Beyond the Deficit Model: The Ambassador Approach to Public Engagement

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Scientists are increasingly motivated to engage the public, particularly those who do not or cannot access traditional science education opportunities. Communication researchers have identified shortcomings of the deficit model approach, which assumes that skepticism toward science is based on a lack of information or scientific literacy, and encourage scientists to facilitate open-minded exchange with the public. We describe an ambassador approach, to develop a scientist's impact identity, which integrates his or her research, personal interests and experiences to achieve societal impacts. The scientist identifies a community or focal group to engage, on the basis of his or her impact identity, learns about that group, and promotes inclusion of all group members by engaging in venues in which that group naturally gathers, rather than in traditional education settings. Focal group members stated that scientists communicated effectively and were responsive to participant questions and ideas. Scientists reported professional and personal benefits from this approach.

Keywords: public engagement of science, science communication, ambassador model, perception of science

In growing numbers and with growing fervor, biologists seek to engage the public in ways that mitigate confrontation and bring attention to the value of science to society (Pew Research Center 2015). Over one million people participated in the 2017 March for Science to recognize scientific achievements and support continued science funding (St. Fleur 2017). In 2013, the National Science Foundation (NSF) strengthened its requirements that investigators articulate broader impacts (BI), with public engagement as one means for research to benefit society (National Science Foundation 2018). The NSF supports the National Alliance for Broader Impacts to guide scientists in designing and implementing quality BI activities and the Advancing Research Impacts in Society (ARIS) Center to communicate societal impacts of scientific research. Over the past 30 years, the NSF's Advancing Informal STEM Learning Program has funded projects that support research on public engagement by scientists. Science communication training programs have burgeoned (supplement 1).

Historically, science communication efforts were based on the deficit model. This attributed public skepticism and hostility toward science to a lack of information, and held that the transfer of information to increase science literacy would encourage science-based decision-making by an informed citizenry (Dickson 2005). However, science literacy does not necessarily result in significant changes in beliefs or behaviors on particular science issues, e.g., climate change (Sturgis and Allum 2004, Allum et al. 2008, Nisbet and Scheufele 2009, Kahan 2015). Rather, much of what shapes public perception of science is more closely tied to individuals' culture, beliefs, values, and attitudes, rather than scientific understanding. An individual's self-identity and the social groups with whom he or she associates have a strong influence on how he or she perceives and contextualizes information (Kahan 2010, American Academy of Sciences 2018).

Scientific evidence contrary to one's beliefs can be perceived as threatening one's identity. However, this effect can be reduced by reaffirming alternate sources of identity or emphasizing shared values (Cohen et al. 2000, Nadkarni 2004, American Academy of Sciences 2018). Public engagement experts now advocate shifting goals from solely improving science literacy or persuading the public to accept a particular scientific conclusion to fostering synergistic and open-minded exchange between the public and scientists (National Research Council 2000, Leshner 2007, Kahan 2010, Bruine de Bruin and Bostrom 2013, National Academies of Sciences 2016, Besley et al. 2017, Makri 2017).

Identity not only affects how people contextualize scientific information, it also affects where people engage with

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science. Identities derived from personal history and family traditions can determine whether people choose to pursue science learning in their leisure time by visiting traditional science education venues (e.g., lecture halls, museums, science centers; Falk and Dierking 2012). Despite efforts on the part of these venues to attract diverse segments of the public, some groups still experience exclusion (Dawson 2014).

Efforts to address participation include reframing science as a leisure activity by placing science in recreational and entertainment venues (e.g., science cafes in bars, science festivals and "guerrilla science" in public spaces). Such work may engage a subset of those who might not visit informal learning venues in their leisure time. Another approach, citizen science, provides opportunities for the public to engage with scientists by assisting with research (Silvertown 2009), and allows the public to more easily identify with scientists. The thousands of projects engage millions of people to collect, categorize, transcribe, or analyze scientific data to answer emerging questions (Bonney et al. 2009, Dickinson et al. 2010, Bonney et al. 2014, Kress et al. 2018).

Although these and other efforts have made significant strides to facilitate exchanges between scientists and members of the public, there is a need to extend efforts to engage groups that may not participate in science through traditional channels, even in "science–leisure" settings (Bultitude 2014, Dawson 2018). Kennedy and colleagues (2018) reported that three major UK science festivals disproportionately reached economically privileged and educated audiences who are already invested in science. Citizen science studies have revealed that volunteers tend to be well educated and motivated by an existing interest in the research topics (Bradford and Israel 2004, Raddick et al. 2013).

We describe an ambassador approach for scientists to engage groups who do not or cannot access science through traditional outlets because of variations in health, mobility, economic status, language, and other factors (Pew Research Center 2015, National Academies of Sciences 2016, American Academy of Sciences 2018). This approach first develops the scientist's impact identity (Risien and Storksdieck 2018), which is the integration of the scientist's research, personal interests, and experiences, to achieve his or her desired social impacts. We then use this to help the scientist identify a focal group to engage (i.e., a group convened around common interests, values, experiences, or circumstances that resonate with the scientist's impact identity), learn about the focal group via a site visit or immersion, and place engagement activities in venues in which the focal group naturally gathers, rather than requiring group members travel to academic or science education locales. This strategy draws on protocols for government ambassadors as the scientist is effectively bridging the nation of science and other nations or parts of society just as a government ambassador would. In the present article, we describe the goal, objectives, tactics, and preliminary outcomes from one scientist training program that applies the ambassador approach, the STEM Ambassador Program (STEMAP).

Goal and objectives of the ambassador approach

The goal of the ambassador approach is to build relationships for open-minded exchange between the public and scientists, particularly with those who do not or cannot engage with science (National Research Council 2000, Leshner 2007, Kahan 2010, Makri 2017). Although objectives of the traditional deficit model (e.g., improve science literacy, convey scientific process, generate excitement about science) can be incorporated in the ambassador approach, they are not the major focus. Rather, ambassador objectives emphasize active public participation and dialogue (modified from Besley et al. 2017): (a) demonstrate that scientists and the focal group have shared values, (b) reveal that scientists have identities outside of science and respect for diverse focal group identities, (c) manifest that the scientific community cares about the broader community's well-being and opinions, (d) demonstrate scientists' desire to learn from and with focal group, (e) increase accessibility of scientists to community and community to scientists.

STEMAP outlines the above goal and objectives of the ambassador approach in an orientation with all scientists in STEMAP training (referred to as *ambassadors*). Ambassadors are encouraged apply the training to reach beyond their existing networks to facilitate open-minded exchange in focal group venues.

Tactics of the ambassador approach

Ambassadors achieve the objectives by applying the tactics below (figure 1). Tactics and actions are presented in the order most commonly applied, but this process is flexible. In the following section, we provide examples of three ambassadors: an ecologist, a microbiologist, and an urban planner.

Connect: Identify opportunities for exchange with a focal group

Self-identity and our connection to others influences how we contextualize information (Kahan 2010). The ambassador approach guides scientists to identify shared interests, values, or experiences with members of a focal group, which can serve as an entry point for the scientist to build a relationship with groups that may not often be approached with public engagement opportunities. We first identify the scientist's impact identity, on the basis of Risien and Storksdieck's (2018) conceptual framework. Under this framework, scientists draw on the many dimensions of their identity—as scientists, community members, parents, hobbyists—to develop an impact identity. Scientists then identify engagement opportunities that align with their impact identity to create engagement plans that they find rewarding and fulfilling.

Scientists develop their impact identity by responding to a series of interview questions related to their research, personal interests, and experiences (supplement 2). Scientists

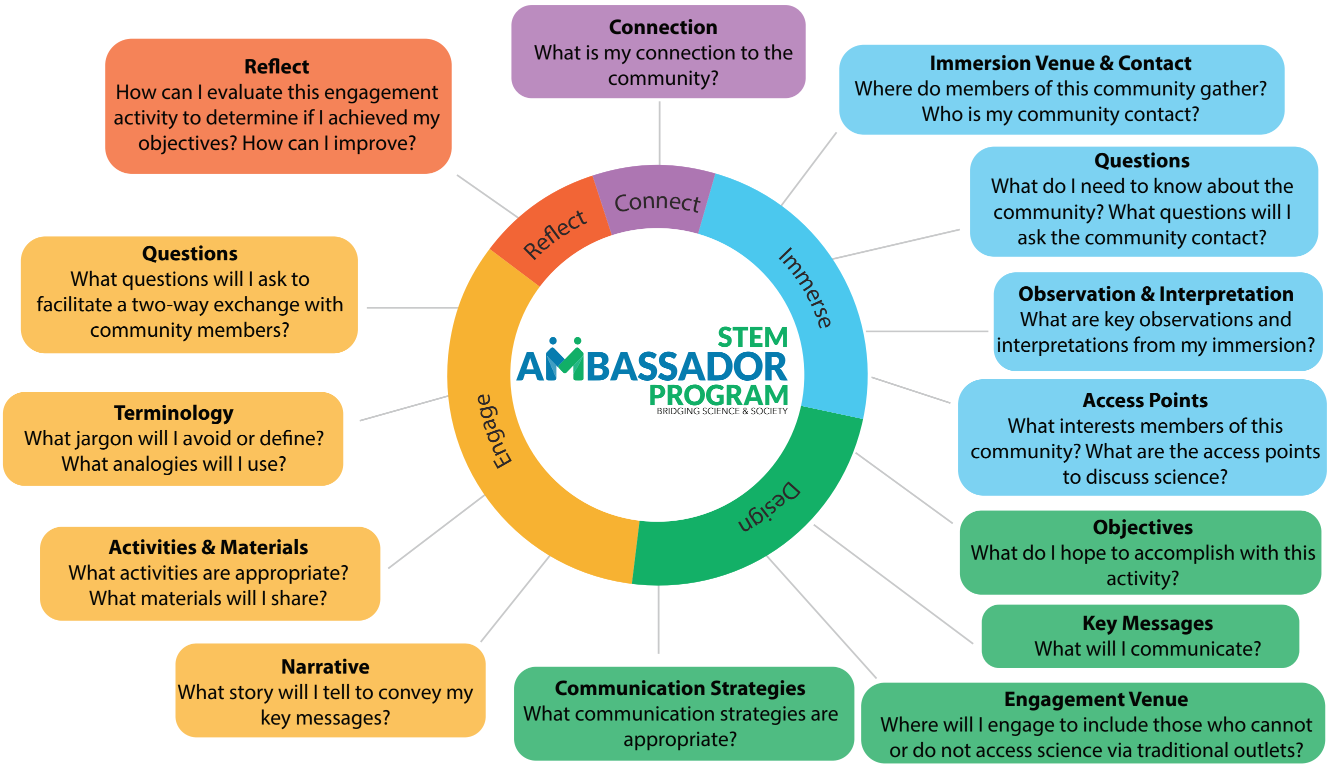

Figure 1. STEM Ambassador Program engagement map, depicting the sequence of activities (clockwise), and posing questions addressed by ambassadors throughout the program.

list keywords related to their responses and brainstorm which focal groups may resonate with one or more of these. Scientists are encouraged to reach beyond their immediate networks to uncover novel connections. As examples, (a) a forest ecologist identified a shared interest in trees, which have ecological and spiritual values, with religious congregations; (b) a microbiologist who enjoys making kombucha (a fermented drink made by microbial metabolism) identified a shared interest in the science behind fermentation cooking with cooking enthusiasts; and (c) an urban planner studying water conservation identified a shared interest in water-wise landscaping practices with horticulturists and landscapers.

Immerse: Apply empathetic design strategies to learn about the focal group

After identifying a possible focal group, the scientist initiates contact. STEMAP focal groups generally have not historically been approached with science engagement opportunities. Thus, when initiating contact the ambassador highlights shared interests, relevance to the focal group, and opportunities for exchange (supplement 3). In some cases, ambassadors may find they need to start with their own networks and those of their colleagues. For instance, a scientist who sought to engage with the Pacific Islander community did so by first reaching out to the Office for Equity and Diversity on her campus for guidance and contacts. The office then assisted in making contacts within that community off campus. The ecologist in Example A does not belong to any religious congregation and struggled to make contact by cold calling local churches. She approached a personal friend who is a member of the Unitarian church. Her friend assisted her in making contact with the minister. The relationships the ambassador built with the congregation later precipitated other relationships with local churches outside her network.

After initiating contact, the ambassador deepens his or her understanding of the focal group and further explores opportunities for exchange by carrying out an immersion or site visit (hereafter, immersion visit) to the venue in which the ambassador will interact with focal group members. These visits inform engagement strategies by helping the scientist discern the focal group's shared values, traditions, and activities (McDonagh and Thomas 2010). As with the engagement activity, the visits are specific to the focal group to address feasibility issues and reduce the burden on the group hosting the ambassador.

The ambassador first identifies a locale in which the focal group naturally gathers. As examples: (a) the ecologist identified a local churching which congregants meet each Sunday; (b) the microbiologist identified a local grocery store that offers fermentation cooking classes; and (c) the urban planner identified a horticulture training program at the county jail to prepare inmates for careers in landscaping.

The ambassador then learns about the focal group by reviewing the group's authorities (e.g., texts, journals, websites) and making ethnographic observations during in-person immersion visits (supplement 3). The nature and extent of the visit depends on the affordances and constraints of the focal group venue. These may include meeting with focal group representatives, taking a tour of the venue, observing a meeting, or participating in an activity in the venue. Scientists work with a representative of the focal group to arrange an immersion visit that will allow the scientist to learn about the focal group without inconveniencing the representative or disrupting the group's activities.

As examples: (a) the ecologist searched the texts of different religions and identified verses that mentioned trees and forests. She attended a church service and met with the minister to learn about the congregation and shared her interest in the spiritual significance of trees; (b) the microbiologist met with the instructor at the cooking school to learn about the format of the fermentation cooking classes (she was not able to attend a fermentation class because of scheduling constraints), explored how her knowledge of the microbial processes behind fermentation might help enhance course offerings, and expressed an interest in learning new fermentation techniques; and c) the urban planner met with the horticulture staff (she was not able to meet the inmates themselves because of security protocols) at the jail to learn about the goals of the horticulture training program, discussed how her background in water conservation might help support the program's mission, and expressed an interest in learning about water wise landscaping practices from the inmates and horticulturalists.

Design: apply insights from immersion visit to design engagement activities that take place in the focal group venue

Insights from the immersion visit are incorporated into the design of the engagement activity by applying a design thinking approach traditionally used by design professionals to develop user-centered products and solutions (Goldman 2017). Scientists then apply targeted messaging techniques to place the engagement activity in the venue in which the focal group naturally gathers, allowing them to connect with those who might not otherwise seek out science (Schmid et al. 2008, Larson et al. 2009).

In this process, the ambassador uses insights developed through the immersion visit to design engagement activities that achieve one or more ambassador objective and align with the group's existing programs, activities, and traditions. The ambassador then shares draft activities with focal group representative for feedback.

As examples: a) the ecologist prepared a sermon about the many ways that different religions use and honor trees, based on her research on religious texts, and shared this with the minister; b) the microbiologist prepared information on the microbes that transform the foods prepared during the fermentation cooking class, and shared this with the chef; and c) the urban planner codesigned a workshop with the jail's horticulturalist. She prepared information on water conservation, which she shared with the horticulturalists for feedback. The horticulturalists organized complimentary hands-on activities to test the efficiency of jail irrigation systems.

Engage: Engage with focal groups using best practices in science communication

Decades of science of learning research have established best practices to support positive science learning experiences. The ambassador approach draws on the theories and practices developed by Portal to the Public that include understanding and building on peoples' preconceptions of a topic, using effective questioning techniques to assess interest and understanding of a topic, and allowing for reflection and discussion (Selvakumar and Storksdieck 2013).

The scientist applies insights gained in the immersion visit and best practices in science communication to engage with the focal group. The scientist highlights shared identities or interests, imbeds questions to facilitate exchange, shares a narrative to create a connection with the group (e.g., personal stories, historical narratives, research anecdotes), and invites group members to share their expertise and experiences.

As examples: (a) the ecologist presented a sermon, "Trees and Spirituality," to congregations of different faiths. She revealed a personal narrative describing her scientific and mixed religious background and drew on verses referencing trees in religious texts. The ecologist held informal discussions with congregants at the social hour following services in which she asked for their interpretation of trees in their religious texts; (b) the microbiologist presented a fermentation cooking class with the chef. She described the role of microbes in fermentation cooking, showed samples of fermented foods under a microscope, and revealed her personal interest in learning new fermentation recipes; and (c) the urban planner presented a workshop for inmates alongside jail horticulturalists and shared water conservation resources. She shared a personal narrative describing how her childhood in a water-stressed region of India led her to pursue water conservation research. She and the staff then facilitated a hands-on activity with the inmates to test irrigation system efficiency.

Reflect: Reflect on and report outcomes

Just as progress in science is dependent on the objective analysis of observations and the transparent reporting of research findings in the scientific literature, advancements in public engagement require reflection and reporting of outcomes from innovative engagement activities. Such reflection can serve the ambassador by improving future performance. Reporting outcomes serves the public engagement community and may also result in media coverage, which can raise the profile of the ambassador and his or her institution.

As part of their reflection, ambassadors request and incorporate participant feedback in future engagement activities. If administering formal surveys is not feasible, they make observational notes on how activities were received. They share outcomes via informal discussions with other scientists through meetings, the scientific or education literature, newsletters, and social media.

As examples: (a) the ecologist reported her experiences with religious congregations in environmental, ecological, religious, and conservation journals and newsletters (Nadkarni 2002, 2004, 2007); (b) the microbiologist provided a survey to class participants (supplement 4). Feedback was incorporated into a second engagement activity at the cooking school. The event was described in the STEMAP newsletter (http: //www.stemap.org/newsletter.html); and c) the urban planner provided a survey to inmates. Questions included "What advice would you give to improve this lecture?" and "Did the scientist do a good job of being responsive and answering questions?" The scientist reported her experiences in the STEMAP newsletter to help other ambassadors benefit from what she had learned.

Impacts of the ambassador approach

Our results are from exploratory research carried out with 40 scientists (two cohorts of 20 ambassadors) trained in the ambassador approach at the University of Utah (UU) in 2016 and 2017. The cohorts were recruited via email messages sent by their department chairs, flyers posted on department bulletin boards, the newsletter of the Office of the Vice President for Research, and word of mouth. Participating scientists were from eight fields: engineering, biology, geology, health sciences, anthropology, physics, math, and urban planning (4 postdoctoral students, 31 PhD students, and 5 members of the faculty). Scientists completed an entrance survey at the beginning of their participation in STEMAP and an exit survey and interview on completion of the program (supplement 5, supplement 6).

Ambassadors from all disciplines carried out 83 engagement activities in 35 locales. Of those, 54 related to biological and environmental sciences (supplement 7). Where feasible, focal group members were asked to complete a survey following the activity. The survey questions and formats varied to accommodate unique venues and focal groups; not every question was asked in every venue, and not all participants returned a survey (supplement 4). The program was evaluated by an external evaluator.

A total of 732 surveys of focal group members were collected at 24 STEMAP engagement events, which included community council meetings, guided outdoor recreation trips, senior centers, an after-school program for refugee youth, a grocery store, a plant sale, and a summer camp. It was not possible to administer surveys at all ambassador events because of logistics of human subject reviews, (e.g., gaining parental permission for youth in custody; i.e., students in secure care facilities or juvenile detention centers).

Impacts on ambassadors were generally positive. When asked to reflect on their experience in STEMAP, 97% of ambassadors described their participation in the program as valuable or very valuable. A number of program benefits were identified in interviews with members of the 2016 cohort (supplement 6). These included opportunities to engage with other scientists, an expanded view of public engagement opportunities, and general fulfillment. Nearly half of the ambassadors reported that their assumptions or stereotypes about public engagement with science or about participants were challenged through STEMAP, and framed this as a benefit of their participation (table 1).

Ambassadors in both cohorts reported that STEMAP led them to develop new public engagement skills and increased their interest in continuing to engage with new focal groups (table 2). Over half of the ambassadors acted on this interest, with 63% (n = 40) completing more than one engagement activity through STEMAP or partner programs. Actual additional participation may be higher, as alumni may have carried out other activities independent of STEMAP.

For both cohorts, pre- versus posttraining comparisons documented a significant increase in ambassador self-assessed confidence in their science communication skills ($p < .01$). Pre- and posttraining surveys also revealed shifts in ambassador perceptions of barriers to engagement. The percentage of ambassadors who perceived a lack of opportunities or a venue for outreach dropped from 71% to 29%, suggesting that the process to identify impact identity helped scientists realize new engagement venues and opportunities. The percentage of ambassadors who identified time constraints as a barrier to engagement increased from the pretraining survey to the posttraining survey (table 3), which may indicate that scientists developed a more realistic idea of the time and work it takes to do successful public engagement. Although the percentage of ambassadors who identified time as a limitation increased, this did not seem to deter scientists from applying to or completing the program. The 2017 STEMAP application included an outline of hourly ambassador commitments. Despite the requested time commitment, the program received nearly double the number of applicants for available spaces. Furthermore, retention of ambassadors in both cohorts was high, with 95% of scientists completing the program.

Impacts on focal group participants were also largely positive. Engagement activities yielded positive outcomes by both conveying science content and facilitating open-minded exchange between the scientist and participants. The majority of participants agreed or strongly agreed that they learned something new and that they would like to know more about science and the scientist. Engagement activities facilitated exchange between the scientist and participants, with over 80% of participants agreeing or strongly agreeing that the scientist was encouraging and open to the focal group's input. Engagement activities also appeared to positively shift participants' confidence in science and

Table 1. Benefits of STEMAP identified by ambassadors in the 2016 cohort in interviews (n = 20).

Effect	Benefit category	Percentage of ambassadors
Affected own science	Reconsidered a message	20
	Challenged their understanding or thinking of their own science	15
	Talked in-depth about their work	15
	Learned from participants or nonscientists	10
	Recognized privilege of being a scientist	5
Enhanced scientific career	Career development	50
	Modeled how to engage for grad students	5
	Realized public engagement is their passion	5
Enhanced science communication skills	Improved their science communication skills	80
	Gained experience or confidence	50
	Gained practice in time management	5
Shaped scientist's' perception of public	Broadened public engagement possibilities	65
	Assumptions or stereotypes challenged	45
	Learned about participants or nonscientists	40
	Felt their work is valued	25
Enjoyment, fulfillment, or health	Provided a break from research (including mental health)	35
	General enjoyment or fulfillment	65
	Giving back to public (public benefit)	55
	Enjoyed interacting with participants	15
Increased connectedness	Connected with other scientists	70
	Connected to communities	50
	Developed relationships	45

Note: Interview results were categorized and coded by the nature of the benefit described by the ambassador. Percentages represent ambassadors who mentioned a benefit that falls into a particular benefit category. See supplement 6 for interview questions.

Table 2. Reflections on the impacts of STEMAP activities on ambassadors in the 2016 and 2017 cohorts (percentage of respondents, n = 31).

Statement or question	Response
The STEM Ambassador Program increased my interest in offering science outreach activities to new audiences (*strongly disagree to strongly agree*)	97
I have gained new skills for offering successful science outreach activities because of my participation in the STEM Ambassador Program (*strongly disagree to strongly agree*)	94
I want to do more science outreach activities as a result of participating in the STEM Ambassador Program (*strongly disagree to strongly agree*)	96
I want to reach out to new audiences as a result of participating in the STEM Ambassador Program (*strongly disagree to strongly agree*)	87
Overall, how would you rate your experience in the STEM Ambassador Program? (*not at all valuable to very valuable*)	97

Note: Responses represent the percentage of ambassadors who selected 4 or 5 on a Likert scale from 1–5, where 4 and 5 correspond to "agree" or "strongly agree" and "valuable" or "very valuable." The scale for each statement is in parenthesis.

Table 3. 2016 and 2017 ambassador self-perceptions of limitations of their own ability to participate in public engagement activities (percentage of responses).

Limitation statement	Pretraining survey (*n* = 34)	Posttraining survey (*n* = 31)
I lack opportunities or a venue to do so	71	29
I lack the skills to be effective	20	3
I have difficulty conveying my research to the general public	15	3
I have serious time constraints	71	84

Note: Responses are the percentage of ambassadors selecting 4 or 5 on Likert scale, where 4 corresponds to "agree" and 5 corresponds to "strongly agree." These are all responses for which the change from before to after training was 10 percentage points or higher.

Table 4. Focal group indicators of engagement, confidence, and future actions.

Category	Statements	*n*	Response (agree or strongly agree)
General reflection	The scientist did a good job communicating information	188	93
	I would like to know more about this scientist's work	101	88
	I learned something new today	229	85
	The presentation was interesting to me	286	83
	I feel that the scientist paid attention to whether the audience was understanding the material, lecture, or activity	63	81
	I felt like I was learning science while attending this event	53	79
	I'd like to hear more from this scientist	279	75
	I would like to learn more about biology	279	72
Engagement	I think the scientist tried to make this a good experience for me	65	94
	I felt like an active participant in the event	52	86
	The scientist was open to having audience members ask questions or share ideas or the scientist encouraged us to ask questions and share ideas	191	85
	I think the scientist tried to make this a good experience for this particular community setting and group	60	84
Confidence and future actions	I am more confident to engage in similar events in the future after this event	88	81
	I will discuss the information shared today with others	197	78
	I will seek out more opportunities to learn science	92	75

Note: Responses are the percentage of participants selecting 4 or 5 on Likert scale, where 4 corresponds to "agree" and 5 corresponds to "strongly agree." Sample sizes indicate the number of participants responding to each statement.

willingness to engage in science activities in the future; 81% felt more confident to engage in similar events in the future (table 4). Retrospective multiple choice questions (n = 54) revealed that the majority of participants became more interested in seeking out scientific information or participating in science events after engaging with an ambassador (76%). The remaining (24%) indicated their interest level had not changed and no participants indicated their interest level had declined. The majority of participants (65%) also stated that after attending the presentation, they more strongly consider themselves as someone who can understand and do science. The remaining 33% were unchanged in their perception or no longer considered themselves as someone who can understand and do science (2%).

Reflections on the ambassador approach

Risien and Storksdieck (2018) proposed that developing a scientist's impact identity can have positive effects on engagement outcomes by allowing the scientist to better link his or her work to society. The ambassador approach draws on this framework and other social science research, which holds that self-identity and connection to others influences how people contextualize information (Kahan 2010). With the ambassador approach, scientists develop their impact identity to facilitate an authentic dialogue with a focal group.

In the STEM Ambassador Program case study, scientists had generally positive experiences in engaging with focal groups, and members of focal groups gained science knowledge as well as increased confidence to engage with science in the future. STEMAP guided scientists on applying specific tactics to engage and achieve ambassador objectives, rather than emphasizing engagement strategies for particular audiences. This allowed the application of the ambassador approach to a broad range of focal groups, and better prepared ambassadors to independently engage with new groups throughout their scientific careers, a goal to which many ambassadors reported that they aspire (table 2).

Ambassadors engaged an array of focal groups including incarcerated adults, seniors in county-run day centers, refugee youth, youth in secure care or detention facilities, electricians, and outdoor recreation guides (supplement 7). The diversity of focal groups speaks to the capacity of the ambassador approach while also raising questions about each group's prior engagement with science. The ambassador approach assumes variation in the extent and type of science engagement within focal groups. Seemingly hard-to-reach groups that appear to lack physical access to science may get science from other sources. For example, although they cannot visit a museum, some incarcerated adults may engage with science by reading popular science magazines or watching science shows on the television in their cellblocks. On the other hand, some cooking enthusiasts may have the capacity to visit museums, but instead select other leisure activities. By bringing science to a venue in which science is not the primary focus, the ambassador may engage those who are limited in engagement opportunities (e.g., an inmate legally prohibited from visiting a museum) and those who simply prioritize other activities (e.g., a cooking enthusiast who prefers to attend a cooking class over visiting a museum).

In this initial study, engagement with all of these groups—even those who are apparently distant from science—revealed that they were interested in learning more about science. We posit that groups that may appear distant from science are open to conversations with scientists if they perceive that the scientist has made an effort to learn about them, respects their ways of knowing, and is receptive to their ideas and questions. Future work of the STEM Ambassador Program will include surveys to quantify the previous science engagement experiences (e.g., how often participants visit museums, read popular science articles, engage with scientists) of focal group members to assess success in reaching those who cannot or do not engage with science in traditional ways.

Future research should also explore the extent to which ambassador tactics are or can be applied to other models in addition to STEMAP. For example, community-based participatory research (CBPR), involves scientists evoking questions or problems that the public wishes to address or solve. This model is distinct from STEMAP in that STEMAP aims to generate exchange, but not necessarily in a directed way to address a particular problem. However, the ambassador approach may help facilitate the types of interactions and relationships needed for CBPR and other engagement models.

In the STEMAP case study, scientists engaged smaller groups than if they had presented in more traditional science learning venues. However, even one-time events with a few attendees can be impactful, particularly if the scientist engages those who otherwise would not be served by traditional outreach programs (e.g., science presentations in a prison can make inmates aware of new employment and educational opportunities; Ulrich and Nadkarni 2009). With 6.5 million scientists and 325 million people in the United States (US Census Bureau 2017), each scientist would need to interact with only 52 people—just one person per week—to engage every person in the nation.

Many STEMAP activities were initiated by the ambassador approaching a focal group with a relevant topic or mutual interest. However, focal group members may also contribute to this alignment. This tended to occur after the ambassador's first engagement activity. For example, ambassadors worked with an adaptive outdoor recreation organization that provides specialized equipment to make outdoor activities such as rafting, skiing, and mountain biking accessible to people of all abilities. Initially, an ambassador provided relevant geology content on one of the group's hiking trips. The group later identified other areas of alignment and reached out to STEMAP to invite ambassadors to provide information on other trips and guide trainings. The focal group also requested ambassadors prepare talking points for use by trip leaders.

In addition to focal groups requesting activities by new ambassadors, several welcomed back returning ambassadors. The majority of ambassadors chose to complete more than one engagement activity (63%, $n = 40$). Several did so in the same or similar venues. For example, a neuroscientist made four visits to local senior centers (supplement 7), improving his presentation and activities each time on the basis of participant feedback. Another ambassador expanded on her work with STEMAP after receiving grant funding from her professional society to develop a 6-week workshop on material science and engineering for young women in a residential treatment facility.

The process of training ambassadors required considerable staff input. The program required 2 months per year from the director, a full-time program manager, a half-time program coordinator, and a 10 hour per week student intern. However, over 90% of ambassadors reported that program staff input was important for the success of their activities. Because few academic institutions can commit to this amount of staff time, making the ambassador approach more widespread will require streamlining the training process. STEM ambassador training initially consisted of a full-day workshop followed by intensive one-on-one staff support to guide scientists in recalling workshop material as they developed engagement activities in the weeks that followed. Initial efforts to enhance staff capacity include breaking the training into 5 sessions: orientation (1 hour), interview to identify impact identity (1 hour), immersion workshop (2 hour), engagement design workshop (2–4 hour), and science communication workshop (2–4 hour). Reflection is achieved via regular group meetings with ambassadors and reflection articles written by ambassadors for the STEMAP newsletter. Each workshop and group meeting was presented as the scientist moved through the STEMAP process to design his or her engagement activity, reducing the need for one-on-one staff support to help scientists recall relevant workshop material. Current work is focused on expanding training by offering training at other institutions, as professional development for public engagement trainers, and online.

Unveiling, respecting, and understanding the identities of both the scientists and engagement participants is critical to foster meaningful interactions and reduce deficit model thinking. Risien and Storksdieck (2018) urged those in academia to make use of the growing number of science communication programs at universities that help scientists develop relationships and skills to pursue innovative broader impacts. This STEMAP case study describes an ambassador approach that complements existing engagement efforts by offering novel objectives, tactics, and actions by which individual scientists can ~~themselves~~ apply the framework of impact identity to initiate collaborative and synergistic interactions with society.

Supplemental material

Supplemental data are available at *BIOSCI* online.

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