Building Elementary Teachers' Background Knowledge and Confidence Enriches Environmental Curriculum and Enhances Teaching and Learning

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Abstract

We conducted a follow-up research study with 79 science teachers of grades 3-12 who were part of a scientific research experience in rural counties. We analyzed two of the elementary teachers’ reflective writing during the two courses and an on-line questionnaire to all participants on the vertical teaming that we utilized during the scientific research in the Science Collaboration: Immersion, Inquiry, Innovation (Sc:iii) Program. We visited the two teachers in their schools with their students after one year of teaching following the scientific research. The two elementary school teachers built their self-confidence for teaching science by participating in two graduate courses, which culminated in scientific research in rural facilities near their schools. With this enhanced self-confidence, the elementary school teachers expanded their expertise in science beyond the research experiences. They had the power to act to develop and teach a new curriculum with an environmental focus on studying local natural bodies of water over the school year. Their students looked for patterns in their data over time, and tried to understand the reasons that turbidity, pH, and salt levels would change with change of the seasons and rains or droughts during the school year.

Introduction

Rural Science Education

Improving the knowledge, skills and self-confidence of practicing K-12 science teachers is our challenge. By doing so, teachers bring a renewed understanding and excitement for science to classrooms and can pass along their enhanced skills and growing expertise to their K-12 students. Yet, many K-12 teachers, particularly those in rural areas, find themselves isolated from other scientists and science educators and often have scarce resources for experiments and other classroom activities.

Enochs (1988) points to the isolation of rural teachers as a prime cause for the problems surrounding the recruitment and retention of qualified teachers in rural settings. To help counter this isolating tendency, Enochs suggests that rural schools “connect science instruction to their rural environment,” (p. 9) using local “industries, businesses, and state and county agencies” as partners in the effort (p. 10). Others promote similar approaches, such as Colton (1981), who encourages teachers to develop an interdisciplinary approach to science education that focuses on local resources to help rural students connect science to their lives.

Teacher Professional Development

Alberts (2009), the editor of the journal Science, asserts that besides the ability to “know, use, and interpret scientific information,” our next generation of students also needs to be able “to generate and evaluate scientific evidence and explanations, to understand the nature and development of scientific knowledge, and to participate productively in scientific practices and discourse” (p. 437). One way of encouraging deeper and more engaged methods for the learning of science is to provide scientific research experiences for science teachers. The teachers can use these experiences to help communicate these notions of scientific inquiry to their students.

Silberstein, Dubner, Miller, Glied, and Loike (2009), for example, provide quantitative evidence that urban high school students earned a 10.1% higher pass rate on the New York State Regents science examinations when their teachers had engaged in scientific research in an urban, university setting (Columbia University) for two consecutive summers. In this project, a total of
10-13 middle and high school science teachers participated each year from 1994-2005, with
some teachers in their first and others in their second year in the program. Each teacher worked
with one scientist during the summer. During the academic year after conducting the scientific
research, a graduate student would usually help teachers implement inquiry into the classroom.
During the summer program, one day per week was devoted to professional development
activities that focused on building a professional learning organization and web of
communication and support for the teachers.

School superintendents discovered that the tactics of the Columbia University’s program
help lessen science teacher attrition rates, which increased cost-savings for schools. These
research experiences for teachers not only help with student learning of science but also decrease
teacher attrition by connecting them with both educational peers and working scientists.

Most of the research on K-12 science teachers conducting scientific research involves
secondary teachers. Sadler and Burgin (2009) review the empirical research on teachers doing
scientific research, and indicate that “teachers participating in research apprenticeships tend to
develop more sophisticated ideas about the dynamic nature of science particularly when they
assume more active roles in the planning and design of their investigations” (p. 16). In a critical
review of the literature on learning science through research apprenticeships, Sadler, Burgin,
McKinney and Ponjuan (2010) point to the need for the research of such programs to expand
beyond self-report data from participants to include longitudinal studies of individuals in such
programs.

Sadler et al. (2010) also critically review the literature about these research experiences’
positive influence on teacher self-confidence, stating, “The general result is that teachers feel
more confident in their abilities to do science as well as teach science as a result of having
actually experienced it first hand through apprenticeship programs” (p. 246). Effective
collaboration among teachers also increases teachers’ self-confidence (Melear, Goodlaxon,
teachers described themselves as having become so confident over the course of their summer
experiences that they felt capable of leading their own students through a similar process” (p.
11).

Typically, the design for these professional development programs assembles teachers
that are at the same or close to the same level. Three examples of professional development
programs with teachers within their own school levels are the 1) NRC Chemistry Roundtable
(2009), 2) US Department of Energy Office of Workforce Development for Teachers and
Scientists (2010), and 3) Columbia University’s Summer Research Program for Science
Teachers, (cited above). Rarely, however, do professional development programs incorporate
both elementary school and secondary teachers into their approach (Loucks-Horsley, Hewson,

Vertical Teaming

Our science teacher professional development program for the rural panhandle region of
North Florida has many similarities, in terms of approaches and goals, to the Columbia
University project; yet in design, our program has several important distinctions. For example,
rather than working at a university, like Columbia University’s program, our teachers conducted
their scientific research within their rural school district, working in the field with area
organizations and scientists (Sc:iii, n.d.). Another notable difference is that the Columbia project
admitted only secondary teachers (most of whom were from high schools), while our program
created vertical teams of K-12 teachers, spanning elementary, middle and high schools. This concept of vertical teaming started in the early 1990s, though its initial focus was to facilitate and improve curricular development rather than teacher professional development.

Vertical teaming engages “a small number of people from different levels within an organization who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable” (Bertrand, Roberts & Buchanan, p. 18, 2006). Vertical teaming involves the collaboration and exchange of ideas among educators across the grade levels. Bertrand et al. (2006) enunciate the four goals of vertical teaming as: “collegiality, professional growth, school improvement, and transition” (p. 2).

Other states with high numbers of rural districts and teachers, like Oklahoma, South Dakota, and Colorado, use vertical teaming for a number of purposes: curriculum alignment in reading and mathematics for grades 5-12 (Oklahoma State Regents for Higher Education K-21 Initiatives, 1989); facilitation of “long-term, embedded professional development that impacts teaching and learning and is determined after thoughtful consideration of the school’s improvement goals” in South Dakota (Technology and Innovation in Education, p. 3, n.d.); and enhanced literacy for the underrepresented students, the Latinos, and the ESL students (Larner & Quate, 2007). For rural regions particularly, vertical teaming offers science teachers a greater ability to communicate with other district teachers, share ideas and learn about local resources, and feel connected both to the larger scientific discipline as well as educational community.

This Study

This study consists of 79 teachers for grades 3-12 who came from rural schools in the panhandle of Florida. These teachers were in a two-semester program called Science Collaboration: Immersion, Inquiry, Innovation (Sc:iii, n.d.), which offered free, graduate credit to the teacher participants. The first semester was an online course, Nature of Scientific Inquiry, followed by a summer course, Scientific Research Experience, in which teachers engaged in scientific research at a site in their home or neighboring county. The Sc:iii program produced a monograph (Calvin & Gilmer, 2008, 2009) that includes chapters by ten teachers about their experiences during the scientific research, and an hour-long, award-winning DVD, Teachers Doing Real Science in the Real World (PAEC, 2008).

As an early model, the NSF-funded professional development program called CO-LEARNERS (Gilmer, 2002; Hahn, 2002) used vertical teaming with pre-service and practicing secondary science and mathematics teachers and a practicing scientist. The articulation of prospective and practicing mathematics and science teachers during the scientific research proved productive in terms of learning science and mathematics content as well as pedagogy. Therefore, we chose a similar collaborative approach with the Sci:iii program; this time, though, we grouped practicing teachers from different levels of local schools.

In the Sc:iii program, each of 29 collaborative teams had one scientist and, ideally, one practicing teacher from each level of K-12 education—elementary, middle, and high school. Due to geographical constraints, however, some teams had two or four teachers, instead of three, generally from different levels. In teams, the teachers’ task was to engage collaboratively in scientific research with each other and the participating scientist at their rural research sites (Sc:iii, n.d.; Calvin & Gilmer, 2008, 2009).

Overall, our program’s goals for the two-semester sequence in the Sc:iii program included the following: 1) help the teachers understand the nature of science and scientific inquiry; 2) enhance the teachers’ understanding of science content knowledge and the practice of
science process skills through scientific research; 3) provide opportunities for teachers to collaborate in vertical teams across grade levels; 4) enhance teachers’ grasp of technology, using both online learning and research conducted with scientific equipment.

Research/Evaluation Questions and Theory Guiding the Study

The following two research questions guided this study, which was conducted one academic year after the conclusion of Sc:iii program: 1) How did vertical teaming influence the teachers of grades 3-12 in their science content knowledge and science process skills; and, 2) how did teachers incorporate experiences such as vertical teaming, collaboration and scientific research to their grades 3-12 classrooms?

We utilize cultural-historical activity theory (Engeström, 1999) and the theory of structure agency (Sewell, 1992, 1999) to think about the teachers as our subjects, interacting with each other through tools (Internet, scientific equipment), communities (their collaborative groups), division of labor (divided among team members, scientists, and science educators), rules (ethics in science), as they experience the scientific culture as they achieve their objects (gathering data for the scientists) and move towards their outcomes (teaching science through inquiry, with students asking and answering their questions). The structure we provide influences the sense of agency that the teachers feel as they engage in science and as they involve their students in science.

Methods

Quantitative and qualitative data in this study were derived from an anonymous survey administered online, one academic year after the conclusion of the summer scientific research (see Figure 1 for the survey questions analyzed in this paper). These survey questions focused primarily on the teachers’ learning from the vertical teaming and its application to their classrooms (grades 3-12). The study garnered responses from 53% of the teachers, with 38% from elementary, 31% middle, and 31% high schools. Since most of the teachers in the program were women and the survey was anonymous, we use feminine pronouns to refer to all teachers and their comments for simplicity.

Figure 1: Survey Questions Given One Year After Sc:iii Program

1. **What level of K-12 education do you teach?**
2. **What specific grade(s) do you teach?**
3. **Vertical teaming is defined as the collaboration and exchange of ideas between educators across the grade levels. Indicate below at what level(s) your partners were in your vertical teaming.**
4. *In what ways did vertical teaming enhance your Sc:iii research experience?*
5. *In what ways did vertical teaming contradict your Sc:iii research experience?*
6. *What have you already done (or do you intend to do) in class that will help prepare your students for science classes in their next level of education?*
7. *Please provide a brief description of the type of experience you have implemented or are planning to implement for your students, and what you expect your students to learn from the project.*
8. *How do you think that working with older/younger students will enrich your own students’ learning experience?*
9. **Do you think that vertical teaming between educators will improve science FCAT scores?**
10. **On a scale of 1 to 10, with 10 being the most effective, how would you rate the effectiveness of vertical teaming in helping teachers exchange ideas about the teaching of scientific inquiry in public schools?**

Questions were either quantitative/ simple response (double starred) or qualitative longer responses (single starred).
Survey Results

One author, Gilmer, coded the data from the five qualitative questions (see questions with a single star) using the qualitative software program, QSR. The qualitative data sorted into four main coding categories: 1) curriculum, 2) science content knowledge, 3) science process skills, and 4) students engaged in inquiry. Data from each category follow:

Curriculum

Teachers expressed concern for providing a curriculum that addressed their students’ needs for learning science not only in their current grade level but also for the following year; perhaps in part due to the communication they had with each other in the vertical teaming.

Planning curriculum

The results of this survey included data on the effect of vertical teaming in curriculum planning. For example, this elementary school teacher remarked:

Vertical teaming allowed us to see what was being taught across the grades in our school systems. It made us realize how important a strong base in elementary school helps [to] develop the middle and high school student.

Another teacher commented: “I could see what topics we were covering across the grade levels and how effective we were being over the years.” These two teachers now more clearly saw their role in the larger development of children’s education. As one middle school teacher noted, because of the exposure the teachers gained in vertical teaming, “we can revise our planning and teaching to emphasize some of the middle school’s weaknesses.” Through the interaction facilitated by Sc:iii’s vertical teams, the teachers gained the opportunity to broaden their view of their students’ education.

Additionally, in vertical teams, teachers were able to discuss the topics and approaches used by other team members, thereby stimulating thoughtful pedagogical discussions as well as building personal connections between the teachers from the same district but across grade levels. One high school teacher realized that her science expertise was not common to all the science teachers, stating:

In our [larger] county group, it was very informative to understand what coursework those teachers were familiar with and taught in their classrooms. In one instance, with the middle school teachers, I will get those students in my classrooms [as they advance to high school]. That [middle] school is the feeder school to my high school. It was good to know what they were teaching.

Within our little group of four teachers [on our team], we had only one elementary teacher and three high school teachers… The two of us who were strong in science helped those who were not, to better understand the subject… I took for granted having been in the science field in the beginning of my career and leaving it to teach, that some scientific topics can be difficult to understand, even as an adult.

As this teacher’s statement shows, each teacher brought a different expertise to the vertical team, thereby allowing each member the opportunity to teach and learn from one another. Based on their experience, 92% of the surveyed teachers believed that vertical teaming between educators would help the students score better on the state-mandated Florida Comprehensive Assessment Test (FCAT, 2010) for grades 5, 8, and 11. In part, teachers assumed this outcome because of vertical team’s capacity to “provide continuity” for their students since, through this communication, teachers have a “better understanding of what [the students need] to know” as they proceed to the next grade level. With vertical teams of teachers
discussing both science and science education, students stand to benefit from this increased understanding of the curriculum at various levels.

Addressing teachers’ needs in laying foundation for students’ next grades

An elementary school teacher observed that vertical teaming “helped me to understand what I need to teach in order for my elementary students to be prepared for the next level.” A middle school teacher remarked that now after Sc:iii, “I talk with my high school contact person often about what I am doing in class and what skills my kids need to improve on, etc.” Another teacher stated that vertical teaming “enhanced my ability to see the bigger picture of what is happening with our science curriculum.” This increased communication helps teachers prepare their students for learning at the next school level.

Science Content Knowledge: Pushing the Boundaries in Environmental Science

Most of the projects in the Sc:iii program were environmentally focused, with teachers working with state park rangers, estuarine wildlife managers, fish and wildlife scientists, or environmental chemists. Many teachers translated their Sc:iii research experiences into their classrooms by involving their students in environmental research similar to their Sc:iii research.

One teacher, for example, led her students in conducting research similar to her work the previous summer in Sc:iii at a “habitat restoration area, [where students] shared activities [with each other], including [examining the] animal and plant life [that the students] found there.” Another teacher had her 5th grade students develop a model of an aquifer system, which she learned in her Sc:iii research experience, and share it with younger students at the same school. Through this exercise, the teacher enabled her students to become “the ‘experts,’ [and that process] really helped solidify their knowledge.” In a variety of ways, these teachers found ways to translate and extend their research experiences from Sc:iii to their own students.

Science Process Skills

Engaging in collaboration and providing similar experiences for others

One quantitative survey question asked teachers to score how effectively vertical teaming helped teachers exchange ideas about the teaching of scientific inquiry; 50% scored this benefit as 8 or higher (on a scale of 1 to 10). This score points to the ability of vertical teaming to improve collaborative learning. As one teacher succinctly observed, vertical teaming “helped me to understand working collaboratively.” Many of the teachers saw the benefits of extending such collaborative skills and approaches to their students, and have begun grouping their students in collaborative teams in the classroom in order to emphasize the importance of “shared activities” and enhanced “critical thinking skills.”

Collaboration, though, can be hard to organize. One teacher mentioned the difficulty of getting “administrators at all levels on board with collaboration,” saying “due to schedules, it is almost impossible to get groups together.” Within her school, however, this teacher embraced a model for collaboration, pairing 5th graders with kindergarten students, while noting that “both groups seem to benefit from the experiences.” While collaboration may be difficult sometimes to coordinate, often the benefits are worth the effort.

Like the last example, other teachers embraced the model of vertical teaming from the Sc:iii program and encouraged their students to work with students of different levels. In regards to high school students, one teacher noted, “the older students learn through teaching their
younger partners. The teaching experience helps reinforce the concepts.” Similarly, another teacher observed:

If my students can explain to younger students how to do something or how it functions, that helps them to retain [the information] and proves their comprehension. The older students can increase their own sense of self-esteem, as they can be teachers and role models for the younger ones. The teaching by the older [students] helps to reinforce the knowledge they gained and now [they can] pass on to the younger ones.

In the survey, another teacher cited how important teaching others is to facilitating deep learning:

In the case of my older students designing their projects, at least partly, with the younger students in mind, it really helped them to think about what major scientific concept they were focusing on. Also, as any teacher well knows, you learn a subject so much better when you teach it yourself.

Students tend to learn well from their peers. As one teacher asserted, “Hands-on activities, [which are] peer-based, are an effective tool of education. [Students] are more responsive to their peers and not afraid of failure.”

In vertical teaming of K-12 students, older students can teach the younger students, allowing the mentor to learn the content better through teaching and the mentee to be more at ease learning science from an older student. Vertical teaming provides not only a model for teachers to interact with local peers but also as a model of learning for the students within the classroom.

**Encouraging science inquiry in the classroom**

Teachers’ levels of understanding concerning scientific inquiry varied widely. For example, one teacher wrote that inquiry is “observing, recording, classifying, discussing, and modeling the behavior of scientists.” This definition, however, encompasses just a small part of the inquiry process; missing from her response is the idea that inquiry is a process of asking questions. Such questions direct the scientists’ thoughts, actions, and methods of data analysis, which often results in asking more questions.

By comparison, a different teacher incorporated a fuller notion of scientific inquiry into her class activity of testing for bacteria at several sites within the school. She explained:

I have provided experiences for my students that allow them to question, collect information, modify their ideas, and discover science for themselves… Students hypothesized where most bacteria would be found [at the school], collected samples, and compared results. They analyzed their results to determine whether the [data] did or did not support their initial ideas and discussed ways their investigation could have been more valid.

This teacher’s teaching model is to encourage her students to ask questions before, during, and after the data collection. Similarly, another teacher incorporated her summer Sc:iii experience of working on a local river and estuary system into her lesson plans, explaining:

I really focused mainly on my environmental science students by taking them on an extensive trip to the Apalachicola River and estuary system. We worked diligently on aquatic ecosystems topics throughout the year and integrated this theme into most units. We had culminating projects at the end of the year that we displayed in the library and elementary students viewed them and had interactive puzzles etc. to do.

Having culminating activities at the end of the year is critical for helping students put their ideas together and develop new ideas and questions for future inquiries. The culminating poster day we had in Sc:iii program, in which each collaborative team presented their research to scientists and other teachers, probably inspired this teacher to do something similar with her students.
Students Engaged in Scientific Inquiry

Two elementary school teachers engaging students in environmental research

Like the teachers mentioned above, many teachers, who experienced hands-on learning during the Sc:iii program, involved their students in environmental field research near their schools. Some teachers, especially those at the elementary school level, engaged their students in yearlong projects. One elementary school teacher, Dawn Pack, started conducting environmental research with 5th grade students at a local bayou after completing the Sc:iii program, and has continued this effort for the past two years. Another teacher, Cynthia Philips, also involved her students in field research for the past two years; for her school, their research site was at a nearby man-made lake. In Cindy’s case, she had the students in 4th grade in the first year after the Sc:iii program and then continued the research with the same students in their 5th grade science class in the second year post-Sc:iii. For both classrooms, the bodies of water that the students are researching are within walking distance of their school.

Dawn used (and continues to do so) a bayou near her school for her students to do hands-on activities and inquiry. She got parents involved in the project and recruited other volunteers to help in the effort, including her scientist-research mentor from Sc:iii. In Dawn’s description of her class project in the vertical teaming questionnaire, one-year post-Sc:iii, Dawn stated:

With the help of a local environmental agency, my husband (who is my best volunteer) and many wonderful parents, this year I was able to get my 5th graders to Joe’s Bayou to test the water and make observations. The main goal was to give them experience gathering, recording, and analyzing data… We visited the bayou from November through May. Students are creating posters to show what they did and what they learned and will present them on “Poster Day” (just like a real scientist would do).

These “Poster Days” occurred at the end of the year, with student teams presenting posters of their research to other students, parents, scientists, and various school personnel. Penny visited Dawn’s classes on poster day and spoke with Dawn’s students about their learning. Students were particularly interested in February’s trip to the bayou, saying comments like, “In February we saw a sea anemone with tendrils that could sting,” and “we saw a ‘fish wall’ after influx of fresh water and then the water departed, leaving dead fish.” Students explained their posters to the visitors, and emphasized the questions they had asked, much like scientists do (with one group having the saying, “Even Einstein Asked Questions” on their poster). Students in Dawn’s classroom learned about water quality parameters (hardness, salinity, pH, and temperature), shape of fish tails, oxygen levels, algal blooms, overpopulation of fish or plants, stress, decomposition, data entry, and ways to organize, analyze and display data.

Dawn says that the Sc:iii program “was definitely a confidence booster, but it also prompted me to increase my background knowledge even more, which I believe has improved my teaching.” Since she finished the Sc:iii program, Dawn has completed her aquatic species collection license, created and implemented the Joe’s Bayou Project, completed a master’s course on ocean science, completed a 40-hour Master Naturalist Coastal Region class, taught several teacher in-services, written and obtained a number of grants, and more. Okaloosa County selected Dawn as Teacher of the Year for all schools in their county in spring of 2010, now almost two years since the Sc:iii program. Dawn credits the Sc:iii program for her motivation, explaining, “It was through the training and research experience [from Sc:iii] that I gained the confidence to create and carry out the Joe’s Bayou Project. Not only did my students learn a lot, so did I.”
Cynthia conducted her so far two-year, environmental research project at manmade lake within walking distance of the school. Shortly after the Sc:iii program ended, Cynthia applied for funding from a local environmental group to support the purchase of equipment for the sampling and recording of the data. Cynthia explains, “The goal is to immerse students in an understanding of how scientific research is conducted, how to apply scientific methods and the importance of taking care of our natural resources.” The students collected data about the lake water (including pH, rate of inflow and outflow, turbidity, dissolved oxygen, temperature, nitrates and phosphates), took soil samples, and documented the plants and animals from around the lake as a function of time. She involved the students in technology while they recorded and analyzed their data. In the vertical teaming survey one-year post-Sc:iii, Cynthia wrote:

My 4th grade students spent the year doing research of the water quality of a local lake. They recorded weekly data and were able to analyze the data to determine trends and patterns associated with the lake’s water quality.

At the end of the academic year, Cynthia’s students’ learning culminated with the students presenting posters on their data about the lake at the lake. Other students from different grades, parents, scientists, engineers from the funding agency, politicians, and even a newspaper reporter were present to learn from the students’ talks and displays. Penny visited the school on the poster day, and one student commented to her, “I learned that helping wildlife and conserving water could help our environment.” Two male students mentioned that after they had started removing the trash from around the lake, they noticed that the catfish had been getting larger. The students also noted their increased awareness of the role the lake plays in their local environment, with one student stating, “The lake protects the Bay and keeps our community safe.” As the 4th graders proceeded to 5th grade in Cynthia class, they were able to continue the same project at the lake. In their 5th grade year, they have continued the monitoring of the water quality, while also concentrating on the living organisms in and around the lake.

Cynthia said that she had thought she was a good science teacher before Sc:iii but realized, “I was not the science teacher I thought I was. [Sc:iii] totally changed my approach to how science should be experienced by students and not just taught by the teacher. I found myself as excited about learning as my students.”

Both Dawn and Cynthia embraced both the local environmental approach as well as vertical teaming method advanced by Sc:iii to better educate and connect the students to their school, community members, and the local environment.

**Teachers needing more support for inquiry**

Other teachers wanted to do similar research with their students but had not yet organized themselves to do so. For instance, a teacher stated:

I would like to implement a water part of their learning that includes experiences with testing of water and finding out why certain waters are like they are, with and without salt.

Lack of funds is one problem teachers experienced in translating their field research to applicable options for teaching lessons. Others, however, did not see how to apply the field research learning they experienced in Sc:iii to their teaching within the classroom. For instance, one teacher commented,

I wish the research experience had been something that I could really take back to my classroom. I sprayed for non-native plants and was not sure how I could bring that into my classroom.
Statements such as these illustrate the need for providing additional support to teachers during the academic year after their scientific research. Such ongoing support would help teachers better convey their research experiences to their students. The Columbia University (2009) program, for example, provided a level of ongoing support from a graduate student during the academic year after the teacher’s scientific research experience to help teachers figure out practical ways to translate their own science research experience to their classroom activities. Unfortunately, funding by the US Department of Education for our Sc:iii program extended through the spring and summer semester, but did not continue into the next academic year, inhibiting us from providing a resource and mentoring to more teachers, following the teachers’ research experiences.

Discussion

The teachers exhibited patterns in their responses to the impact of vertical teaming. Specifically, the teachers expressed that this approach aids in: 1) learning environmental science content knowledge through scientific research; 2) understanding curricular planning and strategies, including concerns/issues and curricular drivers for different K-12 levels; 3) profiting from expertise and experiences of other learners, while developing mutual respect; 4) preparing learners’ needs for the next level of schooling, and 5) increasing sense of self-confidence and eagerness to learn more science for participants.

One teacher summarized her opinion of the benefits of vertical teaming as:

I think it is very important to work across curriculum as well as across grade levels. Although curriculum mapping is supposed to do that, we do not live in a perfect world! I loved the vertical teaming approach in this experience.

In the survey, teachers provided examples of learning from their vertical team members: science content knowledge; strategies for teaching students with lower reading or understanding capacities; and higher order questioning for more advanced students. One teacher commented, “We were able to develop lessons plans that dealt with the same topic, but on multiple levels. My middle school partner also worked with ESE students, so this gave us a chance to learn how to modify lessons for her students.”

Teachers provided examples in which they could ease the transition of their students from one grade level of schooling to the next, like providing: 1) science fundamentals, starting at lower grade levels; 2) knowledge and skills to work in groups while students are still in 5th grade so they will be ready for middle school; 3) preparation of middle school students for reading level needed in high school; 4) involvement in real-world science, so science was less abstract; and 5) communication among teachers at various levels. One teacher summarized: “For example, as a 5th grade teacher, I would challenge upcoming 4th graders to work over the summer... to bring in their findings when school starts. Their experiences will help get the kids excited and become aware that the responsibility of learning is truly on them.” Vertical teaming facilitates these interactions and educational developments.

In summary, teachers viewed vertical teaming as an effective way of learning not only science content and process skills but also the breadth of the curriculum spanning the K-12 system. As teachers collected research data in the field they could discuss curriculum with each other and ways that they could enhance the learning of their students. For example, one teacher recalled:
We talked all the time we were working [in Sc:iii], especially as we were traveling back and forth about the levels of depth we went in each grade etc. This helped us understand better what each of us needed to do at each level.

Teachers in vertical teams shared information with each other. Each teacher brought different strengths and weaknesses to the research experience. Through communication and collaboration, they experienced science together, developing an understanding of the science content knowledge, processes of science and curriculum, while doing their scientific research.

Professional development generally involves teachers at the same level of teaching. However, vertical teaming provides a different way to learn the content of science, the processes of science, and teaching strategies from each other and to work towards common goals. This approach exposes teachers to the overall K-12 curriculum, so that they can see a broader view and their place within the curriculum. Teachers learn about new resources available to them to support the learning of their students. The opportunity for teachers to do scientific research provides real-world science experiences and the vertical teaming helps the teacher develop relationships with other local teachers and scientists who contribute time, materials, and expertise, even after the research experience concludes. This approach to teacher development helps place these rural science classrooms and their students into both the local as well as the larger scientific community. As a teacher shares her experiences and connections with her students, the students can connect the methods and wonders of scientific inquiry and discovery to their local environment.

References

Gilm


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K-12 vertical teaming; collaboration; curriculum planning; elementary schools; secondary schools; science; science content knowledge; scientific research; science process skills, environmental research; inquiry skills.