



Introduction

The Maine Physical Sciences Partnership (PSP) has fostered an important partnership between the University of Maine and local K-12 educators to improve teaching and learning in physical sciences in grades 6-9. The project has strategically addressed this effort through the selection and support for implementation of new instructional materials, and through professional development and leadership opportunities such as collaboratives, cohort meetings, and other activities that provide opportunities for university faculty and teachers to work together. Inverness Research has been documenting the work of the project since its inception in 2010 and has noted positive impacts for both teachers and students. This brief presents highlights of what teachers and students have to say about the project's contributions.

Impacts on Teachers

Maine PSP teachers who were observed, interviewed, and surveyed by Inverness Research report multiple benefits from their experience in the project—benefits that have led to increased content knowledge and confidence in teaching science.

❖ **As teachers' understanding of science content and effective ways to teach has grown through their participation in the Maine PSP, their confidence in teaching science has grown as well.**

Over two-thirds (69%) of teachers responding to a spring 2015 survey reported feeling confident or very confident¹ teaching physical science, compared to just 62% in 2013. And in 2015, more than three-fourths (78%) reported feeling confident or very confident teaching earth science. Survey comments illustrate the ways in which the PSP has contributed to teachers' confidence:

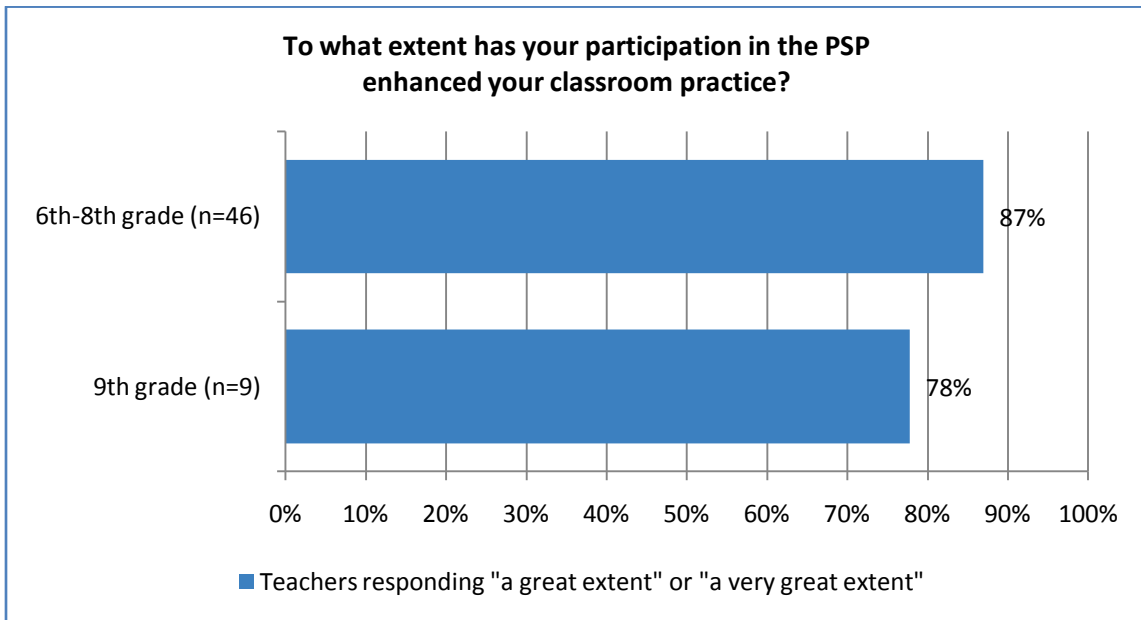
- * *When teaching the more physical side of environmental sciences and Earth sciences, the Maine PSP has greatly increased my confidence.*
- * *There have been many professional development opportunities through the PSP that have helped increase my confidence in all aspects of physical science teaching.*
- * *I gained confidence in my understanding of the science and the science practices, and in recognizing what really good science teaching is. And the professional development that the PSP offers is good science teaching.*
- * *When I think about all of the different things that I have done with the PSP—the collaboratives, the cohort meetings, and the Teachers-In-Residence—my own personal*

¹ On a scale of 1 to 5, where 1 = not confident at all, 2 = not confident, 3 = mixed, 4 = confident, and 5 = very confident.

growth and development in content knowledge and pedagogy is gigantic, and I am a much better teacher than I used to be.

❖ **Perhaps most importantly, teachers report that their classroom practices have been changed as a result of their participation in the project.**

On the 2015 survey, the majority of teachers rated their experience in the Maine PSP as having enhanced their classroom practice to a great or very great extent:



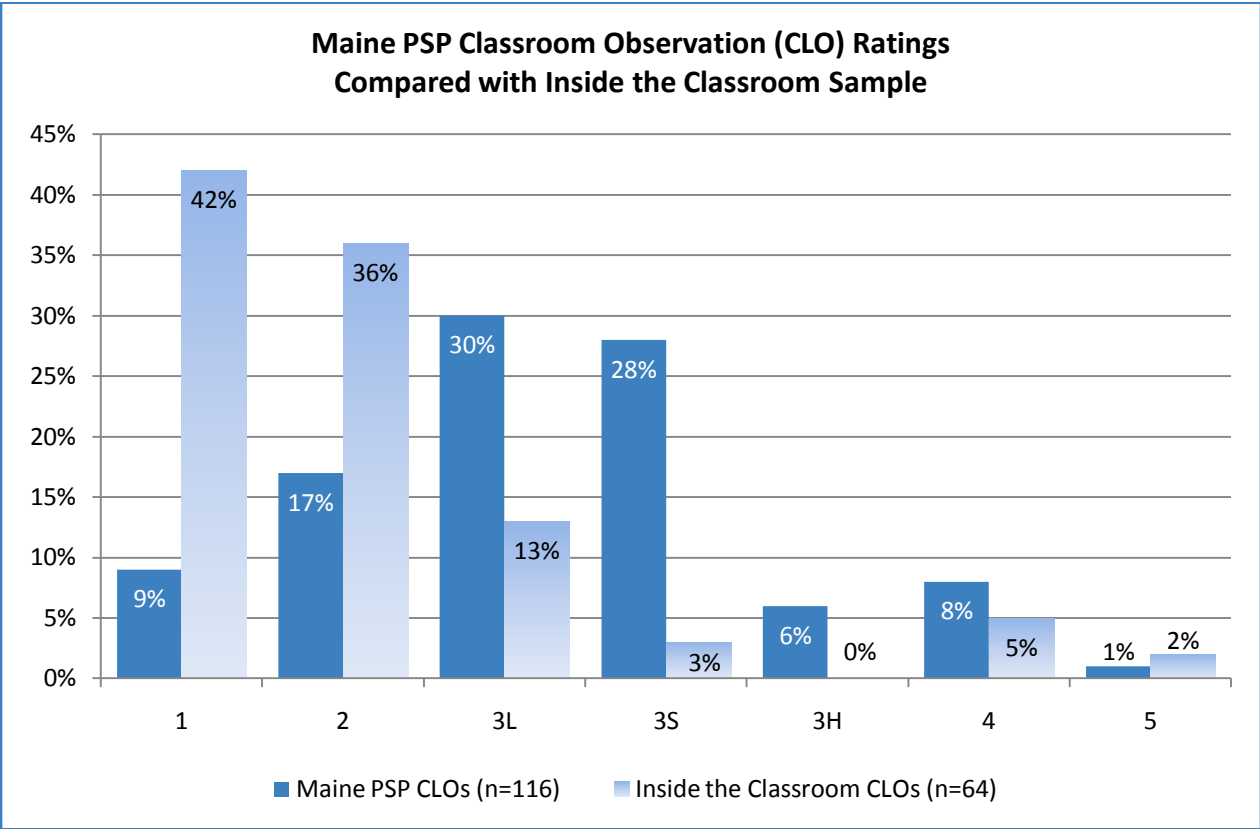
NOTE: Graph represents percentage of teachers who responded 4 or 5 on a scale of 1 to 5, where 1 = not at all, 2 = to a very small extent, 3 = to some extent, 4 = to a great extent, and 5 = to a very great extent.

The vast majority (89%) of teachers also reported that they intend to continue using the instructional materials and implementing the practices they learned through the Maine PSP even after the project ends.

❖ **The project is having a positive impact on the classroom practice of participating teachers.**

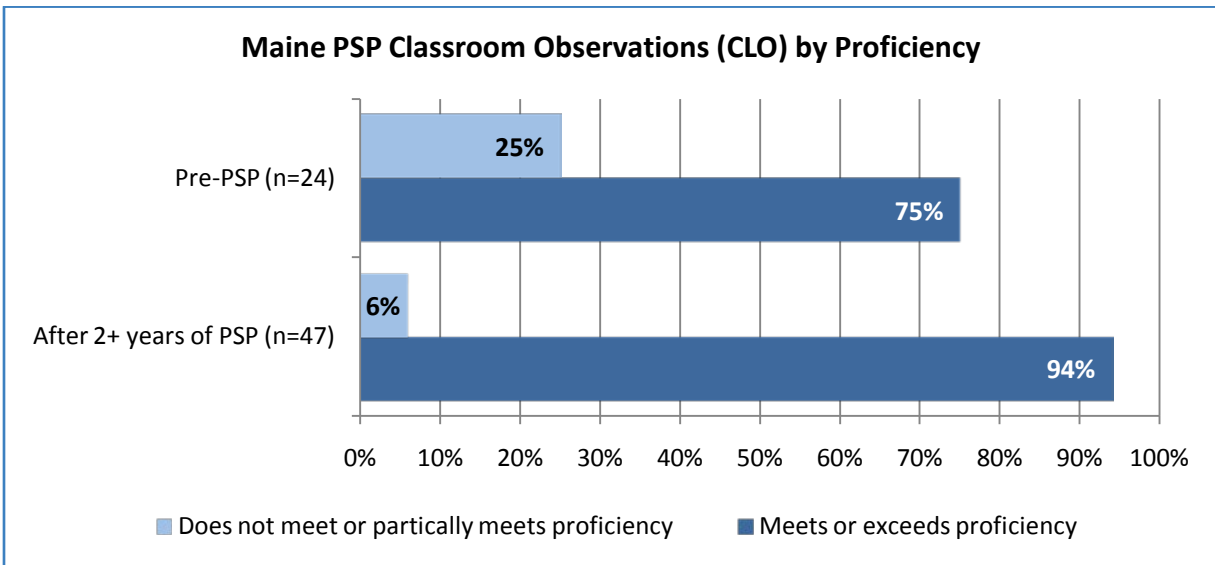
Observations of science lessons by Inverness Research in classrooms of teachers participating in the Maine PSP are more highly rated than classrooms in a national sample of middle school science lessons collected through the Inside the Classroom study conducted by Horizon Research,² as the graph on the following page highlights.

² Each lesson, for both the Maine PSP and the Inside the Classroom study, was rated using a classroom observation protocol adapted from one developed by Horizon Research, Inc. for evaluation of the NSF-funded Local Systemic Change projects. The protocol asks researchers to rate lessons across several dimensions, including lesson design, implementation, science content, and classroom culture. Researchers then synthesize subcomponent ratings into an overall capsule rating. Capsule ratings range from Level 1 (ineffective instruction) to Level 5 (exemplary instruction). Level 3 (beginning stages of effective instruction) is sub-divided into ratings of 3-low, 3-solid, and 3-high. Observers for both the Maine PSP and the Inside the Classroom Study received similar training prior to conducting observations.



A summary of observations over time reveals that the implementation of the PSP supported instructional materials is raising the floor. We are seeing students more often working collaboratively while doing more hands-on inquiry activities with a clear purpose and direction than in the early stages of the project. We are seeing teachers who are becoming more comfortable with the project curricula and therefore who are implementing lessons in a more confident way that allows for more student input and questions. The lessons that were rated “2”s were instances where the teacher was using a highly traditional approach that included little to no student engagement or checking for understanding. The classroom management issues we’ve seen in the past have become much less pronounced over the life of the Maine PSP project, due in part to a more engaging science lessons.

We translated the classroom observation data to the Maine proficiency standards, placing those lessons rated as “3” or above on the Horizon protocol into the “meets or exceeds proficiency” category. The graph on the following page shows a significant shift to a higher percentage of proficiency in the lessons we observed pre-PSP to those we observed after two years or more experience with PSP.



NOTE: "Does not meet" or "partially meets proficiency" includes lessons rated as 1s or 2s on the Horizon scale; "meets or exceeds proficiency" includes lessons rated as 3L, 3S, 3H, 4, and 5 on the Horizon scale.

❖ **Consistently, across all five years of data collection, teachers report that connecting and collaborating with other teachers has been the main benefit of participating in the Maine PSP.**

Through multiple ways and venues—the Summer Academy, Teachers-in-Residence, professional development sessions, online journal sharing, and cohort and collaborative meetings—teachers shared ideas, pedagogy, and questions with each other over time. Their collaborations grew; they eventually worked together on their own project and became part of a network of cross-district teachers. This has been a highlight of the project for many of the teachers who are often the only science teacher in their small, rural school.

Quotes from teachers illustrate this finding:

- * *I think the most important thing has been working with other science teachers on common issues.*
- * *The most important part of the PSP is having the connection to other people and being able to talk about science and teaching science in a way that students are going to enjoy it. Being the only science teacher in the middle school is very isolating.*

Impacts on Students

❖ **The experience of the more than 3,600 students in PSP classrooms has largely improved since the inception of the grant.**

Students now have access to better, more comprehensive instructional materials, and more connected, confident, and knowledgeable teachers to guide their science learning. As a result, the students have a steady diet of meaningful hands-on activities, are generally more invested in science, have more opportunities to collaborate with other students, and have started to take

responsibility for and ownership of their science learning. They also have the experience of examining real-life problems, approaching science as real scientists do.

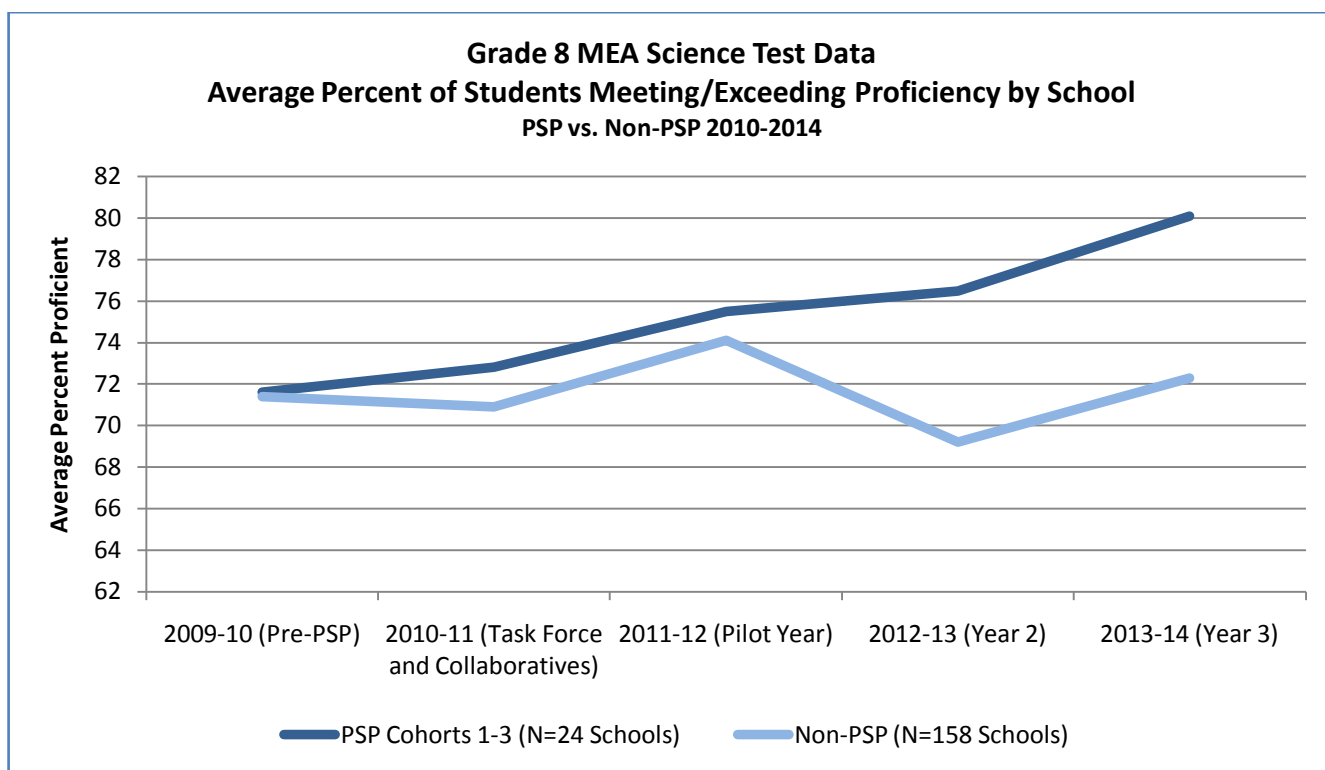
Comments from students interviewed by Inverness over time indicate that there is a notable difference between their science classes prior to PSP and now:

- * *I don't want science to be "take out your book." I want to do it.*
- * *I like hands on activities. It's a little more fortifying.*
- * *The teacher gives us the responsibility to read and set up the experiments.*
- * *Science is easier and more interesting if you do it and experiment with it yourself.*
- * *This year our teacher lets us find out for ourselves what will happen.*

❖ Preliminary data analysis indicates that the Maine PSP is having a positive effect on students' Maine Education Assessment (MEA) scores.

The graph below shows the average percent of students meeting/exceeding proficiency on the Grade 8 MEA Science Test. (Average, meaning the average percent of students meeting/exceeding proficiency for schools in that grouping. This weights small schools and large schools equally.)

The trend shows that students in PSP and non-PSP schools scored similarly in 2009-10 (pre-PSP). PSP schools started to pull away from non-PSP in 2011 (task force) and 2012 (pilot year) testing. The gap increased in 2013 and 2014, with PSP schools improving significantly, relative to other schools in the state. We do not yet have a complete data set for 2015 testing.



❖ **Students in Maine PSP classrooms consistently report that they like science class more than they have in the past.**

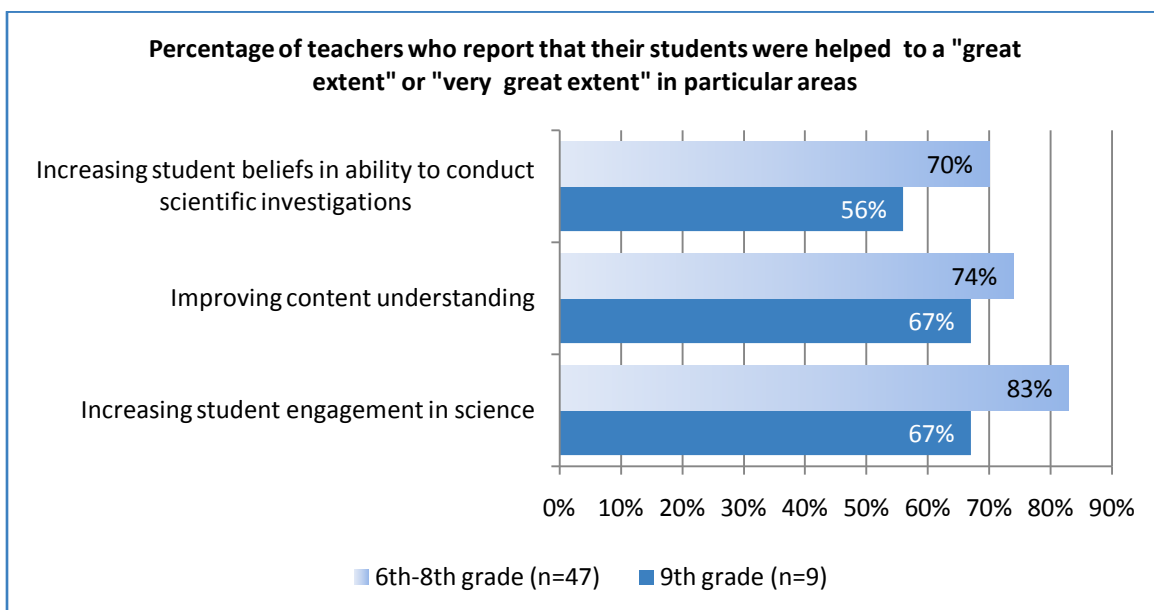
Students tell us that they much prefer doing activities to reading about science in a textbook. They also enjoy working together on projects and they feel what they are learning is more cohesive and connected. The following quotes from a wide variety of middle-grade students across Maine PSP schools express these improvements.

- * *We work in groups more this year.*
- * *I like how we have everything we need to do experiments.*
- * *It's the experiments that you do that you remember.*
- * *I'm more of a visual learner, so it makes it easier for me to understand how something works if I'm not just reading it.*
- * *We are doing more hands-on and going deeper this year.*
- * *When we learn more things and new things we learn what we want to be. I want to be a scientist so I can discover new things.*
- * *Our class looks more like a science lab.*

❖ **Many Maine PSP teachers believe they see increased student engagement as a result of the project's work.**

- * *I think the [instructional materials] have helped increase student engagement. The materials have helped bring continuity to the whole science program itself. They have given me more activities that are connected, and the students get a better picture of how they can use the science in real-life situations and activities.*
- * *I used to have a room full of desks and now I have a room full of tables (for collaboration).*
- * *There is a different tone in the classroom and the kids are willing to talk more and ask more questions and to wonder.*
- * *Students can design their own investigations, create their own questions, figure out ways to answer those questions, determine for themselves what kind of data needs to be collected, figure out a good way to represent it, and they can start to parse what story is being told by the data.*
- * *I think my participation in the Maine PSP led to higher achievement and higher engagement for my students because as my teaching got better, their understanding and their learning and the process got better for them.*

As the bar graph on the following page illustrates, survey results show that Maine PSP teachers largely agree that the project has helped their students to a great or very great extent in particular areas.



NOTE: Graph represents percentage of teachers who responded 4 or 5 on a scale of 1 to 5, where 1 = not at all, 2 = to a very small extent, 3 = to some extent, 4 = to a great extent, and 5 = to a very great extent.

Classroom Vignette: Facilitating Meaningful Student Collaboration

The following vignette of a 6th grade lesson in the “Weather and Atmosphere” unit of the Science Education for Public Understanding Program (SEPUP) demonstrates the way in which a skilled teacher is able to facilitate meaningful student collaboration in a Maine PSP classroom. The students described in the vignette have moved along the continuum of classroom discourse to a place where they have learned to listen carefully to each other and to value each other’s comments to such a degree that they can be persuaded to change their minds, given the evidence. The teacher demonstrates a high level of skill in facilitating the discussion and guiding the lesson so that students feel respected and secure in sharing their ideas.

Over several weeks, the class had been evaluating various scientific data about population growth and its effects on the environment in the fictional city of Sunbeam. Students took on the roles of different scientists: atmospheric scientist, hydrologist, meteorologist, climatologist. They evaluated things such as precipitation, pollution, ground water levels, and temperature as the city's population grew over time (1940-2010). The day before the lesson described below, students met in groups of job-alike scientist colleagues to discuss and compare their data.

The lesson began with the teacher asking students to reflect on what they had been working on. After a quick review where students articulated the big picture focus of the unit, the teacher reminded students they would meet with people in other scientific roles during this lesson. She asked students why it might be important to meet in these cross-job groups. Lots of students had ideas: "So different people can learn about different areas," and "So people get more solid evidence." Before small groups convened the teacher asked them to read about the upcoming task from their text (silently), and the class had a brief discussion about what they needed to do.

Students then got into groups with their notes. They shared data, trying to expand their understanding of the city's growth and the resulting environmental impacts in various areas. The

teacher moved between groups and asked questions, both clarifying and open-ended. Students were knowledgeable and confident as they shared their data with each other.

After about 10 minutes of sharing in small groups, the teacher brought the class together to transition to the next activity. She asked, "Did anyone make conclusions about population change and the environment, because that's really our focus..." This was a bit of a rhetorical question as she then handed out a worksheet which asked students to agree or disagree with four statements about Sunbeam City, e.g., whether or not it would run out of water, whether the atmosphere there differed from other places in the world, and whether people can change weather and atmosphere. After coming to their own conclusions individually, they had to predict what people in their group would say to these statements.

After 10 minutes, the teacher brought the class together and asked them about the first statement, "Is water running out?" One student said he strongly disagreed and that the water was being used but was being replenished. She asked him to give evidence to support his belief. To do so, this student went back to the reading and his notes, and while he did the teacher called on another student who agreed with the statement, saying that the fresh water would run out even if other kinds of water would not. The teacher noted his distinction between fresh and other kinds of water, asking the class to think about the different sources of water in the city. Meanwhile the first student had found his evidence and shared it with the class, noting numbers of liters used from the river and from ground water. He cited more data and the teacher engaged with him, asking clarifying questions but also just listening. After a few minutes she asked the class how many agreed or disagreed that water was running out, and as she did the original student said, "I just changed my mind! I agree that water is running out because I now see that people are using way more water than is being replenished." Another student said, "If they limit their water in their gardens and yard they could make it up." The teacher asked him to elaborate on this and engaged other students in this line of thinking. A few shared that they or their neighbors had collected rain in barrels to conserve water. Another student said, "I'm a climatologist, and they don't get that much rain in Sunbeam..." The teacher commented that this was a nice example of students/scientists sharing information and that they would pick up the discussion in the next class.

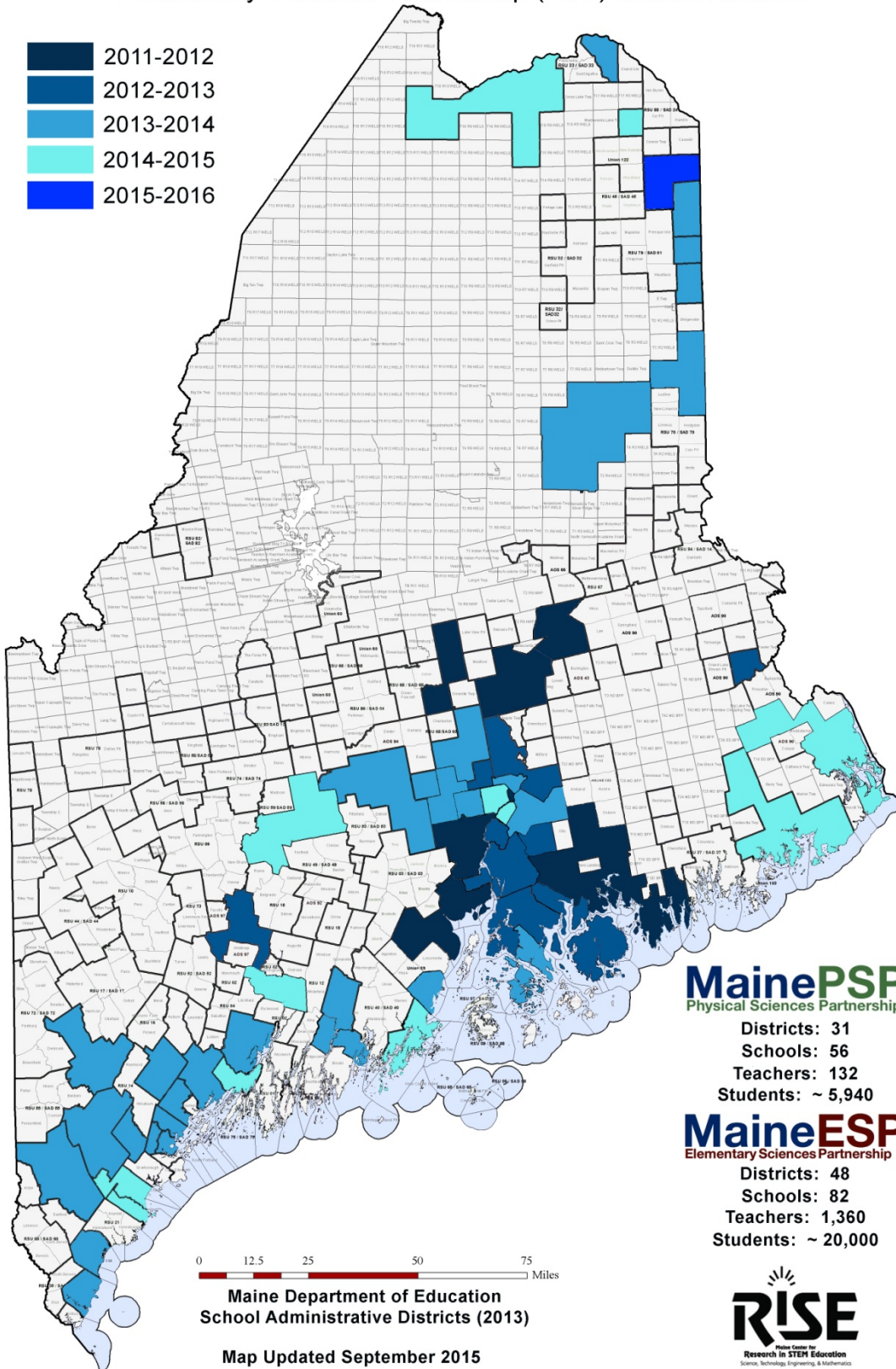
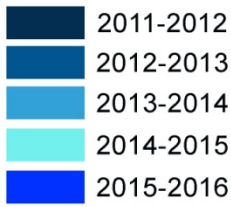
Summary

This brief has highlighted some of the ways in which the Maine PSP has made important contributions to teachers, classrooms, and students. The partnership helps teachers overcome isolation by providing opportunities to work with colleagues in meaningful ways on real issues. It increases confidence by building teacher content knowledge and providing professional development. It provides skills and opportunities to take on leadership roles and create capacity in the local schools and districts. Participation in PSP has resulted in many positive impacts on students, the largest being that students are doing more real science in class than they were in the past. This in turn has helped create more student engagement in science class and ultimately better attitudes toward science.

Inverness Research, a national education evaluation and consulting group headquartered in Northern California, has over 25 years of experience studying local, state, and national investments in the improvement of education.

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Maine Center for Research in STEM Education
 Maine Physical Sciences Partnership (PSP) and
 Elementary Sciences Partnership (ESP) School Districts



MainePSP
 Physical Sciences Partnership

Districts: 31
 Schools: 56
 Teachers: 132
 Students: ~ 5,940

MaineESP
 Elementary Sciences Partnership

Districts: 48
 Schools: 82
 Teachers: 1,360
 Students: ~ 20,000

