of these audiences or participated in engagement opportunities in the past year from a prescribed list (Figure 7). It is worth noting that how often anyone engages in any activity is dependent on the opportunity or invitation to do so, which in turn may depend on one's professional responsibilities or local reputation, and does not necessarily indicate a preference for these audiences or activities.

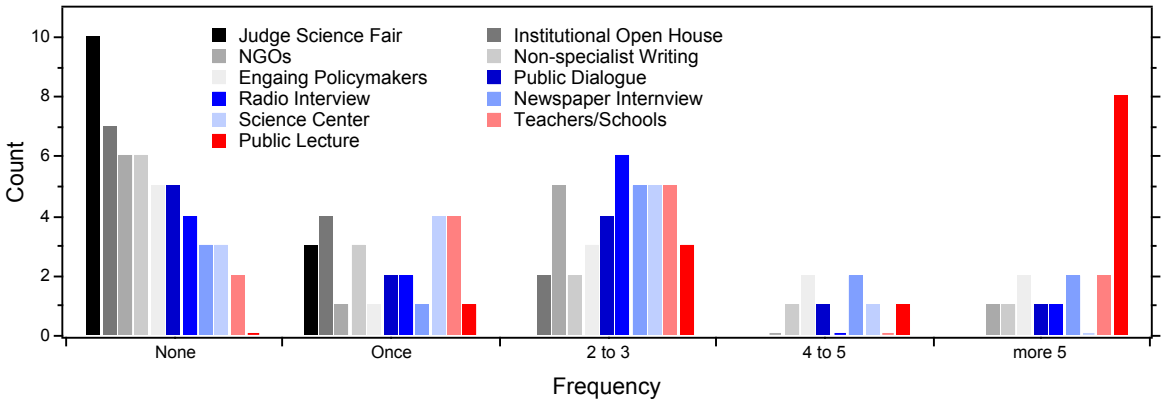

Figure 7. Frequency of selected science communication activities in the last year.

It is immediately obvious, that the *Respondents* did not participate very much as judges at Science Fairs or Competitions; responses to this category were limited to 'None' or

'Once'. Participation in 'Institutional Open Days' was also low, although this may be due to the fact that the institution where a particular *Respondent* works does not hold such events.

Clearly, the most popular activity was 'Public Lecture' (including being on a Panel), the only categories in which no one responded 'None'. In fact, eight of the thirteen *Respondents* reported having given a lecture or been on a panel more than five times in the past year. This was in contrast to participation in 'Public Dialogue' (or debate), which was much lower. There was substantial engagement in most of the other categories, notably: working with teachers and schools (including writing educational material); talking to policy makers; and being interviewed by newspaper or radio reporters (with an overall preference for newspapers). On average, people spoke to popular science writers less frequently than other media. It is worth keeping in mind that while the *Respondents* continue to favor 'Public Lecture' as their method of science communication, there is reason to think that the content and delivery of these lectures has changed.

The Interview Data

Of the thirteen *Respondents* who completed the *SfaCP* survey, nine indicated that they were willing to be interviewed. Four were approached, one from each level of work experience (Figure 1). In this section they are referred to as the *Interviewees*.

How the *Interviewees* Became Involved in *SfaCP*

Three of the four *Interviewees* did not know Haines-Stiles before he began putting together *PPZA*. In fact, they were aware that, at some level, they were being "cast" or "vetted" for the part of *Traveler*. One *Interviewee* felt he had been selected because he was a graduate student; another said she thought she "partially fit the demographics, a youngish female"; and a third was recommended by one of Haines-Stiles videographers because she had worked with him on a previous project. The fourth *Interviewee* had a prior relationship with Haines-Stiles, having worked with him on another project. Indeed, he thought he might have written a letter of support for the *PPZA* proposal to the NSF.

All of the *Interviewees* were very pleased to be asked to join the *SfaCP* campaign. Phrases such as: "I was eager to do it"; "I was very pleased to be involved"; "I was happy

to help"; and "I was really excited because I felt like it was an endorsement of my ability to talk to people about science, who weren't scientists" typified their descriptions of how they felt about being asked to participate in this enterprise. However, there was a bit of trepidation on the part of some of the *Interviewees*. For example, one said that "just not knowing what working with TV producer really mean[t]" might have caused some initial apprehension at the invitation.

What *Interviewees* Had To Do To Participate in *SfaCP*

None of the *Interviewees* had any real work-related problems participating in *SfaCP*. The youngest one said, "I was a student at the time so I didn't have much responsibility. So if they wanted me to go somewhere, it was really easy for me. I did talk to my advisor, and said that I was taking part and of course he wasn't going to say 'No'. Just talking to my advisor [and telling him] that I am actually going to be gone – not actually asking for permission." Both of the academics had flexible schedules and could accommodate *SfaCP*. As one said, "I was able to plan around it knowing it was coming early enough I was able to arrange either for giving an exam at that time or having a guest lecturer come in or something like that. So I could work around it easily." The other added, "I was able to rearrange my teaching without getting lots and lots of approvals up the chain. They (her institution's managers) sort of trust us to do what needs get done." The government scientist had to resort to another method of participating; "I actually took vacation time to participate so that there wouldn't be a potential conflict in me doing that."

Preparing Their *SfaCP* Presentations

The *Interviewees'* recollections of the development of their presentations for *SfaCP* varied quite a bit. The *Interviewee* with the least education outreach experience commented that he didn't have to do very much for his presentation. "They pretty much had most of the materials and they knew what they wanted me to say", he said. "They had good materials already (video of his fieldwork) and I just had to give them some plots of the data that I took". He agreed that the presentation seemed scripted and he did not write the script. As he said, "I actually didn't know that it was all scripted like it was." However, he made it clear he was not asked to say anything that made him uncomfortable.

An *Interviewee* with a great deal more outreach experience described a somewhat different process. According to him, he and Haines-Stiles talked about what would be of mutual interest to them for his segment. “He (Haines-Stiles) also sent me I think a video or even a Power Point presentation that I could use as an example.” These showed the *Interviewee* how other *Travelers* had performed similar segments in previous *SfaCP* events and provided him with a model and some ideas. The *Interviewee added, “*He (Haines-Stiles) kind of had part of it scripted but he also said follow what else you would like to do. So he kind of customized it to what I could talk about (his own research) but he had some segments that I think he thought worked really well – and they did. He knew kind of what he wanted and he kind of knew what I had to talk about so he was very flexible in letting me say what I wanted to but also making sure I said stuff that would have gone well with the program he had come together with the other speakers.” In this case, it appears that the preparation of the presentation was more of an iterative and collaborative process.

The third *Interviewee* corroborated this description of the presentation preparation process. She described having a really “close interaction with both Geoff and Erna. So they had some ideas of the kinds of things they wanted covered throughout the presentation. And then said, ‘Are you comfortable talking about these things? What would you like to add?’ and so it was very much an iterative, back and forth process, dialoguing about what figures would work best, what text is best or what things are best to say. Some were their ideas and some were my ideas.” However, her experience went beyond that of the other *Interviewees,* as she actually captured the video that accompanied her segment. “I was able to get my hands on one of their (*PPZA’s*) video cameras. We were out in the middle of [her study area] and another group had it and passed it off to us after some arm wrestling. So we just had the video camera with us for probably a week or not much more than that.” These videos were subsequently edited by the *PPZA* team and used in her presentation. She also alluded to some of the difficulties in making the presentation work. “I still remember vividly the first sort of practices, and I think Geoff probably wanted to crawl into a hole and die because we were doing so horribly. We knew that we had sort of scripted things to say, or points we wanted to make and we had a limited time and that’s so not what we’re used to. So training ourselves to stick to the script, keep it short – certainly took a bit of training.”

The final *Interviewee* described this same experience in even more detail. She talked of Haines-Stiles showing the gathered *Travelers* "a storyboard or the equivalent of that. And said, 'Now listen, I just want you to talk to the audience. I don't want you to prepare anything special. You'll be fine.' And I, like the rest of the cast, came there pretty unprepared, and we had a dry run, and it was horrible. I was mortified; we were all mortified by how badly we spoke to this video that was streaming behind us. Because Geoff was like, 'I put this up and you couldn't even talk to it.' And we were all rambling and it was, I can't even tell you, it was horrible. I mean, I think all of us were like, 'Oh my gosh, we should all pack our bags and go home.' We were so embarrassed. So what Geoff and Erna did was they gave us our clips and sent us off to our rooms and said, 'I'll see you tomorrow morning'. And they made hour-long appointments with each one of us and I think that everybody was so appalled by the job that they had done. You could see that we had all spent time in the evening kind of actually talking to our videos. You know, realizing what was playing behind you and then really trying to tell a story. Then we sat down individually with Geoff and Erna, and basically showed them what we had done overnight. And then they said, 'OK, those are really good points. These are some other points that we would like to see work in here. Can you do that?' And we eventually, in that hour-long session, came up with what we would actually be doing."

This last recollection includes many of the points made in the other interviews: there was a loose "script"; *Travelers* were invited to add some of their own information or stories; and it was an iterative process. It also makes clear that this was not always a seamless process; a great deal of work went into some of the presentations. It is worth noting that the two *Interviewees* that described some of the more arduous aspects of the presentation development process participated in some of the earliest *SfaCP* events. As time went by, the *PPZA* team may have developed methods to better facilitate the development of the presentations. It seems that the varying experiences of the *Interviewees* may have had something to do with the evolution of the presentation preparation process and the *PPZA* PIs' perceptions of the relative experience each *Interviewee* had at creating and giving presentations.

How They Felt Giving Their *SfaCP* Presentations

As previously stated, the *SfaCP* had very high production values. This had an impact on the *Travelers* as well as the audience. As one *Interviewee* stated, "It was great! There's

an awful lot of build up to it, just in the videos, the sound, the variety of short segments, or the trailers that Geoff had organized to lead up to it, they kind of worked the audience up to a frenzy." Another *Interviewee*, who uses the *SfaCP* introduction segment in the outreach activities she currently does with another *SfacP* alumnus, said, " we often use the *Polar-Palooza* intro segment just to get the crowd psyched. We're both still sitting there bouncing up and down during the whole thing; it gets us psyched too."

A third *Interviewee* provided a more detailed description of this phenomenon: "It's like being a science rock star, which is an oxymoron. But you know, Geoff and Erna have just got some amazing visual stuff, so you're standing behind the stage and you're all "mic-ed up", and everything and you're getting yourself all psyched and then that incredible opening sequence comes with that throbbing music, and you're like, 'This is so great! I can't believe I'm doing this!' and then you get out and you're with some really dynamic folks. I don't think I knew anybody in the first tour; so you're hearing new science and that's kind of jazzing you up and then it gets to be time [for your presentation], and again, because you have just these fantastic visuals, you've finally got your act together and know what you're going to say - I found that it was just a lot of fun. I had the nerves but the nerves were good nerves not the paralyzing nerves."

Two other I*nterviewees* also described the sense of camaraderie and excitement and energy alluded to above. Said one, "it was fun, everyone worked really well together. In all the groups I was in, people were really positive and supportive and joked around a lot and laughed at each other foibles." The other described the charged atmosphere in the event venue: "Its weird to say but the audience and I and the other presenters would feed off each others' energy - if that makes sense. If the audience was into it – I could see that they were interested in what we were saying and what we were presenting - that made it good."

At least one *Interviewee* was surprised by his performances: "I didn't know that I would actually do as well as I did. As I said, I didn't make the presentation myself and [since] the thing is sort of scripted I didn't know if I was going to remember a lot of things and the sequence of the slides or the videos." Nevertheless, like the other *Interviewees*, he described his experience in very positive terms.

Lasting Memories of *SfaCP*

When asked what their lasting memories of *SfaCP* were, all *Interviewees* immediately responded that it was fun and it was a positive experience. They talked about the audiences, the impact of multimedia, and working with the other *Travelers*. Praise and respect for the efforts of the *PPZA* PI's (Geoff and Erna) were universal.

The audiences' reactions were a central memory for all of the *Interviewees*. As one said, "It was the first time I had the experience of talking to that many people and to see the response of the crowd to the things that we were saying, and some of the visual imagery. To see that many minds focused on what you were saying – it felt pretty powerful. And I think we have an important message, about climate science or about stewardship of the Earth and the vehicle I think was captivating. That stood out with me – I think the public wants to know what we're talking about, wants to get real facts, real knowledge about what's happening to the world and the *Polar-Palooza* stuff had an opportunity to present that first hand from the visuals but also from the testimonials of the scientists that were participating." Another commented, "I think the range of groups we talked to was quite interesting. From groups of screaming school kids to ….. a small, intimate crowd; so we got to have one-on-one discussions with people and then there were some times a room had a thousand people in it. So they were all very different but I think the way that they [Geoff and Erna] put it together, it felt like we connected with the audience – I don't know if the audience thought that. I think, from our standpoint it feels like we were actually telling a story in a way that was interesting to people and, based on the questions afterwards, I think that's sort of where that notion comes from. People were really excited about it and really interested and asked a lot of questions and I think clearly learning things about doing science and about some of the data that they hadn't learned."

Several *Interviewees* had specific memories about audience reaction. For example, one recounted that after one *SfaCP* presentation "women came up to us crying afterwards. 'Thank you for all that you do.' I'm like, 'You're crying – I'm just a scientist.' So there were some striking moments where people were really clearly quite moved by what they saw and much more so than I certainly would have ever expected."

All commented on the exceptional production value of the show. As noted in the previous section, there was a huge audio and visual build up before the *Travelers*

appeared on stage. As will be seen in the next two sections, the *Interviewees* valued the video segments they were given by the *PPZA* organization and have tried to incorporate more audio, as well as visual, content into their presentations. As one said, "just seeing the combination of multimedia, the impact that can have. I think that was pretty strong. The visuals and the audio certainly helped to give a sense that they (the audience) weren't in Kansas anymore."

Interactions with the other *Travelers* also produce lasting memories. Said one *Interviewee*, "I did enjoy …. the social contact with the other scientists. The ability to share stories – war stories if you will - of how things had worked in other *Polar-Palooza* venues, from someone who had been more seasoned; what we might expect coming up. So I think circling together into a coherent team quickly, all having common goals. I guess I kind of enjoyed the collegiality of that as well. That kind of stood out to me." On a more professional note, one said, "I think part of the interesting thing for me was really learning about the other science being done, interdisciplinary science that I wouldn't otherwise have known about and so the science connection. While we may not collaborate on anything, you know, I feel like I've learned more about science (from the other participating scientists)."

The professionalism of the *PPZA* PI and co-PI, and the tremendous amount of hard work they did, also stood out. One summarized it this way: "I guess, lastly, it was just in praise of Geoff. He never lost his cool even when things were right up to the last second as he's very skilled at shifting slides around, reformatting music. I mean, he is programming up to the very last seconds before its show time. He's customizing it to the particular speakers … it was certainly very adaptable and he was very skilled at adapting to fit the particular circumstance."

Benefits of Participating in *SfaCP*

Benefits from participating in *SfaCP* appeared to fall into several categories: increased confidence in participating in science communication activities, meeting fellow polar scientists, and access to resources that were produced for *SfaCP.* As one *Interviewee* said, "I would definitely say that there is a long-term impact in that I am much more comfortable talking in front of the public and I would say definitely doing those public presentations with *SfaCP* was great practice." Another added, "Over time it (her *SfaCP* presentation) became more my comfort zone. I never lost the excitement of being part of

the show but I got more comfortable doing it and as a result I could learn more about what everyone else was doing rather than being kind of focused on this other thing (worrying about her performance)."

Other *Interviewees* brought up this notion of learning from their fellow *Travelers*. One said that each event "was a different program because I was interacting with different scientists. So I gained some colleagues and some folks I have seen subsequently at different meetings and say, ""yeah, yeah, I remember you". We had this similar kind of experience. So that was good too. There are lots of broader impacts in how this all played out, not just the events but the scientists got something out of it too." Another commented, "I learned what scientists were doing that I didn't know about. That was a really nice benefit of it (participating in *SfaCP*)."

All of the *Interviewees* talked about the videos that they were given for their own use. One *Interviewee* said of the video clips produced by the *PPZA* team, "I think the biggest benefit for me was that Geoff and Erna made these videos and they gave those [to me] so I can actually use those when I do the outreach. And it's really good because those videos work really well. Geoff and Erna, their stuff is just fantastic and it's really suited for doing the outreach and makes the job a hell of a lot easier for me." Another *Interviewee*, echoed this sentiment, "They are just the right size, short segments, short little excerpts. Because I teach a class on Antarctic[a] and I can just pull in a nice clip about the meteorite hunters or coring on the Nathaniel Palmer (NSF's Antarctic research vessel). So he's given me resources, which I really appreciate, to be able to help my students to be able to experience the Antarctic itself."

Changes In Their Science Communication As A Consequence of *SfaCP*

All of the *Interviewees* reported some changes in their science communication activities as a consequence of their participation in *SfaCP*. For the *Interviewee* with the least experience, it was simply the realization that this is something he should be doing: "I do it more often. I do sort of make an effort but maybe not enough. Maybe I should do more." When asked if, as a young scientist, he wasn't more concerned about building his career right now he replied, "Yes but then I think doing the outreach is a part of it now." He did refer to the NSF's Broader Impacts policy on proposals as one of the reasons he has pursued some of his outreach activities. The Broader Impacts Review Criterion (The

NSF Grant Proposal Guide, 2013) is often interpreted by PIs as science education outreach. This *Interviewee* realized that this means more than going to schools, "it has to be somewhat elaborated – be specific. So I do make an effort that way. And when I write grant proposals I put some money to do the outreach ….. I am very conscious of making an effort to do the outreach." He has also thought about "making educational materials and actually doing more resources" such as videos, although he has not figured out how to do that yet.

A second *Interviewee* has broadened the venues she communicates in. "I'm still hesitant but a little more willing to be on the radio, and perhaps TV, even though I find that very painful. I'm more willing to suck it up and do it than I would have been before." She was also more aware of her audiences and what she needed to do to engage them. She spoke of, "thinking even more about the audience and what questions people might have coming in. I have tried to think about that in the past but I think that this (*SfaCP* experience) has helped me do a better job of that and also creating different ways to tell a story using visual imagery. So trying to make visuals simple and clear and pleasing but also using some audio. It's usually just us yapping on and on but breaking things up and really changing up the pace in longer presentations is important I think."

Two of the *Interviewees* also spoke specifically about mentoring graduate students. One took a student with him when he visited schools in the rural part of their state. He envisioned making graduate students an integral part of his future science outreach efforts. A second said, "I really encourage my (graduate) students to do it (outreach) as much as they can. I try to get them into the habit of communicating what they do, or if not actually doing it, thinking what they would tell a normal human being about their research. Can you communicate this to the general public? I just try to, I guess, impart what I learned from the *Polar-Palooza* experience in terms of really making some statements at least at a level that the non-expert can understand."

A third *Interviewee* appeared to have modified his formal teaching practices as a consequence of this *SfaCP* experience. "if I were to consider what my lectures are like [now] its more like a variety show – I've probably got five or six different type of elements that I want to cover within those 50 minutes that I have the students' attention. So I try to break it up a lot. Maybe I got it from Geoff [Haines-Stiles], maybe I was going to do it that way anyway, but I see that as long as you are entertaining you are also educating, as

long as you have their attention and their engagement they are learning something. So I guess my lectures are kind of like a mini version of a *Polar-Palooza* but just 45 lectures worth of them. But I'm not just lecturing, I guess is what I'm saying, I'm mixing it up much in the same way the *Polar-Palooza* events were very rich in terms of their diversity. He continued, "I recognized that I needed to add more of it (multimedia), I think I was sold on its value but I think I recognized that's how kids these days are actually learning more. They are very much visual learners, if you hook them a little bit on something they have seen that way and then you sent them off later on that evening to go visit a website that has similar things they're going to get sucked into the concept on their own. So it's kind of using all these different resources to get them to go beyond just the classroom experience."

The fourth *Interviewee* appeared to have completely embraced science communication and outreach as a consequence of her *SfaCP* experience. She said, "I think I understand my role better having done *PPZA*. I appreciate the necessity of getting out there and doing these sorts of things. I'm more committed, I'd say, to doing it and more willing to let it take a fair amount of time. If people call me I usually say 'Yes'. There are a lot of things that, as I'm getting more senior in my career, I'm just saying "No, I don't want to do that' but I rarely turn down an opportunity to go out to talk to schools or the public or anything like that." She has also broadened the science content of her outreach. She has become "more comfortable going out of my comfort zone, including other information. For instance, I think before *PPZA*, I didn't really spend a lot time talking about anything other than [my research]. Now I talk about deep glacier cores a lot, other information that comes to me so that I can actually broaden out the story and the evidence I bring to a presentation. So I think that's changed." She concluded by saying, "I want to do more of this. That's the one bad thing about *PPZA*; it kind of pumped me up for doing more of this."

The Ancillary Data

Pre- and Post *SfaCP* Outreach Activities

Of the thirteen *Respondents* who completed the *SfaCP* survey, four provided ancillary information that consisted of a list of science education and outreach (i.e., science communication) activities that they did before and after their *SfaCP*. Three of the four were also interviewed.

Several of the *Respondents* showed little outreach activity before their *SfaCP* experience. It was unclear whether or not this was a case of no activity or incomplete reporting. One of the *Respondents*, who was also interviewed, stated that he didn't remember doing any outreach before *SfaCP*. Since then he has participated in, on average, two outreach events per year. It is interesting to note that he terms them "lectures", as in "guest lecturer" or "special lecture", most of the time. This is not surprising as about half the events consist of talking to undergraduate Geography classes. However, it does seem strange that he would use this terminology to describe interactions with elementary and middle school students. This may indicate that his thinking about outreach activities is predominantly didactic.

The pre-*SfaCP* activities of the second *Respondent* were centered primarily on visits to young school children (grades 1-5). After *SfaCP*, this *Respondent's* activities included radio and television interviews, museum staff and teacher training workshops, presentations to a club of retired scientists, engaging with children outside of school and testifying before a regulatory commission on a local issue. Clearly the outreach base has expanded dramatically for this individual.

A third *Respondent* provided a more generalized list of activities. Her understanding of outreach included participating in the creation of documents and websites that summarize interdisciplinary information for a broader scientific and policy audience, something she has done for many years. By 2008, she described herself as "actively participating in a wide range of educational outreach activities" that include mentoring in the 'Women in Science' program and providing course leadership for the Institute for Lifelong Learning at the local university and being one of her institution's "go-to people for tours and guest lectures on climate change". Since then, she has created an outreach program, which consists of a yearlong collaboration with an 8th grade science class that was funded in part by the NSF. This program allowed her to host two of these students for two weeks during the summer at her institution, where they had hands-on, real-world, science experiences. She is now collaborating with the teachers at this middle school to develop an earth science module. As indicated in the previous section, this *Respondent* does outreach activities so often that she doesn't see them as "special "events", rather they are just part of what she does. This indicates both an increase in the number of outreach activities she engages in and the complete assimilation of this type of activity into her professional life.

The final *Respondent* provided a very detailed summary of her outreach activities. These were very diverse and numerous. For the years 2007-2008, the activities were primarily "invited" (invited lecturer, invited panelist, invited keynote speaker), with some notable exceptions including: content advisor to the first Lego League Challenge; and featured scientist on climate change program on the local public broadcasting radio station. In 2009, the *Respondent* became involved in the PolarTREC (Teachers and Researchers Exploring and Collaborating), which "is a program in which K-12 teachers spend 2-6 weeks participating in hands-on field research experiences in the polar regions" (PolarTREC website, accessed 9 June 2013). She has been involved in this program for several years. In 2010, her activities began to include young children (Boy Scout Troop – 2nd and 3rd graders) and the following year a significant number of her outreach efforts were in K-12 schools. In 2012, as a consequence of her research, she had quite a bit of contact with the media. Over the years, this *Respondent's* outreach activities have broadened to include more contact with children, both in and out of the school environment.

Other Ancillary Data

A few "published" sources of information about the *Travelers' SfaCP* experience were identified. These included a website and two articles.

Dr. Michael Castellini's *SfaCP* experience is featured on his Center for Ocean Sciences Education Excellence (COSEE) Alaska website (accessed 20 May 2013). On the website it says, "He and his fellow 'travelers' had intensive training beforehand, learning to tell stories effectively with split-second timing accompanied by elaborate audio/visual media. .... Mike's experience with *Polar-Palooza* has had a long-term effect on his outreach efforts. He has used his experience as a broader impact on NSF proposals. …. He continues to use the knowledge gained through his experience as a model. 'They took scientists and trained them to do professional-quality presentations. Now whenever I give talks, I start with telling a story'." He also characterized his *SfaCP* participation as "the most fun and impactful science that I've ever done." Embedded in the page is a short video (1:29 minutes), in which he gives an overview of his *SfaCP* experience. Here he described the first time doing *SfaCP* as "just plain scary" and declared that, "they (Haines-Stiles and Akuginow) came in with a quite different model" of making and presenting scientific information that was "timed seriously to high definition movies and

slides." The words he used, his tone of voice and body language clearly conveyed his enthusiasm for this enterprise.

In her article for *Oceanography* (2011), Ms. Jacqueline Richter-Menge described her *PPZA* experience as being "akin to living the oxymoron 'Science Rock Star' a week at a time" (a description that also appears in the interviews and the *PPZA* evaluation (Perry, 2010)). She conveyed the excitement of her experience with words like "fast-paced", "eye-popping", and "ear-blowing". Like some of the *Respondents*, she referred to the "coaching" she received from the *PPZA* principal investigators. She also described taking *SfaCP* to other venues (i.e., local schools and radio stations) and doing "hands-on work with K–12 educators during workshops, and participat[ing] in a special event for home-schooled students." Some members of the audience even collected her autograph. She had so much fun "sharing she polar adventures", that she agreed to participate in four more *SfaCP* events in the US (and two in Australia).

Finally, Amundsen (2008), in his review of the *SfaCP* presentation at the Chabot Space and Science Center in Oakland and the Lawrence Hall of Science in Berkeley, California, noted that the presentation "highlights the scientific passion of those working on Arctic and Antarctic research". He referred to the "the sheer joy and excitement of field science" which "balanced the more sobering examples of current and potential climate change impacts, most ". These were "beautifully exemplified by visual and audio presentations [of] the Antarctic field work." His only complaint was that he (and others) "would like to know more about what life is like out on the polar ice." While this article is written from the point of view of the audience, one can infer from these comments that the *SfaCP Travellers* conveyed their enthusiasm for their life's work.

DISCUSSION

The Respondents Cohort versus the Travelers Population

As noted above, approximately 48% of those contacted responded to the survey. Were these people representative of the whole population (27 *Travelers*)? As Duda and Nobile (2010) note, online surveys have several drawbacks that can affect the scientific validity of the data. These include (a) sample validity, (b) non-response bias, (c) stakeholder bias, and (d) unverified respondents. They state that, "for a study to be unbiased, every

member of the population under study must have a known chance of participating." This was accomplished in this study as each identified *Traveler* was contacted directly.

There is a possibility that those who did not response to the survey have the potential to be different from those that did (Duda and Nobile, 2010). Since the population for this study was "known", some comparisons can be made. The proportion of male to female participants (8:5) was similar to that of the overall population (16:11). An attempt was made to determine the work experience of the entire population at the time of *SfaCP* based on the data available on the internet. Although this may not be entirely accurate, it was sufficient for a qualitative comparison. It is clear from Figure 8 that most of the early-career individuals are missing from the *Respondents*. Similarly, the senior academics (SA) are under-represented. Nevertheless, the four categories that account for most of the population (GS – Graduate Student, MA – Mid-career Academic, SA – Senior Academic and SGS – Senior Government Scientist) are all represented in the *Respondents* cohort.

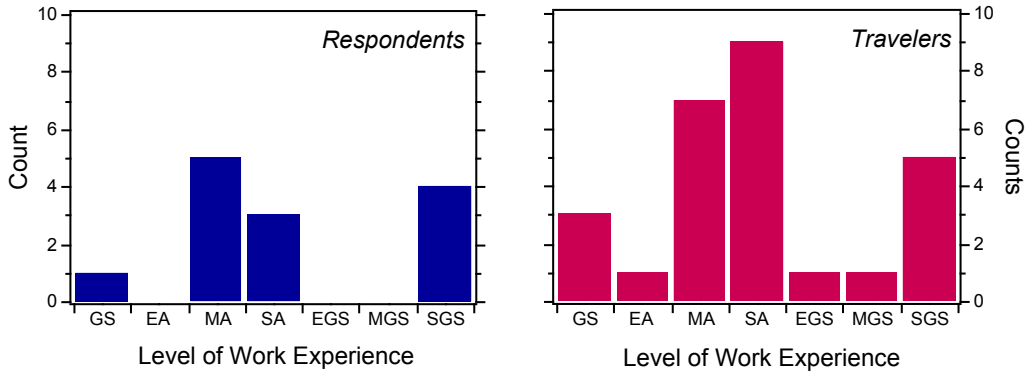

Figure 8. Comparison of the reported level of experience of the *Respondents* (left) and the inferred level of work experience of the *Travelers* (right) at the time of *SfaCP*. (GS = Graduate Student; EA = Early-career Academic; MA = Mid-career Academic; SA = Senior Academic; EGS = Early-career Government Scientist; MGS = Mid-career Government Scientist; SGS = Senior Government Scientist)

People who have a vested interest in the outcome of the survey (stakeholders) may be more inclined to complete the survey, complete multiple surveys, or urge others to complete the survey (Duda and Nobile, 2010). In this particular instance, there were no stakeholders per se. Nevertheless, it is reasonable to think that those who had particularly meaningful experiences might be more inclined to fill out this survey. A comparison of the number of times the *Respondents* and *Travelers* participated in

SfaCP (Figure 9) shows that those who participated only once are under-represented in this study. Indeed, of the 14 people who did not respond to the survey, nearly 60% appeared at only one *SfaCP* event. Approximately half of the SAs participated only once or twice in *SfaCP*. It may be that these people did not feel sufficiently invested in their *SfaCP* experience to think it worthwhile responding to the survey. However, the individuals categorized as early academic (EA) and early government scientist (EGS) participated in more than three events, a level of involvement that connotes significant investment and lasting memories. As a consequence, it is difficult to speculate as to why they did not participate in this research.

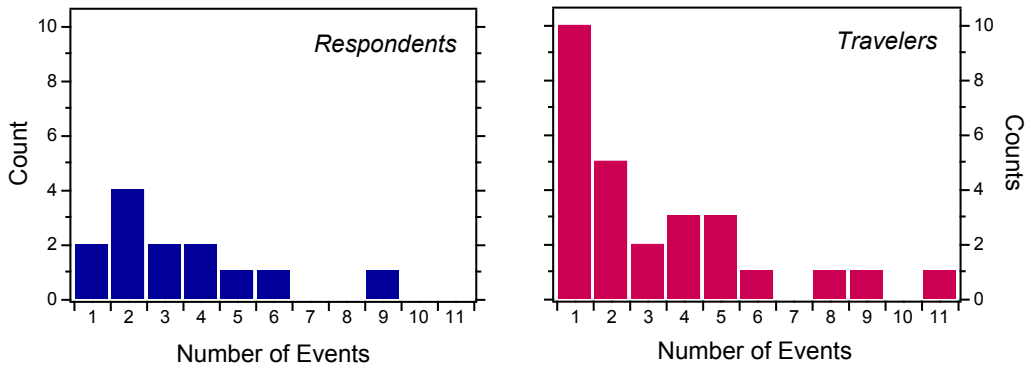

Figure 9. Comparison of the number of events the Respondent cohort (left) and Travelers population (right) participated in.

Since the respondents had to submit Consent Forms, they are verifiable.

Qualitatively speaking, the *Respondent* cohort appears to approximate the *Traveler* population sufficiently for this exploratory analysis.

Comparison of the Survey, Interview and Ancillary Data

In many respects the survey, interview and ancillary data tell the same story, although with varying levels of detail and clarity. The experience was overwhelmingly positive (in fact one person stated flatly, “nothing negative”) and ‘fun’. Many of the *Respondents* came away from the experience energized and willing to put more of themselves into their presentations (“more of a showman”, “I am bringing more energy to my presentations”; “more extroverted with the public”). They chose the words with positive connotations to describe their *SfaCP* experience (Figure 4). These words and concepts also occurred in the interviews and ancillary data (exciting, fun, challenging, etc.). It was

also obvious that the *Respondents* had rethought some of their approaches to public presentations, particularly the incorporation of the multimedia. One of the most cited benefits of participating in *SfaCP* was receiving copies of the videos that were used in subsequent public presentations by the *Respondents*.

There were only a few hints in the survey data that some *Travelers* may have found aspects of *SfaCP* more challenging; indeed many chose this term to describe their experience (Figure 4). Only one person described the *SfaCP* experience as hard work. Perry (2010) corroborated this description, reporting that the *Travelers* worked closely, and at length, with the *PPZA* staff to develop their presentations. Most of the *Interviewees* recalled the iterative process of creating their presentations that also implied a great deal of effort. Why didn't more people remember the hard work? As one *Interviewee* said, when asked directly about this discrepancy, "It was hard work. ….. But it was fun ….."

Similarly, from the survey data, it was clear that people thought that they had to do little (or nothing) to fit into the *SfaCP* model. This was not supported by the interview or ancillary data. According to Dr. Castellini's webpage and video, "they (Haines-Stiles and Akuginow) came in with a quite different model" of making and presenting scientific information. In order to accommodate this model, "He and his fellow 'travelers' had intensive training beforehand, learning to tell stories effectively with split-second timing accompanied by elaborate audio/visual media." The result was that, "They took scientists and trained them to do professional-quality presentations." All of this implies a great deal of effort by the *Travelers* to adapt to the *SfaCP* model as well as hard work.

In his video clip Castellini described the first time doing *SfaCP* as "just plain scary." This sentiment was echoed by one of the *Interviewees* who said that her first *SfaCP*, "really sticks out in my mind because I was just panic ridden. I mean, I was just sure that I couldn't do this." Both of these quotes imply considerable lack of comfort, which does not emerge from the survey data.

Finally, several *Interviewees* described working with the PI and co-PI, who were universally praised for their professionalism and hard work. Said one, "He's (Haines-Stiles) not like 'Oh, I'm talking to the elite polar explorers'"; and another, "If you start working with Geoff and Erna, you know they don't suffer fools at all." Both of these

comments imply that the *PPZA* team could be demanding and did not always approach the *Travelers* in a manner they were accustomed to. This might have been another disorienting aspect of *SfaCP* for the *Travelers*, yet no one in the survey mentioned it.

Reconciling the Survey, Interview and Ancillary Data

How is it that some of the less comfortable aspects of the *SfaCP* experience were not as widely reported in the survey data as they were in some of the interview and ancillary data? Was it that the few people who reported them were outliers in the *Respondent* cohort or was something else at work? It is important to resolve this discrepancy because *Transformative Learning* only occurs when there is some kind of dilemma. In the context of *SfaCP*, this is most likely to be something that pushes the *Traveler* out of her 'comfort zone' or puts him 'off his stride'. If the survey data are to be taken at face value, there is little evidence to support this happening.

Survey versus Interview Questions

In part, it could be that there was less latitude for 'complaints' in the survey. With the exception of Question 6 (Figure 4), and through inference Question 7 (Appendix 2), the closed questions did not address the emotional impact of the experience in any depth. Only one person took the opportunity to describe the experience as 'hard work'; a few deemed it 'challenging'. No one added any other descriptors to the list, either positive or negative. There was really only one opportunity for the *Respondents* to describe their *SfaCP* experience in their own words: Question 8. It invited them to recount the most memorable aspects of their *SfaCP* experience (positive and negative). As noted in the ***Survey Data*** section, the comment that came closest to being negative was framed as "least favorite" and referred to a certain lack of autonomy and control over the preparation of the presentation. A few people used the word 'intense' when answering this question but this was not portrayed as a negative attribute. The *Interviewees* may have been more expansive in their answers because they were speaking rather than writing them. The interview questions gave them more scope to describe their experiences and the interviewer was able to ask follow-up questions to elicit full responses.

Human Memory

This study relied completely on the participants' memory. Memory is a constructive activity and there is little evidence that people actually remember what they used to think and feel (Hyman & Loftus, 1998). People construct a version of the past based on remaining memories, general schematic knowledge, and the demands of the remembering context, which inevitably leads to errors. Furthermore, people reconstruct their previous attitudes based on their current ones, and whether or not they think their attitudes have changed (Hyman & Loftus, 1998). It is important to recall that the *PPZA SfaCP* campaign lasted from October 2007 to April 2009. As a consequence, a *Traveler's SfaCP* experience was some 3.5 to 5 years ago and the *Respondents* may not remember their experience accurately.

The discrepancies between the survey and interview/ancillary data could also have something to do with the *Respondents'* state of mind, which affected their memories. Two of the *Interviewees* recalled the prologue to their appearance on stage. As stated earlier, one *Interviewee* described the audience as being worked up into "a frenzy" before the *Travellers* appeared on stage. Another describes using the *SfaCP* video in her own subsequent presentations: "we'll often use the *Polar-Palooza* intro segment just to get the crowd psyched. ….. We're both sitting there bouncing up and down during the whole thing; it gets us psyched too." Clearly, both the audience and the *Travelers* are being primed to become emotionally involved in the event. This heightened state of emotion can facilitate learning and memory formation (Christianson, 1992; McGaugh, 2000; Richter-Levin and Akirav, 2003). It follows that the memories made under these conditions, might be more vivid or easily accessible that those made under comparatively less emotionally charged conditions such as the presentation preparation and rehearsals.

Csikszentmihalyi's Concept of Flow

When comparing the survey data, on the one hand, to the interview and ancillary data, on the other, 'hard work' appeared to have been under-reported. As one *Interviewee* said, "It was hard work – you were exhausted when you got done, so you were doing something. But it was so fun." The implication here is that the 'fun' aspect of *SfaCP* far outweighed 'hard work'. Is that possible?

Csikszentmihalyi's concept of flow is characterized by peak performance attained in a state of total absorption in an activity (Nakamura and Csikszentmihalyi, 2002). It involves a close match between skills and challenges. These are always in tension. As a consequence, there is a continual progression or improvement in abilities or skills to meet new challenges. However, the participant always has the sense that the challenge is appropriate to her abilities. Flow is usually attained in activities that have clear goals and for which there is constant feedback on performance. There is also a decrease in self-consciousness and time distortion. The flow concept also takes into consideration the interplay between the individual and the environment, that is, the context in which the activity takes place.

According to Nakamura and Csikszentmihalyi, (2002), the gateway to flow is focused attention. "When attention is completely absorbed in the challenges at hand, the individual achieves an ordered state of consciousness. Thoughts, feelings, wishes, and action are in concert." This state can only be maintained if the challenges are constantly changing. This is a form of self-actualization in that it echoes Maslow's peak experiences. These are described as experiences, or moments of intense joy, wonder, awe and ecstasy that leave people feeling inspired, strengthened, renewed or transformed (Maslow, 1970).

SfaCP could certainly have provided such an experience for the *Travelers*. As the survey data indicated, many of the *Respondents* were "challenged" (Figure 4). It was obvious that they had developed new skills to help them deliver better presentations (Castellini: they "trained [us] to do professional-quality presentations"). One *Interviewee* talked of "feeding off the energy" of the audience and his fellow presenters, a kind of unselfconscious emotional surfing. Several referred to the *SfaCP* experience as 'intense", which can be interpreted as "absorbing". The response of the audience also gave the *Travelers* immediate feedback on their performance. If some of the *Travelers* reached a state of flow, they would have been unaware of the amount of work they were doing, at least during the presentation, and even during rehearsals, and would not have reported 'hard work'.

Fun versus Pleasure

One aspect of the survey, interview and ancillary data were completely consistent: everyone reported having 'fun'. But is this the right word? In the previous section, it was

argued that the concept of flow accounts for some of the under-reporting of "hard work". However, this concept and 'fun' are not compatible.

According to Blythe and Hassenzahl (2003), enjoyment, pleasure, fun and attraction are often used interchangeably in everyday discourse. Nevertheless, they contend that, on a fundamental level, there are differences between fun and pleasure. They describe fun as a *distraction*. It is trivial (of no real relevance), relies on repetition (formula) and spectacle and may have an element of transgression (practical jokes, 'gaming the system'). On the other hand, pleasure requires *absorption* and is characterized as a relevant and progressive activity that has an aesthetic quality and involves commitment.

In their descriptions of the most memorable aspects of *SfaCP, Respondents* referred to the "positive response of the audience", "sharing science with people unfamiliar" with the polar research, "the camaraderie and sense of community with my fellow scientists" and having the opportunity to connect with, and educate, the public. All of these activities are highly relevant to the *Respondents* and involve commitment. They also have an element of self-actualization, which brings them in line with Csikszentmihalyi's concept of flow. As a consequence, I think that when the *Respondents* say they had 'fun' they really mean that they derived a great deal of 'pleasure' from their *SfaCP* experience.

The Mnemic Neglect Effect

All of the survey and interview data depended on the *Respondents'* memories of experiences that happened 3.5 - 5 years ago. Because they were produced closer to the time of *SfaCP*, the ancillary data are less reliant on such recall. As noted in the ***Methods*** section, human memory is not entirely reliable (Hyman & Loftus, 1998). In addition to confusing the timeline of events, when it comes to autobiographical memory, we recall some things better than others. This phenomenon is called mnemic neglect effect.

Sedikides and Green (2009) describe mnemic neglect effect as a self-protective mechanism. According to them, we preferentially remember self-affirming (positive) feedback. This information is well processed, which creates many pathways to the memory and makes it easier to retrieve. The opposite happens with self-threatening (negative) feedback: it is shallowly processed creating few pathways which makes it much more difficult to retrieve. It is possible that some of the participants barely remembered (or do not remember) any unpleasant incidents that conflict with their self-

image because of the mnemic neglect effect. Additionally, in the face of the overwhelmingly positive feedback from the audience, they may not have felt that the negative feedback was important or relevant and did not report it.

That being the case, why did others note the negative feedback they experienced? There are two instances when the mnemic neglect effect can be overcome. In the first instance, the negative feedback comes from someone close to the recipient: either from a loved one or a respected colleague. In the second instance, negative feedback is well processed when it is reframed as potential improvement or constructive criticism. It is most likely that the *Respondents* who reported the negative feedback remembered it because it fell into the latter category.

This was clearly the case for one *Interviewee.* When asked what her lasting memories of *SfaCP,* she said, "Mostly, I think the fact that it was a real privilege to get to do that. You really did feel like you had earned you, stars. The fact that you also kept your stars. Because they could kick you out of the shows at any point. They didn't have to invite you back. So that was kind of one of the other big things. After you do your first show, they're like 'OK, we'll be in touch'. And you're waiting by the phone for the next date. 'They called me. They want me back! I did OK!' (laughs)". Obviously, she was intent on doing well and improving her performance so she would be asked to participate again.

It is interesting to note how two *interviewees* described a shared negative feedback experience. As noted earlier, the first spoke of thinking "Geoff probably wanted to crawl into a hole and die because *we* were doing so horribly." The second recalled, "I was mortified; *we* were all mortified by how badly *we* spoke to this video that was streaming behind us. *It* was horrible. I think *all of us* were, 'Oh my gosh, *we* should all pack our bags and go home.' *We* were so embarrassed" (my italics throughout). In the first instance, the *Interviewee* distanced herself from the incident. She spoke of the reaction of the PI to the rehearsal, not her own, and retreated into the group ("*we* were doing horribly"). In the second instance, the *Interviewee* talked about her feelings concerning the situation but then quickly generalizes them saying the entire group felt that way. In this way she moved from a strictly autobiographical memory to a more generalized memory that included the negative feedback directed at others and their responses (which she assumed mirrored her own).

One can infer that most of the people who recalled the more uncomfortable aspects of their *SfaCP* experience saw them as opportunities for self-improvement and professional growth. The *Interviewees* who recalled difficult rehearsals; the person in the survey who termed *SfaCP* 'hard work'; and Dr. Castellini, who remembered his first experience as 'scary', all went on to participate in many more *SfaCP* events. Of course, this afforded them the opportunity to see many of these kinds of incidences. This could have produced many shallow memories, which taken cumulatively, produced a more accessible and lasting impression.

Was 'Stories from a Changing Planet' a Transformative Learning Experience?

As described earlier, *Transformative Learning* is an adult learning theory that is characterized by: elaboration of existing frames of reference, learning new frames of reference, transforming a point of view, and transforming "habits of mind". While originally described as a ten-step process, subsequent research has shown that the essential steps are a disorienting dilemma that leads to critical reflection, the trying on new roles and a changing beliefs or role expectations. This learning process is most successful when undertaken in an atmosphere of support, trust, friendship and intimacy. Did *SfaCP* provide the opportunity for *Transformative Learning*? If so, did the *Respondents* realize that potential?

A 'safe' environment facilitates the *Transformative Learning* process. Being surrounded by fellow scientists created a professional community for the *Travelers*. For many *Respondents* recollections of the most memorable aspects of *SfaCP* included "meeting and working with the other participants" and "the camaraderie and sense of community" that engendered. One "very much appreciated the team effort of working with peers in this process, folks from other fields, but with similar passion for science and for education and outreach efforts." Several spoke of, "learning about the science that others were working on, which [they] hadn't encountered before because it was a different discipline than [theirs]" and having the opportunity to get to know these other scientists as people "rather than names on papers." One of the *Interviewees* said that there was "usually a couple of people whose paths you had crossed before so that became kind of nice because you began to see people and the repetition of seeing people was fun." Another *Interviewee* stated explicitly that in the various groups she was in "people were really positive and supportive and joked around a lot and laughed at

each other foibles." In short, the *Respondents* appeared to have felt safe and secure in the *SfaCP* environment.

For most scientists, public engagement activities are individual, "one off" experiences over which they exert a significant amount of control. She is not required to critically assess her message or methods of communication. *SfaCP* offered a very different experience for the participating scientists both in terms of presentation preparation and its delivery. All of the *Interviewees* described the presentations as scripted. Said one, "it was very much an iterative, back and forth process …. Some were their ideas and some were my ideas." Of course, scientists may go through an iterative process when creating a presentation with a co-author. However, it is reasonable to assume that the *PPZA* team had a somewhat different agenda than a fellow scientist (entertainment as well as facts). This could have made the exchanges somewhat more tense or disorienting for the *Traveler*. Recall that one *Respondent's* "least favorite" (memory) was a lack of control and autonomy over his presentation. According to Perry (2010), these presentations were further refined through a series of meetings and consultations, rehearsals, and debriefing. As described earlier, for some, the rehearsals were very disorienting experiences which were characterized as "horrible" and left the participants feeling like they should "all pack [their] bags and go home" because they "were so embarrassed."

If creating the presentation did not disorient individual *Travelers*, delivering it might have. The final product, that is the *SfaCP* presentation, was carefully orchestrated. Recall that, in his video, Dr. Castellini refers to giving his first *SfaCP* presentation as "scary"; one *Respondent* wondered if she could "do this". An *Interviewee* revealed that, "I didn't know if I was going to remember a lot of things and the sequence of the slides or the videos", a reference to the scripted nature of the presentation. For some, learning to speak about the video streaming behind them was challenging. All of this implies that the scientist's control over her message and how it was presented was greatly diminished. This process might have been unsettling for some of the *Travelers* and could be interpreted as a disorienting dilemma/situation (Step 1 in the *Transformative Learning* process).

The framing of the information was also different from what many of the *Travelers* probably use in their own presentations. It is reasonable to assume that most of them routinely use the lecture model in their public engagement activities. To be sure, the

language and visuals are different from a formal presentation to a peer-group but it is still an information-, or data-, driven monologue. For *SfaCP*, the *Travelers* were forced to modify the focus of their presentation to include themselves. Personal stories about the *Travelers* were constructed to help the audience care about them and their research. It was important to the success of *SfaCP* that the audience [saw] the scientists as "real people just like them, and that they [the audience members], too, could become scientists and conduct research at the Poles", (Perry, 2010). This approach was probably novel to many of the *Travelers* and could have led some of them to question how they viewed: an audience (and possibly themselves); the needs of the audience; and their previous approaches to science communication and outreach. Indeed, the survey data were filled with such information. For example: "I allow myself to express more excitement in the research. I make sure to relate to people how I became a scientist and that my path is not only not so unusual but that they can pursue the same path and feel the joy and excitement of research"; "When I speak to the public, I pay great[er] attention to the visuals (slides, videos) - that they contain as few words as possible but still convey the message"; and "realizing that my normal word choices have to be different when talking to the public". Clearly, many of the *Respondents* critically assessed their assumptions (Step 5).

This presentation format forced the scientists to take on a new role: storyteller. While some of the more experienced *Travelers* may have adopted some aspects of narrative to their previous public engagement work, here it became the primary method of communication. This was reinforced by the fact that they were in the videos streaming behind them. Another feature of the *Travelers* experience was that of scientist as "rock star". After the *SfaCP* presentation and the subsequent Question and Answer session, members of the audience approached the scientists to talk further and ask for autographs. A young member of the audience at one venue said, "I wanted to meet a scientist, and I got everyone's autograph!" (Perry, 2010). Not a regular feature of a run-of-the-mill public engagement activity.

In some cases, *Travelers* were asked to present other scientists' research, which might be outside their specific area of expertise. Dr. Catellini says in his video clip, "by the time we were done, we had all done everybody else's things" because some people could not be at that particular event. This was corroborated by one of the *Interviewees* who described the evolution of her proficiency at being a 'general purpose' expert this way: "I

learned more and more about what everyone else was doing so if I had to give their bit I was much more comfortable giving their bit because I had heard them give it. I compared it back and was fairly confident until somebody asked me a question." These aspects of the *SfaCP* experience - storyteller, celebrity and 'all purpose' expert - constitute a provisional trying on of new roles (Step 6).

The process of drafting, refining and delivering their *SfaCP* presentations created the opportunity for the *Travelers* to thoroughly review their existing frames of reference, learn new frames of reference, and transform their point of view. I have argued that many of the *Respondents* did this. But did this lead to a permanent change in their "habits of mind" which is the hallmark of a *Transformative Learning* experience (Step 10)? Was their new frame of reference translated into action? The survey data indicated varying amounts of increased involvement with science communication (Figure 6). As one *Respondent* said she was, "trying to be more open to more venues (like radio and televisions) despite her obvious discomfort with these media. Another noted that, "it (participating in *SfaCP*) raised my awareness about how much the public does NOT know, and each time I speak to a public audience, I now make a point of mentioning 2-3 points about climate change that I feel everyone should know." This change in science communication was corroborated by the ancillary data (pre- and post *SfaCP* outreach activities), which indicated a broadening of outreach activities in terms of methods of communication and audiences reached. In fact, one of these *Respondents* appeared to have fully integrated education and public outreach into her professional life.

The *Interviewees* also indicated that they had changed the way they approach science communication. This included encouraging their graduate students to participate in science communication using the tools that *the Interviewees* have learned from *SfaCP.* There was also a new appreciation for what it means to be a fully functional scientist. Said one, "I think I understand my role better having done *PPZA*. I appreciate the necessity of getting out there and doing these sorts of things; more committed, I'd say, to doing it and more willing to let it take a fair amount of time. If people call me I usually say 'Yes'. There's a lot of things that as I'm getting more senior in my career I'm just saying "No, I don't want to do that' but I rarely turn down an opportunity to go out to talk to schools or the public or anything like that." At her institution she has told her colleagues, "This is really our responsibility. We should be doing more of this. I'm not necessarily successful at getting it but sitting around a table you will hear me argue that this is one of

the most important things that we do." Obviously the data support the notion that many of the *Respondents* have internalized what they learned through their participation in *SfaCP* and have translated those lessons into actions.

The most persuasive example of *Transformative Learning* was found in a response to an open question on the survey. When asked, "Did the SfaCP experience affect your professional activities (Questions 10 and 11 – Appendix 2), one *Respondent* wrote: "By showing me the intense satisfaction of education and public outreach (EPO), I have chosen to continue to be involved in EPO even after retiring from active research." This represents the implementation of a completely new frame of reference.

LESSONS LEARNED

As this research project progressed, it became obvious that some aspects of its execution could have been done better. Both surveys and interviews require meticulous planning, and, ideally, the questions asked in each format should be piloted and refined before they are deployed. Furthermore, semi-structured interviews require practice and interviews over the phone loose the non-verbal cues that might add extra meaning to the dialogue. This kind of instrument development and delivery practice was not possible due to the short timeline of the project.

Some of the misunderstanding arose due to a lack of clarity. For example, Survey Question 9 says:

> "Please list publications that arose from your *SfaCP* experience (as a consequence in full or in part). Include all media: **Print**: internal and organizational newsletters, newspapers and magazines; **Web**: blogs, articles, podcasts, animations; **Radio**: pieces, interviews by or with you; **Television**: auditions, interviews, pieces; **Events**: screenings, talks or presentations."

One *Respondent* replied:

> "I'm unclear whether this question refers to things that happened during or after the *SfaCP*…."

There also seemed to be some confusion about what the *Travelers* were being asked to do. As one non-respondent wrote in an e-mail:

> ”You requested, ‘The survey also includes a request for a document that summaries your science communication activities (interviews, presentations, classroom visits, etc.) for the years 2006-2012 and any other materials that you produced while you were participating in *SfaCP,* or shortly after this experience, that you would be willing to share (blog entries, journal entries, internal newsletter article, published articles, presentations (ppt, etc.)).’ Apologies, but the request is simply too time-consuming to be completed.”

Actually, providing this information was purely voluntary and quite apart from filling out the survey.

Finally, Question 6 should have offered a more nuanced array of choices. It asked the *Respondents* to choose all of the words that described their *SfaCP* experience. They were also invited to add any other appropriate descriptors – as mentioned in the **Results** section, no one did. Had this outcome been anticipated, more thought could have been given to the words provided. As it is, some of the words, such as ‘hard work’, may have been interpreted as ‘negative’ and not selected for this reason, rather than because it did not describe the experience. All of these missteps might have been avoided if there had been time to “pilot” the survey, including the Consent Form, with a few colleagues.

The timing of the research effort also may have contributed to the lack of participation by some *Travelers*. Many of them are academics and were finishing up their courses, and possibly preparing to go out into the field, in late April and early May. As one *Respondent* wrote after getting the follow-up e-mail, “I will get to this over the weekend OK? Graduation this weekend and last exams today.” Another wrote, “Thanks for tolerating my schedule.” Another expressed his intention to complete the survey but did not fill it in. Given his area of research, it is reasonable to assume he was already at his remote, fieldwork location before the survey became available online.

SUMMARY AND CONCLUSIONS

The *Stories from a Changing Planet* (*SfaCP*) component of the US-based, International Polar Year education and public outreach effort *Polar-Palooza*, was a multimedia roadshow that married high production value images/videos and sound with live presenters. These people, known as *Travelers*, were polar scientists and Native

Alaskans. They provided the human face for the polar science and the people dealing directly with the consequences of climate change.

While it is customary to evaluate such endeavors in terms of their impacts on the intended audiences, this research focused on the effects that participating in *SfaCP* had on the scientists; specifically, whether or not they experienced a change in the way that they thought about, and participated in, science communication activities post-*SfaCP*. *Transformative Learning Theory* was used as a framework for this evaluation. It was deemed to be particularly appropriate because it describes the meaning making process in adult learners and addresses itself specifically to permanent paradigm shifts.

Through the analysis of online survey data, remote one-on-one interviews and ancillary data, a picture of the *Travelers' SfaCP* experience emerged. In addition, their attitudes towards, and involvement in, science communication activities were assessed. It was determined that the *SfaCP* experience provided the *Travelers* with the necessary conditions for *Transformative Learning* (a dilemma leading to self-evaluation and opportunities to act out new roles) and most, if not all, of the *Respondents* reassessed their thinking about science communication and put their new frame of reference into practice. These changes in behavior included: an increase in the amount of time spent on outreach activities; changes in the kinds of outreach activities; the inclusion of more multimedia materials in presentations; adding personal 'stories' to presentations; communicating in more accessible language; and becoming more emotionally available to the audience. One *Respondent* has, in effect, changed his occupation as he has retired from full-time science and now devotes most of his time to education and public outreach. An *Interviewee* stated, "The goal was to go teach people but I learned a whole lot in the process." As a consequence, it can be reasonably concluded that *SfaCP* was a *Transformative Learning* experience for many of the scientists who participated in this study.

RECOMMENDATIONS

Stories from a Changing Planet provides a model for *Transformative Learning* in a science communication context. It demonstrates that short, intensive experiences that challenge the participants and push them out of their 'comfort zone' can affect significant changes in their attitudes towards public outreach. As a consequence, I would like to

suggest that the Science North/Laurentian University Graduate Program in Science Communication consider incorporating the *SfaCP* model into its curriculum by producing its own mini "palooza". This could be done as part of the Science Practice course or the Live Presentations course and would afford students the opportunity to synthesize and put into practice many of the skills and concepts they have learned into a single artifact that could be presented to the public (and raise the local profile of the program).

In addition, this model could be used as a Professional Development tool for early career Scientists (graduate students and Postdoctoral Fellows) and/or new, young or inexperienced Faculty. The LU Science Communication students could offer it as a series of weekend workshops as part of the Live Presentation course. There are several benefits to this kind of endeavor beyond building presentation skills and creating effective science communicators. The public presentation of the mini "palooza" would attract a broad audience, including children under 13 years-of-age. Several studies show that children have made up their minds about pursuing a career in science by this age (Archer et. al., 2010; Lindahl, 2007). As a consequence, the min "palooza" could be a kind of "recruiting' tool. Furthermore, at least one of the *Interviewees* made it clear that he has incorporated the lessons he learned from *SfaCP* into his first-year geology course. He said, "I see that as long as you are entertaining you are also educating, as long as you have their (students') attention and their engagement they are learning something", so, "my lectures are kind of like a mini version of a *Polar-Palooza* but just 45 lectures worth of them." This kind of engaging lecturing can help retain students in university science programs.

There is on important caveat to these kinds of activities. As one *Respondent* said, "I understand that it's (science outreach) not for everybody. I guess that's one of the things I learned too. It really isn't for everybody." It is easy to image that, for some people, the intense and challenging situations required for *Transformative Learning* could not just push them out of their 'comfort zone' but push them 'over the edge'. However, for some, or perhaps for just a few, such learning opportunities could be truly transformative.

ACKNOWLEDGEMENTS

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APPENDIX 1 – Consent Form for Surveys

Participation Consent Form

Study Title: Was the Polar-palooza "Stories from a Changing Planet" Campaign a Transformative Learning Experience for the Participating Scientists?

Investigator: Kim Morris
Chantal Barriault, Investigation Supervisor

I am currently a student in the Science Communication Graduate Diploma Program at Laurentian University in Sudbury, Ontario, Canada (*http://sciencenorth.ca/sciencecommunication/*). As part of the program, I am required to complete a research project. I am studying what, if any, impact participating in the Polar-palooza "Stories from a Changing Planet" (*SfaCP*) campaign had on the scientists' attitudes towards science communication and public outreach. This study will fill a gap in the research on science communication.

Since you were one of these scientists, I hope that you will participate in this study. Your participation will be comprised of completing a questionnaire that assesses your *SfaCP* experience and its impact on your subsequent participation in science communication and public outreach activities. The questionnaire should take about 20 minutes to complete, although more time may be required if you need to refer to documents such as CVs or institutional annual reviews to refresh your memory.

Your participation is strictly voluntary. The survey data will be analyzed and summarized in such a way as to protect your identity. The digital copy of the completed survey and any paper copies that are produced to facilitate analysis will be destroyed one year after the research project is submitted for evaluation (1 July 2014).

The survey also includes a request for a document that summaries your science communication activities (interviews, presentations, classroom visits, etc.) for the years 2006-2012 and any other materials that you produced while you were participating in *SfaCP,* or shortly after this experience, that you would be willing to share (blog entries, journal entries, internal newsletter article, published articles, presentations (ppt, etc.)). This information will be used to determine if there was a change in the frequency or type of science communication that you participate in pre/post *SfaCP*. These data will be analyzed in such a way as to protect your identity. At the end of the study, these documents will be destroyed as described above. Please note that providing this information is voluntary and done at your discretion.

If you have any questions or concerns about this study or your participation in it, you can contact me (*kmorris3@laurentian.ca*), or my supervisor, Chantal Barriault (1-705-522-3701 ext. 245 or email *barriault@sciencenorth.ca*). If you have any ethical concerns about this study, please contact the Research Ethics Officer at the Laurentian University Research Office (1-705-675-1551 ext. 2436 or toll free at 1-800-461-4030 or *ethics@laurentian.ca*).

This project will be finished by 1 August 2013. At that time, I will contact you by e-mail to ask if you would like a copy of the report.

Please sign and date this consent form to indicate you are willing to participate in this research and return it to me, via e-mail (*kmorris3@laurentian.ca*) or fax (1-705-522-4954) at your earliest convenience.

I have read and understood this Consent Form. I agree to participate in the aforementioned research by completing the project survey. I may also elect to supply other documents to support this research.

Participant's Signature _____ Date _____

APPENDIX 2 – Survey Questions

This survey is divided into four sections:

Q1 – Q4 General questions about your science communication activities;
Q5 – Q15 Questions about your "*Stories from a Changing Planet*" (*SfaCP*) experience;
Q16 – Q17 A few general questions about you; and
Q18 – Q22 Continued participation in this research.

Please note that if you decide to continue your participation in this research, you will be asked to explicitly identify yourself by providing your name. Otherwise, your survey answers are anonymous.

Q1 Scientists are being asked to engage more with non-specialist public. What, if anything, does this mean to you?

Q2 Which groups do you speak to as part of your science communication efforts? Please, check all that apply.

___ Policy-makers
___ Young people in schools
___ Industry/business community
___ Young people outside school
___ Popular science journalists
___ General journalists (press, TV, radio)
___ NGOs (non-Governmental organizations
___ Schools and school teachers
___ The non-specialist public
___ Press officers at your institution
___ None/Don't know
___ Other media (writers, documentary and other programming makers)

Q3 Which groups did you speak to as part of your science communication efforts before your Stories of a Changing Planet experience? Please check all that apply.

___ Policy-makers
___ Young people outside school
___ Press officers at your institution
___ Popular science journalists
___ The non-specialist public
___ Young people in schools
___ General journalists (press, TV, radio)
___ Industry/business community
___ NGOs (non-Governmental organizations)
___ None/Don't know
___ Schools and school teachers
___ Others in the media (writers, documentary and other programming makers)

Q4 Thinking about public engagement with, and communication about, science, roughly how many times in the last year have you done each of the following?

		None	*Once*	*2-3 times*	*4-5 times*	*> 5 times*
a)	Working with teachers/schools (including writing educational materials	____	____	____	_____	____
b)	Participated in an institutional open day	____	____	____	_____	____
c)	Given a public lecture, including being part of a panel	____	____	____	_____	____
d)	Taken part in a public dialogue event/debate	____	____	____	_____	____
e)	Been interviewed on radio	____	____	____	_____	____
f)	Been interviewed by a newspaper journalist	____	____	____	_____	____
g)	Written for the non-specialist public (including the media, articles and books)	____	____	____	_____	____
h)	Engaged with policy-makers	____	____	____	_____	____
i)	Engaged with non-Governmental organizations (NGOs)	____	____	____	_____	____
j)	Worked with science centers/museums	____	____	____	_____	____
k)	Judged competitions	____	____	____	_____	____

Q5 Please list all of the locations at which you participate in *SfaCP* (US/Canada only).

1) _____
2) _____
3) _____
4) _____
5) _____
6) _____

Q6 My *SfaCP* experience was (Please, check all that apply):

___ Fun ___ Frustrating

___ Challenging ___ Rewarding

___ Exciting ___ Educational

___ Hard work ___ Inspiring

Other (Use as many words as needed)

Q7 How well did your previous science communication experiences prepare you for your participation in *SfaCP?*

____ Very well – I did not have to change anything in my approach to fit into the *SfaCP* model

____ Reasonably well – I had to modify my approach somewhat to fit into the *SfaCP* model

____ Not very well – I had to make significant changes to my approach to fit into the *SfaCP* model

____ Not at all – I had to completely rethink my approach to fit into the *SfaCP* model

Q8 Please describe the most memorable aspects of your *SfaCP* experience (include both positive and negative).

Q9 Please list publications that arose from your *SfaCP* experience (as a consequence in full or in part). Include all media: **Print**: internal and organizational newsletters, newspapers and magazines; **Web**: blogs, articles, podcasts, animations; **Radio**: pieces, interviews by or with you; **Television**: auditions, interviews, pieces; **Events**: screenings, talks or presentations. These are some of the possibilities. List as many as you can remember. Please use this format: "Title of Piece," Name of Publication, Date.

Q10 Did your *SfaCP* experience affect your professional activities (changes implemented in the workplace, on your career, through projects or initiatives)?
_____ Yes _____ No

Q11 If yes, please briefly describe how.

Q12 Has your *SfaCP* experience had any impact on your approach in communicating science?
_____ Yes _____ No

Q13 If yes, please briefly describe how.

Q14 Are there other outcomes have resulted from your participation in the *SfaCP* program? Please describe.

Q15 Please indicate your level of work experience at the time of your participation in *SfaCP*.

____ Graduate Student

____ Post Doctoral Researcher/Fellow

____ Entry Level Academic (Assistant professor)

____ Mid-career Academic (Associate professor)

____ Senior Academic (Full professor)

____ Junior Government Scientist

____ Mid-Career Government Scientist

____ Senior Government Scientist

____ Other (please specify) _____

Q16 Including time spent on research in Graduate School, how many years have you been involved in conducting scientific research? Please enter whole numbers (more than 6 months in one year, round up).

_____ years

Q17 Thinking about the last 5 years of your career, how much of your time has been devoted to:

		Most or All	*A lot*	*Some*	*Little or None*
a)	Research	____	____	____	____
b)	Teaching	____	____	____	____
c)	Management and administration	____	____	____	____
d)	Science Communication and Outreach	____	____	____	____

Q18 Would you be willing to be interviewed about your *SfaCP* experience (telephone, Skype, other teleconference technology)? Please note that this interview would take about 1 hour and be recorded for subsequent analysis.

____ No ____ Yes

Q19 Would you be willing to provide the researcher with a document that summaries your science communication activities (interviews, presentations, classroom visits, etc.) for the years 2006-2012?

____ No ____ Yes

Q20 Do you have any other materials that you produced while you were participating in *SfaCP* or shortly after this experience that you would be willing to share (blog entries, journal entries, internal newsletter article, published articles, presentations (ppt, etc.))?

____ No ____ Yes

Q21 If yes, please briefly describe these items.

Q22 If you answered YES to Q18, Q19, or Q20, please provide your name so that you can be contacted directly.

Thank you very much for your participation in this research.

APPENDIX 3 – Consent Form for Interviews

Participation Consent Form

Study Title: Was the Polar-palooza "Stories from a Changing Planet" Campaign a Transformative Learning Experience for the Participating Scientists?

Investigator: Kim Morris
Chantal Barriault, Investigation Supervisor

I am currently a student in the Science Communication Graduate Diploma Program at Laurentian University in Sudbury, Ontario, Canada (*http://sciencenorth.ca/sciencecommunication/*). As part of the program, I am required to complete a research project. I am studying the impact that participating in the Polar-palooza "Stories from a Changing Planet" (SfaCP) campaign had on the scientists' attitudes towards science communication and public outreach.

You participated in Phase 1 of this study (e-mail delivered survey). In this survey, you indicated that you would be willing to participate in a follow-up interview about your SfaCP experience and its impact on your subsequent participation in science communication and public outreach activities. The interview should take about one hour to complete.

Your participation in this phase of the research is strictly voluntary. You have the right to withdraw at any time without penalty. The interview will be documented by notes taken during the interview and by digital recording. This will ensure the accuracy of the interview transcriptions, which will be the basis for the subsequent evaluation and analysis. Your identity will be kept confidential. The transcript and digital record will be kept under key-lock with my research supervisor. The digital copy of the completed survey and any paper copies that are produced to facilitate analysis will be destroyed on year after the research project is submitted for evaluation (1 July 2014).

If you have any questions or concerns about this study or your participation in it, you can contact me (*kmorris3@laurentian.ca*), or my supervisor, Chantal Barriault (1-705-522-3701 ext. 245 or email *barriault@sciencenorth.ca*). If you have any ethical concerns about this study, please contact the Research Ethics Officer at the Laurentian University Research Office (1-705-675-1551 ext. 2436 or toll free at 1-800-461-4030 or *ethics@laurentian.ca*).

This project will be finished by 1 August 2013. At that time, I will contact you by e-mail to ask if you would like a copy of the report.

Please sign and date this consent form to indicate you are willing to participate in this research and return it to me, via e-mail (*kmorris3@laurentian.ca*) or fax (1-705-522-4954), at your earliest convenience.

I have read and understood this Consent Form. I agree to participate in the aforementioned research by being interviewed by Kim Morris at a mutually convenient time. I understand that this interview will be digitally recorded.

Participant's Signature Date

APPENDIX 4 - Interview Questions

Hello. This is Kim Morris calling from the Science Communication program at Laurentian University.

How are you today?

I appreciate you for taking the time to talk to me. As I mentioned in my email to you, this will be a semi-structured interview with open-ended questions. Hopefully, it won't take more than an hour of your time.

The focus of my research project is on what, if any, impact did participating in *Stories from a Changing Planet* have on your attitudes towards science communication and public outreach. I would like to remind you that this conversation is being recorded for future analysis and that you are free to decline to answer any question that makes you uncomfortable and may terminate the interview at any time.

Q1 **How did you become involved with *Stories from a Changing Planet?***
Prompting Questions:
- How was it pitched to you?
- What was your initial reaction to the idea?
- What persuaded you to become involved?

Q2 **What steps did you have to take to in order to participate in *Stories from a Changing Planet?***
Prompting Questions:
- Did you have to ask someone else's permission to participate in the campaign?
- Did you have to take time off work?
- Did you have to substantially re-arrange your schedule??

Q3 **Would you describe the process of preparing your presentation for *Stories from a Changing Planet?***
Prompting Questions:
- How much time did it take?
- Was this a new process to you?
- How did you feel about it?

Q4 **Would you describe the experience of giving your presentation for *Stories from a Changing Planet?***
Prompting Questions:
- How did you feel about it?
- How was it different from your normal public outreach experience?

Q5 **What are your lasting memories of this experience?**

Q6 **Has the way you think about public outreach changed since your *Stories from a Changing Planet* experience?**

Q7 **Has the way you participate in public outreach changed since your *Stories from a Changing Planet* experience?**
Prompting Questions:
- More frequent? [How often?]
- Different audiences? [Who?]
- Different approaches? [Describe]

Q8 **Has the way you think about or approach your work changed as a consequence of your participation in *Stories from a Changing Planet* experience?**
Prompting Questions:
- Change in (or broadening of] focus? [Include more public outreach]
- Mentoring/encouraging others to do public outreach?
- Other things?

Q9 **Is there anything that we haven't cover that you think is important that you would like to add?**