Montshire-Rivendell-Dartmouth HHMI Science Camp

Year Two Evaluation Report

Based on Interviews with Dartmouth College Science Mentors and Rivendell Host Teachers

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Introduction

Science Camp is a collaboration between Dartmouth College, Montshire Museum and Rivendell School District that brings science-enrichment activities to elementary school students. Supported by a four-year grant to the College by the Howard Hughes Medical Institute, Science Camp partners Dartmouth student mentors’ knowledge and enthusiasm for science with Montshire Museum’s expertise in science education to bring hands-on science to over 150 third, fourth, fifth, sixth and eighth graders in the rural, interstate Rivendell School District. Although the primary goal of Science Camp is to bring excitement, expertise and relevance to elementary school science classes, the program is designed to benefit all participants. Thus Science Camp offers instructive teaching experience to the Dartmouth volunteers who act as mentors and provides new materials and ideas (as well as help in the classroom) to host teachers.

2008 marks the second iteration of Science Camp. The first year’s recruitment for Science Camp mentors had revealed strong interest in such a teaching opportunity among Dartmouth students, and the first year evaluation confirmed the soundness of the Science Camp concept. Both Rivendell teachers and Dartmouth mentors believed that 2007 Science Camp met its goals for enhancing school science. They said that elementary school students in Science Camp learned more than the interesting science in the lessons; they also learned, in the words of one mentor, “that science can be fun and that they can do it too.” Mentors themselves uniformly said they enjoyed the experience and reported that they acquired valuable, transferable pedagogical skills. Mentors and teachers also agreed that a closer connection between the lessons and the Rivendell curriculum and better communication among participants would make Science Camp a stronger program.

Responding to this feedback, Montshire planners introduced two important changes for 2008: (1) they keyed the weekly science lessons to the curriculum in each grade and (2) they augmented communication with teachers, starting with an introductory meeting among teachers, mentors and science educators in December, a month before Science Camp began. The first change—integrating lessons with what students were learning in their regular science study at the time of Science Camp—alleviated faculty concerns about losing instructional time to science topics unrelated to grade learning goals and about losing the opportunity to reinforce regular science learning. The second change—improved communication, initiated by a December gathering where faculty and mentors discussed Science Camp goals and their respective roles in the classroom—provided a more secure foundation for the subsequent classroom collaboration.
Despite snowstorms that cancelled half the planned lessons, the 2008 Dartmouth-Montshire-Rivendell Science Camp was sufficient to demonstrate the value of these revisions. As this report documents, integrating lessons into the curriculum eliminated teachers’ concerns about the viability of Science Camp; improving communication among the participants helped teachers and mentors be more effective in the classroom and gave participants a greater sense of ownership in the project. While this years’ participants suggested ways to make Science Camp an even better experience, they overwhelmingly endorsed the 2008 modifications. As one retuning teacher commented, “Science Camp was well thought-out this year. It’s solid.”

Like the first-year evaluation report, this report draws on individual interviews with the nine participating faculty and the 19 Dartmouth student mentors to document the second year of Science Camp. Evaluator Jane Korey conducted confidential, in-depth interviews with each participant in the weeks immediately following Science Camp (March 12 – April 6), taking extensive notes during the interviews. Although not always verbatim, the quotations cited in the report faithfully reflect the interviewees’ remarks. To allow comparison with the first year, few changes were made to the interview protocols for each group. The protocols are included as appendices to this report.

**Program Activities**

Science Camp begins in the Fall term of the academic year with the recruitment of Dartmouth College students to serve as science mentors. During that same period, Montshire science educators develop inquiry-based science lessons for each of the participating grades. In December, host teachers and mentors get acquainted with each other and the program in a meeting at Montshire Museum. For six weeks in January and February, mentors participate in weekly Monday night trainings; on the following Wednesday they travel to Rivendell schools to present the science lessons to elementary students. Science Camp culminates with a February open house at Montshire Museum, where all Rivendell students and their families, teachers, mentors and program personnel join to explore the museum and celebrate the accomplishments of the Science Camp students. The program closes with a dinner and opportunity for reflection among teachers, mentors and program personnel hosted by the Dartmouth Center for the Advancement of Learning. This section describes the major components of Science Camp.
**Mentor Recruitment**

Email announcements were sent to science departments and organizations in October 2007 soliciting applications for the 2008 Science Camp, held January-February 2008. Thirty students completed applications (up from 23 last year) and the recruitment committee selected 21 as mentors, with two alternates. Mentors said that the strategy of contacting students through science departments was effective, since they were more likely to attend to email from a known department member. A few suggested other ways of publicizing the opportunity, such as posting on department bulletins or brief talks at department seminars. Many applicants were motivated by a desire to share their love of science and serve as role models for young students, as special teachers had done for them. But even more—16 of the 19—specifically mentioned the opportunity to improve teaching skills as a reason for applying; all graduate students did so. Some graduate students had been teaching assistants and wanted to do a better job at that; many planned a career in teaching. As one graduate student wrote, “As I look to my future as a college professor, I strongly believe that working with young children provides a valuable experience on instructing college students that will influence and improve my teaching for years to come.”

Several mentors mentioned that descriptions of the program accompanying the application were brief, providing little information about the Science Camp commitment. One said, “I didn’t really know what I was getting into with this program, so it was all pretty much a surprise. It would be better to give the mentors more information about what their role will be in the program before they start, because I know that many of us were unaware of what we were getting into. I wasn’t sure if I was going to be teaching an entire lesson, or assisting the teacher, etc..” Another noted, “I didn’t really have many expectations. I didn’t know whether we would be expected to design our own curriculum, whether we would teach alone or together.” Making the boundaries of the effort clearer in the application process would allay such concerns and might help to attract more students.

**Mentor Assignments**

Montshire educators assigned mentors to partners and classrooms for the duration of the program, giving each pair the opportunity to develop as a team and to establish rapport with their students and host teacher. Nineteen mentors were placed in 11 classrooms, working with nine teachers. Due to attrition, three mentors ultimately did not have a partner in the classroom. Five of the nine teams included both a man and a women, five linked graduate students and
undergraduates, and no team included mentors from the same major or discipline. The table below, which organizes the mentors by the grade they taught, shows the range of ages and interests mentors represented.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>3rd (2 classes)</th>
<th>4th (3 classes)</th>
<th>5th (2 classes)</th>
<th>6th (2 classes)</th>
<th>8th (2 classes)</th>
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<tbody>
<tr>
<td>GENDER</td>
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<td>1 woman</td>
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<td>1 undergrad</td>
<td>2 grad. students</td>
<td>3 undergrads 1 grad. student 1 post-doc</td>
<td>1 undergrad 2 grad. students</td>
<td>2 undergrads 2 grad. students</td>
<td>1 undergrad 3 grad students</td>
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<td>• Engineering /Physics • Physics/Astronomy • Genetics/Bioinformatics</td>
<td>• Biology (2) • Envir. Studies • Chemistry • M.D./Neuroscience</td>
<td>• Chemistry • Genetics • Envir. Studies</td>
<td>• Biology/ Spanish Genetics • Neurobiology • Ecology &amp; Evolution</td>
<td>• Cognitive Neurosci. • Toxicology • Women’s Studies • Physics</td>
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Most mentor teams appear to have functioned together well, although several said that their teams never achieved a relationship where both felt they were contributing equally. The most notable regrets were expressed by mentors who had no partners. Both they and their host teachers noted that lessons were implemented more effectively and enjoyably when two mentors worked together. As one mentor said, “I would love to have had a partner. You really need two people so that kids can ask questions and show you what they are doing.” A teacher concurred, “It’s better to have two students. The one I had did a good job, but it’s harder with only one.” Although two alternates were selected, they were not activated. Selecting more alternates would provide a “deeper bench” and help to ensure that every classroom is served by a team of mentors.

December Training Day

This year Science Camp began with a December gathering at Montshire where Rivendell faculty and Dartmouth mentors got acquainted and learned together about the goals and methods of Science Camp from Montshire science educators Greg DeFrancis, Amy VanderKooi, Rachel Donegan and Mike Fenzel. Seven of the nine teachers\(^1\) attended, as did most Dartmouth

\(^1\) One teacher was unable to attend. Another who could not come on that date set up a separate time in December to meet mentors.
mentors. This early forum represented the first step toward the improved communication within
the program that teachers had called for last year, and they universally applauded the event.
Both they and the mentors felt that this opportunity to get to know one another and for mentors
to learn about the children they would work with made for a smoother and stronger start to the
program. Some typical comments from teachers:

- It was good that we sat down ahead of time and talked about the strengths and
  weaknesses of the class, class management, how I handle the class. We did this at
  the Montshire training day. That was good; it helped.

- That was a wonderful day, great. We were all on the same page. It felt nice,
  working together. I loved the training day.

- I did go to the Montshire in December for the meeting with mentors. That was a
  good thing—emphasize that! It was very important.

Classroom Pre-visit

The next step preparatory step was to involve visits by mentors to their assigned
classrooms, where they would meet Rivendell students and experience their classroom routine
before actually presenting a lesson. Most teams planned advance meetings, but scheduling
difficulties prevented all but a few from occurring. One pre-visit that did take place was deemed
“beneficial” by the teacher, who said it allowed the mentors to “hit the ground running.” Several
other teachers and a number of mentors who were not able to accomplish a pre-visit, suggested
such visits as a way to improve the program. One teacher whose pre-visit fell through noted that
“it might have made it easier if it had [happened].” Another said, “I would suggest non-teaching
visits. It would be helpful for them to observe a class beforehand, to watch the teacher with the
kids.” Mentors concurred. Asked what might be done differently, one replied, “I would like to
have visited the class beforehand.” Another expanded:

Offer more chances to visit a week before. We had to organize this on our own,
and we couldn’t do it on our own. Why not just add a week and take that first
week just to meet, to get to know the kids. It would help us do better and it would
allow us to talk about the science that excites us and allow us to know them. We
need to put more emphasis on our relationship with the kids.

The second benefit this mentor noted—introducing students to mentors’ science
experience—was also recognized by teachers. One commented, “It’s important to see real
scientists and students that are preparing for a career in science. It helps my students relate to
that as a career possibility. I wish we had more time for the mentors to talk about themselves,
what they do as science students.” One teacher whose mentors were not able to visit the class before Science Camp took the first regular lesson day to introduce mentors and their scientific interests to the students. Mentors in that class cited the experience as particularly useful:

I felt really comfortable [in the classroom]. This was on account of that first “meet and greet” day when we saw the class and saw how it works. That was really helpful. This helped them realize that we are “whole people,” and that is the point of the program. I think all mentors should do this. If they can’t do this, then they should come and just observe in the class before Science Camp starts.

The first day we just talked about ourselves and the kids saw that normal people do science. They saw the mentors as almost on their level. I also think all groups should do what we did on the first day, let the kids introduce themselves and say something about what science they like, and we do the same. That was when I brought in [some material] and a hand-out I had prepared. ” It was kind of like creating a lesson—I had to think about what to say. This might allow mentors who can’t teach close to their field the opportunity to do a mini-lesson on their own topic.

Where pre-visits occurred they were judged to be helpful, particularly as an opportunity for mentors to personalize the science experience. When they did not occur, their absence was apparent. As this report recounts more fully later, teachers believed that the mentors’ function as role models for science careers was the greatest value added by Science Camp. It makes sense to designate time when mentors can amplify that role.

Mentor Training

As in 2007, in January and February mentors received training for each Wednesday’s lesson at a two-hour session the preceding Monday night. As they had last year, mentors found the Monday night-Wednesday afternoon schedule convenient and the time commitment manageable. On Monday, the 6-7 PM hour was devoted to dinner and a discussion of relevant pedagogical issues. Both before and after, teams spent an hour preparing to implement the next lesson. Because Science Camp activities this year were keyed to each grade’s science curriculum, a separate training was held for each grade. In addition, the two fifth grades were not in synchrony with each other, necessitating two preparations for that grade.² As a result, Montshire doubled the staff devoted to Science Camp to four educators and held six preparation

² Mentors noted that the fifth grade trainings were less satisfying for them because there were few colleagues with whom to discuss plans and concerns.
sessions each night (two preparation sessions were held before dinner and four afterward),\(^3\) compared to two educators and two training sessions in 2007.

Mentors were divided on the value of the introductory all-group discussions. Most said that they learned from sharing experiences among the group and from the pedagogical discussions, especially the discussion about how to construct a good question and the conversation, following an exploration of museum exhibits, about what makes a good learning opportunity. Several noted that these discussions helped to unify the group. Eight mentors (four undergraduates and four graduate students) judged the sessions interesting and useful overall, like this undergraduate, who said:

I found this really interesting. I hadn’t thought about teaching before, now I think about teaching and different learning styles a lot. It was interesting to learn about how to word questions. How you word them makes a big difference, but we tend to take questions for granted. I found the theory behind inquiry science very interesting.

Ten mentors, although recognizing usefulness in these sessions, had reservations about their overall value, at least in terms of the time allotted. These mentors (three undergraduates, seven graduate students) typically said the sessions were “sometimes” helpful, but tended to be “redundant,” “repetitious” or “too long.” As one said, “There were times when I felt I learned from these sessions, but I didn’t feel they were entirely necessary or worthwhile. It was nice to hear about everyone’s progress and Greg had some good things to say, but I’m not so sure it was necessary each and every time.” Another noted, “Sometimes they were helpful. It was interesting to hear about others’ experiences, but there could be more substance there.” A third noted. “It would have been more useful to have some instruction in techniques. Sharing experiences is good, but we need another step.” The fact that many mentors did not complete the assigned reading further eroded the value of all-group discussions.

Mentors said the hour-long preparation sessions where they learned how to teach the next lesson was time well spent. They said the Montshire educators were well-prepared, had good materials and good plans for presenting them. Most were satisfied with a system that placed responsibility for developing the lesson plan with Montshire, but left mentors free to be creative in teaching them. These descriptions of the training process are representative:

The lessons were pretty planned out, but I think we were given some space in terms of how we went about teaching it. It wasn’t exactly a strict lesson, which was nice because I think each mentor had an opportunity to go about it freely. The

\(^3\) In 2007 one set of lessons was used for the 2\(^{nd}\) and 3\(^{rd}\) grades, another set for the 5\(^{th}\) and 6\(^{th}\) grades, requiring two training groups and two educators.
goals were clearly established at each training session, and activities were planned accordingly, but I definitely had a little freedom in teaching it. That was also a learning experience for myself, seeing what methods work better than others. Overall, I was very happy with how the lessons were planned each week.

[Our educator] had the idea, supplies, worksheet. We did what our students would do: we would do the experiment ourselves—we gave it a test run. Then we would revise based on that experience. We came up with ideas too. We designed the lesson along with [the educator]. Then [she] would revise in accordance with our feedback.

[Our educator] had lessons that were already pretty structured and that was comforting. We weren’t pushed to contribute to the lessons but we were invited to do so. Our input mostly had to do with teaching style, more than content. We would try to figure out whether it was better to have them learn this by doing a graph or asking questions, for example. So I would say there was a good balance. We had the freedom to express ourselves but we also had the safety net of a well-prepared lesson plan.

At least four mentors said that they would have liked more input into creating the lessons, but as one pointed out, “As a grad student I’m pretty busy, and it was nice to have a prepared lesson. It was safe, ready and you knew it would work. On the other hand, if I design the lesson, I’m more invested and it’s more rewarding.”

Classroom Experience—Teachers’ Perspective

Integrating lessons into the curriculum. Responding to teacher and mentor feedback from the 2007 Science Camp, Montshire educators committed to create hands-on science lessons that were integrated with the science curriculum for each of the grades three through six (the second grade, which had participated in 2007, was replaced this year by the fourth grade). The third grade lessons this year concerned magnetism and electricity, the fourth grade studied astronomy and the solar system, the fifth grade worked with heat in one school and mechanics in the other, the sixth grade also studied electricity and magnetism, while the eighth grade used questions about environmental impacts to learn about the scientific process and experimental design. Rivendell teachers gave the lessons high marks overall, saying the lessons were “well-paced” and the materials “great.” Some lessons, especially the ellipse exercise in the fourth grade and the balancing exercise in the fifth, were singled out for praise.

Teachers universally and enthusiastically endorsed connecting the special Science Camp activities to the established curriculum. Throughout the interview teachers emphasized how
important was the integration of the special hands-on activities with the established learning program. Here are typical comments from returning teachers:

This year the lessons tied into the curriculum. This is fantastic. My students had a better understanding because it tied into the curriculum and because it was continuous and built week to week. There were great ideas and lessons. It was worthwhile this year because it was allied to the curriculum. I can’t think of any way to improve it.

This year the lessons were more connected to what we do, so they were more valuable. The unit was directly tied to the curriculum.

Teachers who were new to the program were clearly familiar with the concerns raised by the previous year’s program. This comment is from a new Science Camp participant:

I knew that teachers who participated last year were less than happy because the lessons weren’t aligned with the curriculum. When I heard that this year the lessons would tie in with the curriculum, that the effort had been made to help the teachers achieve the goals they needed to achieve, I looked forward to participating.

It is indicative of the importance of curricular linkage to the strength of the project that last year half of the host teachers said they would not volunteer to participate again in Science Camp (if participation were voluntary), citing the lack of connection to the curriculum as a major problem with the program. This year all host teachers said they would volunteer, and many mentioned the curricular integration as a reason why. As one teacher responded, “I would volunteer. I liked having it part of the curriculum. That was important.” Another gave this qualified response, saying, “I would volunteer if it stays connected to the curriculum.”

Communicating lesson plans. Before Science Camp began, Montshire educators sent all teachers a syllabus of the topics to be covered in their six classes. Last year teachers had recommended that lesson plans be shared, and they all appreciated that this year they were “in the loop.” Since the lessons were keyed to the class curriculum, having the syllabus allowed teachers to coordinate their teaching closely with the Science Camp activities. As one said, “I had a synopsis of the lessons beforehand, so I could key my teaching so the kids were ready for Science Camp. Having the synopsis helped me make the lessons fit smoothly into the curriculum.”

In addition to the syllabus for their class, some teachers received more detailed weekly lesson plans by email, either from a Montshire educator or from their Dartmouth mentors. Those who received the more complete weekly descriptions of Science Camp activities felt better able
to prepare their classes and to be ready with materials and ideas that would help the Science Camp lessons run smoothly. One reported, “[The Montshire educator] sent a weekly lesson plan, so I knew what was going to happen, and I emailed her. She did a great job of communicating to me each week. Communication was key and good. It’s important to maintain that.” Another reported, “The Montshire educator sent the activities for Wednesday on Monday or Tuesday. This way I could prepare my students, remind them of things they’d studied earlier. This was very helpful.” One teacher who did not receive weekly updates (but who felt that overall communication within the program was good) explained that a more specific weekly lesson plan would have been helpful. “I had the syllabus of topics, but I didn’t know what would be taught each week, exactly, so I couldn’t prepare the kids ahead. I need more specifics about what will be taught, including some suggestions for pre-teaching activities, to do before the program.” The practice of sharing detailed lesson plans with teachers should be made systematic, so that all teachers can prime their students for the lesson and have on hand materials and props to assist.

In general, teachers reported more email communication between themselves and both Montshire educators and Dartmouth mentors this year than in 2007. Not only were there more “official” communications such as the program syllabus and weekly updates, but there appears to have been more informal communication among participants—checking in, weather queries, nailing down details. Communication is a good index of the health of a collaboration; increased information-sharing within the program this year suggests greater collegiality among the participants.

Student learning. Although mentors were able to present only three or four of the six lessons in the series (some mentors came back on their own after Science Camp officially concluded to present another lesson), so that students did not have the full opportunity to build and consolidate concepts, teachers believed that students were motivated by the experience and that most understood the science they encountered (and mentors mostly agreed). As one teacher reported, “My students were excited and intrigued, wondering, ‘What will we learn this week?’” Another remarked, “My kids look forward to it; they are more focused during Science Camp.” Asked what their students “took away” from Science Camp, every teacher said their students understood the main concepts presented for their grade.

The fourth grade presented the greatest challenge for teachers, mentors and students. The fourth grade studied the solar system and astronomy, and both teachers and mentors recognized that this topic was conceptually challenging and difficult to adapt to inquiry learning. All teachers and mentors said that some students struggled with the concepts, and some mentors
mentioned that they did as well, leaving them less able to clarify concepts for students. Mentors and teachers felt that the lessons were not sufficiently “hands-on” and relied too much on worksheets, which did not hold student interest. No one had a ready solution for this, except to change Science Camp to spring, so that it would align with the study of ecology. (Changing the term in which Science Camp is offered had wide support on other grounds this year, since the weather-related school closings had cut the program in half.)

While teachers felt that Science Camp excited students and helped them consolidate classroom learning, all but one said that the greatest value added by Science Camp was the presence of young role models in the classroom. One teacher said, “They got the fresh faces of people who are actually in the sciences. I can do the science lessons OK myself; Science Camp gives them Dartmouth College mentors as role models. This may be the most important aspect of the program.” Another said the value added was that students “saw real researchers in action, they saw that careers can be based on research, that you can make a living from science.”

Commenting on the school district’s role in their experience, one teacher out that the program could be even stronger if Rivendell offered participating teachers release time from in-service to work on Science Camp, perhaps for debriefing meetings with mentors during and after Science Camp (several mentors indicated that they would like an opportunity to get feedback from their host teachers; such meetings could serve that purpose). Several teachers who were new to Science Camp felt that the district had not given them sufficient notice about their participation the program, either in terms of content or scheduling.

Teachers viewed these shortcomings as minor; the overall teacher experience was strongly positive. They enjoyed working with the Dartmouth mentors and they were pleased to see their students engaged and learning science. Improved communication among all participants made it easier for them to fulfill their role in the program and more effective in doing so. Finally, the linkage of Science Camp lessons to the existing program of study strengthened and deepened their science curriculum.

Classroom experience—Dartmouth mentors’ perspective

An enjoyable and worthwhile experience. For their part, Dartmouth mentors described their interactions with Rivendell students as enjoyable, their relationships with their host teachers as comfortable and productive, and the overall experience as worthwhile. They appear to have easily established a mutually satisfactory division of labor with their hosts, and mentors were pleased (and relieved) to have teachers take responsibility for managing student behavior. The
Rivendell teachers praised the mentors' knowledge, flexibility, enthusiasm and communication skills. “They were great with kids.” Host teachers were reluctant to identify shortcomings in the mentors’ teaching efforts, often pointing out that the only way to acquire better classroom management skills is through experience.

Like the teachers, mentors appreciated that lessons were keyed to the curriculum and judged them well-designed. Asked what was surprising about the program, one mentor commented, “The Science Camp curriculum really matched the school’s curriculum and that was great. I was also surprised at how good the lessons were. The lessons really worked, the kids learned.” Another mentor said, “The demos really helped the kids ask questions. Because the lessons were tied to the curriculum, they could tie the Science Camp lesson to previous learning nicely; our lessons elaborated on that.” As one mentor remarked, “Nothing they did was trivial, and that was good.” Mentors in the sixth and eight grades felt the lessons worked well despite a great range of student abilities and interest at those grade levels and a short (45 minute) class period. As one sixth grade mentor explained, “It was tight. But our lessons went along with what they were learning— that really helped.”

All the mentors felt that Science Camp was a worthwhile experience for Rivendell students. One explained, “It was different, it breaks the routine. They were excited about Science Camp and they were bummed when there were snow days. They enjoyed it, were excited about learning.” A second said, “The kids were excited about the real-life connections Science Camp lessons offered, and they got a better understanding of the world. It made the regular science curriculum more relevant and sparked their interest in science.” In addition to learning science, one mentor noted that students “learned a lot about working together, looking for ways of solving problems, and realized that science was very interesting and all around them.” Another summarized, “They enjoyed it and I think they learned a lot.” Like the teachers, mentors believed that their function as role models was among their most important contributions; almost every mentor mentioned the importance of their providing positive role models for science at some point in the interview.

A number of mentors mentioned the important role of take-home objects for deepening and extending the impact of science camp through interaction with students’ parents. One said, “Kids like to have things to take home. Our class made thermometers with pipettes and they got to take the pipettes home. One kid went home and told me how he continued to experiment with his and showed his parents what he had learned.” Another emphasized the power of take-home objects to build support for science in the home: “Allow kids to take things home the day they
Teaching challenges. While their overall experience was strongly positive, most mentors encountered teaching challenges that indicate lacunae in the training process. Two-thirds of the mentors specifically mentioned that there were times when they were unable to answer questions posed by Rivendell students or to clarify concepts students did not understand. They wanted to do more than just a good job, and were unhappy when they felt they did not meet their own high expectations. As one mentor said, “I was prepared, but I felt like a fraud. I didn’t fully understand the material myself.” Another said, “I was prepared for the basics—[our educator] did an awesome job at that—but that’s just a fraction of the class experience. I wanted to do the best I could, not have to say ‘I don’t know’ all the time.” They identified several strategies that would prepare them to present the material more effectively. The most frequent recommendation—offered by eleven mentors—was allow mentors to teach in their own field, where possible. These responses are typical:

Let us teach science we are involved in. It would make us more knowledgeable and enthusiastic.

[I would recommend that you] try to match the mentor with the subject, not the grade. When my students asked me why they needed to [do the specified activity] I couldn’t tell them. I didn’t understand myself.

The lessons were a bad match with our backgrounds. We had to learn the concepts ourselves and couldn’t always answer questions in class or really offer innovative teaching.

I was excited to learn more about a field I didn’t know much about, but I had less to share than I would have if I had been teaching in my own field.

Mentors also said that more background material on their topics, in addition to the lesson plan, would help them deepen their knowledge. A number said that after the first lesson they did their own homework the night before the lesson. One graduate student said, “I did a little additional research each time before I went. It gave me a deeper understanding.” An undergraduate explained, “After the first week, I did my own research about the topic and made a plan about how to present it.” Another undergraduate said, “I would like to have more background information so that I could answer more complex questions. I felt I had little to provide in that way. One student was very knowledgeable and I couldn’t offer him much.” If Montshire made available a bibliography of vetted resources for each lesson, it would be easier for all mentors to fill in gaps in their knowledge.
Mentors said that more guidance in how to present the lesson would also have been helpful, from organizing the flow of the lesson to allocating team responsibilities. Mentors wanted strategies for choreographing the lesson and for framing and explaining concepts, especially when the standard explanation was not completely successful. A teacher who felt that mentors explained well and were flexible in trying different tactics if one didn’t work, still believed they would benefit from “more time to reflect on what kids’ responses might be, and how to correct misconceptions that might ensue.” These comments by mentors were typical:

We need to know the general concepts they should be learning so that we can frame the activities appropriately. What concept is being taught? What are kids likely to ask? It needs to be apparent to kids why are we doing this. We need to discuss more specifically the principles behind the exercises—“we do this because…”.

I would also like help figuring out how to present the material in a simple way. For one lesson I came up with an easier way to explain [a concept] and it worked better. I also needed more guidance about how to go about the lessons. What is the main point we are supposed to be getting across. What steps will help us get there?

It would be nice if there was more emphasis on dealing with problems likely encountered in the classroom.

It would have been helpful to me if we had not just gone over the content of the lesson but also talked about how to pace the lesson, the time management problem, and how to transition from one part of the lesson to another. It would also be helpful to discuss a bit more about how we function as a team, what our roles should be, how we figure out how to apportion our efforts. Should we do this activity with small groups, both stand in front of the class—how should we do it? Who does what?

While it’s clear from the interviews that some training groups addressed these issues some of the time, and that some mentors navigated these challenges more easily than others, all mentors should be prepared in these areas. Conversations about organizing team function might be appropriate for an all-group meeting. Trainings would be strengthened if they consistently discuss the motivation for the lesson, the general concept explored through the activities, and misconceptions that might arise—and how to rectify them.

Mentors also said they would have done a better job if they had known more about the academic background of the Rivendell students. One mentor said, “I would like to have known from teachers what knowledge the kids have about these topics. I needed to know the level of math and science of these students, so that I could teach better. The initial meeting could have been more productive. For example, I would like to have seen any text the kids might read on
this topic.” Another commented, “I had no idea where the class, the students were in terms of what they knew. I would like to see the class curriculum.” As the first mentor suggested, the initial host-mentor meeting at Montshire would be an opportune time for teachers to brief mentors on the science, math and reading levels of their students, perhaps by sharing texts or student work.

Mentors’ concerns about their ability to explain the Science Camp lessons adequately are somewhat surprising. Last year only second and third grade mentors worried about their ability to communicate concepts to their very young students; this year explanatory concerns include all grade levels. The proposal to match mentors with topics in their field surfaced infrequently last year; this year it was the most common mentor recommendation (apart from moving Science Camp out of Winter term). And last year virtually no one called for supplementary literature to bone up on their topic.

It is not clear why this issue is more prominent this year than last. It may be that the abbreviated session of Science Camp did not give mentors adequate opportunity to develop their explanatory skills, leaving many of them feeling still unaccomplished at the end. Or it may be that this is an unexpected consequence of matching lessons to the curriculum. Last year’s free-standing lessons involved topics chosen for their suitability to hands-on activities, and they had been refined over time by Montshire educators, who could consequently anticipate questions that might arise. This year was the first implementation of Science Camp lessons purpose-made for the Rivendell curriculum. With new and sometimes challenging topics and without the benefit of field-testing, there may have been more open ends for mentors to manage. It may also be that students were able to pose more challenging questions this year because they had a stronger background in the area. Because students were studying the same science in their regular classroom and in Science Camp, they may have had nascent questions which were brought to the fore by Science Camp activities.

However, even if well-tested, free-standing lessons were easier to teach, that would not justify abandoning the curricular linkage that is critical to the value of the program in the school district. As mentors point out, assigning them to teach material they understand independently may help them expand on the lessons when necessary—and simplify, when that is called for. (Contrarily—and this is the argument against this practice—knowing a subject well can also make it easier to slip into jargon and complicated explanations.) Similarly, providing access to background materials to help them broaden their understanding of the topic will enhance their ability to teach it. Making sure that training sessions are clear in motivating the lesson, linking
the main concepts to the activities, and anticipating misunderstandings will help mentors be clear and effective in the classroom. Finally, acquainting mentors with the knowledge and skills of their students will help them pitch their explanations at the right level.

Classroom experience—Rivendell students’ perspective

It is worth noting at this point that evaluation of student learning for Science Camp relies entirely on reports from mentors and teachers. One mentor mused, “I would love to talk to students to see what they actually remember. Or was it only fun?” From a programmatic perspective, some form of direct student evaluation would strengthen Science Camp’s legitimacy. One teacher suggested that a brief written reflection by each student at the end of Science Camp, in response to a well-crafted question by Montshire educators, might provide a good measure of student learning. Assessing student learning directly would also provide Montshire educators with information that would help them refine the lessons.

Culminating Activities

Science Camp concluded with a February evening open house hosted by Montshire Museum. Rivendell students and their families were invited to join school participants, Dartmouth mentors and Montshire staff for a two-hour exploration of the museum, where Science Camp student work was also on display. Brief welcoming remarks were provided by Montshire Director David Goudy and Principal Investigator Roger Sloboda to over one hundred attendees. Attendance at this year’s open house was much reduced from the previous year, disappointing mentors and teachers. The fact that weather had cancelled half the Science Camp classes this year meant that there was less time to advertise the open house; the fact that weather had led to rescheduling the open house itself gave families less lead-time for planning. Mentors and teachers strongly urged that the open house be better publicized so that more Rivendell families might be introduced to the opportunities at the museum. A teacher suggested that having Rivendell youngsters make brief presentations about their work, in addition to displaying it on tables, might increase family interest and attendance at the event. Teachers and mentors in the sixth and eighth grades, noting that almost none of their students attended, suggested that other culminating activities, perhaps a visit to a College lab or classroom, might be more interesting and more useful for older students.

In late May mentors, teachers and Dartmouth and Montshire program staff gathered for a wrap-up dinner and conversation at the Dartmouth Center for the Advancement of Learning. In
an open and friendly interchange, participants shared their diverse perspectives on the program. The sentiments voiced by teachers and mentors are all included in this report. What was important about the evening was that they became part of a respectful and public conversation, establishing that Science Camp is a genuinely shared enterprise that rewards the institutional partners, the individual participants, and the Rivendell students, whose “world is made bigger,” in the District Superintendent’s words, through this collaboration.

**Outcomes**

*Outcomes for Rivendell students*

Employing engaging role models and hands-on activities that are stimulating and relevant to their own lives, Science Camp aims to increase interest and confidence in science among elementary students and to provide a sense of how science is done. Despite its reduced and unpredictable schedule and the loss of the rhythm that resulted, this year’s program appears to have achieved its goals. Both mentors and teachers identified three major outcomes for Rivendell students: (1) they saw that science was interesting—even fun, (2) they learned something about how science was done and (3) they saw that careers in science were open to them. Below are some typical comments from mentors in response to questions about student learning and the value to students of the Science Camp experience.⁴

**Students learned that science is interesting and fun.**

I think they learned that you can do cool things in science. It was cool that we had two women—I hope they picked up on that. And it was also cool that we were of different ages.

They learned that you can have fun with science. At first they had many questions for us (what is grad school?), but we seemed more at their level. We interacted with them more as peers, we could make science hands-on, fun, exciting. They could interact with us and also learn.

One girl told me, “I don’t like science, but this is interesting and I understand it. I like this kind of science.” This is a big deal, the goal of the program.

They learned that science is not as boring as the public would have you think.

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⁴ Questions II. 2 - 4 on the mentor interview protocol.
Students got a better understandings about how science is done.

Some were really engaged to travel deeper into the concepts. They were excited about why and how things that are very common actually happen. They thought, “Wow! I really want to understand that.” That’s what science is—asking why. And they want to know why.

They learned the thought processes of science; I think some did. I stressed that all scientists make models, “play with things in their heads.” Models are tools to figure things out. I think they learned about how to think about the world, how to observe.

They learned that in science you don’t have to be right all the time, that there is no prescribed “right” way to do things, that you can figure out the answer by trying different strategies. In this way, actually, what we did does tie into my own work. You just “make your best guess and then try different stuff.” Knowing this helps reduce anxiety about math and science. It’s OK to make mistakes. That’s how science is done.

They learned about the experimental process, that you can learn by doing things. If I have a question, I can figure out a way to answer it.

Students saw that science is done by people like them.

If they see us having a good time with science, they’ll naturally follow along. I think it’s so important that young students have these role models as they grow up, and the Science Camp program is great for that.

They enjoyed having us, coming from the outside to them. It was cool that we were Dartmouth students. I think they gained from knowing us personally and from our enthusiasm for science. They got encouragement about science and saw that “It’s cool to learn about this stuff.”

One boy said he “missed our coolness” when we were not able to come. Interaction with us is one goal of the program.

They realize that this career is possible. Having new people in the class increases their attention span—that’s especially important in science. Science needs to be exciting, interesting.

Outcomes for Rivendell teachers

Rivendell teachers enjoyed seeing their students excited about science. They were gratified to have their science curricula strengthened by the integration of well-designed inquiry activities and they appreciated the materials developed by Montshire science educators. In this regard, a number of teachers mentioned that the district budget
for science materials was limited. Some learned new ways of approaching science topics. Having knowledgeable and personable assistants in the classroom not only made their work easier, it gave them a welcome opportunity to stand aside reflect about teaching. Some exemplary comments from teachers:

My students got exposure to other teachers—other energy and style. This reinvigorates them about a topic. The mentors were young and energetic and gave a fresh perspective.

More heads in the classroom are better. It’s good to have good scientists in the room. It was also fun to work with younger people. They were great, always here, on time, prepared.

It was nice to be an observer in my own classroom. The lessons were so engaging, it reminds me again how much fun it is to teach.

Yes. It gave me an opportunity look at things—[the science we were doing]—from a different perspective. I might do one of the activities on my own in class.

I appreciated a couple of the lessons because we had been doing observation and the lessons turned the observation into experimentation. This led me to ask myself how to make this more of a science experience.

Now I can take ideas from Montshire lessons when I have to teach this next year.

All the Montshire materials were helpful. So my students got a new face and new materials, and that was exciting for them.

*Outcomes for Dartmouth mentors*

It is testimony to the vision of Montshire organizers that a brief program like Science Camp offers mentors gratification in many different ways. On a practical level, Science Camp provides teaching experience that mentors say will help them translate their science to non-scientists, whether those people are their students, members of the public, or scholars in other fields. Every mentor mentioned that Science Camp enhanced their teaching skills—how to prepare, how to pace a lesson, how to use hands-on activities, how to match their presentation to the knowledge of the audience. Eight students also mentioned a heightened interest in teaching as a career as a result of their experience with Rivendell children. At a more introspective level, the task of motivating young learners prompted eight mentors to reflect on their experience as scientists, reinvigorating their own sense of purpose. Weekly time in the classroom brought the joy of seeing children excited by learning to all, while the trainings (and shared travel time)
offered social opportunities that can be rare in the lives of busy college students. Finally, nine mentors mentioned that weekly trips to the Rivendell district offered the opportunity to give back to the community they live in, and to understand it better.

Along the way, mentors also gained new respect for elementary students (“fifth graders can still ask questions you can’t answer”), their teachers (“I have new respect for 4th grade teachers”), and for Montshire Museum. They praised Montshire’s staff, the scope, organization and quality of the program, and the museum itself. One said, “The free food was a benefit (it was delicious), the gas was paid for (that was very thoughtful and reflects well on the program). Also, I learned more about the Montshire (they have great stuff, interesting jobs).” Another concurred, “It was a benefit seeing the Montshire. That was so much fun and very educational—it reminded me how much I like science.” Finally, one graduate student noted that her advisor was a beneficiary of Science Camp as well: “This also benefits my advisor. Grants always want to know what you are doing for outreach, and he can say, ‘my grad student is doing outreach in the schools.’” In the remarks below, mentors describe program outcomes in their own words.

**Mentors learned to communicate science better.**

Science Camp offers broad value that translates to other forms of teaching. I realized for kids this year there may be an innate interest in science; when you actually bring science into their world, make it practical and applicable, they are interested. I take this lesson into the future, to try to connect science with everyone, to have faith in your students that they will get it.

I learned how to use different examples to teach the same concept, how to use “objects” for didactic purposes—graphs and models, for example, tangible things. Teaching kids pushes you to be creative, to use many different ways to explain a concept. You also have to figure out when people don’t understand and then figure out a strategy to get to them. These skills are needed when teaching all ages.

I learned how to be dynamic, how to change plans on the fly. This is useful in any presentation, adapting your presentation to fit the time that you have (what is important, what shall I skip) and the audience.

Sometimes teachers at higher levels think teaching is about presenting facts, and as I have gotten more into grad work I sometimes find myself sinking back into presenting facts. This experience popped me back up to the need to excite students, to get them to think critically. I can easily apply this kind of teaching style at any level.

I learned time management and being able to present ideas to people at many different levels of understanding. We had to figure out what they knew and then
adapt quickly to present the material so they could understand. This will obviously be important later.

I learned how much to prepare for a presentation and I gained more confidence in front of a large group. It also led me to re-evaluate the goal of teaching. You want to pass on a way of thinking more than materials.

Mentors’ interest in science was reinvigorated.
Science Mentor program is a great way to remember the magic in science. Working with kids allowed me to embrace the excitement of science, to see the world through different eyes.

Science Camp also helped to motivate me, because I had to motivate them. I had to think about what science is and why I chose to do it.

This experience gave me another way to get excited about science. I was energized by interacting with students. The PhD is a long slog.

Science Camp made me more excited about my own work. It allowed me to see the fruits of my own labor, to step back and see how I can use the science I know for another purpose. It is nice to realize what you understand and to be able to impart knowledge.

Mentors’ interest in a teaching career was stimulated.
I have been thinking about teaching much more now. I thought I would be a doctor but now I think maybe teaching will be important for me. I guess for me Science Camp has been a culminating experience. It is so important to share information, so powerful. I need to find a way to make this a part of my life.

I learned that I really enjoy teaching. It made me think that I may want to teach at some level. I liked this age group. I now see this as a potential career.

I learned how to communicate with kids, things that work in explaining a new topic. Things that are simple to me are not necessarily simple to others. Even in explaining some of my own research, this helps me. Teaching in n\textsuperscript{th} grade makes this even more apparent. I also learned that I enjoy teaching. I always walked away thinking, “That was so much fun. I want to go back.”

I learned that I really enjoy teaching. I like figuring out how to make ideas accessible to whomever. I enjoy that look of surprise and excitement and figuring out how to elicit that. It’s fun to figure out how to order the material and how to pace the lesson to keep people interested.
Mentors had fun helping children learn.

The benefits you get from seeing kids having fun while learning a lot completely outweighs the hours you’ll spend traveling back and forth to the museum and schools.

I enjoyed it, I looked forward to it; each week was more exciting. I learned and the training was fun. It brightened my week.

I had fun, I made a little contribution to the community, I got to get outside my own graduate work. It was rewarding to see the kids excited. And it was good teacher training.

Yes. I enjoyed the kids—it was a blast. I wanted kids to see that scientists could be young, could be women, could have a sense of humor and still be “nerdy scientists.”

Mentors enjoyed social interactions among the group.

Science Camp was fun and exciting. It was social, and something to look forward to. I enjoyed riding up with my partner in the car.

It was also nice to get outside the Dartmouth bubble and to meet other graduate students and undergrads. Plus I got to know Montshire better.

I like the social time with other mentors, the connection with Montshire, the reprieve from an academic environment and the opportunity to think about teaching.

Mentors were able to serve the community.

The Science Mentor program is a great way to give back to the community by inspiring young students in science while learning and having fun.

I enjoyed the food, the chance to get out of the lab and see local kids, and the opportunity to give back to the community.

It was a chance to contribute to the community. It’s nice to share what I enjoy with others.

I learned about Rivendell and how different it is just 20 miles away from Dartmouth. I have traveled abroad involved in public health and I like to see myself as a global citizen, but here the need to so close, the inequities are right here.
Recommendations

This report has documented that Science Camp was an enjoyable and worthwhile experience for Rivendell students, Rivendell teachers, and Dartmouth mentors. Thus many of the recommendations offered below simply endorse changes already accomplished. The single recommendation heard most often from teachers and mentors was to change the season in which Science Camp is offered. This year’s unlikely series of Wednesday snow storms cut the program in half and disrupted the flow of the lessons. Additionally, mentors noted that even when they did travel to Rivendell they did not always feel safe on snowy roads. If such a change were made, teachers asked that they be notified at the beginning of the school year, so that they can plan accordingly. Other recommendations:

Mentor Application and Training

Improve mentor application materials to include more a complete description of mentors’ Science Camp responsibilities and activities.

Select (and use) enough alternates so that each classroom is served by a team of mentors. Teaching alone is neither fun nor effective.

Make better use of the first hour of training. Mentors need to share experiences—and to eat—but they also want to feel that they are using all their time productively. They are interested in pedagogy and in how people (including themselves) learn. These sessions should advance their understanding of that field efficiently, perhaps offering a more structured opportunity for reflection and a more systematic introduction to science pedagogy.

Insure that mentors achieve a comfortable command of their topic, either by matching mentors’ own areas of study with the topic to be taught or by providing vetted resources for them to study. Trainings should also make clear the general concepts to be communicated and how to frame them.
Program Structure

Continue to link Science Camp activities directly to Rivendell grade curricula. Teachers identified this connection as critical to the program’s value and an important determinant of their participation. It helps teachers meet grade expectations by reinforcing students’ classroom learning and it makes the inquiry activities more effective because students can connect them to previous knowledge.

Continue to hold a December meeting for Montshire educators, host teachers and mentors. This meeting provides a needed forum for the exchange of information about inquiry methods, participants’ roles and student characteristics. Science Camp proceeds better when participants are clear about what to expect and what is expected of them. Consider asking teachers to bring a few representative examples of student texts or student work to illustrate the academic level of their students.

Build an informal “get acquainted” meeting between mentors and their classes into the Science Camp schedule, either by starting Science Camp a week earlier or by providing administrative help to schedule independent meetings for each team. Consider allowing mentors to present “mini-lessons” about their work during this time. Mentors can teach better when they know who they are teaching, and their impact as role models for science—arguably their most important function here—is greater when they and their science interests are better known to students.

Continue to send teachers a syllabus of weekly activities before Science Camp begins. To make sure that more detailed weekly lesson plans are communicated to all teachers week by week, assign responsibility for this, either to the mentor or the educator.

Include take-home objects as part of the science activity, where possible. These allow children to engage their parents in their science learning, extending their own interest and building support for science among parents.

Develop an evaluation of student learning. The primary goal of this project is to strengthen elementary school students’ interest in and understanding of science. Assessing student learning and attitude change directly, perhaps through a short piece of written work, will provide formative evaluation to the Montshire educators who develop the lessons and add legitimacy to the program.
Improve publicity for the Open House, and consider asking students to participate in brief presentations about their Science Camp work to increase interest among families.

Consider alternatives to the Open House for sixth and eighth graders, such as visits to College labs or classroom, that will help illuminate the pathway to a science career.

Continue to hold a wrap-up dinner for program participants. This final conversation creates a face-to-face community where conversation among all stakeholders is shared and public.

**Conclusions**

The goal of Howard Hughes Medical Institute grants is to “strengthen education in biology and related sciences… advance public understanding and appreciation of science and to broaden access to science for all persons, including women and members of groups underrepresented in the sciences.” In those terms, this outreach effort succeeds disproportionately to its modest size. Science education for elementary school students in an under-resourced rural school is strengthened through the addition high quality inquiry activities that enhance the regular curriculum and provide new ideas (and materials) for classroom teachers. The activities are presented by engaging young scientists who contradict the stereotype of stuffy, isolated scientists. As they interact with young students, they demonstrate that scientists are regular people, like them, and that a career in science is not only exciting, it is an real option for youngsters in poor, rural New England towns. The Dartmouth mentors not only receive teaching experience that will make them more effective high school and college science teachers, they find their own enjoyment of science revitalized by guiding youngsters through the discovery process.

The value of the Science Camp concept, which was amply demonstrated in its initial year, was confirmed in its second iteration. Important changes in the second year, especially linking the lessons to each grade’s science curriculum and enhancing communication among all participants, strengthened the project substantially and removed reservations about its fit with the district’s established science program. The main issue that arose this year was mentors’ perception that they were not prepared to explain the science as clearly and completely as they would have liked. They proposed a number of strategies to improve their understanding of Science Camp topics: assign them to teach topics related to their own fields, provide lists of resources for further study, and make the link between concept, activity and motivation clearer in the trainings. Mentors also suggested that they could have done better if they had a clearer
understanding of the academic level of their students. The December training day is one venue where teachers can fill mentors in about their students; the classroom pre-visit is another opportunity for mentors to learn about their students and establish a friendly and informal relationship that increases their effectiveness as role models for science careers. Other recommendations in this report propose fine-tuning a project that is already, as one teacher put it, “solid.”