Montshire-Rivendell-Dartmouth HHMI Science Camp

Year Four Evaluation Report

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

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<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Program Description</td>
<td>4</td>
</tr>
<tr>
<td>Mentor Recruitment and Assignments</td>
<td>4</td>
</tr>
<tr>
<td>Orientation</td>
<td>8</td>
</tr>
<tr>
<td>Mentor Training</td>
<td>10</td>
</tr>
<tr>
<td>Classroom Experience</td>
<td>13</td>
</tr>
<tr>
<td>Teachers’ Perspective</td>
<td>14</td>
</tr>
<tr>
<td>Mentors’ Perspective</td>
<td>17</td>
</tr>
<tr>
<td>Student Outcomes</td>
<td>23</td>
</tr>
<tr>
<td>Teachers’ Perspective</td>
<td>24</td>
</tr>
<tr>
<td>Mentors’ Perspective</td>
<td>24</td>
</tr>
<tr>
<td>Student assessments</td>
<td>25</td>
</tr>
<tr>
<td>Open House</td>
<td>30</td>
</tr>
<tr>
<td>Conclusions and Recommendations</td>
<td>30</td>
</tr>
<tr>
<td>Appendices: Interview protocols</td>
<td>33</td>
</tr>
</tbody>
</table>
Introduction

Now in its fourth and final year, the HHMI-sponsored Dartmouth-Montshire-Rivendell Science Camp program stands as a model for efficiently improving the science experience of elementary school students, their teachers, and their college-student mentors. With its emphasis on science concepts and process, Science Camp brings Rivendell students engaging inquiry science that is, as one mentor observed, “more like college science” than the usual elementary school fare. Students emerge with deeper understanding of fundamental science ideas and a more favorable attitude toward science. Interaction with approachable young mentors helps to erode the stereotypic depictions of scientists that distance them from young students, shifting attitudes toward that expressed by one fourth grader: scientists are “normal people that have studied cool stuff.” Teachers are introduced to new curriculum and inquiry techniques, have the pleasure of working with enthusiastic young scientists, and see their students excited about science. Working with MMS educators and their host teachers, mentors acquire valuable pedagogical skills and improve their ability to communicate science to lay audiences; interacting with energetic youngsters, they refresh their own enthusiasm for science. And every year, Science Camp persuades a few talented young scientists to take up a career in teaching. As one mentor summarized, “Science Camp…fostered a love of science for everyone involved.”

Science Camp achieved this success by bolstering a creative idea—training enthusiastic and approachable young scientists to teach science to elementary students—with a supportive structure and infusing it with respectful communication. Adding a formal orientation session and a classroom pre-visit facilitated collaboration between mentors and teachers. Linking lessons to the existing curriculum made both more powerful, improved communication between MMS educators and teachers and significantly improved teacher satisfaction. Beefing up the pedagogical seminar series for mentors gave them better classroom skills. Time was also a factor: as participants knew one another and their roles better, everyone was better able to self-correct, helping the entire program to run more smoothly and effectively.
As this phase of Science Camp draws to a close, we asked teachers and mentors to identify the core elements of Science Camp, those components without which Science Camp could not be successful. For teachers, three elements stood out: high-quality lessons and materials, dynamic and well-trained mentors, and the responsiveness of the partnership with MMS. Mentors also identified three core elements: the experience of being responsible for the classroom, where what they said (and who they were) made a difference in kids’ lives; interaction with the teachers; and solid MMS preparation and support. Mentors also noted that working in teams and as part of a community of mentors enhanced their learning, while Montshire’s well-prepared lessons and smooth organization allowed them to focus on the pedagogical job—and have fun doing it. Any future incarnation of Science Camp should preserve these elements.

Finally, as MMS considers expanding Science Camp to other venues, we asked teachers how the program should approach a school unfamiliar with the program. Their message was unambiguous. First and most important, “involve teachers from the beginning and explain that this is a partnership; we’re here to work with you.” Another put it this way: “Communication is key. Explain that we’re here to help with science. Ask the school what they want, and be flexible.” A third said, “Assure them that all avenues of communication are open.” Second, explain how this program has already been successful in a local school. They suggested bringing Rivendell teachers who had participated in Science Camp to present about the program, providing expert testimony about how Science Camp “lightens teachers’ burdens,” “provides excellent curriculum and materials,” “gives teachers the ‘hook’ to teach science,” and shows them a “new way to think about science.” One also suggested bringing experienced mentors to the initial meeting to explain what Science Camp meant to them.

Science Camp could take different forms in different environments without sacrificing its central tenets of high quality science, well prepared mentors, and open communication and respectful collaboration among all participants. The following report, based on in-depth interviews Jane Korey conducted immediately after Science Camp with all host teachers and all mentors but one, documents the fourth iteration of Science Camp at Rivendell, describing in detail how the core elements took shape in Winter 2010. Interview protocols are included as appendices to this report.
Program Description

Science Camp began with the Fall term recruitment of Dartmouth undergraduate and graduate students to be Science Camp mentors during Winter term. The first formal Science Camp activity was a two-hour orientation for mentors and participating Rivendell faculty at the museum with Montshire education staff on January 7. The following week mentors visited their assigned Rivendell classrooms to meet the students they would teach and observe the classroom in action. For the next six weeks, mentors met at MMS for a two-hour training on Monday evenings; on Wednesdays they traveled to a Rivendell school to teach hands-on science lessons to third, fourth, fifth, sixth or eighth graders. The program culminated with a celebratory open house at Montshire Museum on March 4 attended by mentors, Rivendell faculty, Rivendell students and their families. This section describes the major components of Science Camp.

Mentor Recruitment and Assignments

Mentor recruitment. In October 2009 project P. I. Roger Sloboda asked science departments and organizations to forward to their majors and members an announcement soliciting Science Camp applications. This formal invitation is supported by unsolicited word-of-mouth promotion by Science Camp graduates, especially among the more stable graduate student populations. This year, twenty-five students submitted applications; two dropped out on account of scheduling conflicts. This strategy yielded applicants who were motivated and highly qualified but, as in the preceding two years, there were just enough applications to meet program needs. If the program wishes to expand, it will need a more effective recruitment strategy. In mentor interviews we solicited ideas for more productive strategies for reaching prospective Science Camp mentors.

More than any other strategy, mentors recommended repeated emails to a wider population of students, perhaps including all students taking a science class, instead of just majors, as well as students taking an education course (many students who are not education majors but who entertain an interest in teaching take an education course or two, as had a number of this year’s mentors). While mentors said that email remains the
best way to contact students, they also noted students routinely delete unopened emails whose author or content is not immediately recognizable to them. However, persistence appears to pay off: if you keep trying, many students will ultimately read emails from unfamiliar sources. It is not reasonable, however, to place the burden for expanded and repeated emailing on department administrators, although it is important to retain the imprimatur of science departments in publicizing the program, especially for graduate students. One strategy might be to combine the two approaches. In addition to the current practice of working through departments, the program could assume direct responsibility for broader and follow-up emails about Science Camp by compiling and using effectively a master list of students involved with science through organizations, department majors/minors or courses.

Mentors also suggested that the announcement should give a fuller picture of Science Camp, perhaps including information about the lesson content, the social opportunities (meeting new people), and the payment. Several pointed out that no one would apply for such a program just for the payment, but the fact that the time is compensated might allow some interested students to apply who could not afford to undertake a volunteer activity. (It is worth noting in this context that each year several mentors mention in interviews that they were not aware until late in the program that Science Camp was not a volunteer activity.)

The announcement should be designed to allay concerns applicants may have about their eligibility and preparedness, the nature of the commitment, and the time required. Because Science Camp is sponsored by HHMI, the application should make clear that it is not a program just for medical and pre-medical students and that, as one mentor put it, “you are given all the tools you need” to do the job. Mentors reported that some students do not apply because in November their Winter term schedules are not certain. Mentors suggested that the message encourage these students to apply anyway, with the assurance that they can withdraw if conflicts arise. Although the time requirements are stated in the announcement, one mentor felt that the 6-7 hour per week estimate of time required was high. It might be useful to point out that the effort is very unlikely to exceed 6-7 hours, and that all mentors thus far have reported that the time commitment was easy to manage.
Mentors strongly reinforced the importance of word-of-mouth marketing, saying that Science Camp graduates should be asked to “talk it up” with fellow students. Emails to Science Camp graduates in the Fall could remind them to encourage fellow students to apply; they should also be featured at the information session, where their testimony would add credibility to the presentation.

The role of graduate advisors is critical in recruiting graduate students. Many graduate students noted the importance of having graduate advisors onboard. One recommended, “Get the graduate advisors interested.” Another noted, “PI’s are the key—tell them it will help with science communication.” More aggressive promotion among graduate advisors, perhaps an email or even paper mail from a respected colleague laying our clearly the demands and rewards of the program, would alleviate lingering concerns—or make advisors aware of the opportunity. Advisors who have had students participate already recognize the value of the program; their students felt that the application made acquiring permission seem daunting and may have discouraged some applicants. Two action items emerge from this situation: indicate in the application that getting permission is a routine matter and proselytize graduate advisors to insure that is a true statement.

Finally, mentors also concluded that “it is good to see it [information about the program] in more than one place,” and recommended using posters, flyers, informational tables at organizational fairs or science presentations—even Facebook and Twitter—to promote Science Camp. It appears that in an age of information overload, the best way to be heard is to repeat and diversify the message.

Mentor assignments. Montshire educators assigned mentors to teams, and teams to classrooms, for the duration of the program, giving each group the opportunity to develop as a team and to establish rapport with their students and host teacher. Twenty-two mentors were placed in 10 classes, working with eight teachers. Again this year, the majority of mentors were women (62%); unlike previous years, however, most were undergraduates (62%). Table 1 organizes the mentors by the grade they taught.
Table 1. Mentor Assignments

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* Another mentor assigned to 6th grade left the College after two weeks in the program, leaving one 6th grade class with a single mentor.

Mentor recruitment and assignments: Summary. While working through science departments to recruit mentors has consistently yielded highly qualified and motivated mentors, the number of applicants is surprisingly low for a program that mentors endorse so consistently and enthusiastically. If the program wishes to attract more applicants, mentors suggested expanding the present recruitment practice by emailing information describing the program’s full range of activities and rewards directly and repeatedly to a large subset of the campus, by actively encouraging past mentors to recruit new applicants (and calling on their testimony at the informational session), by using multiple avenues to get the message out and by working with graduate advisors to make sure that they appreciate the value of Science Camp to their students.
Orientation

January training day. Science Camp began officially on January 7 with a two-hour workshop at MMS where Rivendell faculty and Dartmouth mentors got acquainted and learned together about the goals and methods of Science Camp from MMS science educators Greg DeFrancis, Amy VanderKooi, Rachel Donegan and Mike Fenzel. The workshop used hands-on science exercises to exemplify the MMS approach to science education and to introduce this year’s Science Camp theme: “The Importance of Literacy and Documentation to Children’s Science Work.” After working in two large groups on experiments with density (third and fourth grade faculty and mentors) and batteries (fifth through eighth grade), the groups broke into classroom teams where mentors and faculty could become better acquainted and begin to plan their Science Camp collaboration. To help them understand the program’s structure, participants received a handout laying out the roles and responsibilities of all parties—MMS educators, mentors, RISD faculty, RISD administrators, and Dartmouth faculty/staff. Mentors also received an annotated syllabus for the Monday-night seminar series, outlining the seminar’s goals and learning objectives as well as the topics covered.

Now in its third year, teachers consider the MMS orientation workshop to be a necessary and integral part of Science Camp. They uniformly value the opportunity to refresh inquiry skills, to meet the mentors and to share insights about their classes. Mentors were also enthusiastic about the orientation, seeing it, in the words of one typical response, as “a good way to think about science education, find out what the program is about and meet the teachers.” One mentor said that he was “on the fence” about the program until attending the orientation. “When I saw how excited the teachers were, that definitely hooked me!.”

Classroom pre-visit. In 2009 the Science Camp calendar was extended by one week (to seven weeks) so that mentors could spend one class period visiting their assigned classrooms before teaching an actual lesson. Like the orientation, teachers now

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1 In 2007, the first year of HHMI Science Camp, teachers and mentors met together for an hour at the Samuel Morey School. Attendance was poor and the program much less robust than in project years 2–4.

2 The only mentor who did not find the orientation useful was one whose co-mentors did not attend.
see this opportunity for mentors to get acquainted with the students and with the
classroom routine as fundamental to the program, describing it variously as “essential”
and “key.” Students agreed. All the mentors interviewed said the pre-visit helped them
do their jobs better. Mentors who had the most direct interaction with the Rivendell
students during the pre-visit derived the greatest benefit. Sometimes this interaction took
the form of a lengthy conversation, as this mentor describes:

We had a very open talk in the circle, with lots of questions and answers. The
teacher facilitated, so we could see how he ran the class and how the kids were
used to learning. We talked about what we would do in Science Camp.
Establishing a relationship with the kids before we became teachers led to a very
comfortable environment.

Sometimes mentors participated in the activity of the class, as this mentor
describes. “We saw how the class worked, how much they knew about [the tools we
would be using], how the teacher handled the class and how they responded. It was
helpful to interact with the kids without the extra burden of actually teaching a lesson.”
Her partner said, “We would have floundered without this.”

While all mentors had a chance to meet students and find out something about
them, mentors whose visits involved more interaction with students felt they gained
more; those who spent part of the time on the sidelines observing the class or talking with
the teacher felt they gained less. Several also noted that it would be helpful if students
wore nametags, both at the pre-visit and for several classes after, to facilitate the learning
of names.

Orientation: Summary. The two-hour orientation workshop at MMS and the
classroom pre-visit by mentors are now integral parts of the Science Camp program,
fulfilling essential functions. Again this year teachers and mentors strongly endorsed
these opportunities to familiarize themselves ahead of time with the program’s workings
and participants, noting that the program would function less well without the preparation
they provide. Reviewing inquiry science, meeting one’s team and students, and getting
mentors into the classroom before they teach all promote the open and informed
communication about science that motivates Science Camp.
Mentor Training

Hour one: dinner and all-group seminars. On the Monday night before each of the six Wednesday lessons, mentors spend two hours at MMS preparing to teach. During the first hour MMS provides dinner, mentors have an opportunity to share experiences as a large group, and educators lead a seminar about science pedagogy. This year MMS Education Director DeFrancis asked mentors to complete a brief “mid-term check-in” so that the staff could find out what was working well and address submerged issues and unanswered questions. The overall goal of the seminars is to help mentors develop their ability to communicate science to a lay audience; objectives include understanding the role of inquiry in science teaching, current topics in science education, making meaning of classroom experience, classroom management skills and developing lesson plans.

Mentors rated these sessions as uneven in usefulness: the exchange with other mentors was often tepid and the seminars only sometimes hit the mark.

Ten mentors mentioned how much they enjoyed sharing classroom experiences during the whole-group sessions. Hearing about the experiences of others was both reassuring (“It confirms that you’re not alone.”) and inspiring (“It gave me new ideas.”). But there was less of it than they would have liked. One mentor who observed that “it was a quiet group” went on to add that “it is hard to explain to those not at your grade why what you did or encountered or asked did or did not work. You needed a lot of preface.” Another attributed the silence of the group to the same cause, noting that “discussions were better in the small group, where we had a shared experience to draw from.” He went on to point out that large-group discussions need to be structured to bring the focus to the big picture, where everyone’s experience would be relevant.

The seminars themselves were rated as “good/useful” by five mentors, six said they were “mostly good,” five found them “sometimes useful,” and four said they were not useful at all. Of the sixteen mentors who found the sessions helpful in some part, eleven volunteered that the session about “asking the right question” was the most useful, noting that the concept was new (to them) and important and had immediate classroom applicability. One mentor saw the structure of that session as a model: “We read the paper beforehand and [the information in the session] was directly tied to our classroom
experience. This session changed my behavior.” Six mentors said the video about private theories was thought-provoking and relevant to the classroom, alerting them to science misconceptions among their students and, in some cases, themselves. Four offered that they found value in the discussion of levels of inquiry and different ways of student learning.

Mentors thus valued most the sessions where they learned “concrete skills that translate directly to the classroom.” They voiced a pressing need for what one called “little tricks” that would help them convey science when they shortly faced a class of curious, energetic youngsters. While mentors were interested in learning education theory and appreciated “zooming out to talk about big issues,” and while they enjoyed “messing about with science” with hands-on activities, they were impatient when the connection to their own teaching grew thin. As one mentor explained, “I liked the hands-on exercises, seeing what the kids would have to do, experiencing the science from their perspective. But this was not as useful [as other seminar activities] because it didn’t address my problems—how to get the kids to actually do it!” These exercises not only took time from activities that might have been more helpful, they were sometimes an irritant to students who were themselves no strangers to hands-on science. One mentor observed diplomatically, “There’s a fine line to walk between demonstrating how to talk to nine year-olds without turning the mentors themselves into nine year-olds. Modeling is helpful, but we’re not elementary school students and our responses are not those of nine year-olds.” A blunter appraisal: “It was patronizing. These were important concepts, but the sessions need more hand-outs, less hands-on; more stuff, less fluff.” Seven mentors said they found the pedagogical sessions too long, partly on this account. Five recommended making the large-group sessions shorter and the grade-specific sessions longer, both because they were more immediately useful and because they supported productive sharing of experiences.

Hour two: grade-specific preparation. During the second Monday-night hour, mentors work with an MMS educator in grade-specific groups to prepare Wednesday’s

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3 Because there were five grades and only four educators, one group (this year the 5th grade) met for an hour before the dinner/seminar hour. One member of this group
lessons. Many groups began with a debriefing of the previous week’s lesson, a practice mentors invariably found useful. Educators then typically provided lesson outlines and materials and walked mentors through the activities, exploring the main concepts to be conveyed, discussing various approaches to teaching the materials, and alerting mentors to possible glitches, including student misconceptions. Preparation often included a discussion of lesson logistics—how to organize time and the team members’ respective efforts. When the main elements were present—debriefing, walk through, main concepts, logistical planning, heads-up to possible problems—mentors left feeling confident and ready to teach. When any element was missing, mentors noted the absence: “learning objectives were not clear; [the instruction] was better on exploring than understanding;” “we could have used more discussion of time management, more planning for structuring the presentation with our partners.” In general, however, mentors found the grade-specific preparation effective and enjoyable. One concluded, “It was a good balance. There was enough structure not to feel lost [in the classroom] and enough freedom not to feel rigid.”

The exception this year was the eighth grade, where poor communication between the MMS educator and the teacher and a curriculum whose inherently unpredictable progress was under the control of the teacher made it hard for mentors to plan lessons or know what materials would be needed. One mentor explained, “The kids would not be doing what we expected when we got there, so we had to improvise. It was hard to tie it all together in the end.” Another said, “It was frustrating. In the end we gave up and went with the flow.” Said a third, “We were flying by the seat of our pants, shooting from the hip.” This was not a satisfying experience for mentors, who not only felt that they did not do a good teaching job (although they felt they connected well with the students) but also were burdened with the feeling that they should somehow have been able to fix the situation.

Mentor Training: Summary. Mentors take their jobs seriously; they do not want to fail their students. For that reason, they want their limited training time to be productive. They understand that they can learn much from each other and from the regretted that they could not, therefore, think about how to apply the concepts discussed in the seminar to that week’s lesson.
experienced and capable Montshire educators and they are aggrieved when those opportunities are lost. To make training more efficient, large-group discussions should either be more skillfully facilitated to draw out hesitant speakers and reveal the broader relevance of particular situations or discussion time should be transferred to the small group sessions, where shared experience provides a common vocabulary for dialogue.

The seminar sessions should be tightened. Each year mentors identify as most helpful the “asking the right question” session, where mentors come prepared to participate by reading a short, clear article beforehand and where they are introduced to an idea that is—as the mentor quoted above noted—new (to them), important and directly relevant to their teaching. Each session should include these critical elements. The role of hands-on activities in the seminars should be re-evaluated. It is undeniably important for mentors to appreciate the value to elementary school students of “messing around with science”—and the time that may require—but it is not clear that repeated exercises of this type are the best way to communicate that truth. The inclusion of hands-on activities should reflect the fact that mentors’ experiences with these activities are not, and cannot be, like those of the students they teach.

Most mentors said the grade-level preparation sessions were solid, providing the information, materials, techniques and support they needed to teach. Poor communication and an inauspicious choice of curriculum, however, too often left the eighth grade mentors without those tools. The fact that mentors felt they had no one to fall back on but themselves points to the need for a clearly defined problem-solving structure within the program where mentors can turn in such instances.

**Classroom Experience**

The hour and a half mentors spend with children in the classroom each week is where the rubber meets the road for Science Camp. Here the theory and techniques mentors acquire in Monday night sessions come up against a roomful of eager, but sometimes restless or distracted, youngsters. Here teachers must find the careful balance between ceding classroom authority while making sure that students stay focused and on task. If mentors are well prepared and the relationship between the mentors and host
teacher is productive, as it typically is, Science Camp is successful: students learn and are excited by science, mentors gain valuable teaching experience and teachers get new ideas and the pleasure of seeing their students energized about science. This section discusses the classroom experience from the teachers’ and mentors’ perspectives.

**Teachers’ Perspective**

**Lessons.** Science Camp lessons that extend and enrich the regular classroom science curriculum based on state grade expectations remain the program’s most important feature for teachers. This year the fit with curriculum was perfect for grades three through six, but perhaps too perfect in grade eight. As they did last year, the third and fourth grade classes followed the Insights curriculum for the six weeks of Science Camp, with mentors slotting their lessons seamlessly into the sequence. MMS educator Mike Fenton collaborated closely with third grade teachers, who particularly appreciated his creating several new lessons in magnetism, a topic included in the GE’s but not in the Insights curriculum. The Science Camp lessons, one teacher commented, “dovetailed perfectly” with the regular curriculum, giving them greater depth.

Responding to concerns from fourth grade teachers about the difficulties of teaching astronomy in Science Camp, the fourth grade this year studied states of matter, with MMS educator Amy VanderKooi devoting special attention to density, a topic not well covered in the regular curriculum. One teacher noted that the Science Camp and the regular lessons were “all tied together, so everything made sense. The lessons enriched the regular curriculum, which doesn’t do much with density. This was a new concept that the students got really well.” Another teacher simply described the change as “fantastic.”

The fifth grade, which had studied heat last year, returned to the study of mechanics, which the teacher judged a better curricular fit. The lessons created by Mike Fenton “had more reality to them [than the heat experiments] so that kids can see connections and generalize. This year’s were the best designed experiments and follow-through.”

MMS educator Greg DeFrancis worked with sixth grade teachers to develop lessons about electricity. Teachers liked having the main concepts laid out and some coaching ahead of time for what one considered a challenging topic. Time was also a
challenge in the sixth grade. Unlike the lower grades, middle school periods are only 45 minutes long, making it hard for mentors to finish a hands-on lesson. Topics sometimes had to be completed by the teachers, who would have appreciated receiving a more detailed lesson plan ahead of time, so that the continuation could be better planned.

Close collaboration between teachers and MMS educators in the third, fourth, fifth and sixth grades produced Science Camp sequences that engaged students and enriched the standard curriculum; teachers uniformly commended both the collaboration and the product. However, the choice of the Environmental Detectives curriculum for the eighth grade—albeit engaging—left little room for enrichment. The Environmental Detectives is a rich, hands-on curriculum developed nearly a decade ago in a collaboration between Dartmouth’s Toxic Metals program, MMS and a group of local middle school science teachers, including the Rivendell teacher, who has taught it ever since. Over the years Environmental Detectives acquired life and form in the Rivendell classroom, becoming an academic staple that proved difficult to modify with new material or approaches. As a result, mentors often fulfilled the role of “extra hands,” assistance that was much appreciated by the teacher, but failed to meet mentors’ needs.

Teachers had few recommendations for change in the Science Camp curriculum. One suggested using more open-ended prompts, perhaps even designing a lesson around a situation that students had to solve. Another felt students should be more involved in demonstrating their work at the open house in order to show parents their understanding. Most simply agreed with the teacher who said, “I wouldn’t change anything. It went very well.”

**Relationship with mentors.** Teachers had only praise for their mentors, whom many proclaimed the best “crop” yet. They described their relationship as “open and friendly,” “wonderful,” “excellent.” One teacher said of her team, “Our collaboration was seamless; there was unspoken trust between us.” The easy relationship between teachers and mentors in part reflects the teachers’ growing comfort and skill in their role as hosts, knowing when and how to assist mentors without undermining their authority in the classroom. It also bespeaks the stronger MMS training program. Despite the shortcomings mentors identified (reported above), MMS trainings gave mentors a wide range of classroom management skills as well as solid preparation in their science topics.
Asked about the strengths and weaknesses of mentors’ teaching, teachers’ comments highlighted many areas MMS educators have emphasized in the training—as asking good questions, waiting for responses, breaking down concepts, encouraging all students to participate.

- Their strength was their ability to ask really good questions. They really made the students think, and they didn’t jump in when kids were stuck. They waited. They did a fine job; they couldn’t have done better.

- They set the lesson up nicely and did a good job of explaining at kid level, gave good examples, and did a good job of explaining why it’s important to take notes and graph data.

- They were good at drawing things out of the kids, waiting for them.

- They really knew the material. They were good at answering questions and treating all kids equally.

- They were well organized, creative, spontaneous, methodical, sensitive to the kids’ pace, good with questions and very conscientious. They were always prepared, knew the concepts and had practiced with the materials.

- This group was the best ever. The MMS preparation was better this year and the mentors had more confidence because they were better prepared.

**Value for teachers.** All teachers said Science Camp was a worthwhile experience for them and all would volunteer to participate again (if Science Camp were voluntary!). In large part, teachers value the program because of what it offers their students: better science lessons and a new and different perspective on science and scientists (these results are discussed at greater length in the “Student Outcomes” section). Science Camp also had direct value for teachers, most of whom said they discovered new ideas and new approaches for teaching science. They also appreciated the opportunity to step back and “see science from a different perspective, see how experiments are done and concepts explained.” Finally, as one put it, “Science Camp rubs off on us as well. It’s fun teaching as a team.”

**Teachers’ Classroom Experience: Summary.** Overall, teachers gave Science Camp a grade of “A” (3 grades of “A+,” four grades of “A,” and one “B+”)—the best overall grade Science Camp has received in its four years. Most agreed with the teacher
who said, “This was the best yet.” Teachers who offered comments with their grades cited a close and respectful collaboration with MMS educators and better mentor training to explain their endorsement.

- Science Camp gets better and better. This year MMS was very flexible with planning, asking what would you like, how can we enrich your science curriculum?

- I can’t say too much about how great it went this year. The mentor training was better; the lesson was really at the child level and mentors’ transitions and class management improved.

**Mentors’ Perspective**

**Lessons.** Mentors said most lessons were good: they were age-appropriate with clear concepts and interesting hands-on activities that could be accomplished in the class time. Most also felt the lessons were well structured, moving logically from introduction to vocabulary to hands-on exercises and then to wrap-up. Many mentioned the importance of including note-taking and graphing in the lessons. In almost every grade, however, there were some stand-outs and some exercises that could have gone better.

Third grade: mentors agreed that the hidden circuit board exercise was “great” and the compass activity was “cool,” but they were divided about whether some other lessons (e.g. electromagnetism, galvanometer) were “challenging” or “over their heads.” Several mentors felt that they themselves lacked a deep enough understanding of those concepts to translate them for third graders (and didn’t get that understanding in lesson preparation). While students were excited and enthusiastic about all the lessons and learned about science process through them, some mentors felt that having fun with science was not enough.

Fourth grade: Mentors all praised these lessons, saying that the concepts were straightforward and easy to present and that the lessons built on one another from week to week. The hot-air balloon exercise was a favorite; the melting ice experiment was somewhat boring and not, several pointed out, the best way to kick off Science Camp.

Fifth grade: Most of the mechanics lesson worked well and “pushed the kids the right amount.” Mentors said that the context provided by Mr. Noseworthy’s lessons on
mechanics in between Science Camp lessons was important in making their own teaching successful.

Sixth grade: Although the potato battery exercise was “chaotic,” with many metals to consider and a complex table to track them, mentors said the lessons on electricity were good, although sometimes difficult to fit into a 45-minute class period (recall the teacher’s concerns noted above)

Eighth grade: When eighth grade mentors had lessons to present, with learning objectives and protocols (e.g., the radish seed bio-assay), they said the lessons were good and the teaching was satisfying. But too often they had no lessons. The Environmental Detectives curriculum selected for eighth grade is flexibly structured; students move at their own pace through the curriculum and, in its usual implementation, college students serve as teacher’s assistants. Thus both the structure and the practice of Environmental Detectives worked against pedagogical autonomy for mentors: there were few opportunities to actually teach a lesson, but many opportunities to assist students individually. Mentors were left to “show up and see where they’re at,” in the words of one. Another said, “After [the bio-assay lesson] it was a free-for-all. Go see where the kids are and decide what to do.” While one-on-one assistance from young scientists undoubtedly benefited the Rivendell students, it did not provide the responsibility for organizing a lesson and communicating science concepts to a class that mentors sought.

Whatever shortcomings mentors from all grades may have found in this lesson or that, they recognized that the MMS approach “takes teaching science to another level. It should be taught this way, but it usually isn’t.” Another noted that the science they were teaching was “more like college science, in tune with the meaning of science.”

Relationship with the host teacher. Mentors all appreciated the enthusiasm and engagement teachers brought to the program. When that positive attitude was combined with respectful collaboration, a truly productive relationship developed. Host teachers in successful collaborations maintained a careful balance between ceding responsibility and providing support. One mentor described that equipoise: “She let us do our own thing, but was very much present.” More than anything else, mentors valued being given responsibility for the lesson. Some typical comments;

• It was a hands-off affair. This was our class to teach. I liked that.
• Our teacher told us this was our class—that gave us confidence. It was good to know that we had the time to ourselves—it was our lesson.

• [My teacher] let us take over, was respectful, positive, supportive.

• [My teacher] let me have the floor, got out of my way. I got to teach the kids.

• The most important thing was being responsible for the class—what I said mattered.

While mentors were grateful to have teaching autonomy, they also appreciated the skillful way in which teachers managed their classes so as to support mentors’ efforts. Many teachers prepared their classes ahead of time for the lessons, “priming” students to participate, and followed up afterward to make sure that understanding was secure. Most assigned any needed working groups, using their knowledge of classroom dynamics to help avoid behavioral distractions, and kept students focused and on task. Many would clarify when mentors were unclear, without diminishing the mentors’ authority. These remarks are typical:

• [Our teacher] could guide the class when we lost track, then hand back control.

• [Our teacher] would rephrase what we said in even more basic terms and then we would know how to present the idea better.

• [Our teacher] sometimes helped to clarify a concept, but always chose the right way and the right time.

Mentors invariably appreciated opportunities to chat with their teachers after class, reviewing the lesson and picking up pointers for improvement. Those who did not have this opportunity because of the end-of-day rush wish that they had. Building a short debriefing time into the schedule would help mentors address problems immediately and build their teaching skills and confidence faster.

In most classrooms mentors enjoyed both autonomy and support, and they were generous in their praise for their host teachers. As one said, “I have nothing but the greatest respect for [our teacher]. S/he is an awesome teacher.” Another offered perhaps the ultimate compliment: “We always knew that we wouldn’t fail in [our teacher’s] classroom.” But when mentors’ autonomy was compromised and support was
inadequate, the collaboration was not salutary for mentors, even though the personal relationships among all parties were pleasant.

Probably because teachers supported mentors skillfully and because MMS included classroom management techniques in mentor training, the only real teaching challenge mentors mentioned was teaching a diverse classroom. One noted that you really needed to know students individually in order to find the right approach for them; another wondered how best to include students with special needs, who were often accompanied by an aide. Several observed that their classrooms provided real-life examples of variations in learning modes they had studied in psychology classes. Mentors saw this challenge in a positive light, as yet another opportunity to figure out how to communicate science. Thus mentors uniformly said they were comfortable in the classroom. Lessons were well planned, students were respectful and well prepared, and teachers were welcoming and supportive.

Value to mentors. Mentors overwhelmingly found Science Camp a worthwhile experience. As one enthusiastically proclaimed, “It was worthwhile times three! I always looked forward to it and it was always fulfilling.” The value in Science Camp came both from what mentors received—instruction and practice in teaching science—and from what they shared—a love of science. Asked what they had learned from Science Camp, most mentors mentioned pedagogical skills that were discussed in the Monday night seminars. These quotes from mentors are typical:

• *how to ask good questions*: I learned that there are good and worse questions; this is really important!

• *how to empower students to learn for themselves*: I learned that it’s really important to let kids figure things out for themselves. Science Camp reminded me what it’s like to think at that level, what it’s like not to understand. You have to listen to see how they see the concept.

• *how to allow sufficient time for learning*: I learned how to go hands-on with a class, how to let them do their own thing and be comfortable spending as much time as they needed on each aspect of the lesson.

---

4 The only mentor who did not find this year’s program worthwhile was involved with the 8th grade Environmental Detectives curriculum, an experience s/he described as “fun, but a waste of time.”
• **how to engage and motivate students with different interests and abilities:** I learned a lot about how to motivate a class, how important the class dynamic is. Our class had a very wide range of students. I learned to use different styles—sometimes humor, sometimes more didactic—and how to fuse them.

• **how to break down concepts so students can understand them:** I learned to explain big concepts through smaller, incremental steps, how to connect past learning to present.

Many also mentioned insights they gained by working with MMS educators: the importance of having a learning objective, how to set up an experiment to teach a concept creatively, how to transition from one part of a lesson to another. Finally, they talked about what they learned from the Rivendell students: that different people think differently about the world—including science—and you have to adjust your presentation to engage them where they are.

Over half the mentors entered the program planning to enter some kind of teaching profession, from outdoor programs and environmental education to high school and college teaching. Three more said their Science Camp experience spurred an interest in teaching. As one mentor explained, “Science Camp taught me more about myself, what I can do, what I’m interested in. I was always interested in education, but I thought it was secondary to science. Now I’m very interested in education and will look into it more.” Another said, “Science Camp got me more interested in teaching. That surprised me. I hadn’t thought about teaching as a career, but now [the interest] is definitely there.” These future teachers especially valued being in the classroom, where they could practice skills they will apply directly to their own teaching.

The insights students gained from Science Camp are fundamental not only to inquiry science but also to successful science communication in general. Mentors saw a clear parallel between making science concepts comprehensible and interesting for elementary school students and doing the same for other non-scientists. They said that working with youngsters improved their science communication skills by showing them the importance of knowing their audience and by teaching them how to break down complex concepts for that audience’s level of understanding. These mentor comments are exemplary:
• I learned how to think about a concept at the fourth grade level, without assuming my own knowledge. So I also learned how to think about science concepts in a way the general public of non-scientists can understand.

• I learned that when you have to speak about your work, you have to know your audience and keep it simple. You have to stress the big ideas, the take-away message.

• I learned how to present ideas clearly to someone who is not a scientist. I will run into this a lot in my profession.

• I learned how to communicate more effectively. This will help me educate patients about their medical condition, giving them the information they need to be in control of their situation.

• I learned how to communicate what I do to those outside my field. I can now explain what I do to my mother—or a grant reader.

Mentors also valued the opportunity to share their love of science with children, to “bring science into kids’ lives in a unique and exciting way.” Several recalled a standout science teacher from their K-12 years and appreciated the chance to “give that to others.” But this was not a one-way street. As one mentor explained, “Science Camp gets kids excited about science and reminds college students why they are excited about science.” Another concurred, “Science Camp is a great way to foster a love of science. That’s the best thing it did and it did it for everyone involved.”

Woven though mentors’ teaching and learning experiences are other dimensions of Science Camp that help to make it a fulfilling experience. The interaction with the children was, in and of itself, a great pleasure for mentors. Science Camp also provides social opportunities for mentors to “meet people in other science disciplines” and a break from the normal (and sometimes punishing) student routine, a chance “to get out of the research bubble.” It is not only an opportunity to “get out there and do something good for the community,” it also provides mentors a “real-world experience” that promotes “more perspective on life in general.” As another observed, “It helps Dartmouth students realize that the world is full of people who think differently, who are not exposed to the same things we are. It gives both them and us a different perspective.” And dinner is always appreciated.

Mentors’ Classroom Experience: Summary. Science Camp mentors loved being in the classroom and almost all gave this year’s program very high marks. As one said,
“There wasn’t anything about it that wasn’t worthwhile.” Several said that Science Camp “was the best thing I did all Winter.” Sharing their passion for science with the Rivendell students, who were both different from the mentors and from each other, infused reality into their pedagogical training and built their teaching skills, confidence and interest. Mentors most valued having the responsibility to present an entire science lesson. Working through the full course of a lesson—starting with the initial science concept to be explained, helping to develop exemplifying hands-on activities and explanatory strategies, planning the structure and pacing of the lesson and finally presenting it to young students—gave them insights into science communication that will help them be better science communicators with any audience. Working with skillful host teachers not only made their job easier, it enhanced and expanded the pedagogical lessons. It is testimony to the power of the core feature of Science Camp, the pairing of young academic scientists with elementary school students, that even in the eighth grade, where poor communication and unfortunate curriculum choice thwarted mentors’ teaching efforts, mentors still learned from and enjoyed their experience.5

Student Outcomes

The primary goal of Science Camp is to build student interest and confidence in doing science by bringing exciting and relevant science to the classroom. To determine whether students understood the basic concepts and science process of the science activities they performed and whether they emerged with a more positive view of science as an endeavor, we asked teachers and mentors to assess student gains. We also measured student progress directly, asking students to complete a short pre-post attitude task and a final written constructed response exercise about a concept they studied. All three evaluative perspectives indicate that Rivendell students understood the science they studied and formed a more positive view of science in the process.

5 One eighth grade mentor, who said interacting with the students was a great experience, nevertheless said that s/he would not voluntarily repeat this year’s Science Camp.
Teachers’ Perspective

Again this year, all Rivendell teachers said that Science Camp was a worthwhile experience for their students, bringing them exciting science and expanding their understanding of science and scientists. Several mentioned that their students deepened their understanding of science topics; several also noted the importance of learning how to keep good records about science activities. But teachers said the greatest “value added” of the program was mentors’ presence as role models, who both motivated students about science and demystified science as a career. These quotes are typical:

• They see fresh young scientists, real people with real personalities. They were great role models. We also got to do more inquiry with better materials and well-planned lessons.

• Science Camp makes science more exciting. My students are engrossed in science and they see real scientists and learn about them.

• My students got more than I could have given them.

• We had smoother science lessons, great materials, and more individual attention for the students. The mentors were great role models—that’s very important.

• Having mentors here showed my students a different world of science, that it exists outside the classroom.

• My students formed real relationships with a new person; they saw the human side of science. Science Camp gave them a new perspective on science and scientists.

Mentors’ Perspective

All mentors believed that Science Camp was a worthwhile experience for Rivendell students. Having teachers who were different—and younger—made science more accessible and more fun. Mentors also recognized their importance as role models who demonstrated not only that scientists are “real people” but also that perseverance pays off. As one explained, “They liked that we had different backgrounds. They could see that school effort pays off. If you put in the effort, you arrive somewhere.”

But Science Camp accomplished much more than making science fun. Mentors in every grade felt that their students learned the main concepts presented. While not all students achieved the same level of understanding, mentors felt that third and sixth
graders understood some basic concepts about electricity and magnetism, that fourth 
graders grasped the concept of density (and knew that it was not the same thing as 
weight), that fifth graders understood mechanical advantage, and that eighth graders 
learned much about experimental design. As one mentor said, “Students really 
understood the concepts well; the concepts really “took.” It was exciting. And all the 
concepts were tied to the big idea, so they solidified over the course of Science Camp.”

Mentors also believed that Rivendell students came away with a better 
understanding of science process, from forming a testable question to setting up an 
appropriate experiment to taking notes and gathering data to drawing conclusions. 
Again, mentors in every grade cited these gains. For example, a third grade mentor said, 
“They learned what an experiment is, about finding a testable question, testing 
systematically, manipulating variables, making up different trials.” Fourth grade 
mentors felt their students learned “how to think scientifically,” from designing 
experiments to taking careful measurements to drawing conclusions from data. “They 
may not remember the facts,” one said, “but the concepts and skills will stay.” A fifth 
grade mentor felt students learned “the importance of science process, how to ask good 
questions and develop an hypothesis, how to collect data and make graphs.” A sixth 
grade mentor mentioned, as did several others, that students learned the important science 
precept that “it is OK to be wrong.” Eighth graders not only learned how to develop a 
researchable question and set up an experiment, mentors said they also “began to see 
science outside the classroom” (as did fourth graders who studied density).

Student Assessments

We also measured student outcomes through written assessments of student 
learning and attitude change. Mentors for each class developed a short “constructed 
response” exercise to measure student comprehension of some important concept they 
had presented; teachers administered the exercises after the completion of Science Camp 
and sent them to mentors for grading. The creation of authentic assessment instruments 
was instructive for mentors, who had to revisit the main themes of their topics and create 
novel scenarios to test learning in an age-appropriate and authentic way.
As Table 2 shows, most students completed these exercises proficiently, suggesting that they had more than a superficial grasp of relatively complex concepts like density, force and effort, circuits and dose dependency. Results from three classes are missing; we have yet to perfect the logistics of getting student assessments from teachers to mentors (whose Dartmouth term is just ending) to the evaluator. However, there is no reason to believe that students in the missing classes, who had equally capable mentors and well-prepared lessons, would perform differently. Nor is there any reason to assume that modest proficiency differences among classes indicate stronger or weaker implementations. A single test of a few concepts, developed and graded by different teams, is a rough measure of accomplishment, supporting only the conclusion that most Rivendell students understood the fundamental ideas they encountered in Science Camp.

Table 2. Results of final constructed response questions.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>TOPIC</th>
<th>QUESTION SUMMARY</th>
<th>% PROFICIENT</th>
<th>% PARTIALLY PROFICIENT</th>
<th>% NOT PROFICIENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Crimmin (N = 11)</td>
<td>States of matter 1. What happens if you put a golf ball in water? Which is denser?</td>
<td>73%</td>
<td>18%</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Identify molecular schematics for water, air and golf balls.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Does an ice cube melt faster at room temperature or in the sun? Why?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Derosier (N = 12)</td>
<td>States of matter Think of an estuary, where salt and fresh water mix. Which is denser, fresh or salt water? Show how they layer in a cup. If you add (1) a pebble and (2) a twig, will they float, stay in the middle, or sink?</td>
<td>58%</td>
<td>17%</td>
<td>25%</td>
</tr>
<tr>
<td>5</td>
<td>Belknap (N = 14)</td>
<td>States of matter 1. Identify molecular schematics for solids, liquids and gases.</td>
<td>86%</td>
<td>14%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Identify most and least dense liquids in a layered column.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. What happens to an ice cube in a cup at room temperature? Does that change the mass?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Noseworthy N = 25</td>
<td>Mechanics Levers: 1. Graph and interpret data relating distance, load and effort.</td>
<td>68%</td>
<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Solve lever problem. 3. Identify lever classes. Pulleys: 1. Give example of pulley</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Science Camp intends not only to introduce students to interesting science, it also aims to introduce them to interesting and approachable scientists. The belief that science is a career only for those who are unusual in their talents or personality prevents many students from considering a career in science, even if they may like doing science. Putting hip young scientists in the classroom, who share students’ interests and language, helps students understand that being a scientist does not involve a retreat from “real life.” To determine whether spending time with Science Camp mentors helped students characterize scientists in a more positive and familiar way, we conducted a brief pre-post exercise, asking students to write down five things that come to mind when they think about a scientist. The logistical challenges were at least twice as daunting with the pre-post exercise and we collected only four matched sets, 3 from fourth grade and one from sixth grade. The exercises were evaluated using the rubric in Table 3. Mean scores from students in the four classes are presented in Table 4.
Table 3. Scoring rubric for the “Five things I think about scientists” exercise

<table>
<thead>
<tr>
<th>Score</th>
<th>Type of Comment</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>Negative</td>
<td>Unflattering characterization</td>
<td>Weird, evil, not affectionate, no romance, know-it-alls, geeky</td>
</tr>
<tr>
<td>-1</td>
<td>Mad Scientist</td>
<td>Includes characteristics of stereotypic “mad scientist”</td>
<td>White lab coat, crazy/white hair, aging, goggles/glasses, potions, beakers/flasks/test tubes</td>
</tr>
<tr>
<td>1</td>
<td>Neutral</td>
<td>Accurate, no emotional valence</td>
<td>Do experiments/research/tests/analysis, work in labs/outdoors, study bugs/diseases/rocks, etc.</td>
</tr>
<tr>
<td>1</td>
<td>Positive</td>
<td>Positive emotional valence</td>
<td>Are nice, try to help people, try to make the world better, cure diseases, are smart*</td>
</tr>
<tr>
<td>3</td>
<td>Personal</td>
<td>Refers to students’ own experience (including their experience with mentors)</td>
<td>Can be anyone of any age/wear anything/work anywhere/study multitude of things, studies what my mentors study or what I studied in Science Camp, teaches, reads, thinks, follows special procedures described by mentors, e.g., “take accurate information,” “are careful about what they do when they do experiments,” “explain their work,” “use cool tools,” “love to learn,” “make mistakes,” “graph,” “talk to their lab partners”</td>
</tr>
</tbody>
</table>

“Smart” was coded as positive, although some students may have ambivalent feelings about that descriptor.

Table 4. Mean scores for “5 Things I think About a Scientist”

<table>
<thead>
<tr>
<th>GRADE</th>
<th>NUMBER OF STUDENTS</th>
<th>MEAN PRE-SCORE</th>
<th>MEAN POST-SCORE</th>
<th>MEAN DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Crimmin</td>
<td>9</td>
<td>4.8</td>
<td>6.6</td>
</tr>
<tr>
<td>4</td>
<td>Derosier</td>
<td>10</td>
<td>3.0</td>
<td>13.3</td>
</tr>
<tr>
<td>4</td>
<td>Belknap</td>
<td>13</td>
<td>5.0</td>
<td>7.5</td>
</tr>
<tr>
<td>6</td>
<td>Christie-Maples</td>
<td>15</td>
<td>2.8</td>
<td>5.7</td>
</tr>
<tr>
<td>ALL</td>
<td></td>
<td>47</td>
<td>3.8</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Students in all four classes viewed scientists in a more positive and less stereotypic way after their Science Camp experience. It may be relevant that the class with the greatest gain devoted the final class period to an engaging activity that clearly connected the student experiment to what mentors did as scientists and to the real world. Here is one example from that class showing how a portrayal with stereotypic underpinnings was replaced by a more personal one:
February 1. Five things I think about when I think about a scientist are:

1. Scientists working in a science lab with a lot projects going on.
2. I think of them wearing a long lab coat.
3. They look like Albert Einstein.
4. They study all sorts of things like plants, the earth, humans and much, much more.
5. They make lots of hypothesis’s about there experiments.

March 17. I think a scientist discovers everything or anything in the world like plants, the earth and more. I also think that scientists most of the time work in groups. Another thing is that scientists also don’t fool around and that they take there time on things. I also think that scientist make lots of hypothesis’s because if they didn’t most of the time there experiments wouldn’t work.

Another student in the same class, who started with a neutral to positive view of scientists also emerged with a closer and more dynamic understanding.

February 1. Five Things I Think about when I Think of a Scientist are:

1. Playing with matter and syringes and balloons.
2. Making scientific observations and graphs.
3. Testing hypothesis and wearing white lab coats.
4. Using magnifying glasses to test, study and write more.
5. Scientist love to observe and learn more about why, when, what and how things happen in the world (scientifically such as earthquakes).

March 17.

1. A scientist is a girl or boy who studys interesting problems and ways to fix them in the world.
2. They don’t have to wear a lab coat, they can wear anything. They are normal people that have studied cool stuff.
3. A scientist can have lots of fun doing experiments and making notes about what they do. If another scientist wants to try it they can follow the notes of the other scientist.
4. Being a scientist can be really fun! especially if you see or do something you have never before done or saw.

Student Outcomes: Summary. We measured student outcomes from three different but reliable perspectives: the teachers’ assessments of student gains, mentors’ assessments of student learning and written student assessments. All three measures support the conclusion that students understood the main concepts they studied in Science Camp, including important aspects of science process, and emerged with a more positive and personal view of scientists. Mentors were sometimes surprised by how eager
students were to learn science and how much they were able to understand. Teachers emphasized the importance of mentors as role models, demonstrating, as the student quoted above observed, that scientists “are normal people that have studied cool stuff.”

_Open House_

The March 4 Open House at Montshire Museum provided an appropriate and appreciated venue for participants to share their accomplishments with each other and with their families. Participation this year was the best yet; the building was crowded with excited youth and beaming parents, teachers and mentors. The large turn-out this year undoubtedly reflects more aggressive promotion of the event to children and families and clear, safe winter weather. But it also reflects the enthusiasm Science Camp has generated among students. Everyone loved the Open House. The only suggestion: recruit students more formally to demonstrate their work at the Open House (i.e., “Who can be at our table at Montshire between 5 and 5:30 to show visitors how a compass works?”), so that tables always have a student docent.

_Conclusions and Recommendations_

Now in its fourth year, Science Camp has achieved a form and practice that ensure rewards for all participants. There is no question that Science Camp has met its goals of improving elementary school children’s experience with school science—with all that entails in terms of inquiry and relevance, assisting teachers in their efforts to bolster the science curriculum and helping young scientists become better science communicators. As one mentor noted, “Science Camp is a great way to foster a love of science. That’s the best thing it did and it did it for everyone involved.”

From a rather spare beginning, Science Camp now has in place a sturdy support system for participants. The robust orientation session for all participants and the required classroom pre-visit for mentors ensure that mentors and their host teachers have the knowledge about the program and each other that enables a productive collaboration. These elements are, as teachers observed, “essential.” Genuine partnership and close communication between teachers and MMS staff, especially around aligning the Science Camp activities with the existing curriculum, guarantee that the exciting and well-crafted
hands-on science activities also deepen and extend the science curriculum. A solid mentor training program helps mentors build on their own knowledge and enthusiasm to be successful in the elementary school classroom, improving their science communication skills in the bargain. The final MMS Open House provides a fitting venue for the accomplishments and energy of Science Camp participants.

As one teacher noted, “Every year Science Camp gets better, but every year we see something that can be improved.” Keeping in mind the resounding success of Science Camp, where everyone learned and everyone had fun, the concluding paragraphs discuss those needed improvements.

**Recruitment.** If organizers hope to increase the number of mentors, they will need to take more aggressive action. The present recruitment strategy has worked for the past four years, but just barely. Although it has consistently drawn highly qualified and motivated mentors, the number just meets program requirements. One alternative would be to augment the present method of email announcements from science departments and organizations (a practice with numerous advantages) with a simultaneous invitation directly from program personnel to a broader population, with repeated follow-up emails from the program to both sets of potential mentors. Mentors also suggested diversifying the media employed to get the message out (use posters, a presence at various science gatherings, Facebook, Twitter), making better use of Science Camp alumni as recruiters, and ensuring that graduate advisors actively support the program.

**Curriculum selection.** Choose areas to explore where teachers voice a need for substantive support. The value of Science Camp to mentors lies in learning how to break down a complex concept for a non-scientific audience. Every topic chosen should present them that opportunity.

**Mentor training.** Make the seminars tighter and more dense. Mentors need as much knowledge about learning and teaching as they can acquire in six one-hour sessions and they are accustomed to (and even enjoy) being stretched intellectually. Exploring the theoretical grounding for each topic more deeply would make those principles easier to generalize to non-school settings; including more examples of classroom applications would make them more useful immediately. Limit the use of hands-on exercises in the seminars to what is needed to understand their role and implementation in the classroom.
The lesson on asking the right question provides a useful template for a successful seminar. Educators might exploit their College connection in developing the more theoretical components of the seminars.

Improve opportunities for mentors to share their experiences, either through more focused and better facilitated all-group conversations or by shifting time for discussion to the grade-specific training, where shared experience promotes dialogue.

Communication. The program is to be commended for promoting communication among MMS educators, teachers and mentors. Teachers attribute much of the program’s success to open and respectful dialogue that fine-tunes the curriculum and smoothes the week-to-week implementation. An important opportunity for productive talk that is not exploited is the time right after class, when a short debriefing between teacher and mentor would be very productive.

The failure of communication in the eighth grade this year highlights the importance of meaningful and consistent interchange. It also exposed lacunae in program organization that should be addressed. Science Camp needs a problem-solving structure that any participant can utilize when they cannot turn to their direct associates. Closer involvement of building principals would fill one gap in the problem-solving structure; the designation of several MMS staff or the evaluator as ombudsmen for mentors would complete the arrangement.
Appendix 1.

Teacher Interview Protocol
Dartmouth-Montshire Science Camp at Rivendell
Winter 2010

Introduction. Thanks. Confidential/anonymous.

I. This is the fourth year of Science Camp. Was there anything different or surprising or notable about this year’s program? [For Gordon: Did anything about this program surprise you?]

• Next—and we’ll unpack your answer to this over the rest of the interview—would you say that this year’s program worked better, worse or about the same as previous years’?

II. Next I’d like to talk about how Science Camp worked for your students.

1. What did you think about this year’s lessons?
   Prompts:
   • How was the set-up?
   • Did the lessons engage the students?
   • How was the wrap-up, the “meaning making” part?
   • How did the lessons fit with your regular science curriculum?

2. What did your students learn from Science Camp that they would not have learned from their regular science curriculum and activities? In other words, what is the value-added of Science Camp?

3. Do you think this was a worthwhile experience for your students? Why or why not?

4. What could we change about the program to make it a more worthwhile for your students?

III. Now I’d like to talk about your experience with Science Camp.

1. How would you describe your relationship with the Montshire staff?
   • Was the orientation session effective?
   • Was communication adequate?

2. How would you describe your relationship with the Dartmouth mentors?

3. What were the mentors strengths as science teachers? Were there aspects of their teaching that could (or should) have been better?
• Are there skills and understandings they could realistically acquire—in their training or in some other way—that would make them more effective science communicators in the classroom?

4. Now I’d like to ask you the same thing I asked about your students: taking into account the time and effort involved, was this a worthwhile experience for you? Why or why not?
• If this were a volunteer activity next year, would you do this again? Why or why not?
• What grade would you give Science Camp, on an A – F scale? If not “A,” what would have made it an A?

III. Summarizing thoughts
1. This is the last year of this grant. Please think about the program in its final form and tell me what you consider to be the core elements that make Science Camp worthwhile, those essential components without which the program would not be successful.

2. If HHMI approves the Science Camp re-application, the program will be introduced into several other schools. What advice would you offer us as we begin the process of setting up Science Camp with teachers at new schools?

Is there anything else you’d like to add about the Science Mentor program that we haven’t talked about already?

Thanks so much for your time.
Appendix 2.

Student Interview Protocol
Dartmouth-Montshire Science Camp at Rivendell
Winter 2010

Introduction. Thanks. Confidential/anonymous.

I. Did this program surprise you in any way? Please expand.

II. For the next part of the interview I’d like to talk about the science lessons themselves.

1. First, please comment on the lessons themselves. Were they interesting? Age-appropriate? Logistically smooth?

3. What do you think the Rivendell students learned from Science Camp? (Feel free to think specifically and globally.)

5. Do you think this was a worthwhile experience for the Rivendell students? Why or why not?

III. Now I’d like to talk about your role in the program.

1. [PRE-CAMP ACTIVITIES] There were two activities that took place before Science Camp began.
   • First was the January 8 orientation session at MMS. Please describe briefly what your team (mentors and teacher) talked about. Did that meeting help you do your Science Camp job better? If so, why?
   • Second was the meeting with your class the week before Science Camp actually began. Same question: Please describe briefly what your team did during that hour. Did that meeting help you do your Science Camp job better? If so, why?

2. [TRAINING SESSIONS] Overall, what is your assessment of the training sessions?

   • Were Greg’s pedagogical sessions in the first hour helpful? Why or why not?
   • Did the grade-level training sessions prepare you adequately for the classroom?
   • How did you feel about your degree of involvement in developing lessons for your grade?
   • Is there anything that could have been done differently to make the trainings more effective? Or more interesting? Or more worthwhile to you in the longer term?
3. [CLASSROOM EXPERIENCE] How comfortable did you feel when you were actually with the class in the classroom?
   • Did that change over the course of the program? How? Why?

4. Please describe your relationship with the classroom teacher.

5. Please tell me something you learned from this experience.
   (Why did you pick that to tell me?)
   • Can you tell me something you learned from this experience that you believe will be useful after you graduate?

6. Now I’d like to ask you the same thing I asked about the Rivendell students: taking into account the time and effort involved, was this a worthwhile experience for you?
   • Unpacking the cost-benefit analysis, what were the costs and what were the benefits for you as a science mentor?
   • Please complete the following sentence: “The Dartmouth-Montshire-Rivendell Science Mentor program is a great way to________________________.”
   • Knowing what you know now, would you do this again? Or, put another way, would advise another student to do this? Why or why not?

7. Would you like to comment on the organization of the program—scheduling, food, travel, arrangements with school, use of time, etc?

8. Each year we just make our quota of mentors. Do you have any suggestions for ways to attract more students to the program?

IV. This is the last year of a four-year grant. If our re-application is accepted, Science Camp will expand into new schools. As we do that, what do you see as the critical elements that must be in place for the program to succeed for you, for the students you teach and for the teachers?

VI. Is there anything else you’d like to add about the Science Mentor program that we haven’t talked about already?

Thanks so much for your time.