Montshire-Rivendell-Dartmouth HHMI Science Camp

Evaluation Report

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This report documents the experience of 18 Dartmouth students who served as mentors at an in-school "Science Camp" for elementary school children in the Rivendell interstate (NH-VT) school district. Supported by a grant to Dartmouth College from the Howard Hughes Medical Institute, Science Camp partnered Dartmouth students' knowledge and enthusiasm for science with Montshire Museum's expertise in science education to bring hands-on science to over 150 second, third, fifth and sixth graders in this rural New Hampshire and Vermont district. The series of six weekly in-school science sessions, the first of four annual iterations, were held during Dartmouth's 2007 Winter term. In the words of Dartmouth's HHMI proposal, the goals of the outreach partnership with the Montshire Museum and the Rivendell School district are three-fold: "(1) to excite students and give them confidence about learning science; (2) to provide students with a sense of contemporary science; and (3) to encourage students to see the relevance of science in their lives." While this report will consider those goals as evaluated by the mentors, our focus is on the experience of the Dartmouth students as science communicators. What did they take away from the program? The evaluation of the Dartmouth students' experience asked whether science camp was a worthwhile experience for them, what factors contributed to its value and which, if any, diminished it.

This report is based on confidential, in-depth interviews with 17 of the 18 participating Dartmouth students, given context by the evaluator's classroom observations. All but one of the Dartmouth mentors participated in a 20 – 30 minute interview in the early weeks of Spring term (March 26 – April 5); extensive notes were taken during the interview. Students were asked to evaluate the science activities they implemented and their impact on Rivendell students, to assess the efficacy of their training sessions at the Montshire Museum and to describe their own experience in the program and its value to them. The interview protocol is appended to this report. During the science camp, the evaluator attended most Monday evening debriefings (and some training sessions) and observed on every Science Camp classroom day, usually visiting three Rivendell classrooms during the 90-minute session.

Dartmouth mentors had a very positive asssessment of the program. All felt that Science Camp benefited Rivendell students; their assessments suggest that Science Camp achieved its goals of explaining science and making it exciting, relevant and approachable for the elementary students. The Dartmouth mentors also said clearly that Science Camp met their goals for themselves. In their applications, mentors said they wanted to work with children, learn how to teach and contribute to the local community. In all three areas they pronounced Science Camp a success. All the mentors enjoyed working with the Rivendell students and many emphasized how pleased they were to serve Dartmouth's neighbors in this way. They also identified long-term gains: teaching in an elementary school classroom imparted communication and planning skills with broad applicability. As one mentor observed, working with youngsters forces you to "think about what you are doing in a different way, reduce things to their most essential." Mentors said insights from Science Camp would make them better scientists, doctors, and professors.

Program Description

Recruitment. An email announcement about the science mentoring opportunity sent to College science departments and organizations in November 2006 produced 67 student requests for more information. Several dozen students attended an informational meeting held soon afterward and 23 students, divided almost equally between undergraduates and gradute students or postdocs, submitted formal applications for the program. In mid-December the selection committee[1] chose eighteen mentors who would work as teams in nine Rivendell classrooms. Considering the specific time commitment required during Winter term (6 – 8 PM on six Monday nights for training and 12:45 – 3:30 on six Wednesday afternoons for travel and classroom work) and the fact that most students' Winter schedules were already fixed by the early December application deadline, we judge this response to indicate a strong interest in teaching opportunities among Dartmouth students. Graduate students in particular said they were seeking teaching positions but have had no opportunities to teach.

Training. Mentors were assigned 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. The teams were constituted to reflect the diversity of the group (and of science in general): seven of the nine teams included both a man and a women, eight linked students from different levels of study (one team comprised two graduate students), and no team included students 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 represented in the group.

[1] Roger Sloboda, Nancy Serrell, Vicki May and Jane Korey

GRADE	2nd	3rd	5th	6th
GENDER	3 women 1 man	4 women 2 men	2 women 2 men	2 women 2 men
LEVEL OF STUDY	2 undergrads 2 grad. students	2 undergrads 3 grad. students 1 post-doc	2 undergrads 2 grad. students	1 undergrad 2 grad. students 1 post-doc
MAJOR/ FIELD	Biology Public Health Physics Engineering/ Studio Art	Engineering (3) PBS (2) History	Math Genetics Medicine Engineering/ Physics	Engineering PBS Education Pharmacology-Toxicology

The program began with an hour-long introductory meeting at the Samuel Morey School in Fairlee, VT on January 4 where, under the guidance of Montshire science educators Greg DeFrancis and Amy VanderKooi, mentors and teachers worked together in small groups on the kind of science activity the mentors would soon be leading (and the teachers observing). The first two-hour dinner/training session was held at the Montshire Museum on Monday evening, January 15. All sessions began with dinner and whole-group discussions with Montshire staff where Dartmouth mentors could raise questions and share concerns or observations from the previous week. One Rivendell teacher, sixth grade science teacher Carol Foley, attended all the training sessions. After dinner, students broke into two groups for training, with the second and third grade mentors working with VanderKooi on activities for those grades, while the fifth and sixth grade mentors worked with DeFrancis on activities for the older children. For the six-week program Montshire staff had developed lessons (with supporting materials) on reflection and density for the younger children and lessons on mechanics and chemistry for fifth and sixth graders. During the training sessions, VanderKooi and DeFrancis "taught" the lesson as the Dartmouth students worked through the exercises as if they were elementary students. This strategy allowed the mentors to observe expert teaching practice while experiencing the challenges of the learner. On January 17, nine mentor teams carpooled to the three Rivendell schools to lead their first activities in the classroom. They ultimately conducted four more sessions, missing one planned classroom day on account of a "snow day." The project culminated with a family night at the Montshire attended by Montshire staff, Dartmouth administrators and mentors, and over 200 Rivendell students, families, faculty and administrators.

Mentors' Assessment of Science Camp

We asked the mentors whether they judged the science lessons to be age-appropriate, easy to implement, and effective in terms of student learning (Section II in the interview protocol). Their assessment was strongly positive; indeed, one mentor mentioned the high quality of the activities as something that "surprised me" about the program.

Science Camp Lessons. Mentors uniformly said that the lessons were easy to implement in the ninety-minute period and with the materials provided. There were a few minor glitches—a set of flashlights that didn't work, a missing reagent, rooms too sunny for lessons about shadows and filters—but overall they reported that the lessons were well designed, with discrete parts that could be omitted if time ran short but plenty of intrinsic interest to keep kids exploring if they had extra time.

The other four questions in Section II directly or indirectly raised the issue of student learning: Were the lessons age-appropriate? What did students learn? What did they take away from Science Camp overall? Was the experience worthwhile for their students? While all mentors said the lessons were age-appropriate, half added a "but" that referenced student learning. Among the ten second/third grade mentors, seven felt that some concepts—particularly density—were "hard" for their students to grasp, although they felt that the activities themselves were suitable and contributed to learning in other ways. Of the seven fifth/sixth grade mentors interviewed, three identified the gear ratio lesson with Legos as problematic in one way or another. One felt the Legos were hard to manipulate and led to frustration that inhibited concept learning; one felt the concept was simply too hard for this age group; a third found the exercise "pointless," since students "simply copied what they saw in the directions." The other four fifth/sixth grade mentors were strongly positive about all of the lessons; two volunteered that the lessons skillfully accommodated the wide variation in interest and ability among students of that age.

The question about age-appropriateness forced mentors to think about what elementary school students should be learning about science. Is science learning for this age group about understanding concepts, or may it involve simply becoming familiar with ways of thinking about and doing science? The nine mentors who qualified their responses to the age-appropriateness question, including six of the seven undergraduates, were uneasy with the notion of a science lesson that did not result in conceptual learning. The unqualified "yes" responses of the other eight interviewees, including seven of the ten post-graduate students, implied comfort with the idea that participating in science also constitutes science learning. This difference, of course, reflects the long-standing distinction between the view of science as a body of knowledge and as a systematic activity for understanding the world. In this case, students with deeper experience in science were more likely to represent the science-as-activity perspective than were the less experienced undergraduates.

Student Learning Outcomes. Two interview questions addressed student learning directly. We first asked mentors what they thought Rivendell students learned at Science Camp and then what students "took away" from the "overall experience," offering them the opportunity to think about the impact of the program at different levels. While mentors were somewhat more likely to talk about learning concepts and procedures in the more restricted context, they frequently took a broader view. Statements like "They learned that science is fun" and "They learned that science is part of everyday life" were common answers to both questions. Taken as a whole, there was little to distinguish responses to the two questions and they are considered together in the following discussion. Whatever difference there was in what mentors believed students *should* get out of a science lessons, they were in strong agreement about what the Rivendell students actually *did* learn. While most felt that the benefits of exposure to science concepts and practices will be more apparent later in students' science education, they saw immediate rewards in terms of the children's enthusiasm and changes in attitude and perspective.

More than anything else, Dartmouth mentors said that participation in Science Camp showed Rivendell students that science is fun. Responding to these two questions, every mentor interviewed mentioned that students came to see science as "fun," "cool," "neat," or "exciting." Repeatedly, mentors indicated how excited students were by Science Camp, an enthusiasm that was expressed by their eager anticipation of their mentors' Wednesday afternoon arrival, their eagerness during the lessons, and by their dismay at the lost session. Observation supports that while the activities were often messy and the results imperfect, students were happily engaged throughout and were delighted to have created a rotating cam, a periscope or an accurate prediction about the identity of a "mystery powder." In this regard, several mentors noted that students liked having something tangible to carry away, and suggested creating some record or memento of their experience, perhaps a brief log or journal.

Mentors also felt that the Rivendell students expanded their understanding of science, either in terms of its fundamental concepts or the nature of its activities; 15 of the 17 mentors interviewed mentioned some aspect of science learning in their response. Seven cited exposure to scientific knowledge, terminology and concepts as an important outcome of Science Camp, noting that even if concepts were not mastered, exposure to them—and the accompanying enthusiasm for science—strengthened the children's foundation for later learning. As one put it, "[the elementary students] got an innate sense of how things act." Seven other mentors reported that students learned about aspects of scientific practice: how to observe, how to organize complex observations, and how to do "if-then" thinking. One felt that students came to appreciate that "science comes in a variety of forms." Several suggested that students began to grasp the creative open-endedness of scientific inquiry: one observed that students learned how to figure out the next step to take in a scientific inquiry "and not worry about making a mistake;" another mentor said students figured out "that with simple things you can create more complex ideas, and you can play around with these." These characteristics are central to modern scientific inquiry.

Finally, ten mentors referenced the way Science Camp demystified science, helping students to see it less as an abstract activity carried out by special (and generally inaccessible) people and more as something that was part of everyday life, done by regular people—even, perhaps, themselves. One mentor observed, "The projects were designed to show that science is around them everywhere, that the principles of science are not just to be found in a lab; they can also be found in a puddle." Another concurred, "It was important that they used everyday objects in the activities, things that had a practical aspect. This leads to the idea that science is everywhere in their lives, even where they don't expect it." Four mentors noted that part of making science more accessible involved making scientists more familiar. Seeing younger people doing science provided "young role models they can aspire to" and "helped them relate better to science." It also led, as five mentors mentioned, to the realization that science is something *they* can do. One concluded, "it gave them a better understanding of what scientists do, that it's not so abstract. They can see themselves doing this kind of stuff." Another pointed out that the hands-on activities "allows them to be part of the scientific community." As one mentor summarized, "They learned that science can be fun and that they can do it too."

The mentors' concluded uniformly that Science Camp was a "worthwhile experience" for Rivendell students. Again, they cited students' excitement, their enthusiasm for science, and the acquisition of a "new perspective" on science, one that connected it to creative inquiry, to everyday life and to approachable young scientists. In the assessment of the Dartmouth science mentors, the program achieved the stated goals of instilling excitement and confidence about doing science, communicating a sense of how science is done, and making science relevant to their own lives.

Mentors' Assessment of Their Training and Classroom Experience

Section III of the interview asked students to assess the efficacy of their training, describe their classroom experience, and gauge the value of the program to themselves. They praised Montshire science educators Greg DeFrancis and Amy VanderKooi for their creative pedagogy and thorough planning and their host teachers for their sensitive cooperation and support. While many began gingerly, and some felt challenged along the way to explain concepts effectively or to manage delicate social situations, by the end of the program all mentors felt confident in their instructional roles.

Training. All mentors said that they were well prepared in the science of the lessons they were to teach, and several remarked upon the efficacy of the pedagogy employed by Montshire staff, who modeled teaching practice in the training sessions while mentors assumed the role of students. Several cited the importance of learning how to ask guiding questions. Although most mentors were science majors and solidly grounded in basic science, a few said that they learned some science in the trainings. A number mentioned that they appreciated the Monday-night opportunity to get to know other mentors. One concluded, "It worked really well. I can't think of a better way to do it." Another described it as "perfect."

Classroom experience. Some mentors were troubled by their students' inability to grasp some science concepts, making them feel less confident, especially in the beginning, about their own ability to convey the science concepts to children. At least four second/third grade mentors worried about how to communicate concepts they understood fully in terms children could understand. As one explained,

> Sometimes it was not clear how to approach concepts like buoyancy and density. This is a very subtle thing. I'm very familiar with it, so it was frustrating not to be able to convey this to the students. You don't want to dumb it down and introduce concepts like weight that are really inappropriate—but that they understand—but they don't know mass and volume. When I tried to explain, it didn't go as well as the activities.

Mentors without previous experience teaching young children were most troubled by their perceived inadequacy in this regard, but even mentors who had worked extensively with young children before were sometimes challenged to convey the science. As one experienced young mentor reported, "This was my most challenging teaching experience, trying to explain concepts. It is hard to move on and accept that they don't really understand."

While most of the fifth/sixth grade mentors mentioned that some concepts were not understood, none mentioned that this was troubling to them. It is not clear why they were more sanguine about this outcome. It may be that the concepts of mechanics and chemical reactions are more intuitively accessible to the age group, but the difference may also lie in the nature of the activities themselves. Several lower grade activities took familiar situations (e.g., mirror images, floating things) and asked why they occurred, a scenario that invites and requires a conceptual explanation. Although the upper grade lessons were similarly designed to illustrate an underlying concept, they also produced other new knowledge for children and perhaps for that reason did not require conceptual understanding for a satisfying outcome. The "explanation" for machines that translate motion is apparent in the finished product, and in the chemistry lessons it may be enough to learn that substances *can* interact to change colors or dissolve or bubble without anyone's needing to understand why they do so.

Mentors also faced the same classroom management issues as any new teacher. Most reported feeling "nervous," "awkward" or "like an outsider" on their first day, a feeling they recognized they shared with any beginning teacher. As one described, "It was a little awkward at first. I hadn't realized it would just be us and 15 kids. The teacher stepped back and there we were! We didn't really know how to introduce ourselves or how to get kids talking. But it got better." The mentors encountered the familiar challenges of dealing with students of different abilities and interests and students who wandered off task. Some wondered how to correct students who were wrong without hurting feelings, how to redirect unproductive lines of thought or how to silence the talkative and draw out the timid. All became more comfortable as the program continued, attributing their growing ease to increased familiarity with the students and their host teacher, weekly Montshire debriefings and experience.

Most teams enjoyed—and appreciated—the kind of supportive relationship with the host teacher that was a necessary condition for feeling comfortable in the classroom. Mentors used words like "respectful," "productive," "wonderful," "helpful" and "perfect balance" to describe their interaction with the teacher. They said their host teachers "stepped back" and let them take charge of the class, assisting children with activities as appropriate and interrupting only to connect the lesson to the children's previous learning. They were grateful that the teachers took responsibility for keeping order in the classroom, a job they did not feel competent to do. One mentor described the relationship this way: "We had a complementary relationship. She didn't butt in at all in terms of teaching. Sometimes she provided context, a reference to something the children had already learned. She kept order. She was very helpful. She also had a good strategy for getting them to clean up; that was very helpful." Mentors noted appreciatively when teachers understood and endorsed inquiry science. As one of Carol Foley's mentors noted, "Our relationship was productive the whole way through. Carol was very involved. We had the best situation of all the teams. She was very enthusiastic about the process."

While mentors felt the classroom experience went reasonably smoothly for them and the students, they also had suggestions for improving it, starting with the simple strategy of supplying all students with name tags. Mentors said that getting to know the students was essential to feeling that they belonged in the classroom, and name tags were necessary to that process. They also recommended a closer relationship with the host teacher, starting before the program, to introduce them to the classroom management techniques (for example, the mentors were not told beforehand about the useful district-wide hand-clap system for getting attention) and to provide helpful information about the students, their level of knowledge and comprehension, and their science background. Most noted that the classroom interactions were more efficient after the Rivendell teachers started receiving the upcoming week's Science Camp curriculum, and mentors strongly endorsed that practice. Mentors recognized that their host teachers were highly skilled and a number expressed the desire to benefit from their knowledge. As one said, "I would have liked some feedback from her about how we were doing in the class. I understand this takes more time, but it would have been nice." Another concurred, "I often left wondering how the lesson went. A little feedback from the teachers would go a long way toward improving the quality of the teaching through the term." Four mentors asked specifically for more formal pre-program pedagogical instruction, perhaps a mini-course, workshop or seminar, that would focus on communicating science to young children and managing the social interactions in an elementary classroom.

Program organization. Mentors had nothing but praise for the hard work and organizational skills of Montshire staff DeFrancis and Vanderkooi. As one said, "It was well organized. It's mind-boggling, all that had to take place for this to happen—the organization, materials, everything. A lot of work was done by Greg and Amy." Another typical comment: "It was well planned. The scheduling was good. They did a good job of organizing the materials. The Montshire staff were very supportive, always there to help if we needed it." The car-pooling strategy not only reduced emissions, it gave mentors valuable time to get to know each other, discuss plans and rehash experiences.

Outcomes for Dartmouth Science Mentors

When asked whether participating as a science mentor "was a worthwhile experience for *you*," 16 of the 17 mentors interviewed said emphatically that it was worthwhile and that they would do it again. Indeed, many plan to apply next year and most mentioned that they have promoted the program among their friends. For one graduate student "it was the highlight of my term." Discussing what they learned from the experience, they identified four main factors that contributed to their satisfaction: they had fun, they learned how to work with young children, they learned about teaching and they contributed to the local community. They said that the communications and pedagogical skills acquired through Science Camp would help them in their later careers as science or health professionals.

They had fun. Every mentor spoke about how much fun they had working with the children. Like their students, they too looked forward to Wednesday afternoons. In the words of one mentor, "Working with the kids was a blast!" Several commented that the program offered a break from the "grind" of studying. "It was rejuvenating to see the kids happy, participating and learning." A number of mentors mentioned that the time commitment was easy to manage; no one said that the program was difficult to accommodate in terms of time or schedule.

They learned how to teach science to young children. Asked what they learned from Science Camp, ten mentors talked about learning how to work with young children, citing especially the importance of interactive strategies to engage students with science. As one mentor explained, "I learned that it is really important to expose kids to ideas and to engage them with ideas in a very interactive way." Even the student who did not find the program personally worthwhile said, "I learned that when teaching, sometimes you just have to help students by assisting with the hands-on activity. So when kids didn't understand something, I would figure out an activity to demonstrate the concept instead of explaining it." Part of the inquiry method involved asking the right question, as this mentor notes: "I learned a lot. Over time I got the feel of how to ask questions, how to let students explore." Another theme that emerged importantly was the need to view a question or concept from child's perspective. These comments were typical:

> The big thing I learned is that things that interest me may not engage little kids. The prism was great for me but too abstract for them. That showed me that I need to get into their shoes to figure out what will excite them.
>
> I couldn't predict what they wouldn't understand. I knew they would be excited about science, but *how* they thought really surprised me.
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> I learned that teaching kids is not that easy at all. You have to think in their mentality and that takes a lot of effort.

They gained general pedagogical skills. Mentors also acquired insights into some of the nuts and bolts of teaching practice. Answering the “what did you learn” question, six mentors said they came to appreciate how planning and organization contribute to success in teaching. One noted, “You can’t just walk into someone’s classroom without solid plans. It has to be connected to their curriculum.” Another summarized, “I learned that lots of planning is needed. You have to anticipate all sorts of things. It’s OK to be enthusiastic, but you still must be logical and organized. You have to make it so they want to do it, and that means a making it work for each individual.”

They contributed to the welfare of the community. Finally, mentors also reported that it was rewarding to give back to the community. In talking about why the program was worthwhile, half referred to its community service aspect. For example, one noted, “I feel like I contributed to these kids’ education. This is a nice feeling to have.” Another observed that “this is a great way to get a sense of the local community.” Others took a broader view, contrasting the College’s resources to the region’s resources. “This program is a great way to bring our community into the community around us. Dartmouth College is a great resource of people who want to be involved.” Similarly, another mentor noted, “This program is a great way to use student resources to benefit schools near Dartmouth. Students themselves are a great resource and we can use their skills to contribute in a teaching setting.” The value derived from community service should not be surprising. In their interviews, many of the mentors said they had previously worked with children in a community service program and ten explicitly named the opportunity to contribute to the community as a reason for applying.

Transferring Lessons from Science Camp

Mentors reported that lessons learned in the elementary school classroom would easily transfer to their intended careers. We asked mentors directly what they learned from this experience that will be useful after graduation, but a number volunteered this connection early in the interview. More than anything else, they said that they learned how to break down a construct or idea so that their audience (whoever they might be) can understand it. The three students who plan careers in medicine said this communication skill will help them explain health information to children; the five who plan to teach at the college level said it would help them explain science to undergraduates. Two undergraduates also identified the ability to tailor an explanation to the audience as useful after college. These comments were typical:

> The overall lesson [I learned] is how to get information across. You have to understand who your audience is, what you want them to know, what they bring to it. This ability is useful in any setting.
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> I learned important communication skills. You have to think about what you're doing in a different way, reduce things to the most essential. You have to be very clear in your speaking and explain things in simple ways. Second graders are the best for teaching that.
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> Working with kids will help me relate to my undergraduate students, understand their thought processes. Kids are great for teaching this.
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> I wanted more experience in teaching and this taught me how to explain things in many different ways. I had to think very hard about that. Not everybody learns in the same way. This is a skill that's also needed in teaching undergraduates.
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> This program is a great way to test your ability to communicate science to people who aren't going to get it right away. All scientists need to be able to do this: if people don't understand what we are doing, then what is the point?

Four mentors who expect to teach either in college or high school said that other pedagogical skills, especially the ability to plan and to develop inquiry activities, will be useful to them after school. In their words:

> I learned what really constitutes a hands-on activity, what are the science questions embedded in an activity, and how hard it is to develop activities kids can learn from, not just do.
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> I learned a way to approach organizing a lesson, how to start with a concept and create inquiry activities. I'm not an expert, but I see how the process breaks down.
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> Learning how to engage sixth graders imparts lessons that are useful for all ages. It is always useful to know how to ask the question that leads to thinking. Now when I attend a talk and someone throws out a question, I wonder, "What is the point of this question?"

Finally, four mentors said that participating in Science Camp raised the possibility of a career in education for them. One graduate student preferred to work with science teachers rather than directly with students, but three saw teaching as a new career option:

> I learned that I can be a teacher if I want to. I learned that I like doing this.
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> I learned that I may want to teach sometime, just to make life more interesting.
>
> I learned that I may want to get into education. This has opened a new door for me.

While Science Camp did not set goals for the Dartmouth mentors, the evaluation shows that they benefited greatly from their experience as elementary school science instructors. They took away valuable insights about how to communicate science (or any complex idea) to a lay audience and how to develop inquiry science lessons and activities; they felt they made an important contribution to the community; and they had a lot of fun doing it. The mentors believe that the communication and pedagogical skills acquired during Science Camp will serve them well in their careers, whether they are explaining health information to young patients, science to undergraduates or any complex idea to any audience. There were no systematic differences by gender and the only notable difference that emerged between the experience of undergraduate mentors and graduate mentors concerned the aforementioned reaction to difficulties in explaining concepts; the older students exhibited less concern when the lesson did not achieve conceptual understanding. Otherwise, the mentors' endorsement of Science Camp was similarly enthusiastic, thoughtful and consistent. Remarkably, this brief exposure to the energy and creativity of the science classroom has introduced elementary school teaching as a career possibility to three mentors. Given the great national need for capable science teachers, it is useful to know that a brief, well-orchestrated exposure to real world teaching can motivate talented students toward this career.

Recommendations

Mentors identified two areas where an already-productive and satisfying program could be strengthened. First, they recommended closer coordination between Rivendell teachers and the program at all levels. Almost every mentor mentioned that the lessons worked better after the teachers began receiving the lesson plans and they strongly endorsed continuing this practice. Most suggested other ways in which better planning with the teachers could enhance the coherence, continuity and impact of the lessons. As one mentor commented, "It would also help to integrate science lessons better into existing lesson plans. That would add coherence, instead of Science Camp lessons being isolated events." Another suggested "more coordination with the teachers. We should know what they covered and what they plan to cover so that our activities can be integrated better into their curriculum. This would help the kids more, because it reinforces their learning." Several mentors suggested providing all six lesson plans before Science Camp begins, so that teachers could coordinate their teaching to the lessons. (Several also said that mentors should receive the entire curriculum in the beginning, so that they could teach with the benefit of such an overview.) Some thought the adaptation should go the other way, with the teachers participating in the development of Science Camp lessons tailored to fit their science curricula and the interests of their students. Whichever way the accommodation went, mentors perceived an opportunity for greater impact on students if what they did in the regular classroom and their Science Camp lessons were mutually reinforcing.

Mentors also called for a closer connection between themselves and Rivendell teachers, starting before Science Camp with a face-to-face meeting—or perhaps even just an email exchange—where they could initiate a relationship. Dartmouth mentors felt that they would do a better job if they could learn about the students in their assigned class before they stepped into the classroom; they wanted to know what science the students had studied and their general level of competence. They wanted to be apprised of any classroom logistics that would facilitate their instruction. Several mentors mentioned that their host teachers initially appeared to have reservations about Science Camp; they felt a more substantive initial meeting might help dispel suspicions about personalities or attitudes. Finally, they wanted to benefit from their host teacher's experience through constructive feedback about their teaching. Most Dartmouth mentors applied for the program because they wanted to learn how to teach, and they perceived the absence of coaching from their host teacher as another lost opportunity. One mentor summarized, "The teacher-mentor relationship could be deepened and thus made better." As noted above, four mentors also requested more formal instruction in pedagogy, perhaps a series of workshops or seminars to address issues specific to elementary school and science teaching.

Second, mentors recommended greater voluntary involvement in creating the lessons; they saw this as a way to deepen their perspective on inquiry science, either working with designated topics or their own material. The option of mentors' creating a lesson was floated during Science Camp, but weather-induced time pressures prevented this from happening. One undergraduate said, "I liked the idea of having students create their own projects. I know that this is hard to do—it's hard to backtrack from your own interests to bring them down to a second grade level. If we didn't do our own projects, perhaps another way would be to identify some topics kids would like and let the mentors be creative with them, have more input." Another remarked, "As a graduate student, I'd like to have more involvement in planning the lessons. That would help in learning how to do this. It would also be nice to tailor the experiments to mentors' interests and strengths. It would be OK with me if this took more time."

The matter of "more time" came up repeatedly. Students who recommended additions to Science Camp (extra meetings with teachers, more involvement in planning, extra teaching instruction) all said they would be willing to devote the extra time required to accomplish them. Similarly, the six mentors who specifically requested that Science Camp be longer also indicated that they would be willing to give more time to the program. These comments were typical:

> The program seemed a little abrupt. Six weeks isn't enough. The program would benefit from more continuity.
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> I thought Science Camp went by really quickly. By the time we got comfortable and got going, it was over. I'd like to see it longer. That would be more valuable to the Rivendell students and to us.
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> I think the program should be offered in two consecutive terms. I'd rather do two terms in a row than have to wait a whole year to do it again. That would give *me* a better chance to consolidate what I've learned.

Because the desire to expand Science Camp in some way came up in almost every interview (one mentor proposed extending it to all grades), and because the program's budget is fixed, we asked mentors what difference it made to them, when applying, that a stipend was involved.[2] Some students said it made no difference, some that it was helpful but not determinative. But some said that they had to earn money during the term, and the fact that they were compensated allowed them to participate. While the roster of mentors could probably be filled with volunteers, such an approach would limit the benefits of Science Camp to the better-off and deprive the program of the substantial contributions of those whose economic circumstances require them to work.

Finally, returning to the matter of explaining and understanding concepts that concerned some mentors (undergraduates more than graduates, instructors in lower grades more than upper grades), we suggest that Montshire educators set clear expectations in training. If conceptual understanding is not expected in certain instances, that should be made clear and should be justified on pedagogical grounds so that mentors can focus on what they can accomplish without regrets about what they were unable to do. If conceptual understanding is a reasonable expectation, then more guidance about how to present challenging ideas would be helpful.

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[2] This question was introduced after the sixth interview. The first six interviewees were polled by email about this matter.

Apppendix

Interview Protocol
Dartmouth-Montshire Science Camp at Rivendell
Winter 2007

Introduction. Thanks. Confidential/anonymous.

I. Why did you decide to apply for this program?

- Did it surprise you in any way? Please expand.

[Added beginning with seventh interview:] What difference did it make to you, when applying, that a stipend was attached to this activity?

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

1. In your view, were the lessons age-appropriate?

2. Were these projects that you and the students could reasonably accomplish in the time and with the materials you had?

3. What do you think the Rivendell students learned from the lessons?

4. Thinking about the overall experience for the Rivendell students, what do you think they took away from Science Camp?

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. Thinking first about the science content of the lessons, was your preparation adequate?
   - Why or why not?
   - What should have been done differently?

2. Thinking now about the pedagogical (teaching) aspect of your role, was your preparation adequate?
   - Why or why not?
   - What should have been done differently?

3. How comfortable did you feel when you were actually with the class in the classroom?
   - Did that change over the course of the program?
   - If so, how did it change?
   - What accounts for the change?

4. Please describe your relationship with the classroom teacher. Was that relationship comfortable? productive?

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 <u>you</u>?
   • 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?

IV. This is a four-year program, so now I'd like to ask you to think about the program as a whole and suggest any changes that would make this program more effective in future years. We've covered some of these areas already, but you might want to think about your response in terms of

- increasing value to the Rivendell students
- increasing value to the Dartmouth mentors
- increasing value to the Rivendell teachers

V. Do you have any suggestions for more effective ways to reach Dartmouth students who might be interested in the program in terms of when, where and how to publicize the program?

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.