



Supporting Principal Leadership in Science, Technology, Engineering, & Math (STEM)

An Evaluation of the 2011 AWSP Principal Leadership Retreat

Evaluation prepared by

Chad R. Lochmiller, Ph.D.

Washington State University
College of Education

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**SUPPORTING PRINCIPAL LEADERSHIP IN
SCIENCE, TECHNOLOGY, ENGINEERING, & MATH (STEM)**

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Evaluation commissioned by
ASSOCIATION OF WASHINGTON SCHOOL PRINCIPALS
1021 8th Avenue S.E. | Olympia, WA 98501-1500

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EXECUTIVE SUMMARY

The Association of Washington School Principals (AWSP) in partnership with the Pacific Northwest National Laboratory (PNNL), Washington State Leadership and Assistance for Science Education Reform (LASER), the Pacific Science Center, and Washington State University hosted the 2011 Principal Leadership Retreat at the Sleeping Lady Resort in Leavenworth, Washington. The Retreat provided school and district administrators from the State of Washington with professional development focused on instructional leadership for Science, Technology, Engineering, and Math (STEM). AWSP commissioned an external evaluation of the Retreat to determine whether the Retreat met the facilitators' objectives and how the Retreat could be improved. This report presents key findings from this evaluation.

Key Findings

The data provided by AWSP indicate that the 2011 Principal Leadership Retreat met the objectives developed by the Retreat's facilitators. More specifically, the Retreat:

- *Engaged school and districts administrators in multiple days of professional development specifically focused on instructional leadership for Science, Technology, Engineering, & Math (STEM).*
- *Provided school and district administrators with exposure to the STEM using a variety of applied, hands-on learning activities and presentations from STEM professionals, including a materials engineer from PNNL.*
- *Afforded participants the opportunity to interact with staff from AWSP, PNNL, Washington State LASER, the Pacific Science Center, and Washington State University.*
- *Positively influenced the participant's understanding of STEM content, instructional practices, and the value of STEM for students as measured by surveys.*
- *Demonstrated instructional strategies that administrators attending the Retreat could apply in their schools or districts.*

Conclusion

Overall, comments from the Retreat participants indicated significant satisfaction with the quality of the professional learning experience. Participants indicated that the Retreat could be improved by increasing opportunities for participants to discuss STEM implementation with administrators in similar school or district contexts. Further, participants expressed a strong desire for more tools and resources that they could use within the context of their work.

INTRODUCTION

The Association of Washington School Principals (AWSP), in partnership with the Pacific Northwest National Laboratory (PNNL), Washington State Leadership and Assistance for Science Education Reform (LASER), the Pacific Science Center, and Washington State University hosted the 2011 Principal Leadership Retreat at the Sleeping Lady Resort in Leavenworth, Washington. The retreat provided professional development to school and district administrators from the State of Washington. The retreat focused on the administrator's role as an instructional leader for Science, Technology, Engineering, and Math (STEM). Fifty-five school leaders attended the Retreat. Staff from AWSP, PNNL, LASER, the Pacific Science Center, and Washington State University planned and facilitated the Retreat.

Retreat Objectives

Based on information provided by AWSP, the Retreat had four objectives. First, the Retreat was designed to help participants develop a shared understanding of STEM education in their schools and school districts. Second, the Retreat provided participants with an opportunity to experience first-hand professional learning activities related to science inquiry, mathematics, problem solving, and engineering. Third, the Retreat immersed participants in the various analytic processes of science. This immersion involved experiencing instructional activities research shows are effective with STEM content. Finally, the Retreat engaged participants in thinking about the role that they have as instructional leaders in supporting science, technology, engineering, and math instruction in their buildings using best practices drawn from emerging research.

Evaluation Design

The Association of Washington School Principals commissioned an external evaluation of the 2011 Principal Leadership Retreat. AWSP requested that the evaluation summarize key findings from participant feedback. To complete the evaluation, AWSP retained Dr. Chad Lochmiller, an Assistant Professor in the College of Education at Washington State University. AWSP did ask the evaluator to collect the data used to complete this evaluation. Rather, AWSP requested the evaluator work from data collected by the facilitators during the Retreat.

The evaluator worked with AWSP staff to develop the focus for the evaluation. The evaluator adopted a qualitative evaluation design focused on identifying themes, perceptions, and experiences of the Retreat participants. The purpose of the evaluation was to identify salient comments, passages of text, as well as examples of the type of activities provided to the Retreat participants which demonstrated that the Retreat influenced the participant's thinking about or interest in STEM education. Four questions guided the evaluation:

- What are the characteristics of the schools and districts represented by Retreat participants?
- How were Retreat activities organized, presented, and aligned with the objectives identified by the Retreat organizers?
- How do participants perceive the activities influenced their thinking about STEM or leadership related to STEM?
- What relationship do participants see the Retreat having with their work as a school principal?

The data provided by AWSP included daily reflections from Retreat participants, summaries of feedback forms, pre- and post-surveys of participants views about STEM and its connection to teaching and learning, as well as documents which described the activities planned for the participants over the four day period. Copies of Power Point presentations were also collected and analyzed. The evaluator did not conduct additional interviews, observations, or

document collection. AWSP staff provided clarification where needed. The evaluator submitted a preliminary copy of the evaluation report to AWSP and the retreat facilitators for review. The review provided an opportunity for the facilitators to offer clarifying comments and additional description that could not be acquired through the data provided. The report unfolds with an overview of the Retreat's structure followed by a discussion of activities provided to Retreat participants.

Organization & Purpose of this Report

This report summarizes findings derived from the data provided to the evaluator by AWSP. The purpose of this report is to demonstrate that the Retreat met the objectives established by the facilitators and provided participants with a valuable professional learning. The report unfolds with a discussion of the evaluation design followed by a discussion of the evaluation findings. The report concludes with a discussion of crosscutting themes.

FINDINGS

The STEM Principal Leadership Retreat served school administrators employed in schools and school districts in the State of Washington. The Retreat served administrators in two cohorts. Cohort I entered the 2011 Retreat having participated in a separate Retreat in Summer 2010 as well as three follow-up workshops hosted throughout the 2010-11 academic year. Cohort I received two-and-a-half days of professional development in Summer 2011. The Retreat focused on the connection between STEM education and the state's new teacher and principal evaluation requirements for Cohort I participants. For administrators in Cohort II, the 2011 retreat served as their first professional learning experience. Cohort II received three days of

professional development. The Retreat introduced Cohort II participants to the STEM Design Cycle and provided them with hands-on learning activities designed to promote an in-depth understanding of effective STEM instruction. Cohort II will participate in three follow-up workshops throughout the 2011-12 academic year.

Participant Characteristics

According to registration information provided by AWSP, 55 administrators from Cohort I and Cohort II attended the 2011 retreat. The participants included 27 men and 28 women. The retreat attracted administrators from the elementary (21), middle (11), and high school (18) levels as well as from alternative schools (4) and the central office (1). The administrators represented 33 school districts from across the State of Washington. The participants represented districts located in Eastern Washington (4), Central Washington (4), Northwest Washington (6), Southwest Washington (9), the Central Puget Sound (9), and the Olympic Peninsula (1). Based on the registration information, the majority of attendees worked in small to mid-sized districts.

Organization of the Retreat

The Retreat was organized around a series of hands-on learning activities. The facilitators utilized the concept of the “STEM Design Cycle” to guide the participants' experience. The STEM Design Cycle refers to the process of identifying a problem, investigating a series of alternatives, and ultimately developing a practical solution to a real-world problem. The cycle approximates the kind of work that engineers and other STEM professionals engage in on a regular basis. The facilitators offered a variety of hands on learning activities as well as presentations. The activities ranged from observing effective science instruction to participating

in hands-on activities meant to simulate the kind of "first-hand learning" that research shows is the most effective way to engage students. Throughout the Retreat, participants were introduced to staff and engineering professionals from PNNL as well as staff from Washington State LASER and the Pacific Science Center.

Based on data provided to the evaluator, participants in both cohorts participated in activities that aligned with their previous exposure to STEM education. Cohort I participated in activities designed to help the participant's make connections between STEM education and the state's new evaluation criteria for classroom teachers and principals. The activities provided to participants in Cohort I focused more acutely on science instruction, how to offer effective and meaningful feedback about instruction, and how principals could use evaluation frameworks to evaluate classroom instruction. Table 1 summarizes the activities provided to participants in Cohort I. As illustrated in the table, the activities emphasized the instructional leadership responsibility of school principals within the context of the state's new evaluation criteria.

Table 1.

Illustrative Activities from the 2011 STEM Leadership Retreat for Cohort I

Day 1	Day 2	Day 3 (half-day)
<ul style="list-style-type: none">• Introduction and welcome• Preparation of STEM Notebook for use throughout the Retreat• Quick Write using Think, Pair, Share format• Overview regarding Washington State's new Teacher and Principal Evaluation Requirements• Reflection about effective science instruction	<ul style="list-style-type: none">• Classroom observation activities• Inquiry with a "Mystery Powder"• Practice how to evaluate a STEM lesson with Dr. Peggy Willcuts• DVD video observation, reflection, and debrief of an effective science lesson using Danielson framework• Distinguishing between formative and summative evaluation practices	<ul style="list-style-type: none">• Overview of Marzano's evaluation framework• Presentations by STEM principals

For participants in Cohort II, the retreat provided an introduction to the STEM Design Cycle, the importance of STEM education as a motivator for student interest, and the qualities of effective STEM instruction. Participants in Cohort II worked more closely with an engineering professional from PNNL, who shared her personal story with the participants as well as led them through an activity designed to simulate the Design Cycle that engineers at PNNL use in their work. Participants in Cohort II were also introduced to current research on student learning by PNNL staff as well as resources available to schools through Washington State LASER. Table 2 summarizes the activities provided to participants in Cohort II. As illustrated, the activities provided to Cohort II emphasized introductory information principals need to successfully introduce STEM in their schools.

Table 2.

Illustrative Activities from the 2011 STEM Leadership Retreat for Cohort II

Day 1 (half-day)	Day 2	Day 3	Day 4 (half-day)
<ul style="list-style-type: none">• Introduction and welcome• Preparation of STEM Notebook for use throughout the Retreat• Quick Write using Turn & Talk format• Presentation activities related to defining STEM education• Powerful Learning Experience involving first-hand, second-hand, and third-hand learning	<ul style="list-style-type: none">• Presentation entitled, “Making the Case” with Jeff Estes from PNNL• Activities focused on <i>How People Learn</i>• Presentation entitled, “Road to Becoming a Scientist” with Elizabeth Stephens from PNNL• Introduction to the STEM Design Cycle• Designing a wind mill for power generation and use as a mechanical lift	<ul style="list-style-type: none">• Continuation of the windmill activity• Activities focused on <i>Effective Science Instruction – What does the Research Tell Us?</i>• Role-alike groups linking retreat activities to reform initiatives in participants’ schools and districts	<ul style="list-style-type: none">• Overview of Washington State LASER• Reflective seminar aimed at making practical connections to schools and school districts

As shown in both tables, the facilitators incorporated a variety of professional learning modalities. The activities were often designed to link concepts related to STEM to the practical work of school leadership. Comments collected from Retreat participants indicate that the activities were positively received. One participant responded that these activities caused their “vision and understanding of STEM teaching and learning to increase.” Another participant noted that these activities were valuable because, “We need to see and model these [kinds of learning] activities for our teachers.” Both statements reflect the value that participants derived from the activities as well as the quality of delivery provided by the Retreat facilitators.

Engaging STEM Professionals in Administrator Learning

The Retreat’s facilitators strengthened the connection between the Retreat content and STEM disciplines by directly engaging STEM professionals in the professional development experience. The professionals offered powerful “images of possibility” for what STEM instruction could look like in a school setting as well as reinforcing the value that K-12 science education has for long-term interest in STEM careers. The evaluator did not observe the presentations directly; however, based on the agenda and the Power Point slides provided to the evaluator by AWSP it appears that these presentations were designed to introduce participants to salient research about brain development and effective science instruction, help participants see the relevance of STEM through the eyes of experienced colleagues, and motivate the participants to implement STEM ideas and concepts in their schools through personal narratives and stories by current STEM professionals.

For participants in Cohort I and Cohort II, the facilitators actively involved staff from PNNL as well as Washington State LASER. Of the presenters who attended the retreat, Ms. Elizabeth Stephens, a materials engineer at PNNL, provided one of the most powerful presentations offered to Retreat participants. Her presentation spoke to the impact that K-12 science education can have on student interest in science and a child’s long-term interest in a STEM career. One of the facilitators summarized her personal story as follows:

[Elizabeth Stephens] grew up as the daughter of Hispanic farm workers in central Washington and was the first in her family to go to college. She credits the science program in her school district and, more specifically, a middle school science teacher who saw promise in her, as the two of the biggest motivators for her interest in science and engineering. Throughout her education, she was mentored, participated in internships, and eventually came to PNNL as a materials engineer who designs lightweight parts for electric vehicles.

Based on the presentation materials provided to the evaluator, her presentation wove together her personal story and professional work. Participants offered several positive comments about the power of Ms. Stephen's presentation. As one participant noted, "Hearing the engineer's story was so powerful." Other participants used terms such as "inspiring" and "emotional" to describe Ms. Stephen's presentation in their written feedback. As one participant commented, "The personal story of a young person overcoming adversity with guidance, care, [and] support from a special educator was powerful... I wish we could have talked in our groups more about how this informs practice and how it has implications for ensuring that this type of support happens in our school."

Cohort II participants also interacted with Mr. Jeffrey Estes, Department Manager of the Office of Science and Engineering Education at PNNL. Mr. Estes presented information related to current research on the importance of STEM education as both a regional and national priority. The concept of literacy in science, technology, engineering, and math were central to this presentation. The presentation placed particular emphasis on the connection that STEM education has to each of these domains as well as the relationship that STEM has to the real-world. Participants also heard presentations regarding research from the well-publicized study, *How People Learn* (National Academies Press, 2000). Complimenting this information, participants also heard from Ms. Sonia Siegel-Vexler, co-director of Washington State LASER. Ms. Vexler presented information to the participants about the support LASER provides to schools and school districts for science education. The combination of these presentations appears to have emphasized the need to improve STEM education for K-12 students as well as resources principals and other leaders can use to make these improvements possible.

Hands-on Learning with the STEM Design Cycle

The materials provided by AWSP indicate that the participants engaged in a number of hands-on learning activities which built from and complimented the concepts presented throughout the Retreat. The hands-on learning activities were unique as they reinforced the concepts presented in the STEM Design Cycle. Further, the hands-on learning activities also were used as another opportunity to engage professionals from PNNL in the professional development experience. For example, Ms. Stephens worked with participants to make the connection between the Design Cycle and the work of engineers tangible. Ms. Stephens worked with Cohort I participants in Summer 2010. She presented the participants with a letter from a fictional government agency directing the participants to develop a water filter for use in the Gulf of Mexico in the wake of the BP Oil Spill. The activity modeled the way Ms. Stephens accomplishes her work at PNNL and provided Cohort I participants an introduction the kind of learning activities that resonate with students when introduced to STEM. The participants were charged with conducting the necessary research and development to create a prototype water filter, constructed with easily obtainable materials. Participants were given time to research and develop a device then asked to report back the following day with information about their design and a demonstration of its effectiveness.

In 2011, Ms. Stephens worked with participants in Cohort II to design a windmill that could generate electricity or assist with industrial tasks such as lifting heavy materials. Participants were provided with background information about windmills as well as the materials needed to construct a small-scale windmill. The background information provided the participants with real world examples windmills used for power generation and industrial tasks. The participants were provided with the materials needed to construct a small windmill, this

included balsa wood or plastic for the construction of blades, an electric motor, a small light, and a box fan to simulate wind. The windmill activity proved to be one of the most well received activities provided at the Retreat. Data collected from the participants indicate that they felt the activity was well-designed and provided ample opportunities to “feel” what effective science instruction entailed. As one participant noted, " This experience has renewed my passion for science... It is so easy in an elementary school to move science to the “back burner.” The windmill experience and dialogue with other principals reminded how important it was. I loved participating in the design process and found it amazingly motivating—I can only imagine how kids feel."

Modeling, observing, and critiquing effective science instruction

For participants in Cohort I attending the 2011 Retreat, staff from PNNL modeled effective science instruction on-site at the Retreat and provided opportunities for participants to critique the instruction they observed using protocols consistent with the state’s new evaluation criteria. Dr. Peggy Willcuts, a PNNL education staff member, engaged Cohort I in exploring the properties and characteristics of a “mystery powder” (e.g., *polysodium acrylate*) and develop practical uses for the powder that could apply to a real-world situation. Polysodium acrylate (PSA) is a polymer commonly used in applications to absorb water. The activity required participants to develop a series of experiments to identify the properties and characteristics of the substance both as a dry powder and when mixed with water. During this activity, participants observed Dr. Willcuts deliver a science lesson on-site and then critique the instruction using protocols consistent with the state’s new teacher evaluation requirements. Expanding on this activity, participants also had the opportunity to observe a science lesson via videotape and then

critique the instruction. The video was drawn from the *Success at the Core* video series produced by Vulcan Productions. Following both the on-site and video observations, the participants were asked to debrief what they saw in the instruction.

IMPACT ON THINKING AND LEADERSHIP PRACTICE

Based on the data provided, the participants valued the hands-on learning activities offered throughout the Retreat. Comments from feedback forms and participant reflections indicate that these activities made sophisticated science or STEM concepts practical for the Retreat participants. As one participant commented, "I was experiencing what powerful learning felt like." Another participant added, "There is power in first hand learning that you do not get from second or third hand learning." The participant's reference to "first-hand learning" reflects one of the concepts presented during the Retreat. First-hand learning refers to active and engaging learning that is best suited to STEM. It involves learning from direct experience. Second or third hand learning refers to more traditional learning activities, such as videos, lectures, or memorization.

The data indicates that the activities provided in the Retreat were designed to enhance the participant's analytic skills related to science, technology, engineering, or math. The activities required the participants to identify a problem, pose a hypothesis, conduct an experiment, and solve a problem with real-world application. This pattern of *exploration with application* reflects the Design Cycle Approach presented in the hands-on learning activities throughout the retreat as well as current research about effective science instruction. For several participants, the experiences served as a valuable re-introduction of the scientific method as well as an opportunity to reconnect with the importance of K-12 science education. As one participant

commented, “Sitting down with other principals, teachers, and actual scientists has been a pinnacle of my professional development experience.”

The positive comments offered by the Retreat participants were consistent across the elementary, middle, and high school level. Each of the participants whose comments the evaluator reviewed found connects between their work and the content presented. One school principal’s comment regarding the applicability of STEM to an elementary school was especially indicative of the connections that the activities in the Retreat made to the principal’s school context. According to the administrator’s written comments, “I didn't know how I could make engineering appropriate at the elementary level, but with the understanding that STEM is actually learning how to design something, it makes a lot of sense to me to use this with my elementary kids.” For middle and high school principals, the connections between what they learned about STEM and their schools appeared more direct. As one principal commented, “STEM is about the whole program not the subject so it’s really about more than I thought.” Another principal noted, “STEM is a way of teaching and learning.” One participant noted, “The activities reminded me that we need to be much more intentional with first, second, third order teaching.... Especially with kids who have less experience or limited prior knowledge.”

Although participants embraced the content presented in the retreat, the data suggest that participants were also mindful of the "hard work" that was required for STEM education to succeed in their schools. Several participants noted that the Retreat had inspired them to work more closely with classroom teachers to improve math and science instruction. Retreat participants signaled the professional learning experiences presented reminded them that "appropriate scaffolding" for STEM instruction was an important aspect of their work. As one participant commented, “This work is doable. But what I think is key is to use what is already

going on in your school and building in STEM components from there." Other comments seemed to highlight the importance of connecting STEM with existing reform initiatives. As other participants noted:

- The retreat has given me ideas about how to prioritize STEM in my school and it has helped me understand what good STEM instruction is about.
- The retreat has reinforced the power of hands-on, collaborative, constructivist teaching approaches and how important it is to make sure that's happening in my building.
- I see that STEM is really about high-quality teaching and learning - not just the content of math or science or technology. I think that helped me see where the connections are.
- I see how STEM relates to the "big picture" of instruction. That makes it more applicable to my work in my school.
- This seminar has helped nudge me to plan for and implement more opportunities for our students that are STEM. It [the Retreat] has also helped me to have a clearer picture of what STEM is and isn't.

Retreat activities also appeared to influence participants' thinking about the large purpose behind STEM education as well. Data suggest that participants connected the importance of STEM education with their students' readiness for college and work. As one participant observed, the STEM leadership retreat helped her see "the importance of integrating science, technology, engineering, and math to prepare students with the skills they need to be contributing members of the workforce." Similarly, another participant observed that the Retreat reminded her of the "The importance of encouraging and enhancing higher level thinking skills and problem-solving." The materials provided by AWSP suggest that part of this understanding may have been created by presentations from accomplished principals. For example, the retreat facilitators included principals who discussed the importance of STEM. They also engaged STEM professionals (e.g., Elizabeth Stephens and Jeffrey Estes from PNNL) to make salient

connections between STEM, the larger impact of STEM education, and the importance of K-12 math and science experiences for a student's long-term career aspirations.

Pre and Post-Survey Results

The facilitators surveyed administrators attending the Retreat to determine whether the Retreat influenced the participant's thinking about STEM and whether the participants would introduce STEM in their building upon returning to their schools and districts. Based on the responses from both groups of participants, there were significant gains in both the participant's understanding of STEM education as well as their knowledge of support for staff. As shown in Table 3, the retreat participants in Cohort I and Cohort II initially expressed limited knowledge of quality STEM teaching and learning. The average ranking for participants in Cohort I was 2.16. By end of the Retreat, however, the average ranking rose to 3.40. Participants in Cohort II reported a similar increase. The average ranking for participants was 2.49 compared with 4.00 after completing the retreat. This represents a net increase of 1.51 in the average reported by the participants. Participants also reported a significant increase in their understanding of effective science instruction. Before the retreat, the average score was 2.24 and 2.36 for Cohort I and Cohort II, respectively. After the retreat, the average score was 3.60 and 3.96. This represents a notable increase in the participant's self-reported understanding of effective science instruction.

Table 3.*Participants' Self-Reported Understanding of STEM and STEM Instruction*

	Cohort I (N=40)		Cohort II (N= 45)	
	Pre-Survey	Post-Survey	Pre-Survey	Post- Survey
<i>What quality STEM teaching and learning looks like...</i>	2.16	3.40	2.49	4.00
<i>Research related to effective science instruction and how students learn...</i>	2.76	3.6	2.87	3.96
<i>Why exposure to STEM is important for all students...</i>	2.6	3.69	2.84	4.36
<i>What an effective learning experience in STEM looks like...</i>	2.24	3.58	2.36	4.20
<i>How to support staff in teaching STEM topics...</i>	2.00	3.02	2.13	3.53
<i>Examples of what to “look-for” when observing a STEM class...</i>	2.13	3.29	2.40	3.84
<i>Why STEM is important for a student’s future...</i>	2.56	3.89	3.02	4.49

Note: Participants who completed the pre/post survey were asked to rank their understanding on a five point scale ranging from “No Understanding” (0) to “Complete Understanding” (5).

Data indicate that the Retreat participants identified several salient connections to their school context and expressed a clear intention to implement what they learned at the Retreat when they returned to their school. Participants' comments reveal that the concepts, ideas, and skills learned at the retreat were valuable and participants saw connections between these concepts and their leadership practice. As one participant commented, “I’m much clearer about what is meant by STEM education and how to incorporate it into my school. I have a better

understanding about the instructional strategies that are involved with STEM." Another participant offered a similar perspective noting, "I have a whole new perspective. I feel like my teachers need this training, too. Another participant echoed this view, "I think my vision for STEM in my school has sharpened [at this retreat]. I have a little more focus. I feel like my questions to classroom teachers will be more intentional."

CONCLUSION

The data indicate the STEM Leadership Retreat provided principals with a valuable opportunity to engage in learning experiences related to science, technology, engineering, and math education. The data supports that the activities presented helped participants STEM, its application in schools, and how to adopt it in their work content. Further, the data indicate that there is an important relationship between experiencing STEM instruction first-hand and understanding why it matters for students. Comments from participants made explicit reference to this relationship. Based on the comments from retreat participants, the retreat serves as an illustration of what effective principal professional development in the area of STEM might entail. Further, the data also affirms that the Retreat met the objectives established by the facilitators.

The data provided indicate that there were at least three crosscutting perspectives offered by the participants. First, the data indicates that Retreat participants saw salient connections between STEM education and existing efforts to improve instruction in their schools. The connection to these activities appears to have been strengthened by the delivery of content related to the state's new teacher and principal performance evaluation standards. Several participants referred to the value they derived from observing an effective science lesson in-

person with facilitators from PNNL as well as on videotape. They also found debriefing the lesson with colleagues at the retreat a valuable experience.

Second, comments from participants made explicit reference to the value of learning-by-doing, which facilitators referred to as first-hand learning. Data clearly indicated that participants valued the opportunity to apply scientific concepts (e.g., design, hypothesis, etc.) to real-world learning challenges. Several participants noted that this experience caused them to rethink how they would provide math, science, or STEM professional development in their schools. Participants were especially moved by the participation of Elizabeth Stephens, a materials engineer at PNNL, who shared her personal story about the impact that a middle school science teacher had on her and her decision to pursue an engineering career. Participants readily connected with this presentation – seeing both its relevance to their work as instructional leaders as well as the central role that science plays in motivating students to pursue science, technology, engineering, or math-based careers.

Third, participants expressed a desire for additional tools and resources related to effective math, science, and STEM instruction. A particularly common request among participants was for more examples of "effective STEM instruction" and resources that could be used with staff to help them understand what effective instruction would look like in their context. Participants acknowledged that they did not yet have a fully developed understanding of effective STEM instruction. Data indicate that participants were concerned that they would not be able to communicate what they had learned about instruction without these tools.

One comment about potential improvements relates to the grouping of Retreat participants. Participants indicated that they would like more opportunities to work closely with administrators who lead schools located in a similar context and serving similar students. As one

participant asked, "What does [STEM] look like in a 50% poverty building?" Another administrator expressed interest in seeing more examples of "STEM implementation in small high school settings." Other participants noted that they would appreciate more opportunities to dialogue with colleagues who lead schools with similar demographics, curriculum, and challenges. A common request in the data provided was to group administrators into rural and urban settings.

Finally, participants raised questions related to the cost of implementing STEM instruction in their school as well as to the cost of continuing in the follow-up workshops and future retreats. With schools and school districts across the state facing significant budget challenges, the Retreat participants worried that STEM reforms could not be accomplished without additional revenue. As one participant commented, "How do you fund the acquisition of needed materials?" Another asked, "Is there any grant funding available for this type of education?" Both comments illustrate the concern expressed by Retreat participants that these reforms could not be implemented in their school without additional resources.

