

## 5. Teacher Findings

The Summer Institute offers a professional development component for teachers because teachers are essential to motivating students and fostering their academic achievement. At the Summer Institute, teachers participate in collaborative learning in groups with other teachers and ORNL mentors. Inquiry-based learning is modeled in group settings similar to the ones to which students are assigned. Unlike some other STEM enrichment programs for underrepresented populations of high school students, there is no set curriculum that teachers are expected to bring back to the classroom, nor lesson-planning activities or formal attention to strategies for enhancing students interest and achievement in STEM.

### 5.1 Teacher Respondents

Of the 67 teacher respondents, 64% were female and 36% were male. The percentage of female teachers at the institute was generally higher than that of high school science teachers in the U.S.<sup>26</sup> Nine of the teachers had attended the Summer Institute more than once. Teachers reported that they ranged in age from 23-70 years when they attended the Summer Institute; their mean age was 42 years. (See Table 15.) A total of 47% worked at schools in distressed counties. (See Table 3 on page 12.) Almost half (48%) of teachers were from three states—Ohio, West Virginia, and New York. (See Appendix Table A1).

Most teacher attendees (64%) were high school science teachers. Somewhat more than a quarter (27%) were high school math teachers, and 5% taught computer courses (information technology, introduction to computers, personal computers, and computer applications for business). Teachers often taught several grade levels, e.g., 9-12 or 11-12.

Teachers attending the institute appear to have been experienced, with 63% having taught for more than 10 years. Slightly more than a fifth of teachers (21%) were new to the field, having taught for five or fewer years. Sixty-eight percent reported having attended other math/science/technology enrichment programs. Overall, 40% earned professional development credits for attending the Summer Institute.

As shown in Table 16, 19% had a bachelor's, 67% had a master's degree, and 13% had educational specialist degrees or doctorates; 20 teachers were in the process of pursuing advanced degrees.

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<sup>26</sup> In 2002, the percentage of female high school teachers was as follows: biology—52%, chemistry—47%, physics—28%. National Science Teachers Association (2004). *K-12 Science and Mathematics is Critical to our Future Workforce*. Talking Points. Arlington, VA. <http://www.nsta.org/main/pdfs/TalkingPoints15pp.pdf>

**Table 15—Selected Characteristics of Teacher Survey Respondents**

<b>Mean age in years (n=64)</b>	42	
	N	%
<b>Gender (n=67)</b>		
Male	24	36%
Female	43	64%
<b>Ethnicity (n=65)*</b>		
White	59	89%
Black or African American	4	6%
Hispanic or Latino	1	1%
Asian or Pacific Islander	1	1%
American Indian or Alaska Native	0	0%
<b>Years of teaching experience (n=65)</b>		
1-5	14	21%
6-10	10	15%
11-15	7	11%
16-20	17	26%
>20	17	26%
<b>Teaching position (n=68)</b>		
High school science	42	64%
High school math	18	27%
Computer science/technology	3	5%
Other	5	7%

\* Multiple answers were allowed. No respondents identified as more than one ethnicity.

Note: Percentages in this table may not total 100% due to rounding.

**Table 16—Educational attainment of teachers**

	Education Attained		Education Pursing	
	N	%	N	%
B.S./B.A./B.Ed.	13	19%	0	0%
M.S./M.A./M.Ed.	45	67%	6	60%
Ed.S.*	7	10%	4	40%
Ed.D./Ph.D. or other doctorate	2	3%	0	0%
<b>Total</b>	<b>67</b>	<b>99%</b>	<b>10</b>	<b>100%</b>

\* Education Specialist

Note: Percentages in this table may not total 100% due to rounding.

Many teachers reported having prior research experience; 75% had attended prior professional development for teachers, and a good number also had some research experience as part of their graduate or undergraduate education. Respondents also reported having research experience related to part- and full-time employment (19% and 6%, respectively). (See Table 17.)

**Table 17—Research experience prior to attending the Summer Institute**

	N	%
Professional development for teachers	49	75%
College coursework	58	89%
Research/graduate assistance	16	25%
Independent research	16	25%
Part-time or summer employment	12	19%
Full-time employment	4	6%
Other	1	1%

Note: Multiple answers were allowed.

## 5.2 Overall Assessment

Overall teachers highly valued their experience at the Summer Institute. Asked “What stands out as a highlight of that two-week experience,” 63 teachers named a particular highlight or indicated that the experience, overall, was a highlight. The most common response, named by 40% of these 63 teachers, was networking with and learning from the other teacher participants. For 30%, a highlight was working with an ORNL research scientist, and 30% mentioned learning about a specific topic (e.g., electron microscopy, the history of atomic research, or hay bale walls). One teacher especially appreciated the opportunity of being exposed to other ORNL projects. For 21%, a highlight was their lab experience and contributing to a current research

project. Five of the teachers (8%) mentioned something about the pedagogical process, such as sharing what they learned with the other participants, the presentations, and getting in touch with what it is like to be a student. Some teachers mentioned their interactions with students, the opportunity afforded students, and the field trips. The following quotes illustrate these points and capture teachers' enthusiasm:

*Meeting other teachers and discussing teaching and learning situations. Working with students and observing them working with others and viewing their learning processes.*

*Working in the physics lab on a project that would really be used to help design a new piece of equipment. Sharing ideas with teachers from other states.*

*The ability to work with members of the Oak Ridge Laboratory staff and the knowledge I received.*

*The ability to work at a government facility and do hands-on research was remarkable. I have worked in research previously and the opportunity afforded the students to have this experience was remarkable.*

*Working on a variety of real projects with other teachers and scientists using "state-of-the-art equipment."*

*I enjoyed working with the Robotics Division at ORNL. It was definitely a positive experience and one that I could take back to my classroom and share with my students.*

Evidence of teacher satisfaction with their experience was demonstrated by the fact that 92% recommended the Summer Institute to teachers in their school district and 62% recommended it to teachers in other school districts. Teachers also recommended the Summer Institute to other students. Fully 86% of teachers recommended it to students in their home school district and 25% recommended it to students in other school districts.

### **5.3 Impact on Teaching**

Teachers were asked whether they drew on their Summer Institute experience for various classroom activities. As shown in Table 18, many teachers integrated what they had learned at ORNL into their classrooms.<sup>27</sup> Some reported they were better able to emphasize the importance of science in our world and describe how science is applied to "real-life situations" and how it can affect students' lives. Other teachers incorporated new topics, laboratory experiments, and demonstrations, either as a result of specific knowledge gained while conducting their projects or in conversation with other teachers. Some teachers used materials they obtained from ORNL, (for example, the Oak Ridge history video and "Probeware"), Web-based resources they learned about, as well as their own photos and presentations. The following quotes from teachers

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<sup>27</sup> By comparison, the National Teacher Enhancement Project found that at one-year follow-up, 99% said "yes" to the question, "I have drawn on my program experiences for explanations and examples in my teaching, class demonstrations, or laboratory exercises." Participants were K-8 teachers who attended a three-week summer program at one of five Department of Energy Laboratories. Oak Ridge Institute for Science and Education (1993) *U.S. Department of Energy, National Teacher Enhancement project: Final report on 1990-1992 Teacher Participants*. Oak Ridge, TN.

describe specific ways they applied information learned at the Summer Institute in their classrooms:

*Part of what I teach is the nature of science including methods, philosophy and underlying fundamental beliefs. I convey these ideas through labs, demonstrations and sharing my experiences.*

*I used several of the demonstrations (particularly from our teacher group sessions) in my physics class.*

*In teaching genetics I use the “mouse house” video and can explain more about mutations and how “we” as scientists further the knowledge of each other. I do a lab on protein synthesis and can add information on the genome and advances in technology I learned at ORNL.*

*When I was there they were building a particle accelerator at the site. I was able to discuss that with my chemistry students. Also I learned how to navigate some internet sites that uncode the human genome and I have been able to share that knowledge and have the AP Biology students navigate them as well.*

*I use the tour of the spallation neutron facility to introduce students to the idea of how new technology could change what we know. I use the research we did in building technology to develop an extra credit project for my college prep students.*

**Table 18—Teachers who reported incorporating Summer Institute experiences in their classrooms.**

	N	%
Explanations and examples in teaching	50	77%
Classroom demonstrations	32	52%
Laboratory exercises	31	50%
Other*	18	29%

Note: Multiple responses were allowed.

\* Other included adding field work, sharing Appalachian heritage, describing a national lab to students, and explaining the nature of science.

Interviewed teachers gave specific examples of ways their approach to teaching had changed as a result of the institute. In one case, a teacher involved low-achieving students in research, setting up a competition between a science class with the lowest achieving students and an applied physics class of high-achieving students. Students were challenged to conduct a research project and write up results. Through this process, she discovered that both groups had strengths. Students in the science class got to work immediately but had difficulty presenting findings while the physics class spent a great deal of time deciding what to do, but easily wrote up their results. An added benefit she noted was that the week of the competition, attendance in the low-achieving science class rose from its usual low level to 100%.

Table 19 displays some other short-term teacher outcomes.<sup>28</sup> More than two-thirds of teachers said that the institute influenced them to discuss applications of STEM with students and encourage them to continue their education in STEM subjects. The following examples from interview notes illustrate how teachers felt they changed their approach to teaching.

One teacher explained that as a result of her experience of finding it a challenge to learn about electron microscopes, UNIX and LUnix, she better understood her students' frustration when they don't comprehend classroom material. Now she breaks things down into "simpler bites," goes more slowly, and has more patience when they have trouble.

Another teacher, who said he was now more likely to try hands-on learning with his students, talked about teaching some of the techniques for taking a census of vegetation learned in his assigned ORNL group, which was "tasked" with exploring invasive species.

A teacher who described attending ORNL as a "transformative experience" said that as a result of his interactions with student participants, his current relationships with students are less hierarchical, and now, when students present problems, rather than talking down to them, he tells them that he sees his job as helping them succeed.

Two interviewed teachers noted that a major weakness of their experience at the Summer Institute was the absence of formal discussions concerning ways to apply what they were learning to classroom settings. While the experience had been "awesome," they felt teachers "didn't get much to bring back to the classroom."

As shown in Table 19, 86% of teachers reported they specifically encouraged students to continue their education in STEM. Three-quarters of them shared what they had learned with colleagues, and almost 70% reported that they talked to students about specific applications of STEM research. A majority of teachers said the institute motivated them to seek professional development in STEM.

One teacher said that although she had always pushed her students to achieve, her experience at ORNL resulted in her telling students "with conviction" that there are jobs in science at multiple levels—that in addition to the PhDs working at ORNL, there were many with few years of higher education who were doing important work. She also described telling students about the many opportunities in applied science in other work places.

Another teacher who also maintained she had always encouraged her students academically, reported that, as a result of being in a computer group at ORNL, she became more aware of the need for computer literacy. Now she emphasizes to her students that "every business has computers" and when students help her

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<sup>28</sup> An evaluation of the STRIVE Teacher Research Associates Program 1986-1991, found that one-year after the program, 94% of teachers reported using program experiences for explanations and examples in their teaching, demonstrations, or lab activities; 91% discussed science/math applications with students; and 99% shared experiences and knowledge with colleagues informally. STRIVE is an eight-week program sponsored by NSF and the U.S. Department of Energy for secondary math and science teachers.

figure out something on the computer, she says: “If you get a degree, you can get paid for doing this.”

**Table 19—Teachers who gave high ratings to selected outcomes**

	N	%
I encouraged students to continue their education in science, math or technology.	56	86%
I talked to students about research applications in the areas of math, science, or technology.	45	69%
I used Summer Institute materials or resources I learned about in classes or when working with student groups (e.g., science clubs).	25	38%
I became involved in science/math competitions or other related extra curricular or out-of-school time activities.	7	11%

Notes:

The percentages represent teachers who gave ratings of 4 or 5 on a 5-point scale from 1= “not at all” to 5= “to a great extent.”

Multiple answers were allowed.

#### ***5.4 Barriers to Bringing ORNL Experiences to Classrooms***

However, it was not always easy for teachers to incorporate their experiences to the extent they wanted because of school-based constraints. Approximately half of teachers (51%) reported that they encountered obstacles to implementing changes to their teaching methods, curriculum, or course content upon return to their classrooms. The most common obstacles mentioned on the survey can be found in Table 20. During interviews teachers explained that in light of state standards, they could not “stray from the core ‘cookbook’ curriculum.” One teacher explained that teaching students with a range of abilities usually meant there was little time for the types of enriched curriculum components she would have liked to implement. In this regard, she noted that programs like the Summer Institute were important enrichment opportunities for gifted students. Some teachers reported that their schools did not allow field trips, primarily because of funding cutbacks. Another teacher did not go on field trips because she said there were no places within a reasonable distance to take students.

**Table 20—Percentage of teachers who encountered various obstacles (n=65)**

	N	%
Pressure to cover the standard curriculum	21	32%
Inadequate lab equipment of other resources	21	32%
No resources for field trips	19	29%
Students lack sufficient skills or maturity	15	23%
Experience at ORNL was unrelated to current teaching assignment	7	11%
Inadequate support from the school administration	3	5%

Note: Multiple answers were allowed.

### ***5.5 Pursuit of Professional Development***

Of teachers responding to the survey, 57% indicated that the institute encouraged them to pursue further STEM professional development. Three of the 13 teachers interviewed offered examples. One said she was exploring certification in physics and had already completed two classes. Another, who characterized herself as shy, admitted that she had been quite nervous before the trip and somewhat fearful of technology. She credited the institute with having given her the impetus to subsequently take two additional weeklong training sessions in technology. Another teacher reported that he was now more “more aggressive about seeking out and talking to people in science.”

Interviews with teachers also shed light on a reason that it is difficult to recruit more teachers to professional development opportunities. It seems that those who had been teaching for a long time already had advanced degrees. Young teachers with young families are reluctant to spend a week apart from them. It also emerged that some of those who applied to the institute continually seek professional development. They inferred that they were high achievers, and while the institute may have reinforced their commitment to professional development, it did not necessarily increase their, already high, motivation.

### ***5.6 Impact on Other Teachers***

A majority of teachers (75%) reported that they shared their experience and information learned informally with other teachers.<sup>29</sup> However, only a few teachers conducted formal workshops or in-service activities for other teachers or school administrators. The four teachers who conducted such events estimated reaching 95 others—one reached a group of 50 and the other three reached groups of about a dozen participants.<sup>30</sup>

### ***5.7 Appalachian Region Employment***

At the time of the survey, most teachers were still teaching at the middle or high school levels. Five teachers had retired, three of whom were still employed. Of the non-retired teachers, 77% were currently high school teachers and 10% were teaching middle school including two of the respondents teaching both middle and high school subjects. As shown in Table 21, the large majority was working in the Appalachian region; 91% were living in the Appalachian region and all of these planned to be there five years hence. Of the six currently living outside of the region, two planned to return within five years.

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<sup>29</sup> The 1992 evaluation of the eight-week STRIVE/TRAC reported that 99% of teachers shared experiences and knowledge from the program with colleagues in informal conversations.

<sup>30</sup> Other programs may have formal expectations that teachers share program information and materials. In the year following the program, the 173 teachers from the STRIVE Teacher Research Associates program estimated that they reached close to 20,000 students and more than 5,500 educators.

**Table 21—Current teaching status and place of employment**

	Current teaching status		Percent working in the AR
	N	%	%
Middle school	5	7%	100%
High school	51	77%	92%
Both middle & high	2	3%	100%
Other	3	5%	33%
Retired	5	7%	100%*
<b>Total</b>	<b>66</b>	<b>99%**</b>	

\*Of the 5 retirees, three were currently employed, all of these in the Appalachian region.

\*\*Percentage does not total 100% due to rounding.

### 5.8 Teacher Recommendations

Teachers provided many ideas and recommendations to increase the effectiveness of the Summer Institute through their answers to both open-ended survey and interview questions.

Several teachers suggested more activities and resources for lesson plan development in response to some frustration that they could not see how to incorporate what they learned into their classrooms. To remedy this problem, a teacher suggested that the schedule include time set aside for the teachers to work in groups to develop lesson plans, activities, and modules for classroom use. It was recommended that the groups could then combine all their materials in a notebook so all teachers could take notebooks back to their classrooms. Another teacher suggested offering graduate credit in exchange for creating a unit incorporating the ORNL experience.

Teachers also stated that they would have liked more exposure to the other projects to obtain a broader understanding of ORNL projects to bring back to their classrooms. In response to this perceived need, one teacher suggested that the groups of teachers meet every few days for an “exchange” of what they were learning and doing in their groups. Another suggested that teachers rotate jobs and/or groups throughout the two-week experience.

Another major area of concern that teachers expressed was that their Summer Institute project assignment did not always relate to the content areas they regularly taught. Some teachers expressed frustration over not being assigned to a relevant topic, while others were concerned that there were no relevant topics because available projects were too heavily focused on biology, environmental science, or computers. Specific suggestions were made to include more math, physics and chemistry projects.

The above suggestions were the most prevalent in the qualitative data. However, other suggestions were made by teachers and may be equally useful to improving the Summer Institute:

- Provide more information on job training and careers in the region to offer to their students.
- Address innovative ways for working in classrooms with limited technology resources.
- Allow students and teachers to work together cooperatively.
- Increase follow-up communication or have a reunion.
- Expand the program to include more teachers.

From the above suggestions it is very clear that the teachers' desire is to return to their schools with the tools necessary to help their students both understand STEM subjects and become interested in higher education. Some teachers left ORNL feeling more prepared to do this than others.