

Teacher Collaboration and the Science Rotation

By Peter Hippard

Haley walked up to me at recess with a glazed look in her eyes. She was usually a cheerful fifth grader, but today she looked beat.

“How was that science test?” I asked.

“That was really hard,” she replied.

I got a sinking feeling in my gut. If she, a student with good math and language arts scores didn't do well, then the other students probably didn't fair well either.

“What was the hard part?” I asked, trying to be sympathetic.

“I felt like I didn't know a thing on that test. Why do we have to take science tests only in the fifth grade? Why not in the other grades? Why don't we study more science?”

“We do study science, but I guess it's not enough,” I meekly replied.

“That doesn't seem fair,” she huffed. Then she took out her snack and walked off to the basketball court.

I turned to another upper-grade teacher on the yard and asked if she had heard what I had heard.

“Yes. It's depressing and frustrating,” she said. The two of us discussed how stressful it had been to fit in enough science instruction over the years. So much emphasis had been placed on math and language arts that science had really taken a back seat. We decided to get together with the other upper-grade teachers and try to figure something out.

This paper will examine the effects of our group of elementary school teachers' effort to completely overhaul our approach to teaching science in the upper-elementary grades. We realized that we had to do something very different to prepare our students for the California STAR standardized science test, which takes place only in the fifth grade. We didn't like the idea of standardized tests exclusively dictating our curriculum, but we knew it wasn't fair for the fifth graders to face the science test unprepared each year. One teacher said that she had heard of teachers collaborating to form a science rotation. She explained that each teacher could choose one topic to focus on all year, and then the students would rotate through each class in cycles. Suddenly, many ideas started popping up and our conversation grew more dynamic.

Veteran and newer teachers alike at our site have been overwhelmed with trying to set up science labs. Our group of teachers agreed that if we could focus on and teach just one topic each year, we could not only manage the demands of setting up and breaking down science labs, but we could also become expert at each topic. We surmised that the students would surely benefit from this arrangement as well.

Next, we discussed how the science rotation could possibly help us improve student relations on campus, as the rotations could also give us a space for mixing students from the two distinct programs at our site. Perhaps, by working together on science labs, the students from the two programs would form closer bonds. We also thought that that process of students rotating to different classes could help prepare our fifth graders for the transition into middle school the following year.

The planning began quickly and we implemented the first science rotation the following year. Now, in our third year of the science rotation, I figured it was time to take

stock and see how we were doing. Hopefully, the fifth grade students today would walk away from the state science test feeling much more confident than Haley had four years earlier.

RESEARCH QUESTION

What has been the impact of the science rotation on our school climate, teacher development, and student learning in science?

CONTEXT

Our elementary school is an urban K–5, with two distinct programs within one school facility. The school has housed the two programs for about 20 years. Each program was initiated by active groups of parents who wanted to ensure specific but different types of enrichments in the curriculum. At the time of their formation, neither program was able to fill a single school facility so they were merged into one building. The two programs are funded by one site budget, overseen by a single principal, and share all building facilities.

The district sees our site as one school, and records all testing and other data accordingly. Yet, the two programs have separate parent groups and maintain a clear independence and identity. Over the years, there has been a tension between the two programs, particularly among the students who tend to segregate themselves on campus. The teachers felt that a science rotation that included both programs could help foster better relations, without sacrificing program identity, between all students and the two school communities.

Our school has consistently been one of the highest performing elementary schools in the district, receiving a top California State API (academic performance index) ranking of 10 in 2002. The State of California has released science test scores for fifth graders since 2004. In that year, our students tested 61% at a proficient or advanced level in science. In 2005, our scores dropped to 52%, but then in 2006 went back to 61% at proficient or advanced. These scores compare favorably to the district and state scores, which are at only 30% proficient or advanced. Yet our school performs significantly better in math and language arts (averaging 70% proficient or advanced) so there seemed to be potential for improvement in science. Therefore, our aim was to bring our science scores into alignment with the scores for math and language arts.

Our science rotation class time was scheduled for Wednesdays after lunch for a 75-minute period. We usually managed to fit in four, five-week rotations per school year. However, due to scheduling conflicts, there have been gaps in the rotation, and teachers have needed to create extra class time to make up for the lost sessions.

The primary objectives of the science rotation are to:

- Improve student relations between the two programs by having the students mix together to form science clusters.
- Cover all the science standards in a school year to help raise science scores.
- Allow teachers to focus on one science strand at a time to become more expert at each topic.
- A secondary goal was to replicate a middle school experience by creating a distinct science class period, thereby helping prepare students for the transition to middle school.

Additionally, with overall enrollment on the decline in our school district, and with the school board closing under-enrolled schools, the number of merged school sites is on the rise. Our school was merged over a generation ago, and we have learned much from our experiences of sharing a single site. It is, therefore, my hope that our efforts at cross-program collaboration may serve as a model to help other combined sites.

REVIEW OF LITERATURE

While this paper will explore the benefits of teacher collaboration within the science rotation, I have discovered through my reading how challenges teachers face with teaching the elementary school science curriculum fits into a national problem of poor performance in science. Therefore, I consider here issues of teacher collaboration, the quality of science education in elementary schools, and the overall condition of science education in the United States.

Khorsheed (2007) documents how teachers will not naturally develop effective models of collaboration, but need time and strategies to do so. Specifically, Khorsheed shows that teachers require plenty of professional development time to develop meaningful collaborative models in their schools, and that they should be paid to do so. Yet, even when teachers and other stakeholders come together to create dynamic collaborative models, there can be dangers in letting the model stand for years without critical evaluation (Gajda, 2007). Teachers and other stakeholders often struggle to assess the quality of collaborative dynamics and the merits of collaborative structures at their site. The evaluation piece of collaborative models is often overlooked, but is essential to ensure growing success.

On the other hand, one should not assume that teacher collaboration is a panacea for all school academic concerns (Pomson, 2005). There is great value in giving teachers the freedom to operate their classrooms independently and unencumbered by some of the complexities involved in collaboration. Many teachers have expressed frustration at being forced into collaborating with other staff members. There is true and justifiable ambivalence among many teachers at having to work collaboratively. Yet, these problems often stem from lack of site leadership. Pomson argues, and I have seen in my own experience, that principals and teachers together must communicate in a manner that allows for collaborative models to grow from a needs- and interest-based assessment of their site.

In 2005, the President of Rensselaer Polytechnic Institute, Shirley Ann Jackson, gave a speech called “The Quiet Crisis and the Future of American Competitiveness.” She argued that over the next 10 to 20 years, the science and technology workforce in the U.S. will be retiring at record rates, and there are not enough young people to replace them. Blouham (2007) claims that the crisis to which Dr. Jackson refers stems not from high school, but goes all the way back to the absence of a consistent elementary school science program in our nation’s schools. Of 164 Kansas teachers who replied to a survey developed by Blouham, 59% said they had cut out science instruction to focus on math and reading, and about 20% of the teachers said they had given a grade for science without teaching it at all. Many teachers say that the testing demands of No Child Left Behind have forced them to drastically reduce science instruction in favor of instruction of math and direct literacy. Additional evidence from the National Science Teachers Association indicates that there are regular reports from teachers that science is getting

cut from elementary schools, often at the request of school administrators (Blouham, 2007).

If science is not being consistently taught in elementary classrooms, how can we expect our middle and high school students to successfully take on science? Two recently published documents help frame this predicament in terms of student performance, and the public's attitude toward the study of science in schools.

THE MISSING LINK

Student Performance

In 2005, the National Assessment of Educational Progress (US Department of Education) published a lengthy report on national science scores over the past decade, focusing on tests at grades 4, 8, and 12. Although there have been some small gains in student performance, particularly for minority students, overall growth in science scores has remained flat. At the fourth grade level, the lowest performing students have made the largest gains, reflecting the recent demands to shore up the achievement gap. Yet, the scores of the higher performing students have been stagnant. Only nine states in the country have shown significant progress in science since 2000.

California students are doing very poorly compared to the other states in the nation. California's fourth graders ranked second to last, just above Mississippi. Further, 50% of California fourth graders tested at below basic in science. The trend gets even worse at eighth grade, where 56% tested below basic. By the time most students have completed 12th grade, they are simply not adequately prepared for college level courses in science.

Ambivalent Attitudes

A survey by Public Agenda (2006) showed that student and parent attitudes about studying math and science have become quite ambivalent. Parents tend to agree that schools need to be more competitive in math and science, they feel the amount of science for their own children is “about right.” Students also acknowledge the need for a more rigorous science curriculum, but they themselves do not want to study more science. The Public Agenda report highlights dire concerns about our nation’s high schools. We could help ameliorate this problem by presenting students with a much stronger science program at the elementary level. Our own school’s attempt to revamp our science instruction method can be viewed as one such effort.

METHOD OF INSTRUCTION

The four domains of the California science standards are: Physical Science, Earth Science, Life Science, and Investigation and Experimentation. In our rotation, each teacher focuses on one topic from the standards to teach for the entire year. Teachers primarily utilize the district-approved FOSS (Full Option Science System) science kits. Teachers supplement these hands-on science kits with texts, videos, and other resources. Students from both programs are mixed into groups that stay together all year, traveling to each class on a five-week basis (see Table 1).

On Wednesday, when the bell rings after lunch, the students quickly return to their homerooms, drop off their lunch bags, retrieve their science lab books, and dash off

to their special afternoon class. There is much independent, enthusiastic, and purposeful movement in the halls on these days.

Table 1. Sample Science Rotation

	Magnetism Room #1	Landforms Room #2	Life Science Room #3	Variables Room #4
1st	Group 1	Group 2	Group 3	Group 4
2nd	Group 2	Group 3	Group 4	Group 1
3rd	Group 3	Group 4	Group 1	Group 2
4th	Group 4	Group 1	Group 2	Group 3

Trying to be Consistent

We wanted our science rotation to be as consistent as possible with regard to methods and expectations. Therefore, we provided each student with a science lab book in which to record their findings for all lab work. The teachers created a guide sheet: “Think Like a Scientist” (see Appendix A). This paper was glued onto the inside front cover of their lab books to help students write up their lab reports after each experiment. Our intention was that students would be expected to write their reports in exactly the same manner in all classes.

We discussed how we would assess students, and mutually agreed on general expectations for the students. We attempted to complete every rotation in a timely fashion to enable us to grade the lab books and return them to the homeroom teacher, who was ultimately responsible for the report cards. But completing the grades proved to be a challenge. Elementary school teachers in our district need to write comprehensive reports cards, covering all academic and social categories. Because we cannot simply give letter

grades, communicating student performance became a time-consuming challenge. To make matters worse, young students are just beginning to learn to take care of multiple binders, do extra assignments, and change classrooms to work with different teachers. Thus, we have struggled to create a reliable system of shared evaluation.

COLLECTING DATA

I focused my inquiry on teacher and student attitudes to the science rotation, and on student performance. I also sought the perspective of the principal, ancillary staff, and parents. In addition, I examined school testing data in science for the past two years. To document and evaluate the quality of student inquiry, I used two tools: multiple surveys and work samples. To evaluate the teachers' attitudes toward and success with the science rotation, I conducted opened-ended interviews.

I set up an online survey for the students because I thought it would be an easier way to manage the data. I used our school computer lab to run groups of students through the series of surveys. The questions allowed students to respond by clicking radio buttons and to type their comments. I told each group before they began the survey that the purpose was for the students to help the teachers improve the science rotation for future classes. I wanted the students to know that their opinions were valuable. I made it clear that students could remain anonymous if they preferred. I managed to survey over 60% of all fourth and fifth graders (see Appendix B).

For the teachers, I conducted an in-person survey to ascertain general opinions about what is working well and not well in the rotation process. Additionally, I inquired

into the ways the teachers had individually or collaboratively made changes (see Appendix C).

These questions were intended to enable teachers to express both big ideas as well as specific concerns about the science rotation. I tried to remain as objective as possible during the interview, but since I am one of the teachers participating in the science rotation, I know that my follow-up questions were biased toward reflecting my own observations and opinions. However, the follow-up questions drew out many interesting points for our staff to discuss later.

FINDINGS/ANALYSIS

Student Survey Results

Here I will focus on the most revealing questions from the student survey. The results (see Table 2) demonstrate how well the science rotation is meeting the goals of improving our campus climate by mixing the students between the two programs at our site.

Table 2

1) How do you feel about working with students from the other program	4th Grade	5th Grade
<i>I like it</i>	60%	47%
<i>It's difficult</i>	34%	17%
<i>No opinion</i>	6%	36%
2) Have you made friends from the Science Rotation?	4th Grade	5th Grade
<i>Yes</i>	49%	32%
<i>No</i>	51%	69%

In both grades, most students either enjoyed or didn't mind working with students of the other program. It is interesting that only 17% of fifth graders found it difficult, compared to 34% of fourth graders. This may indicate that it takes time for students to warm up to each other. Also, the fact that over a third of fifth graders had no opinion about working with the other program may indicate that either student relations are actually reasonably smooth, or that there is indifference about working together. Simply put, the majority of students have no real difficulty in working with students from the other program in science.

4th grader comments:

- They were friendly.
- I like it a lot. You get to have new friends!
- I don't like the other program, but I like some people in it.

5th graders comments:

- Sometimes they (other program students) can be mean.
- I met a friend that way.
- I think it's good that we can work with students from the other program.
- It's not any different.

The fact that almost 70% of fifth graders claim to have not made a friend after two years in the rotation suggests that students do not find science class an environment

conducive to making friends. Many fifth graders indicated that because the lab experiments and write-ups are so demanding, there simply isn't time to socialize. Asking students whether they liked learning science in different classrooms with different teachers (see Table 3) provided insights into an area where campus climate can be affected in a positive manner—the relationship between teachers and students. Students clearly expressed that they found working with different teachers to be beneficial, particularly at the fifth grade level, where two-thirds enjoyed the process.

Table 3

Do you like learning science in different classes with different teachers?	4th Grade	5th Grade
<i>Yes</i>	48%	64%
<i>No</i>	9%	20%
<i>No Opinion</i>	43%	16%

4th grade comments from this question included:

- You learn different things.
- I never knew that teacher. I'm glad I met her.

5th grade comments from this question included:

- It prepares me for middle school.
- Different teachers teach differently and that helps.
- I like to know more teachers and what's in their rooms.

OTHER QUESTIONS FOR THE STUDENTS

To discover student attitudes about writing their lab reports, I asked how they would like to write the results of their science labs. Only 11% said they preferred to write the labs in response to open-ended questions; 26% said they preferred to write short answers to specific prompts; and a whopping 63% said they preferred to answer multiple-choice questions.

Finally, in an open question asking students what they liked best and least about the science rotation, we discovered some interesting opinions. In the positive, many students commented that they really enjoyed having the opportunity to work with different teachers. The science rotation gave students a chance to work in otherwise off-limit classrooms with unknown faculty members. Students became more comfortable with all the upper-grade teachers on campus, and teachers reported that this growing familiarity has had a very positive effect on our school climate.

In the negative, students overwhelmingly stated that the worst part of the science rotation was the demands on writing lab reports. They often said they hated the writing. The teachers also noted that the students' conclusions were very weakly written, even among the best language arts students. By demanding that all writing be in an open-ended manner, we left too many students unsupported. They were often unsure how to respond.

FOLLOW-UP STUDENT SURVEY

Just after this year's fifth graders took the STAR Science test, I conducted an impromptu online survey. I wanted to probe the students' perceptions regarding the impact of the science rotation. I wanted to see how their reactions compared to what Haley had told me

three years earlier. Fifty-eight percent of fifth graders reported that the science rotation had been helpful in some way in preparing them for the STAR science test.

TEACHER SURVEY RESULTS

Three of the questions that I asked teachers were especially revealing about what is and is not working in the science rotation and what can be done. In general, teachers have been pleased with the science rotation. They believe that the methodology is sound. They are becoming more adept at teaching science, and more knowledgeable about the specific topic on which they focus. They have also benefited from collaboration. However, they are struggling to address all the current California State Science Standards. They claim that there is not enough time for students to process the information; that the rotation class doesn't lend itself to daily and follow-up observation; that there are too many scheduling conflicts; that we need more meeting time.

Teachers' solutions to these shortcomings focused on using time in different ways—essentially giving students the extra time that is necessary to conduct experiments and process the results.

WHAT WE LEARNED

Assessment

There is much room to improve how we track student progress. We do not have an effective and simple system of evaluation and reporting grades. Therefore, we may need to enlist the support of the administration to enable teachers to spend more time to process grades and to work collaboratively to develop a consistent framework. With more

time, we could go over a few labs from each class and compare how we grade them to see where we are not consistent. We could create an internal, online database for recording student scores and written evaluations to enable us to track student growth from class to class and become familiar with incoming students prior to the next rotation.

Improving Lab Conclusions

Many students said that they simply hated writing lab reports. By only asking students to respond to open-ended questions, we left them frustrated. We need to revise the way we ask students to respond to the experiments. We should modify our lab reports to include short answers to prompts and multiple-choice questions. Though not the best measure of students' understanding, responding to multiple-choice questions could prepare students to perform better on standardized tests.

Scheduling Conflicts

Time is a big problem. We have found it very difficult to squeeze in all science topics to cover the four strands. Scheduling conflicts prevent us from having instructional consistency and have meant that teachers have had to add extra instructional time on their own. It may be better to rotate between fewer classes, perhaps just two, to reduce the number of such conflicts and to simplify the process.

Is science class the time to make friends?

Our hypothesis that the rotation would lead to improved student relations on campus did not pan out. For most students, the rotations were mainly a time for studying science, not

for making friends. However, all teachers noted that the rotations enabled the students to get to know other teachers. This has been an unexpected benefit of improving campus climate.

The staff needs to explore other avenues to improve student relations between programs. Perhaps mixed P.E. classes, common interest Lunch Clubs, and other non-academic time may provide students with opportunities to form stronger bonds between programs.

Follow up with Graduates

Perhaps the only way to evaluate whether the science rotation helped prepare students for the routines of middle school would be to interview graduates of the program. Fifth graders often boast how the rotation makes them feel like they are going to middle school.

The students take pride in freely walking the halls and dashing off to class after lunch. It's a real change of pace compared to the fully self-contained classroom experience from kindergarten to third grade. In the future, we would like to ask our graduates to respond to a survey to reflect upon this question.

NEXT STEPS

The 2007 fifth grade STAR science scores were reported in time for the 2007-08 school year. We were pleased to find that our students were testing at 70% proficient or advanced in science. This has long been our goal, and we think with the rotations we can get the test scores even higher. Because a growing number of students have reported

feeling positive after completing the standardized science test, it is my hope that the frustration expressed by Haley years ago will now be the exception.

For the coming year, we have decided to simplify the rotation. First, we will rotate between just two classes at a time, thus reducing scheduling conflicts.

Additionally, because students indicated that science time was not effective for developing friendships across programs, we will keep our own classes intact in the rotation. This will help to simplify our assessment and grading process.

We have also added an additional science session to each week's rotation. Instead of just meeting on Wednesday afternoons for 75 minutes, we have added a 30-minute follow-up session on Fridays. We use this time to have students reflect on, expand upon, or continue an experiment in progress. Finally, our fifth grade teachers have joined the Schools Focused on Science program with the University of California San Francisco (UCSF). This program is based upon a Genentech Corporation grant that pays teachers to meet and collaborate to work on areas of need in their science programs that will be shared with other schools in the district. Our site will create a rubric and an assessment model that will make it easier for teachers to track their students' progress in a science rotation program.

CONCLUSIONS

The science rotation is more complicated than any of us had ever imagined, yet without it, we would not be able to teach science as well as we do now. We find that we are not only refining and deepening our instructional design, we are learning the process of what

goes into effective collaboration and we now know how important it is to continually assess our own progress (Gajda 2007).

POLICY IMPLICATIONS

District Level

- Make teacher collaboration a key part of professional development in elementary science.
- Provide funding to support faculty collaboration when two or more schools are forced to merge.
- Encourage and support low performing schools to find ways to integrate science into literacy and math classes.

State Level

The number of science standards should be reduced from four to two at the elementary level. The California standards for elementary science currently demand that each year teachers cover four strands: Earth, Physical, Life, and Investigation and Experimentations. This is simply asking too much of schools and results in teachers skimming over topics rather than going into depth, or worse, not teaching science at all. Even at our school, one of the highest achieving in the state and with experienced teachers who are effectively collaborating, we are still unable to do justice to the demands of the state science standards. Schools with struggling populations and higher teacher turnover rates will no doubt be unable to come close to addressing the standards.

Federal Level

The No Child Left Behind act has created a grave situation whereby elementary teachers are forced to focus mainly on reading and math. One negative effect of this act has been that science instruction is being left behind. The irony is that science provides many opportunities to improve both literacy and math skills in a constructivist model (Duckworth, 1990). If the No Child Left Behind act is to remain in force, it must be revised to ensure that science is more explicitly and effectively covered in all elementary classrooms.

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Appendix A

Think Like a Scientist guide sheet:

- 1) Problem – What are you trying to figure out? Write down a question that you will try to answer.
- 2) Hypothesis – What do you think will happen? Make a thoughtful guess.
- 3) Materials - What items do you need to solve the problem? Write them as a list.
- 4) Data – What happened? Show your results as a graph, notes and/or drawings.
- 5) Conclusion – What did you learn? What were the results? Can you explain why your experiment turned out the way it did?

Appendix B

Student survey questions, and the purpose for question

Fourth Grade Survey:

- 1) *Did you hear about the Science Rotation in earlier grades?* To probe into what extent students had discussed this topic on the yard. Was there good talk? Bad talk? Indifference?
- 2) *Did you enjoy studying science in earlier grades?* To ascertain prior attitude sets.
- 3) *How did you feel when you heard we would do the rotation with other classes?* To measure attitudes going into this proposition.
- 4) *How do you feel about working with students from other classes and programs?* To find out how climate issues may have been affected.
- 5) *Have you made new friends from the Science Rotation?* To see how many students made friends.
- 6) *Do you think students are getting along better on campus because of the Science Rotation?* To discover if students have any insights in this area.
- 7) *Do you think you understand science better by doing the Rotation?* To measure learning attitudes and self-assessment.
- 8) *Do you like learning science in different classes with different teachers?* To measure how students felt about changing the learning environment, and for feedback on teachers.
- 9) *What's the best part of the Science Rotation?*
- 10) *What's the worst part of the Science Rotation?*

The Fifth Grade Survey contained all questions that were in the Fourth Grade Survey above, except for the following question:

Did you enjoy Science Rotation in Fourth Grade?

To assess attitudes shaped from the previous year in the rotation.

Appendix C

Teacher Survey Questions:

- 1) How do you see effective science instruction for elementary students in general?
- 2) What are the strengths of the science rotation?
- 3) What are the weaknesses of the science rotation?
- 4) What are some interventions you have made to redress the shortcomings?
- 5) Other thoughts?