Investing in the Improvement of Elementary Science in Washington State

Findings and Implications from a Study of K-5 Teachers Striving to Strengthen their Science Teaching

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Table of Contents

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EXECUTIVE SUMMARY

The Center for Strengthening the Teaching Profession (CSTP) commissioned Inverness Research to undertake a study about what it takes for elementary teachers to strengthen their teaching of science. This report documents the perspectives and experiences of a selected pool of K-5 teachers, representing 67 districts, who are committed to improving their teaching and, in particular, are dedicated to get better at teaching science. It explains what motivates these teachers, what resources they need, what experiences they have and processes they undergo, and what barriers they encounter and surmount in their efforts to improve their science teaching. The report includes findings and recommendations that will help policy-makers and reform leaders support ongoing improvement of elementary science in Washington.

Key Findings

TEACHER BACKGROUNDS

- Nearly all of the quite accomplished elementary teachers in the study have general academic training and little science background; yet most are responsible for teaching science. This is consistent with K-5 teachers across the nation.

- Although these teachers are more comfortable teaching subjects other than science, the majority say that over time, they have become comfortable teaching science.

CURRENT STATUS OF K-5 SCIENCE PROGRAMS

- Nearly all of these teachers are working in a school district that has an established kit-based (hands-on, inquiry-oriented) science curriculum. The kits have served as a vitally important foundation for teachers in developing the confidence they need to teach science.

- Teachers have varying degrees of district and/or school-level support for implementing the curriculum.

- Most of these teachers spend 1-2 hours per week on science. They think their peers spend about the same amount of time or a little less.

TEACHERS' TRAJECTORIES OF IMPROVEMENT

- For these teachers, improvement starts when they are motivated by their own personal belief in the importance of teaching science. Students' positive response to science reinforces teachers' motivation.

- Teachers "get science going" when they have access to science kits and receive training in how to implement the kits.

- Teachers move over time from "getting it going" toward "getting it good." By getting it good, they mean teaching science concepts and practices of inquiry more deeply and skillfully.

- Getting it good requires participating in high quality, science-rich professional development programs. It also involves developing a range of relationships with colleagues in their schools, other teachers they have met through professional development opportunities, university faculty, staff from external science improvement projects, and supportive district administrators.

- Some teachers eventually become recognized for their commitment to strengthening science and engage in teacher leadership roles and activities.

- Strengthening science teaching is a long-term, ongoing endeavor. Two-thirds of the teachers in this study have been working to develop their science teaching for from 4 to 10+ years.

CONDITIONS THAT SUPPORT TEACHERS IN STRENGTHENING THEIR SCIENCE TEACHING

- High quality professional development makes teachers feel both more prepared and more confident. Teachers seek programs from a wide range of sources that offer them science content and science-specific instructional strategies.

- Workplace-based opportunities to work on science together with colleagues enable teachers to hone their teaching skills and assess student work.

- The presence of a local science "champion"—a teacher, parent, or administrator who presses for more science—partially mitigates against the general weakness of science as a system priority.

CONDITIONS THAT CONSTRAIN THE STRENGTHENING OF SCIENCE TEACHING

- Teachers perceive that K-5 science is one of many competing priorities for improvement. Districts often send mixed messages, as in "Teach science if you can but don't take time away from reading and math." At the state level, the lone signal that science is a priority is the 5th grade WASL test.

Recommendations for Policy Makers

Washington State has been working on educational improvement systematically since the early 1990's. To its credit and with the support of NSF grants in several regions, the state has built what appears to be a sound foundational infrastructure for elementary science: high quality kit-based (hands on, inquiry-oriented) curriculum with basic teacher training in use of kits. This foundational infrastructure, which gets some science teaching started, is necessary, but not sufficient on its own, to strengthen elementary science education. Our study points to three policy actions that can make a difference:

1. Sustain investment in foundational infrastructure of curriculum, kit resources, and kit training

Classrooms across a range of districts are equipped with kit-based science teaching materials, and in most cases kits are accompanied by some amount of ESD, district, and/or school-based supports. It appears that science is being taught at least at a minimal level in many classrooms. It takes at least 4-5 years to build this level of foundation, and it is absolutely vital to sustain that investment over time.

2. Raise and clarify the priority of elementary science

All levels of the system must send a consistent message that science is, in fact, a high priority. In the absence of shared priority, improvement of science instruction relies on individual teacher commitment. State and local district leaders must convey the importance of science learning and assure that high-quality science teaching occurs regularly. Principals must promote the teaching of science, schedule for it , and support professional growth as new learning is put into practice

3. Invest steadily in human capital

Investments in teacher development, like other policy actions, are often sporadic or have short timelines; as such, they can be incongruent with the long-term growth trajectories of

teachers. Above and beyond kit trainings, teachers need a steady diet of three kinds of professional development in order to play their part in improving elementary science:

(a) All teachers of science need professional development opportunities where they learn science content and science-specific teaching practices.

(b) All teachers of science need systematic opportunities within their workplaces to work over time to put into practice what they learn.

(c) Teachers who demonstrate leadership potential need professional development that builds their skills in facilitating science teaching improvement in their schools.

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I. Introduction

Elementary science education, like many aspects of the educational system in the United States, is in need of systematic improvement. Adding more assessment is not enough, however; enriching children's science experience in the classroom is critical (Pratt, 2007). Though many factors are necessary in order to improve students' experience, the teacher is the most crucial ingredient. Without knowledgeable and trained teachers who are dedicated to producing optimal opportunities for their students, no amount of funding or intervention can have the desired effect.

In *Taking Science to School: Learning and Teaching Science in Grades K-8,* Duschl (2007) states, "student learning of science depends on teachers having adequate knowledge of science… Currently, K-8 teachers have limited knowledge of science and limited opportunities to learn science. In order for K-8 teachers to teach science as practice, they will need sustained science-specific professional development in preparation and induction programs and while in inservice. Professional development that supports student learning is rooted in the science that teachers teach and includes opportunities to learn about science, about current research on how children learn science, and about how to teach science." Metz (2008) also notes that the elementary school classroom can and should more adequately reflect the robust goals and structure of science as discovery and understanding.

Investigating the strengthening of elementary science in Washington State

Washington State has been working on educational improvement systematically, including attention to science, since the early 1990's. This effort has resulted in state science standards, published in 2003 and revised in 2008, Grade Level Expectations (GLEs), and inclusion of science on the state assessment (WASL) since 2005. With support from several National Science Foundation grants and other resources, Washington State made an investment in the late 1990's in hands-on inquiry-based science, facilitated through the adoption by many districts of progressive curriculum and the establishment of Leadership and Assistance for Science Education Reform (LASER), a statewide resource for

curriculum implementation. In 2008, the Legislature funded regional science coordinators to further advance science learning.

After putting into place many foundational components of an elementary science program, the state is now positioned to increase attention to the improvement of science instruction to support higher achievement for all students. The Center for Strengthening the Teaching Profession (CSTP) commissioned Inverness Research to undertake a study that could support and inform ongoing strengthening of science teaching and learning. The study, undertaken spring through fall 2008, aims to reveal the motivations, needs, improvement trajectories, and surrounding conditions of classroom teachers who are working to strengthen their science instruction within the context of Washington's system. Findings from the study offer policy makers insights into the kinds of policy actions that can realize systematic improvement in elementary science teaching for all Washington's students.

The study: From teachers' perspectives

The primary purpose of this study is to produce insights for policy makers into how elementary teachers strengthen their science teaching over time: what motivates teachers, what resources they need, what experiences they have and processes they undergo, and what barriers they encounter and surmount in their efforts to improve their practice of teaching science. Teachers themselves are the informants for this study. More specifically, the study focuses on K-5 teachers who are working to get better at teaching and, in particular, to get better at teaching science. Our operating assumption was that K-5 teachers who can grow in their ability to teach more science and to teach science better are working in some kind of favorable conditions, drawing from some kinds of available resources, and undergoing some kind of constructive growth and change processes. We were interested in capturing these conditions and experiences, and in learning about teachers' trajectories of improvement. This particular emphasis compliments national landscape studies that target the status of science teaching for the entire elementary work force (Fulp 2002).

The study draws from individual teachers' perspectives in two ways. First, to gain a broad perspective from those who are committed to excellence in teaching, we surveyed all K-5 National Board Certified Teachers (NBCTs) in Washington whose certification suggests that they have a regular classroom assignment and thus are likely to be responsible for teaching science, among other subjects. Of these, 123 responded.[1] Second, to gain a more nuanced and in-depth view about strengthening science teaching in particular, we sought nominations from leaders within state organizations[2] of elementary teachers who have

[1] See Appendix A for the survey form.
[2] CSTP, LASER, North Cascades and Olympic Science Partnership (NCOSP), and the Office of Superintendent for Public Instruction (OSPI).

been focusing specifically on science. We held in-depth interviews with 34 nominated teachers.[3] The teachers in our study sample teach in 67 different districts, or nearly one in four, across Washington. In terms of their science background, science teaching preparation, and confidence in teaching science, they are similar to mainstream elementary teachers across the country who are teaching science in self contained classrooms (Fulp, 2002). In other ways these teachers offer non-typical perspectives because they are seasoned, experienced professionals who are dedicated to improving their teaching. We wanted to capture their experience and wisdom.

To learn from these teachers, we asked about the following in both the survey and the interviews: What was their preparation and background? Under what kinds of conditions are they teaching? How much and what do they teach in science? What is the current status of school and district science programs? In particular, we wondered how they go about improving their science teaching. What motivates them? What has been their trajectory of improvement? What supportive conditions and constraints have existed and currently exist for them? We compiled, analyzed by theme, and compared data from interviews and the survey, and found a high level of consistency across both sources.

The sections that follow address these core questions with both survey and interview data. Along with teacher quotes and survey statistics, we include vignettes of several teachers whose experiences and trajectories of growth reflect what we heard from the full sample. The quotes and vignettes ensure that the teachers' voices portray their own realities and recount their experiences. The paper concludes with implications for policy action in Washington and thoughts about further investigation.

[3] See Appendix B for the interview protocol.

II. Detailed Findings

A. What are the characteristics of elementary teachers who are striving to strengthen their science teaching?

Finding	Many of Washington's accomplished elementary teachers have general academic training and little science background. They are not new to the profession, but rather are seasoned, experienced teachers. Nearly all of them are responsible for teaching science. Although they are more comfortable teaching areas other than science, the majority say they are at least somewhat comfortable teaching science now.

ACADEMIC BACKGROUNDS

Nearly all of our interview and survey respondents are generalists with liberal studies backgrounds. Only one in 20 has an academic background in science.[4] Nearly one-third of survey respondents (31%) reported that their teacher preparation took place in Washington State.

The following interviewee's preparation is typical of many respondents':

> *I did my undergraduate work and got my teaching degree at the University of Washington. My undergraduate degree was history and political science and had nothing to do with science. I got my masters in teaching from the University of Washington as well.*[5]

TEACHING AND SCIENCE TEACHING EXPERIENCE

The teachers in both samples (interviews and survey participants) are experienced teachers. For example, survey respondents (95%) have taught at least 5 years; 37% have taught 6-10 years, 34% have taught 11-20 years, and 24% have taught over 20 years.

While 89% of the respondents indicate that they teach science, only 6% indicate that science is their area of specialty, including National Board certification. A small number (5%) are science resource teachers.

Teachers feel stronger in reading/language arts, math, and social studies than they do in science. Nonetheless, 60% feel effective at this point in teaching their science program; 35% say their effectiveness is mixed and only 5% feel ineffective.

[4] This is consistent with results from a national study of elementary science teachers (see Fulp 2002 in References in this report): 4% of elementary school science teachers have undergraduate degrees in science or science education.

[5] Quotations have been lightly edited for content and clarity.

B. What is the current context for elementary science teaching?

As part of our study, we asked about the context in which these individual teachers worked. In so doing, we made important discoveries about the broader landscape of science teaching in Washington State.

Finding	Nearly all teachers in the study are working in a school district that has an established kit-based (hands-on, inquiry-oriented) science curriculum. Teachers have varying degrees of district and/or school-level support to implement the curriculum, including kit distribution and re-furbishing and introductory training in use of kits. The majority of teachers in our study teach science for 45-120 minutes over two or three days during the week. They think this is about the same amount of time as, or a bit more than, their peers spend teaching science. These teachers generally teach directly from the kits, though some supplement them to teach "beyond" the basic kit. The teachers indicated that the kits have served as an important foundation for developing the confidence they need to teach science.

MATERIALS, LEVEL OF IMPLEMENTATION AND DISTRICT SUPPORT FOR MATERIALS

Most teachers we interviewed, and the majority of survey respondents (87%), reported that there is a school-wide science program. Usually FOSS or STC curriculum is in place with materials/resources support: 71% reported teaching FOSS, 31% reported teaching STC, 10% reported using another kit-based curriculum, and 7% reported using a text-based curriculum.[6] Of these 87%, 61% reported that all, or nearly all, teachers at their schools are using the curriculum; 21% reported that their schools were moving toward full implementation; 12% reported that usage is spotty or not likely to change. Again, these data are from teachers representing 67 of the state's districts, or 23% of all districts.

One teacher spoke of how important the kits have been in shifting the amount of science she is teaching, as well as the quality of experiences she is able to provide her students:

> *Long ago, we didn't have the materials, and I would develop my own science units. Obviously it was harder to include hands-on things. It is a lot easier when the kits and the materials are right there for you to do more of the hands-on approach. That has been a big shift.*

One new teacher reflected on her lack of science background and preparation, and the importance of the curriculum as her starting point for science:

[6] FOSS is Full Option Science System, developed over the last 20 years by the Lawrence Hall of Science in Berkeley, CA. See www.lhsfoss.org. STC is Science and Technology for Children, developed by the National Sciences Resource Center (NSRC), established by the National Academies and Smithsonian Institution. See www.nscronline.org. The total adds up to more than 100% because teachers could choose all that applied.

I don't have a scientific background. I hadn't really taken much in terms of science courses from high school, and I don't remember having much science from my own elementary school years. I think the biggest obstacle was having no idea what it meant to teach science to five and six year olds or what that would look like. In that respect, having packaged curriculum at K-2 was very helpful and I started simply teaching it as it came from the curriculum.

Her view, consistent with that of most respondents, suggests that kits help compensate for teachers' lack of science background. Kits are thus an important foundation for broad improvement of elementary science.

Three-quarters (76%) of the teachers surveyed indicate their districts support them with funds for materials and equipment. One teacher explained the importance of having the unit-related supports that FOSS or STC kits provide:

The material support is really important. I can't imagine teaching the units that I teach without getting my box that is ready to go.

While well-supported kit-based curricula provide a foundation on which science improvement rests and relies, and Washington State appears to have made good progress in building such a foundation, kits are not the entire solution. Some teachers reported that kits are limited by their imperfect match with the state's own Grade Level Expectations (GLEs):

At the fifth grade level, the general knowledge of science is broad and wide, yet outside of the FOSS kits, we have no curriculum to expose students to the needed concepts not covered with the kits.

I find it frustrating that it takes a lot of time to teach the kits, but they don't really tie in at all to our GLEs. It makes me feel less inclined to spend time on science.

Another noted that while her district has adopted FOSS kits, there is only one kit per grade level which doesn't begin to cover the required science topics:

We have adopted FOSS at all elementary grades, but the district has only bought one kit per grade level. Not everyone is trained in their use. We have aligned FOSS to the GLEs and there are many holes that we have not discussed how to address.

Some districts have taken steps to mitigate both the holes in the adoption and the lack of congruence with the GLEs. Describing how her district moves beyond the kits to tie in the GLEs, one teacher said:

In my work as a science coach, we create supplemental packets that go along with the curriculum to bridge between FOSS and the science GLE's. When we teach the initial use classes, for each unit, teachers get that document and then significant changes are made to it. It is sent out to every teacher that has been trained in the unit who is teaching it. Some teachers use them and some teachers don't.

TIME DEVOTED TO SCIENCE TEACHING

The majority of teachers surveyed (80%) teach between 45-120 minutes over two to three days per week, devoting what they think is about the same or a little more time than their peers. Teachers from our interview population teach science more often and for longer periods of time than those from the survey population; most teachers we interviewed taught science three to five days per week. (Recall that the interviewees were nominated because of their efforts to strengthen science in particular; survey takers were solely identified as National Board Certified, and generally were a broader sample reflecting overall professional commitment to excellence rather than to a specific subject area.)

C. How do teachers go about improving their science teaching? What is their trajectory of improvement?

Finding	While there is some variation among respondents, the general trajectory of improvement begins when teachers are motivated by personal belief in the importance of teaching science and by student interest and success with science. Teachers begin "getting it going" when they have access to science kits and receive district or Educational Service District (ESD) training[7] in how to implement the kits. Students' positive response to science reinforces teachers' motivation. What happens next involves teachers moving from "getting it going" toward "getting it good," i.e., using kits but teaching the concepts and scientific practices more deeply and skillfully. This movement frequently involves participating in externally-funded professional development opportunities, as well as developing a network of relationships with colleagues in their schools, other teachers they have met through professional development opportunities, university faculty, staff from external science improvement projects, and supportive district administrators. Some teachers, as part of their trajectory, eventually become recognized for their commitment to strengthening science and engage in teacher leadership roles and activities. This process is a long-term, ongoing endeavor that transpires over many years.

MOTIVATIONS TO STRENGTHEN SCIENCE TEACHING

Nearly all of the teachers surveyed (95%) cited a belief that children need science in order to enhance the way they interact with and understand the world. About one in ten (88%) reported being motivated to teach science because of their students' interest in science, and 73% indicated the fact that our world needs more scientists as a motivator for teaching science.

[7] Often, but not always, provided by LASER staff or regional science coordinators.

Moreover, student success, interest in and enjoyment of science motivate teachers to teach science. Teachers reported that science is a subject that is accessible and engaging to students who may not typically be engaged in school, and most importantly, a subject in which all students can be successful. No teachers in our study agreed with the statement that some students can't do science. Nineteen out of 34 interviewees indicated student learning and excitement as their primary motivator and of these, eight mentioned science as being a way for students who are not mainstream achievers to experience success.

The following comments from teachers point to the success their students have with science:

> *When that shy child or that overactive child that has a hard time paying attention suddenly says, "Wait a minute! I get this! I am engaged and I want to learn," that is what motivates me to keep teaching and to keep teaching science.*

> *For me, science is the hook for kids. I have seen many kids with different ability levels and backgrounds. I can't think of a single kid that I haven't been able to hook into science and get them excited about learning.*

GETTING IT GOING: KITS AND KIT TRAININGS

Beyond the motivation teachers have to strengthen their science teaching, an important first step in the process is working with high-quality curriculum and receiving initial training in how to use that curriculum.

One teacher related the history of the science program in her district and the reasons for its effectiveness—kits and kit trainings, materials support, and ongoing professional development:

> *About 12 years ago we started with an NSF grant. Part of that grant was having the science materials center. Basically, each grade level has three units that are on different rotations. They get sent out from the science materials center three times a year. That has been a pretty stable piece of the program in the district. It is such a critical piece to the success, along with the required professional development. Both have led to more and better elementary science instruction in our district.*

Vignettes: Increasing confidence through kits and kit trainings

These two vignettes illustrate how the presence of kits, along with related trainings and local support for science, help veteran teachers without science backgrounds gain confidence in teaching science.

Barbara

Barbara[8] has been teaching for 18 years and currently teaches 5th grade in a neighborhood school whose students are the children of students that went there before. When asked to describe what motivated her to improve her teaching of science Barbara didn't mince words:

> *The class WASL scores were devastating! I had always considered myself a good teacher, but my scores were awful.*

The test scores were a call to action. Step one was to start attending FOSS kit trainings, sponsored by her ESD, which she continued until she had received training for all the kits she uses with her students. She also attended district science workshops and made connections with other people there who started emailing her with science-related information. Next she enlisted local supports, including a friend, to help her with the management and content of the FOSS kits. She was also assisted by an instructional coach who observed and taught science in her classroom; the coach helped her see that her students should answer the questions instead of the teacher answering all the questions herself.

As a result of implementing the kits and of the professional development and local support she has received, Barbara's confidence has grown, and she enjoys teaching science more than ever. In the past she had difficulty letting go of control and allowing messes. For example, when teaching a unit on plants, she initially just showed the students pictures of plants, but when a colleague brought in pots, plants and dirt, the children loved it.

> *Now I am letting the kids discover on their own and design their own experiments. The kids are participating in science now!*

The students' enthusiasm for science feeds into her own growing enthusiasm:

> *I'm just as excited as the kids are about science, and I'm excited about teaching it. I like having the kids working together in groups and problem solving.*

[8] For purposes of anonymity and confidentiality, the names of the teachers have been changed.

Barbara's strong classroom management skills have been a plus for her in this area, she says. She knows that she still needs to work on being patient and not telling the students what will happen, and she admits to occasionally starting lessons without knowing what is coming next, but overall, she feels much more confident about teaching science.

Sally

Sally has been teaching for 39 years and is currently teaching 3rd grade in a small, rural district where she has taught for 25 years. Until recently, she thought of herself as "not a science person," someone who did not understand science or feel competent doing or teaching science.

> *I wasn't very good at science. I wish now that I would have been more aware that I could be good at it. You never think you can when you are younger.*

She rarely taught science in her classroom. The process of becoming a National Board Certified Teacher awakened her to science, and through the support of LASER[9] during the past three years, she began to focus on science and to develop her skills as a science teacher of children and of other teachers.

> *I think the LASER training is the best training I have ever had. I can't speak highly enough of what they have done. I have learned so much about brain research and how children learn from them. That inspires me because, as a teacher, I want to be better every day, so the kids learn more. They give us tools to do that.*

She now teaches three kits each year to her class, from start to finish. She also teaches science to one of her colleague's classes, and that person teaches writing to her class. She is in the process of learning how to teach other teachers how to use science kits in her classroom and is beginning to see herself as someone who enjoys teaching science and is good at it.

> *I think I have stretched myself. I have learned how to discuss things with children and see what they were thinking. There is a lot more reflection on everybody's part. "What happened? Let's write it down. What does that mean?" I never used to explore these questions with science. That is a big change.*

Sally is also an advocate for science at her school and keeps conversations going with her principal about making sure that science gets time and attention as well as math, reading and writing.

[9] LASER is Leadership and Assistance for Science Education Reform. LASER centers were established by the National Sciences Resource Center (NSCR) in eight states across the nation to support implementation and materials dissemination for K-8 science education. Washington LASER is one of the 8 national centers. See www.nsrconline.org.

GETTING IT GOOD: STEPS AND RESOURCES FOR IMPROVING PRACTICE

Teachers in the study indicated that teaching the kits "as-is" is only a first step; enhancing them in ways that result in more meaningful learning for their students are steps that follow. As teachers work to strengthen their science teaching, they seek avenues to go more deeply with their science instruction with the kits. To go beyond kits, teachers identify and access professional development opportunities that bolster their knowledge about science content, and that help them foster student inquiry, use questioning strategies, embed formative assessment into their teaching, teach writing and uses of notebooks in science, and integrate science with other subjects. Moving from getting it going to getting it good also often involves a wide range of collaborations and relationships that evolve over time with colleagues, other teachers, university faculty, funded project staff, and supportive district administrators.

One teacher's comment on the importance of content training in deepening science instruction was reflective of comments from many teachers:

> *As the years progressed, I became more familiar with the FOSS kits and had some initial training in how to use them. I was also sent to content training, so that not only would I know how to use the kit, but I would understand the concepts of magnets and electricity, and how energy transfers. I broadened my knowledge and that, in turn, helps me use the kit.*

Another teacher noted how working on questioning skills has helped improve her science teaching:

> *I feel like I have made some good leaps in letting the kids take control of the learning. I am working on questioning skills, being able to lead the kids where I want them to go, as opposed to just delivering information.*

For other teachers, science notebooks have helped them dig deeper into student understanding and provide a way for students who are less proficient with literacy to show their understandings:

> *One of the things that I found out is that students with lower writing skills, if you look critically at their notebooks, they have evidence of scientific thinking, just like a child who might have a notebook that is more attractive and easier to look at. This notebook might be chaotic and messy, but when you sit with a child and talk through it, and he points and tells you about it, you see that this child has understood.*

DEVELOPING AS LEADERS IN TEACHING SCIENCE

About half of the teachers in our study engage in work as teacher leaders in science, though relatively few feel well prepared to do so: 20% of teachers responding to the survey

reported feeling "very well prepared" to assume leadership for science in their schools. Teacher leadership in science comprises a wide array of activities, including facilitating science fairs in their districts, mentoring new teachers in science, working on district science committees, leading science kit trainings, facilitating science writing groups, sharing science resources, coordinating kit distribution in their districts, and being teachers on special assignment or instructional coaches in the area of science.

One teacher related the leadership work she was doing in science:

> *I am a teacher leader for my building and within the district. Getting together with some of the other teacher leaders in buildings throughout the district, we have created action plans and we have done some staff training. This last year, part of the grant movement was to take it into our buildings and reach out to other teachers through the professional learning community model.*

A LONG-TERM ENDEAVOR

From teachers' perspectives, strengthening science teaching is a long-term endeavor. The table below shows that two-thirds of these teachers have been working steadily to strengthen their science teaching for four or more years.

Table 1. Years spent improving science teaching

10 or more	23%
6-10	21%
4-5	23%
1-3	34%

Teachers' ability to make the transition from getting it going to getting it better takes time spent both in professional development that provides inputs in the form of knowledge and practices, and also in implementation, i.e., trying new practices and learning from experience. Having opportunities over time to increase their content knowledge is particularly important to teachers, and is something they bring back to their classrooms, as this teacher says:

> *Going through NCOSP during the two-week summer academy, being immersed in content for two weeks, is re-experiencing what it feels like to learn something, to be dying to figure something out, and to confront my own misconceptions. It has been fun and motivating to try to repeat that experience with my own students.*

Vignette: Strengthening science teaching over time

This vignette highlights a teacher with a typical background who is far along on her trajectory of improvement. In her journey she was intrinsically motivated, opportunistic, and highly dedicated.

Patricia

Patricia has been a kindergarten teacher in a large, urban school district for seven years and a science coach for two. She majored in history and political science at the University of Washington and received her masters and teaching certificate in teaching from UW as well. She remembers the field-work in the schools and the literacy instruction as high points in her preservice education. Typical of many elementary teachers, Patricia reported not having much school background in science. In the little science teaching experiences she did have in college, she didn't always understand the inquiry approach advocated in her college methods course.

> *In my teacher preparation, we had one quarter of science. We did activities in my science methods course but I didn't really understand how they were tied together or how you were supposed to pull it off. I think my understanding of inquiry at that point was I was supposed to find out what the kids were interested in, and teach what they were interested in. So if a kid said "I like worms," I thought I was supposed to create a whole science unit on worms. I didn't see how that was possible with 25 students in a class.*

Early in her teaching, having FOSS kits to work with was beneficial to Patricia. She began her science teaching by implementing the kits as they were written:

> *Having packaged curriculum at K-2 was really helpful and that is where I started teaching. The curriculum said, "You do this activity and here is the list of questions." So I did that activity and I asked those questions.*

As she worked to strengthen her science teaching, Patricia participated in several intensive professional development experiences that supported and promoted her improvement. These experiences helped develop skills in facilitating inquiry and science processes with students through questioning, writing, inquiry-oriented activities, and discussion. She also learned what it meant to think deeply about the science content in terms of her own understanding.

One key experience was a six-week summer institute experience at the University of Washington in the Physics Education Group (PEG). She attended this program for three summers. Through this program, she worked through physics activities and had to explain her thinking. She also was a keen observer of how these activities were facilitated, which influenced her questioning skills with her own students.

> *I learned a ton about questioning. Seeing how much the facilitators struggled to ask me the question that would help me move forward in my own thinking was useful. That was a powerful experience to have as a*

learner that I hope to replicate in my classroom with my students.

Another key professional development experience for Patricia has been participating in a grant-funded district expository writing and science writing program for the past five years. Working on incorporating science notebooks into her class, alongside other experiences, has helped her focus on an approach that is geared toward students' understandings of science concepts. When talking about what has changed over time, she describes this shift in focus:

I think I have changed dramatically. My science teaching wasn't about the thinking and it wasn't about the key concepts. When I look at science notebook entries now, I am really looking for evidence of scientific skills: do they have a scientific illustration that is labeled? Is there a title on it? Are they showing the evidence of the key idea? I think that has made both my writing and science instruction better and I can't imagine doing one without the other.

She also acknowledges that focusing on writing in science has helped her probe student thinking more deeply:

It has been powerful for me to look at their science notebooks and ask really probing questions. There are students that are very quick to pare it back to what they think you want to hear, but that doesn't necessarily mean they understand. So I probe a lot deeper now. It is not just enough to say the words; you really have to be able to explain what it means when you say those words.

Working collaboratively with colleagues has also been an important experience in her science teaching improvement journey. She meets monthly with six other lead kindergarten teachers from her district who are teaching the same unit at the same time. She describes the content of their discussions:

We talk about the pedagogy, the inquiry, the points where things get stuck, and the questions to ask. I get a lot of support there. It is really valuable to have a group of teachers to reflect and talk with. The meetings are structured around looking at the students' work in their science notebooks, and it really leads us to look at the science lessons as well.

At this point in her science teaching, Patricia works through three district-adopted FOSS units over the year. Her students receive science instruction for about 80% of the year and that, she thinks, is more science than the other teachers teach at her school site. Each unit takes approximately eight weeks. Her description of the time she spends on science and her approach to teaching science speak volumes about the depth of experience her students are having in science.

I teach three of the FOSS kindergarten science units. I teach science daily when we are doing units for about 30 to 45 minutes. That includes a lot of writing instruction in the science notebooks as well. Generally, we spend two days on a given science lesson. One day would be focused on introducing it, the hands-on portion of the lesson, and then a brief discussion of what we did. The second day would have a much meatier reflection

and a discussion of what happened, with work in the science notebooks. Some lessons take three days depending on how complex they are.

She receives materials support through the district science resource center, although still needs to make her own arrangements when her instruction goes beyond the kits. She supplements the FOSS kits with additional materials from other resources and curricula, in order to provide her students with a rich and deep science experience:

I think that the reflective discussion you have after students are engaged in a hands-on investigation in science is so critical to them being able to take that understanding and apply it to a new situation. A lot of the work that I have done in writing and science has been thinking about ways to have those discussions with students. Some of these pieces aren't necessarily in the curriculum.

Patricia now identifies understanding of the inquiry process and the learning cycle as her strength in science teaching.

Now I feel much more comfortable letting it play out. When I do inquiry-based science, I am not controlling it as I do with other forms of instruction. It took awhile for me to get confident with hearing the kids' questions and redirecting, "on the fly." I have spent a lot of time during class discussions asking what I feel is the same question over and over again, trying to get to the place where it makes sense in terms of what the students have observed and what they are thinking at that point.

Today, in addition to being a full-time kindergarten teacher, Patricia serves her district and region as a lead teacher for two of the FOSS kindergarten science units, working with teachers new to those units through 6 hours of trainings per unit. She is also a lead teacher for a science writing project, facilitating science writing teacher meetings once a week in her district.

Finally, Patricia talks about what happens for her when her students are engaged with science and why she is so passionate about it:

When I hear the students talking to each other about science, or when parents tell me something that their child has said or a question they asked at home, and I can see how it is related to their thinking about the science unit at school, I think that is the real heart of it. I see how good it is for kids and how much they are learning.

D. What conditions support teachers in strengthening their science teaching?

Finding	Three major supports for strengthening science teaching emerged most strongly from the data: high quality professional development, opportunities to work on science with colleagues, and the presence of a local science advocate. Ongoing, high-quality professional development is a vital support; it makes teachers feel both more prepared and more confident as science teachers. When motivated teachers have access to professional development, they take advantage of it. They seek programs that offer them science content and science-specific pedagogies. They find such opportunities in a wide range of venues: at their schools and districts, informal science institutions, local ESDs, and institutions of higher education. In addition, teachers cited the importance of a workplace and other professional environments that support collegiality, where they can examine student work together, and where they can practice and hone their skill in making science learning more meaningful and relevant. Most teachers also said there is a locally-recognized science advocate—an individual teacher, parent, or administrator—who presses for more science and better instruction in their schools or districts. The presence of such a science "champion" partially mitigates against the general weakness of science as a system priority.

PROFESSIONAL DEVELOPMENT

Nearly all of the teachers responding to the survey (88%) participate in their districts' professional development efforts by attending workshops, institutes, or other structured offerings. Four of five (80%) reported having had some science professional development in each of the last three years. One in five teachers reported having had over five days of science professional development in the last three years. The district is the only provider from which a good number of teachers have received at least two days of professional development over the last three years. Participation in professional development also occurs from a variety of other sources: their school (46%), informal science institutions (39%), local ESDs (32%), IHEs (24%), and statewide or national professional development organizations (26%).

Teachers responding to our survey reported that strengthening their teaching of science requires gaining knowledge and skills in several specific areas. We detail these below,

showing teachers' perceptions of the value and quality of the professional development they received.

- There are five areas in which at least two-thirds of the teachers say they are prepared or very well prepared and that they have received good or very good professional development in these areas:
    - *Using inquiry/investigation-oriented teaching*
    - *Incorporating writing in science*
    - *Helping students construct their understanding of science content*
    - *Integrating science content to support reading and/or math proficiency*
    - *Using a problem-based approach*
- At least two-thirds of the teachers say that they are well prepared in another three areas where the quality of the professional development has been more mixed:
    - *Using and teaching kit-based curriculum,*
    - *Assessing student learning in science through assessment tools*
    - *Teaching science consistent with state GLEs*
- Slightly fewer teachers feel well prepared in three areas where the quality of the professional development has not been good as consistently as in some other areas:
    - *Using technology to enhance science instruction*
    - *Teaching science to students who have special needs*
    - *Teaching science to English language learners*

This teacher's comment reflects the positive effect of her participating in a great deal of high quality professional development over time:

> *I think my understanding of the inquiry process and the learning cycle helps me get focused on my science objectives. One of my strengths is that I am able to look at an activity or a science lesson and pull out the thinking aspect of it. To me, it is all about the thinking skill. When I approach what kind of thinking I*

want my students to do and what I want them to be thinking about, having that lens has changed my instruction from being about the activity, to being about the thinking.

COLLABORATING WITH COLLEAGUES IN THE WORKPLACE

Our respondents reported that another condition vital to strengthening their science teaching is having the opportunity to collaborate with their on-site colleagues and learn from other teaching professionals. A majority (61%) reported that they have had opportunities to work on science teaching at their school. Teachers we interviewed were articulate about the importance of collegial interactions in improving their practice:

Having others to collaborate with in my building, close at hand, makes a huge difference. It helps to calibrate things and understand what is happening at each grade level so we can fill in the gaps.

I think my science teaching has improved a ton from interacting with other teachers.

When thinking about how far she has come in her own trajectory of teaching science, one teacher credits the relationships and people she has had the opportunity to work with and learn from:

I could never have done it on my own. I wouldn't be where I am today if I hadn't had other people to reflect, work, and problem solve with.

SCIENCE "CHAMPIONS"

We have learned from prior research[10] that, in the absence of strong system priority, a local science advocate or "champion"—an individual who advocates for and leads local improvement efforts in science—is an important source of support. As part of our background and context questions, we inquired about both the priority of science in these teachers' districts and about the presence of a champion advocating for science. In about half the teachers' districts from our survey sample (47%), a champion was present and at least somewhat influential. Most often that champion was a teacher or district science administrator.

CONTINUAL SUPPORT

Teachers responding to our survey reported the following as their "top priorities" for the types of support that would be most useful in improving their practice: time and structure

[10] For example, the Lawrence Hall of Science references the importance of science champions in a recent study: Dorph, R., Goldstein, D., Lee, S., Lepori, K., Schneider, S., Venkatesan, S. (2007). The status of science education in the Bay Area: Research Brief. Lawrence Hall of Science, University of California, Berkeley: Regents of the University of California. Available at http://www.lawrencehallofscience.org/rea/bayareastudy/pdf/final_to_print_research_brief.pdf

for reflecting on their science teaching (23%), high-quality science curriculum with good teacher materials (20%), and high-quality professional development (18%).

Vignette: High-quality professional development with time and structure for reflection

This vignette tells about a teacher's involvement with the North Cascades and Olympic Science Partnership (NCOSP) and the impact it had on her science teaching improvement process.

Blaire

Blaire has been teaching 5th grade for nine years at the same elementary school in a small school district in north-western Washington. In addition to her teaching duties, she is the North Cascades and Olympic Science Partnership (NCOSP) teacher leader for her school.

Through NCOSP, Blaire received extensive professional development in both science content and pedagogy, largely through institutes that were held every summer. As a teacher leader, she also attended institutes that prepared her to work as the team leader for a group of teachers at her school. She currently leads a team of four other teachers, K-5. All of the district team leaders also provide professional development to district staff. Recently, she led a workshop for the district about finding big ideas in science teaching and making science teaching intentional. Other workshops led by team leaders included topics such as formative assessment and curriculum topic studies. Although the NCOSP grant officially ended in August 2008, the intent of the grant was for the teacher leaders to keep their roles after the grant ended. NCOSP provided time to plan for the phase beyond the grant, and Blaire has the support of her school district and principal to continue her work.

> *Last year was the first year we had that building team and we had funding through the NCOSP grant. This year, there is no funding, but our principal is pretty supportive. He is going to give us some time during half-day PD release days to present to the school.*

Blaire credits NCOSP for her continued motivation to be a great science teacher. She described an experience during one of the NCOSP content intensive institutes that changed the way she teaches.

> *I can pinpoint the thing that changed the way that I teach: it was watching the facilitator of our group. He never answered a question outright, ever. Watching him and understanding the enormous content background he had to have to be able to teach that way was something that I am still trying to develop.*

Through NCOSP she also learned different strategies for assessing what students understand and where they are having difficulty. This included collaborative strategies where teachers look at student work together.

You collaborate with the other teachers, looking at the student work protocol. The idea is that all of you give all of your classes the same thing. Then you look at the work together and see what you can learn from that.

The teacher leaders also met once a month to try out new tools for teaching science. They would discuss these tools in groups so that the teachers had a good sense of how the strategy or tool worked before implementing it in their classrooms.

Even in this context where there are opportunities for science professional development and support for collegiality, barriers for teaching science still exist. Blaire said that one of her biggest challenges for teaching science is that it is seen as a "boutique specialist curriculum." She continued:

Our district science team, the teacher leaders from all of the schools, took this problem to our school board and to our district administration. We said, "Nothing is going to change without a top-down mandate that science needs to be given priority." We were told, "Well, science isn't a priority," flat out.

Blaire described that although she felt "depressed and defeated" by the weak priority of science, she also felt motivated. She knew that it would be up to the community of teacher leaders built by NCOSP to push for "some real teeth put into, some money put behind it and some very clear expectation that science is equally important with math and reading and social studies."

The community of NCOSP teacher leaders not only serves as a voice for science in the district, but they also serve as supports and resources for each other. She contacts the NCOSP high school teacher leaders regularly when she has a question about content and maintains a steady email dialogue with the other NCOSP leaders about their science teaching practice.

I know other teachers in my district. We have been together for so long, everybody from kindergarten to 12th grade, and it is invaluable to me. I know who to go to if I have a question and I know where my resources are. Most of the time, our high school teachers are the ones that I would ask my content questions of. We all are developing tools and resources to share with each other.

E. What conditions constrain teachers' efforts to strengthen science teaching?

Finding	Teachers perceive that elementary science is one of many competing priorities for improvement. At the district level, the message that science is an important priority is mixed at best. At the state level, the lone signal that science is a priority is the 5th grade WASL test. Very few identify the GLEs as a significant statewide signal that science is a priority. Together, this weakness in the general priority of science instruction means that science improvement often relies primarily on individual teacher or administrator motivation.

COMPETING PRIORITIES IN DISTRICTS

Most teachers reported that, at the district level, the message about science as a priority is mixed, at best. There is a district-sponsored effort for improvement in about three-fourths of the districts, but most teachers (71%) say that it is one of many priorities that compete for time and attention. Only 5% say science is a major priority in their district; another 10% say that an improvement effort is anticipated. The lack of clarity of vision at the school level for what students are expected to know and do in science was reported as a mixed or negative factor.

Multiple survey comments were similar to this one:

> *Lip service is given to strengthening science, but that's about all.*

Teachers highlighted the importance of administrative support for science improvement efforts and how the lack of that support can undermine efforts:

> *The enthusiasm seems to fluctuate depending on how much a principal or district leader supports it.*

> *My principal last year was very supportive, but did not have a lot of money for training. My principal this year doesn't seem interested and therefore, all training money went for literacy.*

> *My district and principal have provided no direct support to my learning or efforts in science.*

Many teachers in interviews and survey comments also noted that most districts are placing higher priority on math and reading, which often leaves little time for science:

> *In the last two years, there has been a focus on increasing the amount of time spent teaching literacy and mathematics. This has left much less time for science and social studies. The math and literacy time is somewhat rigid and does not allow for integrating these areas.*

> *Our school district is under AYP. Even the principal, who was gung-ho and excited about teaching science, will mention once in awhile that I am doing such a good job, and then she will break the conversation into*

how we can improve math scores. It is frustrating. They asked me to be the leader in science, to put my neck out for science, and now they don't want to talk about it anymore.

At the elementary level, it seems difficult to get my school staff development team interested in strengthening science teaching. There is huge pressure to reform math instruction in our district, so this seems to be a priority overriding all others. Literacy always comes before any time allotted to science. Until administrators see science as the same kind of priority, or recognize it as a core subject, the advocates for science teaching have to scrape to get time for science discussions, reflection and deeper understanding. As it is, elementary teachers have too much curriculum. The only way we can make this all work is integration, with science as a core component.

While many teachers have attended workshops on science, just one teacher in five indicated they have one or more of the following district-level supports for strengthening science: encouragement and acknowledgment for their efforts, coaching, leadership opportunities, or release time.

MIXED MESSAGES FROM THE STATE

When asked what indicators there are that science is a subject area priority for the state, 95% of survey respondents indicated the 5th grade WASL science assessment, 28% indicated new curriculum and materials that are available, 30% indicated the funding available for professional development (2007-2009), and 25% indicated publicized regional professional development opportunities. A few interviewees cited statewide GLEs as a signal.

One teacher explained the difficulty in trying to interpret the mixed messages she perceives about the importance of teaching science:

I feel like I get conflicting messages. I feel like, on the one hand, I get messages from the district or the state saying that science is very important and critical to teach. But then, I feel the other message that I get is, there is limited time and money and so teach math, reading and writing, because that is what is tested.

Other teachers noted the need for administrators to get a message from the state that science is a priority:

I feel like the principals that I have worked for and that I respect greatly, those who have been instructional leaders, don't value science as much as literacy and math because their supervisors and directors don't seem to value it.

PLEASE send out a statement from OSPI mandating the amount of time elementary teachers must spend teaching science each week. Principals make sure the amount of time spent on reading and math are in sync with the time mandates from OSPI, but since there are none concerning science, it is not regarded as a core curriculum. In fact, many principals allow their teachers to not teach science until after the WASL in grades

3 and 4. Can we honestly expect our 5th graders to learn all the science content and processes in seven or eight months? This needs to change.

AN ENVIRONMENT OF MULTIPLE, SHORT-TERM CHANGES

From the reality of teachers' experiences, strengthening science teaching is a long-term process, requiring a concerted effort over many years. Thus, the climate that teachers work in—which is governed by short-term bursts of attention to science among rapidly shifting priorities—emerged from our study as a constraint to their improvement. When thinking about what would be important for elementary science improvement systemically, one teacher talked about the ever-shifting emphases that occur in the system and that teachers need steady support over time:

Give us some time to do what we are doing well. I feel like, particularly at the district level, it takes years to make systemic change. If the district changes things to fix something, all too often it causes something else to break. Right now, we are going through a big, new math adoption, and while they are attempting to do this, it is causing other things to go by the wayside. A couple of years ago, it was this big literacy push and now that has kind of gone by the wayside.

LACK OF TEACHER INPUT IN IMPROVEMENT EFFORTS

For at least some teachers, the lack of teacher input in science improvement efforts is a constraining condition as well. A few teachers shared in survey comments how their "top-down" districts are not supportive of teacher involvement in reform efforts:

Our curriculum department really does not desire to obtain teacher input; it is very top down.

In my district, a rigid effort has been made to standardize all areas of the curriculum. The process has been entirely top-down, with teacher input not a significant part of the process. Hence, the emphasis has been on having all teachers teach all lessons in the same way, using the same curriculum, and we have actually been discouraged from integrating science into math or into language arts. We have been strongly discouraged from developing or teaching science units different from the district's menu of kits. Teacher initiative withers under such an atmosphere. For my district, the first step of improving science would be again to trust teachers and let them use their own judgment more to address the learning needs of their students. Until that occurs, something vital will be missing; progress will lag.

Vignette: Teachers' need for context that supports improvement

This vignette highlights a teacher on a path to improving her science in a context that has limited resources for supporting such efforts.

Kelly

Kelly has been teaching for six years and currently teaches 4th grade in a small district. Her district has adopted the FOSS kits, which she uses. When she first used the kits, she hadn't yet had the initial kit use training. She found that professional development combined with the classroom experience of using the kits brought her from rote teaching to a place of proficiency.

> *The first year I did the FOSS kit with the crayfish, I killed them all within three days. Day to day, it felt very canned and I didn't know what was coming ahead. Then after doing the kit again, and getting the training on the kit, I felt like I understood it enough to think ahead on the ways to improve it, or enrich it through the questions I ask.*

Her proficiency with the kits was noticed and she was asked to help teach the initial use workshops for her district. She found that in teaching other teachers, she continued to learn herself.

> *Working with other teachers in a training position, I never walk away from a training without having learned something from each of them.*

She found that continuing to improve her science teaching created a positive feedback loop, where learning more brought excitement to her teaching, which stimulated more learning in her classroom which, in turn, motivated her to learn more.

> *The more I learned, the more excited I was, the better I did, and the more excited the kids were. I have people now who think I am a science person. I wouldn't describe myself as a science person. When I think of what a science person is, that is not me. I didn't major in science. But because of the training I have had, people think that I am.*

Unfortunately for Kelly, there is not much support available in her district for deepening her science teaching practice beyond the opportunity to attend initial use trainings for the kits. Kelly would like to deepen her content knowledge, but workshops are few and far between, and most of them occur far from her district and, therefore, require a prohibitive investment of her personal time and money.

> *There are workshops I would like to go to and it is not always easy to get to them. Sometimes the cost is too much for me to pay out of pocket. If I spend $1,000 on a workshop, if I travel somewhere and pay my hotel, I am a better teacher at the end, but there is no way to re-coup that money.*

She feels that she and her fellow 4th grade teachers are the only advocates for science in her school, and they are hampered by the lack of common planning time.

Kelly described a model that she feels would support science teaching in a small district like hers, a model similar to that used to support literacy. She would like to see the district hire science coaches who could continue to offer initial use kit trainings for new teachers in the district or for those who had changed grade levels. Coaches could also teach model lessons and, if the district provided collaboration time, the coaches could facilitate conversation and planning.

> *Literacy coaches come in and watch and visit with me, and then afterwards, they say, "Have you thought about these things?" Or they might teach a model lesson. They also help to build some of the background concepts, especially for people who change grade levels.*

III. Conclusions and Implications

If I said that I didn't teach reading, I would be fired. If I said I didn't teach science, they would say, "Well, try and work it in more." I would call that my biggest challenge. -Washington teacher

If the current expectations of most grade schools are left intact, elementary science will never adequately contribute to the effort to increase American competitiveness. For multiple reasons, elementary science takes a back seat in the curriculum and in school and district improvement plans. H. Pratt (2007).

Elementary science education in Washington State: A system at a crossroads

To its credit and with the support of NSF grants in several regions, Washington State has built what appears to be a sound foundational infrastructure of curriculum and implementation supports for elementary science. Classrooms across a range of districts[11] are equipped with hands-on, kit-based science materials and in most cases are accompanied by some amount of ESD, district, and/or school-based supports. It appears that science with a hands-on, inquiry-based approach is being taught at least at a minimal level in many classrooms. At least some teachers have access to and are taking advantage of high quality professional development that enables them to deepen students' learning experiences.

This level of accomplishment puts Washington's elementary science education system at a crossroads. Even as the improvement efforts over the past decade are visible, there are also signs that the elementary science system is at risk. Importantly, what is in place today is a necessary foundation, but is insufficient on its own, for strengthening elementary science education in Washington State. Further, teachers receive mixed messages from their schools, districts and the state about science being a high priority. Very few teachers receive clear expectation from their administrators to teach science regularly. Rather, with few exceptions, teachers who are personally motivated feel that they are stealing time from other subjects in order to teach science. Moreover, the trajectories that these teachers follow as they strengthen their science teaching are extended; it takes time for teachers with minimal or no science training to gain the confidence and skill they need to teach science well. And yet teachers see policy pressure for improvement as sporadic and often at cross-purposes. In other words, policy timelines are often incongruent with the growth trajectories of even the most dedicated teachers. To reduce the risk of undermining progress to date, and to further strengthen elementary science, strategic and ongoing policy actions are needed. Investments can move the system forward when commitments remain strong over time.

[11] Respondents were from 67 districts or close to one in four.

Recommendations for investing in improvement

Our study points to recommendations for policy action and investment that can both sustain and strengthen improvement of elementary science education in Washington.

1. Sustain investment in foundational infrastructure

It takes years to build the level of foundation reflected in our study. **It is vital to sustain investment over time in high quality kit-based curriculum and training.** Wavering attention to K-5 science could undermine that foundation.

2. Raise and clarify the priority of K-5 science

A strong K-5 science program leads to stronger science in the upper grades. In order to enhance and broaden efforts to improve elementary science systematically, **all levels of the system must send a strong and consistent message that science is, in fact, a high priority**.

In the face of weak system priority, strengthening science instruction relies on teachers' personal commitment and individual initiative. This dynamic acts as a significant constraint on collective effort. True state-level improvements require that state and local district leaders convey the importance of science learning, and that they ensure that high-quality science teaching occurs regularly. School level leadership is also critical: principals must promote the teaching of science, plan and schedule for it, and support professional growth as teachers put new knowledge into practice.

3. Invest steadily in human capital

Beyond the foundational investment in high quality curriculum and basic training, **the strengthening of elementary science teaching requires investment in *human capital*, specifically in the development of teacher knowledge and skill for teaching science and for leading local efforts to improve the teaching of science**.

Our study suggests that teachers need a steady diet of three kinds of professional development in order to play their part in improving elementary science:

a. ***"Inputs" in the form of more content knowledge and science-rich pedagogical knowledge.*** The teachers in our study were aware of their need for more science content knowledge. Effective professional development opportunities of this kind focus on in-depth experiences with science concepts and inquiry, as well as on classroom practices for facilitating students' inquiry in science and for

using formative assessment of student learning to guide instruction. A few examples:

- Professional development offered by informal science institutions such as the Pacific Science Center or Seattle Aquarium
- Initiatives funded through the National Science Foundation, such as the North Cascades and Olympic Science Partnership
- District-based efforts—externally and/or internally funded—that are rich, engaging and focused on content related to the teacher's assignment, such as the Seattle Expository Writing and Science project
- Courses through institutions of higher education

b. ***Systematic, structured supports over time for teachers to put into practice what they learn.*** These supports enable teachers to teach science with greater skill and to move into greater conceptual depth than kits alone permit. In-school structures for collaboration could include professional learning communities, grade-level study teams, study groups, and so on. Resources and models for this work could include lesson study, instructional coaching, curriculum topic study, critical friends groups and protocols, and reflective assessment and documentation similar to that of preparing a National Board for Professional Teaching Standards portfolio.

c. ***Support for teachers with leadership potential to gain skills enabling them to facilitate improvement at their school sites and districts.*** Teachers need collegial school-based leaders, both formal and informal, that they can turn to. The teachers in this study represent a sector of the labor force that has great potential to develop as leading practitioners. They are typical of their colleagues in terms of having backgrounds that are not rich in science, but at the same time, they can become advocates and facilitators for improvement because they are highly motivated and increasingly well-prepared. As it is, many find themselves doing formal and informal leadership work in science, even though they often feel ill prepared to do so. Deliberately building the leadership skills of this pool of highly professionalized teachers would represent a valuable investment in supporting and promoting broad improvement in science teaching and learning.

These investments in teacher development are consistent with recommendations of a major new report on the status of teacher development in the United States and abroad (Wei, et al., 2009). The report conceptualizes professional learning as the "product of

both externally-provided and job-embedded activities that increase teachers' knowledge and change their instructional practice in ways that support student learning." (p. 1)

The need for further research

Even as we are confident that the above policy actions, at a minimum, are needed to strengthen elementary science teaching, we see the need for further research. This study was not intended to be a landscape study. However, the study revealed glimpses of the landscape that merit further investigation. Participants in this study were seasoned, experienced professionals selected for their dedication to improving their teaching; they were not selected to be representative of the total elementary workforce currently teaching science. Capturing the realities and perspectives of the broader teaching workforce is essential in order to fill out a more robust picture of the statewide landscape, and to document the range of teachers' trajectories of improvement. We wonder, for example: How solid is the existing infrastructure of progressive curriculum and initial kit training across all 296 districts? What role does that foundation play in the science teaching of the total elementary workforce? How do the improvement trajectories uncovered in our study compare with more mainstream teachers' trajectories? What additional supports and experiences are needed to promote more and deeper elementary science teaching for all teachers in the state? What kinds of professional leadership exist, are needed, and can be developed? A more comprehensive and inclusive landscape study is needed, one that draws from a carefully constructed stratified random sample of teachers statewide that reflects the full range of the workforce in terms of background, teaching responsibilities, and workplace context.

Such a study would serve two purposes. First, it would provide further assistance to Washington policy makers about the scope of investments needed to both maintain and further strengthen science teaching statewide. Second, the results of such a study would be germane to other states that are conceptualizing or working on the improvement of elementary science. If the results of a broader study were even partly to affirm the results of this one, it would be important to the nation to hold up Washington State as a model of state-level instructional improvement.

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Appendix A: Survey Form

CSTP Survey for Elementary Science Teachers on Strengthening the Teaching of Science over Time – May 2008

1. *Survey validation code:* _____

BACKGROUND INFORMATION

2. **In what district are you teaching?** _____

3. **Which grade(s) are you teaching this year?** *(Check all that apply.)*
   - K
   - K-1
   - 1
   - 1-2
   - 2
   - 2-3
   - 3
   - 3-4
   - 4
   - 4-5
   - 5
   - Other (describe):

_____

4. **Are you responsible for teaching elementary science?**

Yes. I am a multi-subject teacher in a self-contained classroom fully responsible for my science program.

Yes. I am a multi-subject teacher in a self-contained classroom who teaches science and whose students also see a science resource teacher (a teacher whose primary responsibility is teaching science to other teachers' students and who often teaches in a designated "science room").

Yes. I am a science resource teacher.

No. Science is taught at my grade level, but it is handled entirely by the science resource teacher or another teacher (see box below).

No, I am not responsible for teaching elementary science because it is not taught at my grade level (see box below).

This survey is intended for elementary teachers who are responsible for teaching elementary science. If you answered "no" on the question above, please assist us by going to the end of the survey and hitting "submit" now. Thank you.

YOUR PREPARATION TO TEACH SCIENCE

5. **Which of the following degrees and certifications do you hold?** *(Check all that apply.)*

- BA
- BS
- MA
- MS
- Masters in Science Education
- Degree from a teacher preparation program at a Washington university
- Professional Certificate in Washington
- Science Endorsement
- National Board Certification
- Other (describe): _____

6. **If you are National Board certified, which area(s) did you focus on as evidence for certification?** *(Check all that apply.)*

- Science
- Language arts
- Mathematics
- Social Studies
- Early Childhood
- Middle Childhood
- Literacy
- English as a New Language
- Other (Please specify): _____

7. **Are you a teacher leader for NCOSP?**

- Yes
- No

8. **Many teachers feel better qualified to teach some subject areas than others. How prepared do you feel to teach each of the following subjects at the grade level(s) you teach, whether or not they are currently included in your curriculum?**

Earth/Space Science	Not adequately prepared
Life Science	Somewhat prepared
Physical Science	Prepared
Technology	Very well prepared
Mathematics	
Reading/Language Arts	
Social Studies	

9. **How long have you taught science?**

- 1-2 years
- 3-5 years
- 6-10 years
- 11-20 years
- Over 20 years

CURRENT STATUS OF YOUR SCIENCE TEACHING

Your science curriculum

10. **Which of the following statements best describes your current science program?**

I teach some science, but it is primarily the responsibility of a science resource teacher.

I am not teaching much science because I have little time for it, given my other instructional priorities.

I teach an established science curriculum as designed.

I teach a modified version of an established science curriculum (e.g., teaching selected lessons and/or supplementing with additional activities).

I teach a self-designed science curriculum that incorporates materials and activities from various sources.

Other (describe): _____

11. **Is there a school-wide science program?**

Yes

No

12. **What science curriculum materials did you use during the 2007- 08 academic year?**

	School wide adoption	Other curriculum materials I use
FOSS kits	Check if applicable	Check all that apply
STC kits		
Other kit-based curriculum		
Text-based curriculum		

13. **If you checked "other kit-based curriculum," which one?**

_____

14. **If you checked "text-based curriculum," which one?** _____

16. **If your school has implemented a school-wide science program that uses a published curriculum (text- or kit-based), which of the following best describes the current extent of implementation?**

All, or nearly all, teachers are using it.

It is implemented by some teachers and we are moving to full implementation.

Usage is spotty and not likely to change.

Other (describe): _____

17. **If your school uses kit-based curriculum for science teaching, is there a system in place in your district/school/ESD to replenish your kit materials?**

NA

Yes

No

18. **If your school does not use a kit-based curriculum for science teaching, what kind of support, if any, is available for materials and equipment you use to teach science?** *(Check all that apply.)*

None
District, school or ESD resource center
School staff member(s)
Science coach
Parent volunteers
Other (describe): _____

Time devoted to science (to be completed by multi-subject teachers in self-contained classrooms)

19. **How many days a week, on average, do you teach science at some point in the day?**

1 day
2 days
3 days
4 days
5 days

20. **How many minutes a week, on average, do you teach science?**

1-30 min
31-45 min
46-60 min
61-90 min
91-120 min
121-180 min
over 180 min

21. **How does the amount of time you spend teaching science compare to the time spent by the average teacher at your grade level, in your school?**

Much less time
Less time
About the same time
More time
Much more time
NA/Can't say

Current confidence and interest in strengthening your science teaching

22. **Overall, how effective do you feel in implementing your science program?**

Very ineffective
Ineffective
Mixed
Effective
Very effective

23. **How well prepared do you feel to accomplish each of the following in your science teaching, whether it is applicable to your teaching situation this year or not?**

Teach science consistent with state Grade Level Expectations (GLEs)	Not adequately prepared Somewhat prepared Prepared Very well prepared
Help students construct their understanding of science content	
Use inquiry/investigation-oriented teaching styles	
Use problem-based approach	
Use and teach kit-based curriculum	
Assess student learning in science through assessment tools	
Use technology to enhance science instruction	
Teach science to English language learners	
Teach science to students who have special needs	
Integrate science content to support reading and/or math proficiency	
Incorporate writing in science	
Assume leadership for science in my school	
Work with a science coach	

GENERAL SUPPORTS AND BARRIERS FOR SCIENCE TEACHING IN THE SYSTEM

24. **What is your perception of the priority given by the state to science as a subject area?** *(Check one.)*

Not a priority now, and there is no reason to think that is likely to change (*Skip the next question.*)
It is an emerging priority, likely to be more important in the future
It is one of several subject areas that are priorities
It is one of the highest priority subject areas
Can't say

25. **Which of the following supports for science are available to you?** *(Check all that apply.)*

Funding for professional development
New curriculum and materials
Regional professional development opportunities and events
Local/regional/statewide news about science education
Science coaching
Other (describe): _____

26. **Other than the WASL science tests, what indicates to you that science is a priority for the state?** _____

27. **How would you characterize the following groups' support for the overall improvement of science in your school and district?** *(Check one in each row.)*

School	No support
District	Mixed/pockets of support
Parent community	Consistent support

28. **Is there a district-sponsored effort for improvement of science at the elementary level in your district?**

Yes, and it is a major priority
Yes, but it is one of many priorities
Not now, but one is anticipated in the future
No, and none is planned that I know of

29. **If yes, in what ways are you involved with your district's effort?** *(Check all that apply.)*

I attend workshops, institutes, other structured offerings
I participate in opportunities to work on science teaching at my school
I engage in work as a teacher leader
Other (describe): _____

30. **If yes, how helpful to you is your district-sponsored effort for improvement of science?**

Not helpful at all
Minimally helpful
Somewhat helpful
Very helpful
Of great help

31. **Which of the following statements describe your opportunities to work on science teaching at your school?** *(Check all that apply.)*

I have the opportunity to engage in informal work with colleagues.
I have the opportunity to engage in structured and organized work only as a part of my team or grade level
I have the opportunity to engage in structured and organized work as part of a school wide effort
I have an opportunity to work with a science coach
I have little or no opportunity to work on science teaching at my school.

32. **Is there is "champion" advocating for and leading local improvement efforts in science in your school and/or district?**

There is a champion in my school
There is a champion in my district

If there is no champion at your school or district, skip the next 3 questions.

33. **If there is a champion for science, what is his/her professional role?** *(Check one.)*

Myself (teacher)
Another teacher
Science coach
School administrator
District science administrator
Other district leader
Science museum or other informal education provider
Local scientist/mathematician
Other (describe): _____

34. **If there is a champion for science, what is your relationship to him/her?**

I know of him/her

I see him/her at meetings/workshops
We work together to promote or support change
Other (explain): _____

35. **How influential is the champion in advocating for and bringing about change in the district?**

Not influential outside a small circle
Somewhat influential in the district
Very influential in the district

36. **How would you describe the status of science in your school, district and classroom, now compared to 3 years ago?**

NA, I was not teaching elementary science in the same district three years ago (check any in this row and leave the rest blank)	Much lower now Lower now About the same
Priority given to science at your school	Higher now
Priority given to science in your district	Much higher now
Time you devote to science instruction	
Your preparation to teach science	
Your satisfaction with science instructional materials	
Your satisfaction with your teaching of science	
Cohesiveness of your science program	
Priority of strengthening science for your professional growth	
Quality of support provided to you for teaching science	
Amount of support provided to you for teaching science	

37. **Which of the following statements best describes your current level of interest and effort in strengthening your science teaching?**

Strengthening my science teaching has never been a priority for me; I have other priorities. (*Skip to* **MORE ABOUT THE CONTEXT IN WHICH YOU ARE TEACHING SCIENCE**.)

I want to strengthen my science teaching, but have not yet taken concrete steps to change my practice. (*Skip to* **MORE ABOUT THE CONTEXT IN WHICH YOU ARE TEACHING SCIENCE**.)

I have just begun to try to strengthen my science teaching.

I am engaged in a continuing effort to strengthen my science teaching, but I have a long way to go.

I have strengthened my science teaching quite a lot – and I see definite pay-offs - but I am continuing to refine my practice.

While I continue to I make some refinements to my science teaching, I am generally satisfied with it and have turned to other priorities.

Other (describe): _____

DEVELOPING AND GROWING AS A TEACHER OF SCIENCE

Strengthening science teaching: your own path

38. **How long have you been working actively at strengthening your science teaching?**

1 year
2 years
3 years
4-5 years
6-10 years
Over 10 years

39. **Which areas did you focus on in your early efforts to strengthen your science teaching?** *(Check all that apply.)* **Which areas have you focused on as you have continued to strengthen and refine your science teaching?** *(Check all that apply. Skip this column if you have just recently begun to strengthen your science teaching.)* **Which areas have never been a focus for you?** *(Check all that apply.)*

	Focus areas in my early efforts to strengthen my science teaching	Focus areas as I have continued to strengthen/refine	Areas that have never been focus areas for strengthening my science teaching
-Teaching to state grade level expectations (GLEs) -Helping students construct understanding of science content -Using inquiry/investigation-oriented teaching styles -Using a problem-based approach -Using and teaching kit-based curriculum -Assessing student learning in science through assessment tools -Using technology to enhance science instruction -Teaching science to English language learners -Teaching science to students who have special needs -Integrating science content to support reading and/or math proficiency -Incorporating writing in science -Developing mastery in presenting and facilitating science lessons that are unfamiliar to me -Assuming leadership for science in my school -Other	Check all that apply	Check all that apply – leave blank if NA	Check all that apply

40. If you checked "Other," please describe: _____

Supports and barriers specific to your own efforts over time to strengthen your science teaching

41. **Which of the following factors have motivated and supported you as you have worked to improve your science teaching? Which have hindered and acted as a barrier to you? Which have simply not been a factor for you?**

My own interest in science	Hindrance or barrier
My own knowledge about science	Mixed
My own knowledge about how to teach science	Motivator or support
A belief that children need science in order to enhance the way they interact with and understand the world	*Not a factor*
A belief that children need science because our world needs more scientists	
My confidence level for teaching science	
Priority given to science at my school	
Clarity of the vision at my school for what students are expected to know and do in science	
Students' interest in science	
Parent and community interest in science	
Quality of curriculum that I have access to	
My access to professional development to support use of instructional materials	
My access to other professional development related to science	
Quality of professional development I have experienced	
Support provided by colleagues	
Support provided by my school administrator	
Support provided by other district personnel	
Support provided by my ESD	
The experience of preparing my National Board portfolio	
Ease of materials replacement	
WASL requirements	
Standards or Grade Level Expectations (GLE) requirements	
Integration of science into the teaching of other subjects	
Support provided by a science coach	

42. **Over time, where have you found support for strengthening your science teaching? Which sources were supports to you in your early efforts to strengthen your science teaching?** *(Check all that apply.)* **Which sources have been supports to you as you have continued to strengthen and refine your science teaching?** *(Check all that apply. Skip this column if you have just recently begun to strengthen your science teaching.)* **Are there any sources that have never been a support for strengthening your science teaching?** *(Check all that apply.)*

	A support in my <u>early efforts</u> to strengthen my science teaching	A support as I have <u>continued to strengthen and refine</u> my science teaching	This has never been a support for strengthening my science teaching
-Other teachers- -My school administration -My district -Externally-funded efforts at my school/district -ESDs -National Board portfolio preparation process -A science coach -Institutions of higher education (colleges, universities) -Informal learning institutions (e.g., science and tech museums) -Statewide & national professional organization (e.g., NSTA, WSTA, CSTP, LASER, NCOSP) -Online support -Other	Check all that apply	Check all that apply – leave blank if NA	Check all that apply

43. If you checked "Other," please describe: _____

44. **How have your principal and district supported you in strengthening your science teaching?**

	Supports provided by my principal	Supports provided by my district
Funds for materials and equipment	Check all that apply	Check all that apply
Professional development opportunities within my school/district		
Professional development opportunities outside/beyond my school/district		
Mentoring or coaching		
Conference participation opportunities		
Leadership opportunities		
Released time		
Discretionary funds		
Encouragement and acknowledgement for my efforts		
Providing an opportunity to examine/assess student work with my colleagues		
Other		

45. If you checked "Other," please describe: _____

Professional development in science

In answering the questions below, please think about professional development broadly, including not only formal workshops and institutes, but also lesson study, professional learning groups, coaching, critical friends, etc.

46. **Approximately how many <u>total days</u> of science-related professional development have you participated in during the last three years?** *(Estimate your total PD hours, and consider each 6 – 8 hours to be a full day, even if you participated in shorter time increments.)*

2007-2008	None
2006-2007	Less than a day
2005-2006	1 full day
	2-5 days
	More than 5 days

47. **Over the last 3 years, how many days of science PD have you received from each of the following providers?** *(Again, estimate your PD hours, and consider each 6 – 8 hours to be a full day, even if you participated in shorter time increments.)*

My school	None
My district	Less than a day
The local ESD	1 full day
Institutions of higher education (colleges, universities)	2-5 days
Informal learning institutions (e.g., science and tech museums)	More than 5 days
Statewide & national professional organization (e.g., NSTA)	
Other	

48. If you checked "Other," please describe: _____

49. **Over the last 3 years, what forms of professional development have you participated in?** *(Check all that apply.)* **Which have been the most useful to you?** *(If you have not participated in a form of PD, leave the row blank.)*

	Forms of PD I have participated in	Forms of PD that have been most useful to me
Workshop(s)	Check all that apply	Check all that apply
Grade level group(s)		
Coaching		
Lesson study		
Inquiry groups		
Institute(s) (multi-day or multi-week programs)		
Course(s)		
Enrollment toward an advanced degree		
Preparing my National Board Portfolio		
Other		

50. If you checked "Other," please describe: _____

51. **Over the last 3 years, what has been the content of professional development that you have participated in related to science?** *(Check all that apply.)* **Please rate the quality of each type of professional development that you have participated in and then check the ones that have been most useful to you.** *(If you have not participated in PD addressing a content area, leave the row blank.)*

	Content of PD I have participated in	Quality of this PD	PD that has been the most useful
-Teaching to state Grade Level Expectations (GLEs)	Check all that apply	Very poor Poor Mixed Good Very good	Check all that apply
-Helping students construct their understanding of science content			
-Using questioning strategies that help students develop their understanding			
-Using inquiry/investigation-oriented teaching styles			
-Using problem-based approaches			
-Using and teaching kit-based curriculum			
-Assessing student learning in science			
-Using technology to enhance science instruction			
-Teaching science to English language learners			
-Teaching science to students who have special needs			
-Integrating science content to support reading and/or math proficiency			
-Incorporating writing in science			
-Presenting and facilitating science lessons that are unfamiliar to me			
-Assuming leadership for science in my school			
-Other			

52. If you checked "Other," please describe: _____

53. **How much professional development in science did you receive prior to 2005-06?**
- None
- Little
- Some
- A lot
- A great deal
- *NA, I wasn't teaching science then*

54. **As you have tried new things in teaching science, what kinds of feedback have you received to help you figure out if you are getting better?** *(Check all that apply.)* **Which kinds of feedback have been most useful?** *(If you have not received this kind of feedback, leave the row blank.)*

	Feedback I have received	Feedback that has been most useful
Informally watching and listening to my students	Check all that apply	Check all that apply
Formally assessing my students		
WASL scores		
Informal feedback from colleagues		
Formal feedback from my science mentor/coach		
Informal feedback from my administrator		
Formal feedback from my administrator		
Feedback from professional developers		
Preparing my National Board portfolio		
Assessing/examining student work with my colleagues		
Other		

55. If you checked "Other," please describe: _____

56. **How do you decide what the next steps are for strengthening your science teaching practice?** *(Check all that apply.)*

- My own learning goals for my students
- Student performance and interest
- GLEs
- New curriculum
- Someone tells me
- My science coach helps me
- Other (describe): _____

57. **Of all of the opportunities and resources available to you, to what extent has each of the following supports and experiences contributed to your professional growth as a teacher of science so far?**

The experience of teaching my students	Not at all
Curriculum I have used	A little
Professional development I have received	Some
Coursework I have taken	A lot
Formal support by colleagues (e.g., coaching/mentoring)	A great deal
Informal support by colleagues	*NA*
Administrator support	
Preparing for National Board certification	
My participation in a special science reform project	
Other	

58. If you checked "Other," please specify: _____

59. **If you have experienced a critical juncture or transformative experience in strengthening your science teaching, please describe the experience. What happened? Under what circumstances? Why was it transformative?**

_____

60. **What are your goals for strengthening your science teaching for the next three years?** _____

61. **What do you need most in order to reach your goals for strengthening your science teaching?** *(Check up to 3 total)*

	My top priority for support	My second priority for support	My third priority for support
-Time and a structure for reflecting on my science teaching -Opportunities to collaborate with other teachers on strengthening science -Opportunities to work on strengthening science with colleagues at my grade level -Administrator support -A school wide focus on strengthening science -High quality science curriculum with good teacher materials -High quality professional development -Opportunities to work with science faculty members at my local university -Opportunity to deepen my science content knowledge -Opportunity to prepare for National Board certification -Higher priority for science at the state level -More coaching -Other	Check ONE in this column	Check ONE in this column	Check ONE in this column

62. If you checked "Other," please describe: _____

All science teachers - please respond to the rest of the survey.

MORE ABOUT THE CONTEXT IN WHICH YOU ARE TEACHING SCIENCE

63. **How many elementary students are in your district?**
- < 100
- 101-500
- 501-750
- 751-1000
- 1001-5000
- > 5000

64. **How many elementary students are at your school?**

< 100
101-250
251-500
>500

65. **Is your school specially funded in any way for science? If so, what programs or funding sources support science at your school?** *(Check all that apply.)*

NCOSP
OSPI
LASER
Other state initiative
PTA donations
Foundation grant(s)
Industry grants(s) or program(s)
Other (describe): _____
I am not sure if our school is part of specially funded science project(s)

66. **Is your school under Program Improvement status because it is not meeting NCLB Annual Yearly Progress (AYP)?**

Yes
No
Don't know

67. Are there any other comments you'd like to share about your district's or the state's efforts to strengthen science teaching, or your own work in this area?

_____

THANK YOU!

Appendix B: Protocol for Individual Interviews

Interview protocol for CSTP Elementary Science Teacher Nominees:

I. Introduction – purpose for the study and scope of interview

Thank you for agreeing to talk with me today. As I mentioned in my e-mail, I work for Inverness Research, an education research group. We are currently working with the Center for Strengthening the Teaching Profession (CSTP) on a study of elementary science education in Washington. The study is intended to help policy makers make more informed decisions about teacher support and development for elementary science. As part of our study, we want to portray the voices, perspectives, and experiences of elementary school teachers in Washington who are working to strengthen their science teaching. We would like to know about the experiences, processes, supports, and resources that are helping you strengthen your own (and perhaps others') science teaching over time. So this call is about hearing your story about improving your science teaching.

Your name and school/district site will remain anonymous in the study. As a token of our appreciation for your time, we will offer you a $35 gift certificate to Amazon.com.

II. Background – teachers' career trajectories – where they've been, where they are and where they intend/hope to be in 5 years

a. Tell me about your teaching experiences.

What is your current teaching position?
How long have you been teaching in all?
How long have you been teaching where you are teaching now?
What grade levels have you taught?
Where do you hope to be in 5 years?

b. Can you give me a two to three sentence description of your school and community – size, location in state, SES, rural/urban/suburban, student population?

c. What was your teaching preparation like? What was your undergraduate degree in? Where did you do your preservice education? Do you have any graduate degrees and/or certifications? Can you comment on what aspects of your teacher preparation you found to be particular valuable?

d. Are you involved in any kind of teacher leadership work now? (By teacher leadership work, we mean any work or activities that engage you in supporting other teachers' efforts to improve their teaching. This could involve being part of an inquiry group, grade level team facilitator, working as a coach, mentor, leading workshops, steering curriculum committees, being the go-to person for science, being a formal paid TOSA, etc.). Is it inside or outside your school and/or district? Please describe.

III. Perspectives on their science teaching: past, present and intentions for the future

a. Talk with me a bit about your science teaching. How much time per week (or month) do you spend on science in your classroom?

b. What materials/curriculum are you currently using? How effective do you think these are for

your teaching goals? If you supplement the curriculum, what do you use and where did you learn to use or obtain these resources? Can you describe a typical science lesson for me?

c. What would you consider your areas of strength? Areas of challenge?

d. What kinds of barriers have existed for you in terms of teaching science?

d. How confident do you feel about your science teaching? Would you say you are pretty willing to try new things? Why or why not?

IV. <u>What does it mean to "improve your practice"</u> – Impetus/motivation for improvement

a. Describe the kinds of things that motivate you to improve your teaching of science.

Experiences (probe for descriptions, qualities and impacts on instruction and which stand out as most important)
Personal interest
PD (please be specific, which have been better and why?)
Colleagues (if so, are these from your school, district, professional network/organization, etc?)
Organizations/Professional memberships
School/district/state supports and experiences (funding or other kinds of support for attending workshops, conferences, or participation in committees, work groups, etc.)

b. Tell me how your science teaching has changed or developed over time.
- In other words, what types of changes have you made over time in your science teaching?
- Has your approach changed (e.g. textbook to hands-on to inquiry)?
- Have you changed how you identify or teach key concepts?
- Have you changed how you assess what students know and are able to do?
- Has the time you spend on science in your classroom changed over time? (Toward more or less science?)

c. Tell me about how you go about trying new things in your science teaching.
- What makes you decide to try something new?
- How do you gauge whether it is a good idea to keep doing? What kinds of feedback or info do you look for?
- Trying new things can be kind of rocky. What do you do to "keep getting better" at new things in your science teaching?

d. What stands out for you as some of the highlights over time in your science teaching? By highlights, we mean critical experiences or moments – "ahas", if you will – in your development as a science teacher.
- What were the circumstances that made these highlights?
- Are there particular student interactions and outcomes that stand out for you?
- Did these highlight moments influence further changes to your science teaching? In what ways?

e. Are there supports at your school/district for your teaching of science? If so, what are they and how do you access/engage them?
- Where do you find other supports?
- Where have they been in the past? Where are they now?
- What supports have been most useful to you in improving your science teaching?

f. What Barriers and/or challenges exist for you in terms of improving your science teaching? How have you been able to address or overcome those barriers?

VI**. <u>What ifs</u>** …. Recommendations for internal and external supports, processes and systems that could/would facilitate improving elementary science in WA….

a. If you could make two or three recommendations to the powers that be in Washington state for improving teaching conditions and supports for teaching elementary science, what would you recommend?

b. In particular, what kinds of school-based supports, county-level, district-level, state-level supports? What would be your top priorities in terms of conditions or processes that would facilitate improving elementary science in WA?

c. Any other thoughts/reflections about your own science teaching over time or ideas about your own development and supports for your improving your science teaching over time?