Best Practices

The Space Public Outreach Team (SPOT): Adapting a successful outreach programme to a new region

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Keywords
Science communication, STEM, ambassadors, physics, astronomy, outreach, undergraduate students, professional development

Summary

The Space Public Outreach Team (SPOT) recruits and trains undergraduate ambassadors from all disciplines to deliver astronomy and space-science-themed interactive presentations. They deliver these presentations to primary and secondary schools and organisations across the state of Montana, USA. SPOT was started in 1996 by physics graduate students at Montana State University, USA, and it has grown to reach an average of 10 000 students per year for a low institutional cost of less than five dollars (four euros) per student. In the last year, the Montana SPOT model has been adopted in the state of West Virginia. The West Virginia SPOT programme also shows great potential, with eleven ambassadors trained to give two new feature presentations, reaching over 2600 students. In this paper, we describe how the Montana SPOT model works in practice and discuss how this model was adapted with new resources, and for a new audience, such that others may also adapt the programme to inspire space science interest for their own particular setting. We invite these groups to plug into the SPOT brand to broaden the impact of astronomy and space programmes and applications in their own region.

Introduction

There is a widely accepted international need for more support and participation in science, technology, engineering, and mathematics (STEM) enterprises (White House, 2012). One way that this need is addressed is by recruiting and training ambassadors — STEM role models who travel out into their communities and share STEM content through presentations, activities, and research projects. This helps to forge strong partnerships among students, teachers, researchers, and institutions while increasing STEM awareness, interest, and participation.

Two examples of this type of initiative include:

1. The United States Graduate STEM Fellows in K–12 Education programme. This programme paired graduate student researchers with primary and secondary school classrooms for repeated visits over

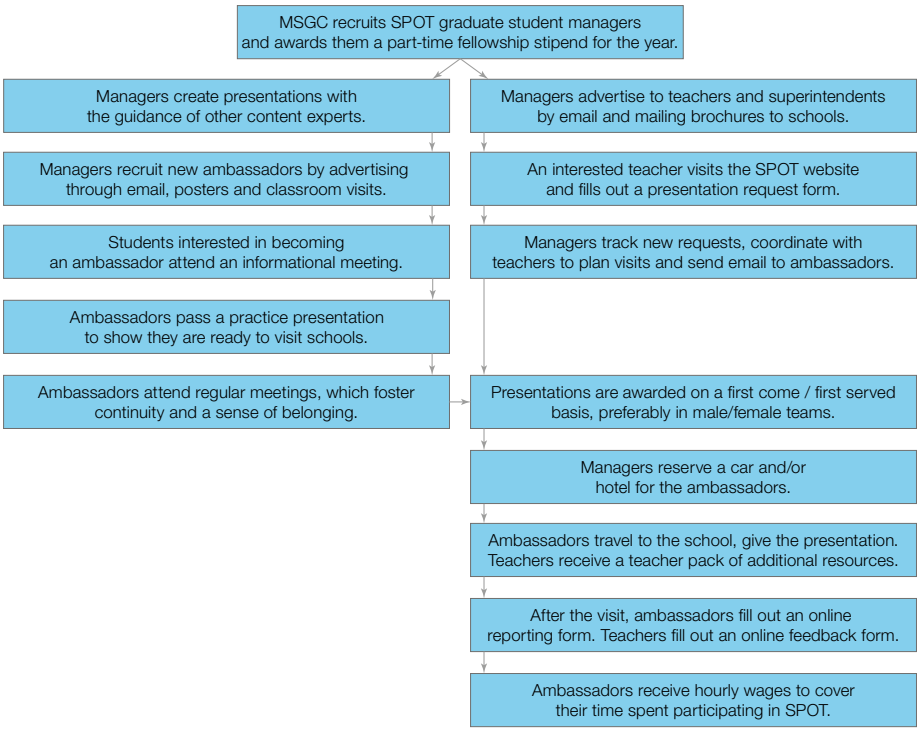

Figure 1. *Schematic of the Montana SPOT model*

the course of a year. Programme evaluation showed that the young students were inspired by the graduate student role models, the graduate students learned how to better communicate their science, and the teachers learned more about the content. Furthermore, the graduate student ambassadors reported extremely positive feelings towards the project, a sense of reward, and an increased interest and ability in science (American Association for the Advancement of Science, 2013).

2. The United Kingdom's national educational charity STEMNET offers a STEM Ambassadors programme through which any STEM worker can volunteer to work with schools to deliver the STEM curriculum and raise STEM awareness. Their network has over 27 000 volunteers, and external evaluation shows that students are 90% more likely to be interested in continuing to study STEM subjects after engaging with STEM Ambassadors. These programmes, however, require ambassadors to take a relatively large proactive role in the development of their presentations and the planning of their visits. This can present many challenges to students and scientists, who often lack significant public outreach experience, resources and time.

The Space Public Outreach Team (SPOT) programme offers a seamless integration of presentation content development, professional development of ambassadors, and logistical planning and coordination of visits. It is a simple, low-cost, and sustainable astronomy education and public outreach (EPO) programme that recruits college students to be space ambassadors and trains them to deliver pre-made interactive slide-show presentations.

The Montana SPOT model

The SPOT concept was originally developed over eighteen years ago by two physics graduate students at Montana State University (MSU) — both of whom are authors on this paper — as a way to celebrate the Mars missions with students. Since then, the programme has been supported by the Montana Space Grant Consortium (MSGC), centralised at MSU, and has grown to include a wide variety of space science and engineering topics. SPOT presentations feature local space science research, institutions, and programmes, with the primary goal being to increase awareness and interest, sending the strong message that you don't have to go far from home to be part of science.

Over time, programme changes were made to reflect changing management, resources, and needs, but the overall model has remained the same. In general, Montana SPOT (MT SPOT) is managed by MSU graduate students who design the feature presentations, recruit college student ambassadors to learn these presentations, and coordinate ambassadors' visits with schools and organisations.

A schematic representation of the MT SPOT model is shown in Figure 1, and details of funding, management, presentation content, ambassador training, programme evaluation, and impact are discussed in the subsections below.

Figure 2. *Montana SPOT programme with visitors at Yellowstone National Park. Credit: Montana Space Grant Consortium*

Figure 3. *Montana SPOT visit to school students. Credit: Montana Space Grant Consortium*

Process

Schools or organisations request a visit from an ambassador via an online form, and with a few phone calls or emails, the SPOT managers coordinate the logistics of the ambassadors' visits. This removes the pressure for the ambassador to design and organise an event from scratch, a task which can be quite daunting and time-consuming. With this simple model, SPOT can be implemented on a variety of scales and can reach thousands of students every year for under five dollars (four euros) per student.

Funding

MT SPOT has been funded primarily by a combination of MSGC Fellowships and the EPO portions of MSU Physics department faculty research grants (Drobnes, 2012), meaning that all presentations are free to schools. The Fellowships pay for graduate student manager stipends, which comprise the main programme cost, and the research grants pay for car rentals and fuel, hotels if necessary, miscellaneous supplies and ambassadors' hourly wages — including driving time and office work.

The specific research group supporting SPOT helps to determine the topics that are featured in the presentations. For example, when the solar physics research group supplied grant money, the featured presentation was the Sun–Earth Connection, and when the gravitational astronomy group supplied grant money, a presentation called *Listening to the Universe* was developed. Since Montana is such a large state, the cost per trip can vary widely depending on how far ambassadors need to travel, but the average cost per trip is approximately 190 dollars. With an annual budget of 30 000 to 80 000 dollars, MT SPOT reaches between 5000 and 15 000 students.

Management

Programme operations typically require two half-time graduate student managers per year. Managers' duties include: advertising to schools and organisations across the state, recruiting and training college ambassadors to learn the presentations, communicating and coordinating with teachers and ambassadors, securing and organising programme supplies and logistics, and designing a new space science presentation for the following year.

Managers generally stay on for two years, ideally with a period of training overlap when a new manager starts. Since these managerial positions are funded as MSGC Graduate Fellowships, SPOT management is folded into the normal day-to-day duties of a graduate student, meaning that a graduate student can have a much lighter teaching-assistantship load. This non-traditional graduate assistantship offers valuable experience in management, mentorship and science communication.

Presentation content

Presentations are interactive PowerPoint slide shows designed to engage audiences of almost any size — ranging from a one-room school house to a large auditorium — and pique interest in a selected space science topic for 30–50 minutes.

The slides include notes that provide a storyline as well as extra information for ambassadors learning the show to study and practice. Content is optimised for student audiences aged 10–14 and made to complement the science education curriculum. The notes include additional information for interactions with older audiences, some of which can be glossed over for younger audiences. For very young audiences, an abridged version of each presentation is also created.

Presentations usually start with general space science and engineering concepts, then delve into more region-specific topics. For example, the presentation *Mission to Mars* talks about what it takes to design, test, and build an interplanetary mission, getting students to help brainstorm the sorts of things that must be taken into consideration.

Fun quizzes, such as "How long does it take to get to Mars?" or "How high could you jump in Mars' reduced gravity?" and videos, such as NASA's *Seven Minutes of Terror* video of the *Curiosity* landing, keep students entertained and invested in understanding. Furthermore, featuring Montana-specific people and programmes, such as a female engineer from MSU who went on to design the *Curiosity* rover's wheels, and the Lunabotics programme in Montana in which students can become involved in designing a moon rover, help to make the content relatable, with the explicit message that you don't need to go far from home to be part of science and space exploration. Figures 2 and 3 show some of the presentations taking place.

Ambassador training

SPOT managers recruit undergraduate ambassadors from all disciplines and

give a short invitation to attend an information meeting with food and drink provided. Physics, engineering and education students are especially encouraged to join to ensure that ambassadors will have a range of content and education skills that they can share with one another. During the information meetings, potential ambassadors are introduced to the logistics of SPOT and watch a SPOT presentation given by a current ambassador.

After the meeting the new ambassadors download the presentation with notes and are asked to practice a small portion to be given at the next meeting. This offers a low-stakes environment where ambassadors get immediate feedback on their strengths and weaknesses, as well as a chance to get clarification on content. Ambassadors must pass a practice presentation in which they give the entire presentation without notes to get cleared on content knowledge and communication standards before visiting schools.

Once ambassadors experience the enthusiasm of a captive audience during their first or second classroom visit they are typically hooked, although there are some barriers to participation that must be addressed.

Namely, the initial time investment of learning the presentations and practicing communication skills is often the most difficult part of becoming a SPOT ambassador. Therefore, building incentives for ambassadors to persist with the programme from the start is critical. One way this is accomplished is by withholding payment until ambassadors have actually visited a school.

Secondly, team-building opportunities, such as through an optional one-credit seminar that meets once per week, or student-led movie nights and camping trips, aid in persistence.

Finally, it is important to work with ambassadors' schedules, as college class meeting times often conflict with typical times for school visits. The highest rate of school visits occurs during ambassadors' holidays when term has ended for universities, but not for schools.

These best practices for professional development ensure quality, and help ambassadors to develop translatable skills that will give them a tremendous advantage and flexibility as they go forward with their careers. Furthermore, ambassadors get to know each other and they develop a sense of purpose and autonomy. This kind of involvement and sense of belonging is one of the key factors in university retention efforts (Lotkowski, 2004).

Evaluation

Assessment of the impact of SPOT on the students who receive the presentations is mostly based on teacher feedback via an online evaluation form, providing a suitable indication of the level of student engagement.

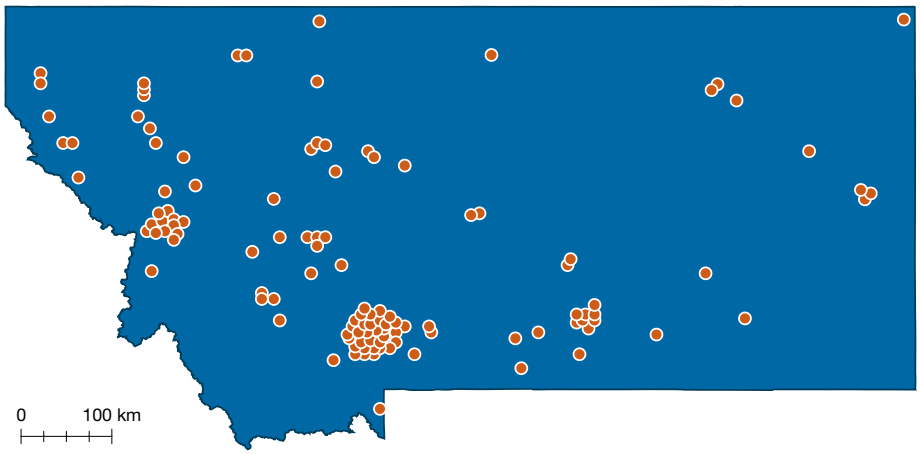

Figure 4. *The 2011–2012 MT SPOT reach. Credit: The Montana Space Grant Consortium*

While teachers of children aged eight and younger have a less uniform perspective of their students' engagement, almost one quarter of teachers of those aged nine and older report on their students' interest in the presentation by commenting that some students might still be talking about what they learned days after the presentation. They also comment on their students' focus and the high quality of questions posed during the presentation. Selected quotes from teachers include:

We were all excited to know about the eclipse that was going to be appearing in the sky the next morning. A lot of kids got up to view it, not many would have even known.

I had two students get interested in the Borealis [high altitude ballooning] project… I have already contacted the Borealis project director so two of our upperclassmen can find out more about the project, and hopefully design an experiment.

Just like any small school, our resources are limited and these presentations are so important for our students to get another resource to add to their science background.

In addition to the online evaluation forms filled out by teachers, reporting forms filled out by ambassadors are also used. These track the ambassadors' impressions of their preparation and comfort level when answering questions, the organisation and relevance of the presentations, as well as recommendations for improvements.

In particular, evaluation data shows overall positive reviews of the SPOT model, with the most frequent suggestions for improvement including a more prominent hands-on component and a way to tie the SPOT visit more easily to the curriculum. Managers monitor these suggestions and strive to continually adapt and improve the presentations and programme logistics to suit these new and changing needs.

The SPOT programme has been touted several times at national and international conferences as a successful EPO model for others to emulate (Larson, 1998; Littenberg, 2007; Williamson, 2011; Williamson, 2014)

Programme impact

External evaluation during the 2011–12 financial year (Grimberg, 2012) indicated that SPOT had a broad reach — 9.7% of all Montana school pupils received a SPOT presentation, with 52% of visits being in rural or under-represented areas; students were engaged with the presentations and learned of new opportunities because of the visits; and college ambassadors gained knowledge of the content and a greater sense of independence and confidence in their science communication and problem-solving capabilities.

For this evaluation report, MT SPOT ambassadors visited a total of 119 schools and organisations across Montana (Figure 4). During these visits, ambassadors gave 208 presentations, reaching 13 642 students and 676 teachers. Of these students, 1822 were from under-represented groups and over half of all institutions reached were located in rural, isolated areas.

On-site observations of a range of schools — small, large, rural and urban — confirm SPOT's positive impacts on students' and teachers' excitement and interest in science, with the additional indication that SPOT ambassadors inspired young students to enrol in higher education, learn about college life, and learn about career pathways in STEM.

The evaluation report also highlighted how valuable the SPOT experience is for the college ambassadors. From a focus group of seven SPOT ambassadors, some of the skills gained and lessons learned that emerged included:

- higher-level communication skills;
- a sense of independence by being exposed to non-mainstream educational settings;
- new insights into science education, how students learn, and ways to engage students;
- a deeper understanding of the subject matter being presented;
- a sense of reward and enjoyment when students asked questions that opened conversations to relevant topics;
- greater comfort in problem-solving real-life situations on the spot;
- an appreciation of the lack of science exposure in small, isolated, rural schools, along with a sense of truly contributing to students' STEM education.

Figure 5. *Ambassadors practicing a hands-on activity during the WV SPOT training weekend at the National Radio Astronomy Observatory (NRAO) in West Virginia, USA. Credit: NRAO*

One MT SPOT ambassador commented:

SPOT was the defining thing in my college career. I came here as a freshman in my physics career. I will always look back at my college years and look at these presentations as the highlight. They represent me so much. College is SPOT.

Not only does SPOT provide professional development for the ambassadors, it also gives them a sense of purpose and belonging in the STEM community.

Finally, perhaps the most important products of SPOT are the partnerships among higher education, research institutions, and schools, in addition to the network of ambassadors for astronomy and space science that it creates.

Ambassadors are available as volunteers for other outreach events, but more broadly, many ambassadors get their friends involved and talk about SPOT on social media, developing a strong commitment to STEM education. Having such a network of connected students working for a cause is the new medium for change in our global economy (Sandu, 2014), making SPOT an important vehicle for enhancing STEM awareness and interest. With modest resources, this network is an almost self-perpetuating way of increasing awareness of STEM concepts and opportunities.

Adapting the SPOT model to a new region: The West Virginia model

During the summer of 2013, the idea of adapting SPOT to a new region was discussed by stakeholders in West Virginia, including the National Radio Astronomy Observatory (NRAO), the WV Space Grant Consortium (WVSGC), and the NASA Independent Verification and Validation Center (IV&V). The SPOT model was recognised as a way to enhance the existing educational efforts of these organisations and to strengthen partnerships with schools, colleges, and universities across the state. The West Virginia Space Public Outreach Team (WV SPOT) was created, with the intention of running a pilot scheme during the 2013–2014 academic year.

To leverage the unique resources of West Virginia stakeholders, and to celebrate the diverse space science being done in West

Figure 6. *Ambassadors next to the Green Bank Telescope during the WV SPOT training weekend at NRAO in West Virginia, USA. Credit: National Radio Astronomy Observatory*

Virginia, the WV SPOT model is slightly different from the Montana model.

First, WV SPOT management is implemented by education and outreach staff at NRAO and IV&V as part of their regular job duties. Second, WV SPOT ambassadors are recruited from existing astronomy and space science engineering clubs at several colleges and universities around the state.

Because ambassadors are geographically distributed, investment is made to bring ambassadors together for one or two immersive training weekends (Figure 5), covering travel and room and board costs — rather than regular short meetings throughout the semester as in MT SPOT. Finally, WV SPOT ambassadors are paid a flat fifty dollar honorarium per school visit, with schools paying an additional fifty dollar travel fee — whereas MT SPOT pays ambassadors hourly and offers presentations free to the school. It is interesting to note that this fee for schools has not seemed to be a deterrent.

During the 2013–2014 pilot year, WV SPOT showed great potential. Two West Virginia specific presentations were created that, as with MT SPOT, highlight other programmes around the state in which students can become involved. For example, the *Invisible Universe* presentation features the Pulsar Search Collaboratory, in which students learn to search for pulsars using NRAO data, sometimes making new discoveries (Rosen, 2010; Rosen, 2013).

In addition, one of the ambassador training weekends was held at the NRAO, West Virginia. This retreat-like setting is particularly immersive because it is located in the National Radio Quiet Zone where cell phones have no signal. Ambassadors collected their very own radio data and visited the famous Robert C. Byrd Green Bank Telescope (GBT), featured in the SPOT presentations (Figure 6).

In total, eleven ambassadors from four different universities completed their SPOT training and visited 26 schools and organisations around the state (Figure 7).

Forty-six presentations were given to 2660 students and 127 teachers for a total programme cost of less than 9000 dollars. Ambassadors' and teachers' responses in reporting and evaluation forms show overall positive reviews, with outcomes and suggestions mirroring those in Montana. After such a successful first year, WV SPOT stakeholders are even more invested in helping the programme flourish, and the impact of WV SPOT is expected to be even greater for the 2014–2015 year and beyond.

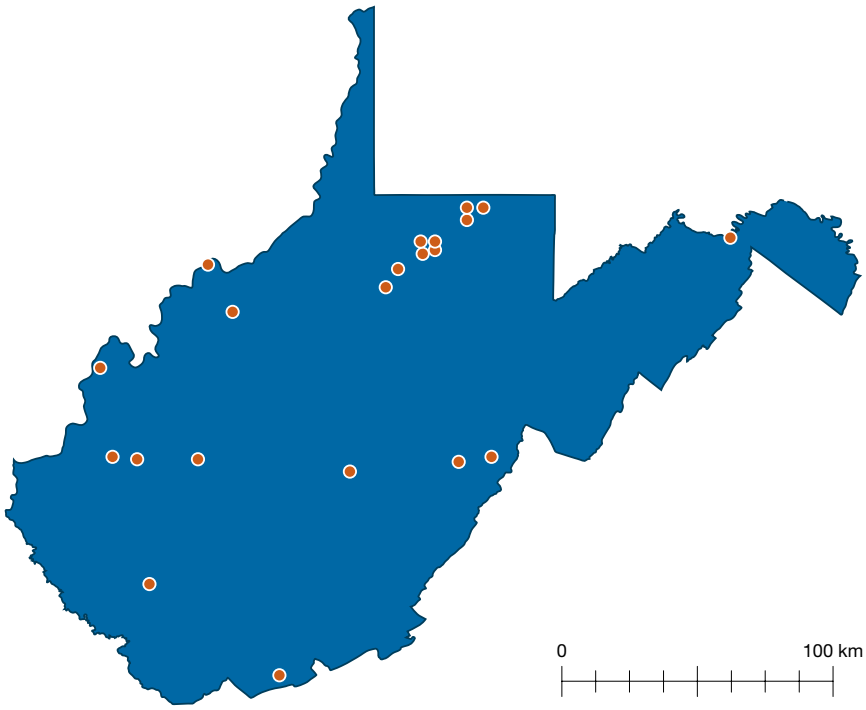

Figure 7. *The 2013–2014 WV SPOT reach*

Conclusion

With over eighteen years of success in bringing astronomy and space science to students and teachers, the Space Public Outreach Team (SPOT) is a simple, sustainable, low-cost outreach model that others can adapt to increase people's interest in and appreciation for science. We invite those looking to leverage the SPOT model to browse our websites and plug into the SPOT brand. We can be contacted to share our pre-made slide shows as a starting point for building content that highlights astronomy and space science research in new areas and with new populations, and we are available for consultation or to answer questions as needed.

Acknowledgements

The SPOT model began under the name of the Mars Pathfinder Outreach Program (MPOP) in Montana in 1996. More people than we can name have been involved in making SPOT a success. Additionally, without the year-by-year commitment to SPOT by MSGC, NRAO and WVSGC, along with significant support from the Solar Dynamics Observatory, dozens of managers and over one hundred ambassadors, SPOT would not be possible.

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Links

STEMNET http://www.stemnet.org.uk/new-report-proves-the-impact-of-stemnets-programmes/

Montana SPOT: http://solar.physics.montana.edu/spot/

West Virginia SPOT: https://sites.google.com/site/wvaspot/

GK-12: http://www.gk12.org/

Biographies

Kathryn Williamson, Joey Key, Angela Des Jardins, Shane L. Larson, Tyson B. Littenberg and Michelle B. Larson were all managers of SPOT during their time as physics graduate students at Montana State University and have dedicated much of their careers to advancing STEM education and research.

Irene Grimberg researches science learning and teaching with a focus on rural and American Indian populations, and served as the external evaluator for SPOT during the 2011–2012 year.

Sue Ann Heatherly has advanced education and public outreach at NRAO through countless high-impact programmes such as the Pulsar Search Collaboratory.

David McKenzie is a solar physicist at Montana State University and provided a critical link with Solar Dynamics Observatory collaborators to increase SPOT's impact.