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Getting the Most Bang from Your Volunteer Hour: Easy Assessments in the Dark Skies, Bright Kids Program

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Abstract. Dark Skies, Bright Kids! (DSBK) is an outreach organization that seeks to enhance elementary-level science literacy and encourage inquiry through fun, hands-on activities. DSBK was formed by, and is operated through, volunteer efforts from professional scientists at all career stages, e.g., from first-year undergraduate students to tenured professors. Although DSBK has amassed over 14,000 contact hours since 2009, there has been no formal evaluation of the programs impacts. Over the past year, DSBK introduced a large-scale, student-led internal assessments program with the systematic evaluation of student workbooks, volunteer surveys, and observations. While the data indicated broad-scale success for the program for both of its goals, it also revealed the organizational and educational practices that not only maximized student achievement, but also created the largest overall volunteer satisfaction with their time commitment. Here we describe DSBK in detail, summarize the student-led implementation of the assessments program, discuss how the results of the assessments have positively impacted our operations, and generalize these results for other scientist-led outreach efforts.

1. Motivation

Dark Skies, Bright Kids! (DSBK)[1] is an astronomy-themed outreach program at the University of Virginia targeted at underserved, elementary-aged populations in public schools. Since 2009, DSBK has contributed over 14,000 volunteer contact hours toward the education of students in Central Virginia. The core of the DSBK program is an eight to ten week after-school “astronomy club” that covers a set of major astronomical topics. The content is presented to students though a combination of demos that build curiosity and excitement, and hands-on activities that demonstrate those scientific concepts. In addition to the club, DSBK organizes custom one-time events with schools and local informal education providers (e.g., libraries, recreation centers, and museums), participates in local and regional science festivals, and organizes the annual (and well attended) “Central Virginia Star Party,” in partnership with local businesses and astronomy organizations. This vast program is operated entirely by volunteers drawn from the students, staff, and faculty affiliated with the Department of Astronomy at the University of Virginia. DSBK is funded from education components of research grants,

[1]www.astro.virginia.edu/dsbk

gifts from the community, and outreach support funds at the university. In recognition of its accomplishments, DSBK was honored as a 2012 "Program that Works" by the Virginia Mathematics and Science Coalition, the highest award for informal education programs partnering with the Virginia Department of Education's public school system.

As of the 2013–2014 academic year, DSBK was only able to accommodate 25% of its requests for elementary-aged programming. Based on this over-subscription rate, we believe DSBK fills a highly desirable niche for informal science education, at least for schools in Central Virginia. There are several unique aspects to the program that we believe are paramount to its success:

- **The outreach is led by its scientist volunteers and takes a mentorship approach to instruction**. A key aspect of our program is to recast the perceptions of scientists from stereotypical (and pervasive) visualizations into those that more accurately reflect who we, as scientists, are. Thus, volunteers build relationships with our students on an interpersonal level to demonstrate that we (scientists) are not so different from them (students).

- **The majority of our volunteers have no formal instructional training**. Many of the volunteers are teaching assistants or enrolled in training programs for instruction in higher education, but have no professional preparation for working with this demographic.

- **All of our events are planned around the students we wish to serve**. More specifically, (i) events take place at the students' schools, (ii) activities are of the length of an average elementary-age attention span, (iii) lessons are intermixed with kinesthetic activities (known as "Wiggle Time"), snacks, and other breaks, and (iv) content is reasonably coordinated with their science curricula (when feasible).

- **DSBK focuses on underserved populations**. This includes those that are (i) socio-economically disadvantaged, (ii) historically under-represented in STEM, and/or (iii) have no other access to other forms of science enrichment, either due to physical distance (e.g., some of our schools require up to an hour of driving time from the University) or other logistical challenges (e.g., small study body, lack of transportation, etc.).

- **The primary goal is to improve attitudes toward science and to influence perceptions of who scientists are**. While content is a consideration, the individual lessons are explicitly designed as play. DSBK is designed for the students to do science in much the same way that scientists view their work. Care is given to promote one-on-one interactions between students and volunteers to demonstrate that scientists are relatable.

- **DSBK itself is organized like a research group**. More specifically, the volunteers "collaborate" and "contribute" to the overall mission in much the same way that diverse scientists pool their individual expertise to solve a scientific problem.

DSBK is a program that exists *in addition* to the normal responsibilities of our student, staff, and faculty volunteers. Its success is ultimately driven by the genuine desire of these individuals to improve the science-education opportunities in our community.

From a leadership and management perspective, our primary challenge is ensuring that each volunteer hour is maximized for our desired impact—that of getting scientists into the classroom—which of course involves a number tasks that take place out of the classroom. These include, but are not limited to: program logistics, funding applications, activity development, organization of resources, and promotion of the program. With growing concerns over how graduate students spend their time before entering today's competitive job market, DSBK began a series of internal strategic discussions, from which a program of internal assessments was born.

The primary motivation for our assessments program is internal; our volunteers expressed a desire for evidence that their efforts are having a meaningful effect, both that students are learning or demonstrating an increased aptitude toward science, that the time invested in refining lessons and activities is meaningful, and that their own teaching skills are improving. Stated differently, our volunteers desired the types of feedback they are accustomed to receiving from their mentors in their scientific efforts. This need for feedback is a natural extension of the operational model of DSBK, one that mimics the style of a research group more than that of a professional outreach organization. We note that our assessments program is more strictly one of program evaluation, but we maintain the name ("Assessments") given to it within DSBK.

2. The DSBK Assessments Process

The DSBK assessments program was designed to collect data (both qualitative and quantitative) for its individual events. The program was led by student volunteers, but largely implemented for an undergraduate thesis. Effort was taken to weave these data collection activities into the existing DSBK structure to minimize extra effort from the volunteers. With these considerations, the data collection was undertaken along four lines: (i) volunteer feedback forms, (ii) student journals, (iii) volunteer observations, and (iv) audio/visual documentation of students doing the activities. While these data are collected for the majority of the DSBK events, only those associated with the eight week club are used here.

Figure 1 is an example of a volunteer feedback form, which uses a Likert scale to collect volunteers' perceptions of the event. Anonymous forms were completed at the end of each club meeting by each volunteer. The responses for each question were averaged for each of the eight club weeks. This served as our "Logistics Score" for each club and was used to evaluate the actual organization of the day as perceived by student volunteers.

Figure 2 is an example page from the student journal for the "Physical Comet Model" activity.[2] In the assignment, the student is asked to draw the tail on the comet at discrete points along its orbit. Each of the club themes had a handful (1–3) individual journal pages similar in spirit to that demonstrated by Figure 2. Each journal page was identified and then evaluated by the assessments committee and each question was scored based on the intended answer, with ambiguous responses given fractional credit. The scores for the set of questions for each theme were averaged for a final mean value

[2]The corresponding activity plan is available at `http://www.astro.virginia.edu/dsbk/resources.php`.

Date or Primary Topic:________________

DSBK Weekly Astronomy Club Assessment Form

Please indicate your views on the following aspects of the club you witnessed today. If you worked with more than one activity or part of the club, you may fill a form for multiple parts. This information will be handled confidentially and anonymously. The original form will only been seen by the volunteer compiling the data.

Name of Activity: ________________________

Level of engagement in activity:

1	2	3	4	5
Disengaged	Somewhat disengaged	Neutral	Somewhat engaged	Engaged

Other rating:

Level of engagement in journal:

1	2	3	4	5
Disengaged	Somewhat disengaged	Neutral	Somewhat engaged	Engaged

Other rating:

Level of interest in journal:

1	2	3	4	5
Disinterested	Somewhat disinterested	Neutral	Somewhat interested	Interested

Other rating:

Level of interest in activity *topic*:

1	2	3	4	5
Disinterested	Somewhat disinterested	Neutral	Somewhat interested	Interested

Other rating:

Intellectual level of activity:

1	2	3	4	5
Too low	Somewhat low	Okay	Somewhat high	Too high

Other rating:

Smoothness of day's activities:

1	2	3	4	5
Rough	Somewhat rough	Neutral	Somewhat smooth	Smooth

Other rating:

Additional Comments About the Club Today:

This can include information on preparation for the club, on how the students behaved, or any other topic related to the club. Please continue on back if you require additional space.

Figure 1. The form completed by volunteers at the conclusion of each club activity that uses a Likert scale to survey the logistical effectiveness.

for each topic. This served as our "Student Learning Score" for each of the eight clubs and provided a measure of how well the instruction proceeded for the day.

Volunteer impressions were recorded at weekly "de-brief" meetings and combined with the audio/visual documentation to evaluate the overall effectiveness of the club event. The ratings ranged from positive to negative for the commentary and from en-

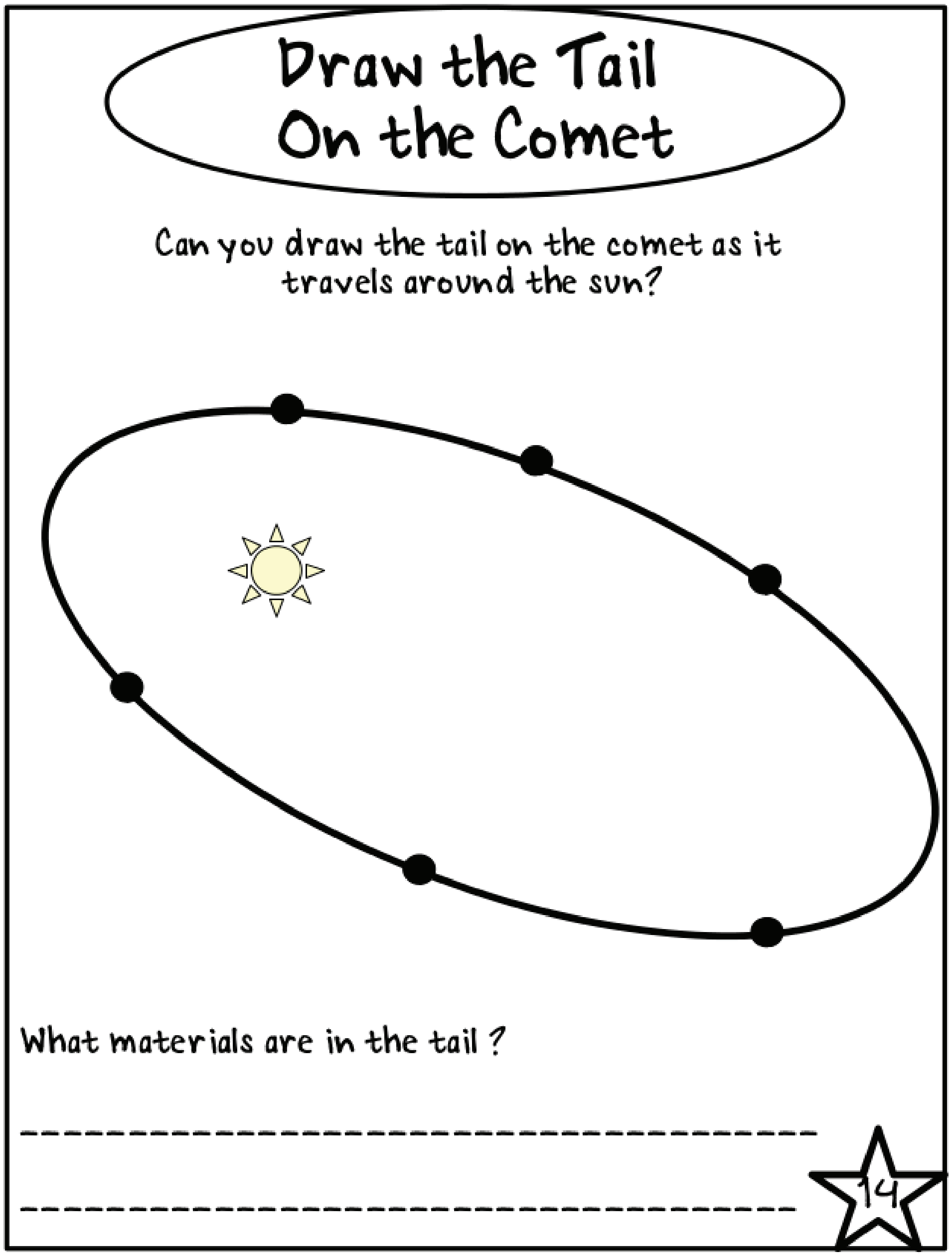

Figure 2. An example page from the student journal for the Comets activity. This page demonstrates the playful nature of the DSBK teaching and masks the "test" in the form of a familiar game.

gaged to disengaged for the audio/visual documentation. This served as our "Effectiveness Score" for each week and tracked our internal sense of accomplishment.

The results for each of these metrics—logistics, student learning, and effectiveness—were tallied and each club was ranked based on its raw score. We noted specific days that were compromised by low attendance or other disruptions and generally these tracked appropriately with poorer scores in one or more of the criteria. From this we were able to identify our “best” and “worst” weeks as those that ranked consistently lowest and highest among the three metrics. We summarize the results of the study in the next section.

3. Results: Factors for Success

On the whole, all of our evaluations for all eight weeks were generally positive. The weekly sessions went smoothly, students demonstrated a grasp of the key concepts each week, and our internal sense of accomplishment was high. However, one club meeting stood out as particularly good and one stood out as particularly poor. Comparing all stages of the club, from its initial conception, detailed planning, execution,and reflection, we identified five key operational areas that correlated broadly with the highest and lowest scores. These five areas are:

1. **Clear and Limited Goals**. When the learning goals were clearly stated (e.g., The student will know the parts of a comet) and relatively few in number (2–3), then each activity was focused on those goals. Volunteers made choices to reinforce those goals in one-on-one interactions. On the other hand, when the goals were broad and stated generally (e.g., “What are the different types of light?”) and there were many (5+), then the activities lacked coherence. Each topic was only covered briefly with no reinforcement.

2. **Alignment between Activity and Worksheets**. When the evaluation materials were well aligned with the actual content of the lesson, then the lesson could be well assessed. This typically occurred when the logistics for the lesson were decided with enough advance notice to adjust the worksheet.

3. **Clear Point to the Activity**. When the activity leader clearly communicated the main concept to be explored for each activity, the volunteers focused on ensuring that the concept was reinforced. The decision tree was clear for the adjustments that occurred on the fly; for example, if material was forgotten or a “hot moment” occurred, the volunteers were able to formulate a solution to the problem without compromising the effectiveness of the activity. If the goal of the activity was unclear or could be interpreted multiple ways, then the volunteers were less coordinated in their on-the-fly efforts.

4. **Interactivity Levels**. When students were involved actively in an experiment, they were engaged and participated at a high level. When the students were just handed materials or given instructions, they took less away from the lesson. As a result, students were easily distracted and the volunteers were more stressed.

5. **Volunteer Energy and Attitude**. When the weekly sessions took place during stressful periods of the semester, the volunteers had low energy levels. As a result, the activity was poorly planned and volunteers were less engaging. This was correlated with both the instruction and the one-on-one interactions.

Broadly, these five factors listed above can be categorized as organizational in nature and can be mitigated with slight modifications in management style. In the semesters following this work, DSBK used these observations to identify specific areas in which to improve. Generally, this data-driven and specific approach was much more powerful and achieved their goals more efficiently than with previous strategic discussions. In the next section, we generalize these results for similar organizations.

4. Recommendations for More Effective Outreach from DSBK

In the previous sections, very specific evaluations were conducted on DSBK. Here we generalize those results for other scientist-led outreach programs.

1. **Align activities with learning goals**. When learning goals are articulated, the lessons are designed around those goals. Volunteers know exactly what they should emphasize, and student learning is more effective. Broadly, volunteers will be less stressed because their on-the-fly decisions are easier.

2. **Do not work against prior knowledge**. It is important to know what material students have seen before. If students are familiar with an activity, then it gives an opportunity to teach more advanced concepts instead of boring students with something they have done before. Moreover, one must be aware if students know how to use certain basic scientific tools, like graphs and charts.

3. **Reinforce concepts from previous activities**. Student recall from week to week was sometimes poor, which gave volunteers a sense that their volunteer time was undervalued. Moreover, it becomes hard to evaluate the "meta-goals" of improving science literacy if students are never asked to recall or apply material covered previously.

4. **Engage students in puzzles**. Students learn more when given the opportunity to engage in the learning process. Engaged students tend to be less disruptive and easier to manage. Investigations formulated as play can have powerful results because it fosters one-on-one interactions with volunteers. Generally, volunteers will also have fun.

5. **Volunteer energy must be high**. Appropriate scheduling is perhaps the most vital component for a successful event, in terms of planning, preparation, execution, and reflection.

6. **Be aware that excitement does not always correlate with learning**. It is important to make sure that exciting aspects of outreach—using an IR camera or being in a planetarium—are actually coherent activities. Students will not necessarily draw conclusions on their own, as professional scientists tend to do.

In a general sense, many of these items are "givens" to those individuals with formal education training and may come as no surprise to the reader. For scientist volunteers, these lessons were not obvious without supporting data. The assessment program provided a platform for the discussion on how to teach effectively, not just for outreach, but for any context.

Presenting this material to the volunteers in the DSBK program proved to be quite influential. The scientist volunteers were generally far more motivated by recommendations supported with data (even more so for quantitative data) than with anecdote alone. This process parallels how a scientist learns new information or skills within their research activities. Moreover, the data often supported a more successful experience than the students intuited from their personal observations. This bolstered the confidence of those volunteers in their abilities. Used as part of a strategic planning workshop (combined with more extensive volunteer surveys), DSBK was able to modify its operational model to provide more preparation time for activity leaders, placing a higher amount of planning over vacation periods instead of during the academic semester. Moreover, activity leaders were able to assess, in an unbiased way, which activities required substantial revision. Activity leaders were able to collaborate with other volunteers, including those on the assessments team, to improve their activities.

5. Reflections on the Process

The assessment program within DSBK was entirely led by graduate students. The students set up a feedback loop of experimental design, testing, implementation, and discussion that resembled a series of small-scale research projects. These projects occurred in a low-intimidation environment for the students to participate in all phases of the research process, from posing a question, designing data collection, collecting data, assessing data, discussing, and drawing conclusions. Further, the assessment team gained presentation experience through routine summaries during weekly planning meetings. In a professional environment increasingly dominated by large collaborations, opportunities for students to design and implement studies from the ground up are becoming sparse. The model of DSBK outreach—with a research, analysis, and reflection component (albeit an informal one)—could play a role in developing science literacy, at a professional level, in the student volunteers themselves.

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