Evaluation of the

Appalachian Regional Commission Oak Ridge National Laboratory Summer Institute for Math/Science/Technology

March 2006

Academy for Educational Development

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Highlights

This report describes some of the key immediate and long-term outcomes achieved by the Appalachian Regional Commission (ARC)–Oak Ridge National Laboratory (ORNL) Summer Institute for Math/Science/Technology for student and teacher participants. This two-week summer program provides high school students and teachers from the Appalachian region the opportunity to work with mentor scientists from ORNL on inquiry-based, applied projects in science, math, and computer technology. The institute culminates with group, student and teacher, presentations about their projects. Other planned activities are designed to promote teamwork, expose students to college opportunities, and promote pride in the cultural richness and historical importance of the Appalachian region.

The goals of the Summer Institute, in operation since 1990, are to1) encourage more high school students to continue their studies beyond high school, 2) encourage more students to pursue careers in the projected shortage areas of science, technology, engineering, and math (STEM), and 3) raise the level of math, science, and technology instruction in high schools throughout the region to facilitate the first two goals.

The findings in this report are the result of an evaluation conducted by staff of the Academy for Educational Development, in which data were collected from eight cohorts of participants attending the Summer Institute between 1997 and 2004. The evaluation took place in 2005-06 and is based on surveys from 89 students and 67 teachers, as well as interviews with a small number of participants. The evaluation has several limitations, including absence of a comparison group that would have made it possible to attribute outcomes solely to participation at the institute. Also, this evaluation was able to collect data only after participation in the institute, whereas with a carefully constructed pre-post comparison, the evaluation could have measured changes in student/teacher knowledge, attitudes, and intentions.

Key findings for students and teachers follow.

Students

- Male and female students from each of the 13 states in the region participated in the Summer Institutes, and 31% of students came from counties designated as economically distressed by ARC.

- Seventy-four percent of students said they felt more confident in their STEM abilities as a result of the institute.

- Participation in the Summer Institute influenced 24% of students to take more science classes and 22% to take more math classes when they returned to high school. Somewhat more than half the students reported that their experience at ORNL reinforced prior decisions about the science and math courses they had already chosen to take (56% and 52%, respectively).

- All the student-survey respondents reported that, even prior to attending the Summer Institute, they planned to attend college. Even so, the students reported many ways that the institute reinforced their intentions to go to college and reduced some of the barriers.

More than 50% of students reported that the program positively influenced their intentions to go to college.

- Fully 96% of student participants who had graduated from high school at the time of the survey had continued their formal education. Of the 83 respondents who provided data, a great majority (79%) went to four-year institutions; 15 % went to community colleges or technical centers; 2% to military academies; and 3% did not continue their education beyond high school.

- Of the 23 students who attended the institute in summer 1997 and 1998, all reported having attained higher education—26% had some college, 39% had earned a bachelor's degree, and 35% went on to graduate work.

- After the Summer Institute, 36 students went on to earn a total of 46 degrees from higher education institutions. Overall, 54% of degrees earned were in STEM—38% of associate degrees, 52% of bachelor degrees, and 86% of graduate degrees.

- In total, 51 student-survey respondents indicated that they were currently pursuing post-high school education; 82% were pursuing degrees in STEM fields, including core subjects, health, and computer sciences.

- Fifty-five percent of participants who were employed full-time reported that their jobs required proficiency in one of the STEM fields "to a great extent."

- The highlight of the experience named by students most often was interacting with people, especially their peers, from different regions of the country and meeting the ORNL scientists.

- Many students reported that the Summer Institute experience helped them gain more mature perspectives socially and academically, an observation that was corroborated by teachers. According to many students, it was particularly significant to become aware that "there were others like me."

- Fifty-nine percent of students currently reside in the Appalachian region, and 53% anticipated residing in the region five years hence. There was no difference in intention to remain in the region among those who had majored in STEM or were currently majoring in STEM.

Teachers

- Teachers from each of the 13 states in the Appalachian region participated; 47% of teacher participants were from ARC-designated distressed counties.

- Many teachers reported that they incorporated activities and approaches learned at the Summer Institute into their classrooms. When they returned to their classrooms, 77% drew on their experience at the institute for explanations and examples, 52% did so for classroom demonstrations, and 50% incorporated new knowledge in their lab experiments.

- Eighty-six percent of teachers said that, following the institute, they encouraged students to continue their education in science, math or technology.

- Sixty-nine percent reported talking to students in their classrooms about research applications in the STEM areas.

- Seventy-five percent reported that they shared their experience and things they had learned with other teachers through informal conversations. Four teachers who gave formal presentations to colleagues estimated reaching a total of 95 teachers.

- Fifty-seven percent of teachers said the institute encouraged them to seek more professional development in STEM.

- Of the benefits of attending the Summer Institute named by teachers, they most often described the opportunity of meeting and networking with other teachers from the region.

- Many interviewed teacher participants desired a more effective professional development component that would provide them with lesson plans and resources to better integrate their ORNL experience into their own classrooms.

- Ninety-one percent of teachers currently reside in the Appalachian region, and 93% said they planned to reside in the region five years hence.

Based on the findings, the evaluation report offers recommendations to help the institute fulfill its purpose more deliberately and effectively. The first recommendations listed below address the program overall, and then address specific student and teacher components of the program.

Overall Program

- Clarify recruitment criteria and process for students and teachers and make these criteria known to participants as well as the groups that recruit them.

- Increase the number of youth from underrepresented groups in STEM.

- Create connections with college-access programs in the region to expand the applicant pool and support student success over the long term.

- Continue to conduct a mixed-method evaluation using a design that incorporates data collection before, and at two points following, participation in the Summer Institute. This will necessitate better student tracking.

Student Components

- Match student interests with projects or, if this is not possible, provide students with the opportunity to sample many projects.

- Provide opportunities for students to meet or work with graduate students and young professionals.

- Foster peer communication during and after the institute, both within and among different cohorts.

- Create connections between the Summer Institute, sending school, and parents to support participants' progress when they return home.

Teacher Components

- Give more attention to curricular issues by providing more structured time for teachers to discuss both specific curricular implications as well as ways to continue to promote interest in STEM education and careers among their students.

- Foster networking among teachers from multiple years of the Summer Institute.

- Make explicit expectations that teachers share their experience with other teachers in their schools and districts.

Table of Contents

Tables

Figure

Appendix Tables

1. Introduction

1.1 Background

The Appalachian Regional Commission (ARC)–Oak Ridge National Laboratory (ORNL) Summer Institute for Math/Science/Technology is a partnership administered by the Oak Ridge Institute for Science and Education (ORISE), a program of the Oak Ridge Associated Universities.

The Summer Institute was designed to address the declining availability of a scientifically literate workforce in the U.S., as well as to improve professional development for teachers in order to increase student achievement in these areas. Census data described below indicate that many counties within the Appalachian region lag behind the national average in college completion rates. ARC, seeking to promote economic development in the region, has funded this and other programs to increase the "intellectual capital" of the area.

The institute's three main goals are 1) encourage more high school students to continue their studies beyond high school, 2) encourage more students to pursue careers in the projected shortage areas of science, technology, engineering, and math (STEM),[1] and 3) raise the level of STEM instruction in high schools throughout the region to facilitate the first two goals. An unwritten but underlying goal of the program is to encourage students who obtain higher education, especially in STEM fields, and teachers who have achieved higher competencies in STEM, to remain in the Appalachian Region. To assess the results of its more than $2 million investment in the Summer Institute since its inception 16 years ago in 1990, ARC funded this evaluation to determine the extent to which these goals have been achieved. The evaluation sought to measure short- and longer-term outcomes aligned with the Summer Institute's goals, including the following for students and teachers:

Students

- Participation in STEM courses while in high school
- High school completion
- College-going
- Degrees pursued and earned in STEM and non-STEM fields
- Employment in jobs requiring STEM proficiency

Teachers

- Incorporating activities and approaches learned at the Summer Institute into the classroom and sharing new knowledge with other teachers
- Encouraging students to pursue higher education in STEM fields

[1] Throughout this report, for simplicity, we use the acronym STEM (science, technology, engineering and math) for all programs addressing at least three of these fields.

- Pursuing professional development

This evaluation was designed to illuminate how the Summer Institute influenced these outcomes. Because it was not possible to measure longer-term outcomes for students who were still in college, the evaluation sought to measure attitudes and intentions that might mediate these outcomes. ARC also asked that the evaluation compare findings with outcomes obtained by similar programs. As will be discussed in section 2 below, such comparisons were generally unavailable, both because it is difficult to find comparable programs (e.g., in terms of target population, program duration and approach), and because few evaluations, if conducted, publish their findings. Finally ARC asked AED evaluators to make recommendations for establishing an ongoing evaluation capability for the ARC-ORNL Summer Institute. These recommendations can be found in the appendix to this report.

1.2 Description of the Appalachian Region

As a context for this report, it is important to understand the Appalachian region, which was established in federal law and comprises 410 counties in West Virginia and in parts of 12 other states extending from the southern tier of New York State to northeast Mississippi. The economy, once dependent on heavy industry, agriculture, and resource-extraction, is now more diversified and reliant on service-sector employment. The population of 22.8 million is distributed across the region, with the largest percentage in metropolitan counties (56%), 27% in counties adjacent to metropolitan areas, and 17% in rural counties. The regional poverty rate of 13.6 is 1.2 percentage points above the national average.[2]

According to ARC, the region faces educational challenges, including low rates of educational attainment and college completion:

> Recent research on educational attainment has revealed a widening gap between the nation's and Appalachia's educational attainment rates. Detailed census data on young adults tell two stories. The high school educational attainment gap has closed even further across Appalachia, but particularly in the north, as well as Northern Alabama. The college completion rate, with the exception of Northern Alabama has not narrowed, even after controlling for age.
>
> Looking at county-level changes, only 18 of the 410 counties have higher college attainment rates than the nation, and most are in college towns. Intrastate differences show that Appalachian counties have lower college attainment rates than every state except Alabama and South Carolina. With respect to gender, Appalachian trends parallel the nation, with women improving their educational attainment rates compared to men, especially in completing Associate's degrees. Because Appalachia's college-age population is forecast to grow little over the next decade, the window of opportunity for the region is to improve the college-going rates and to provide further educational opportunity among those with no college or some college to attain a degree.[3]

[2] Appalachian Regional Commission. 2005. *Request for proposals for An Evaluation of Outcomes from the Appalachian Regional Commission–Oak Ridge National Laboratory, Summer Math/Science/Technology Institutes.* Washington DC.

[3] Ibid.

1.3 Description of the Summer Institute

The ARC–ORNL Summer Institute for Math/Science/Technology is one of many programs funded by the Appalachian Regional Commission in pursuit of its mandate to improve education, economic conditions, and leadership within the region. The institute is held each July at the Oak Ridge National Laboratory in Oak Ridge, TN. The institute, initially managed by the ORNL education office, has been administered by staff of the Oak Ridge Institute for Science and Education since 2001. Participation is open to students and teachers from all designated counties in the region. The governor of each state proposes nominees and the final selection of participants is made by ARC staff.

Held during two weeks in July, this program does not undertake any formal follow-up with schools or participants. The following description of the program, edited in places in line with the purpose of this report, appeared in the ARC request for proposals for this evaluation in 2005.

The institute has openings for 52 participants each year—26 students and 26 teachers, or two students and two teachers from each state in the Appalachian region. An additional eight participants may attend if states cover their costs. Teachers and students are divided into separate research groups, and the teachers have no formal responsibility for the students. These small groups work with one or more of the ORNL scientists, who are designated as "mentors." Scientists may be current or past ORNL employees. For two weeks, the scientists guide assigned groups of students or teachers on projects that are either designed as learning experiences or are part of ongoing research needed by ORNL or one of its clients. Topics in 2003 and 2004 included:

- Robotic systems and engineering development
- Simulations of combined cooling, heating, and power systems
- Building envelope technologies
- Properties of a magnetic ion beam-steering device
- Fusion energy
- Calibration and testing of neutron focusing mirrors
- Stream ecology
- Global climate change
- Nano-biosensor technology and human genome bioinformatics
- Collaborative research and its implications
- Website design and development

Four resident teachers employed by ORISE supervise students during non-institute hours. These chaperones work with students in the evenings to help them understand the applied research they have been conducting and help them design the final presentation all groups make about their projects. Mentor teachers work with teacher participants to strategize about ways they can bring their experience back to the classroom.

The ORNL experience is enriched by activities outside the lab. To build teamwork, an essential part of the research environment, participants are encouraged to complete a ropes course and participate in social events, such as a trip to a Smokies baseball game and Dollywood. There are also several science/education field trips each year to such places as the American Museum of Science and Technology and Tennessee Aquarium and IMAX theater, and the University of Tennessee and Maryville College campuses. The Summer Institute experience also includes a cultural activity designed to develop pride in Appalachia. For example, in previous years, Bill Landry, host of *The Heartland Series*, has lectured to participants. Institute staff have also arranged trips to the Museum of Appalachia in Norris, TN.

The teachers and students attend at the same time, stay at the same hotel, and have meals and attend cultural and social functions together. Students and teachers have their travel, lodging, meal and related expenses paid. Teachers receive a small stipend.

2. Evaluation of Other High School STEM Enrichment Programs

This section of the report summarizes ways that STEM programs have approached evaluation, and some of the pitfalls that prevent the field from capturing truly reliable and cross-cutting data. Where possible, we have included literature on the successes of these types of programs. It is important to state upfront that published results that indicate participant progress in the sciences or overall program impact are difficult to find and, when found, are difficult to compare with results of other programs. Many individual STEM programs are either not required to publish their evaluation data or cannot publish evaluations because they have not received the appropriate human subjects permissions. However, some well-documented evaluations of pre-college STEM programs do exist, and some resources cited in section 7 of the report use anecdotal data to identify "what works."

2.1 Evaluation Approaches

Most programs conduct evaluations because they are required by a funder, because the program directors are interested in learning how their efforts are being received by the participants, and/or because the directors wish to assess long-term impacts. The National Science Foundation (NSF) usually requires that programs devote 10-15% of their overall budget to evaluation activities. Increasingly, even small funding organizations are requiring evaluations. This research is often conducted by third parties, mainly to enhance objectivity, but also because program directors often have competing demands for their time and lack expertise in program evaluation.

STEM programs engage in two main types of evaluations—*summative* and *formative* evaluations. Summative evaluations assess the impact of specific, measurable program goals, some of which may have been jointly set with the funder. Results are generally quantitative, but often include qualitative data that have been collected over the duration of the program. High-quality summative evaluations are generally expensive and have limitations, for example, the absence of comparison groups that would allow attribution of results to a specific intervention. However, if the studies use standard evaluation methods and a funder is willing to pay for dissemination, the results may be published. Compared with summative evaluation, formative evaluation of STEM programs is conducted with higher frequency. The insights gathered during a formative evaluation are meant to inform future iterations of the program rather than inform the field. In order to assist STEM programs in understanding both the value and process of program evaluation, NSF released an evaluation handbook for program directors in 1993.[4]

The Howard Hughes Medical Institute (HHMI) also funds several programs nationwide, including some of the ones included in this review. In July 2005, the first study on the evaluation of these programs was archived.[5] HHMI wanted to evaluate evaluation; literally, it wanted to determine if there were any consistencies across a set of pre-college STEM programs with highly diverse purposes, target populations, and operations. HHMI also wished to learn how evaluations were conducted. Participants in 35 pre-college STEM programs for both teachers and students

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[4] Frechtling, J.A. (1993) *User-Friendly Handbook for Project Evaluation: Science Mathematics, Engineering and Technology Education.* VA: The National Science Foundation.

[5] http://www.nahsep.org/study.html

and a control group of programs, which were selected as finalists in the proposal review process but ultimately were not awarded a grant, completed surveys and responded to questions about their evaluations. This particular study of the evaluation of STEM programs is the most recent and most comprehensive study of its kind. Below are some notable highlights, although the entire study is worthy of examination:

> Almost all of the sites (n=31) were utilizing surveys/questionnaires. Several sites (n=27) were conducting observations (one project director indicated that the site had conducted informal observations following the implementation of a neuroscience curriculum in participating teachers' classrooms). Twenty-one sites conducted interviews; some of these were informal, representing a way to revise project components to be more effective in the classroom. Nineteen sites were using performance measures/participant portfolios, and 12 conducted focus groups.
>
> [At one site] project staff are still grappling with what key elements of their program most influence an increase in student achievement at the 15 schools with which they are working.[6]

General indicators of program success were shared by the NSF subset of STEM programs known as the Research Experiences for Teachers (RET) programs, where teachers are invited to work alongside scientists in the lab or in the field.[7] According to participants, success seems to be centered on two main indicators—collaboration with university scientists and/or fellow educators and increased confidence in, and awareness of, the scientific enterprise.

2.2 STEM Evaluation Results

Published results that demonstrate participant progress in the sciences or overall program impact are difficult to find and, when found, are difficult to compare with results of other programs, due to limitations such as the following:

- Almost no baseline data are gathered by programs across the literature. Baseline demographic, attitudinal and other pre-participant data, including data for the entire applicant pool could answer questions such as: Who applies? Who was chosen? Why? What changes in attitudes and intentions occur over time?

- The impact of STEM programs on the attitudes, aptitudes, and behaviors of participants may not manifest during the program itself, yet that is when most evaluation activities are conducted in order to gain the highest response rate for surveys, focus groups, and interviews.[8]

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[6] Ibid.

[7] Emily Driscoll, RET at Northeastern University (2004) http://www.ret.neu.edu/NSTA-Dallas/Carousel.pdf

[8] Frechtling, J.A. (1993) *User-Friendly Handbook for Project Evaluation: Science Mathematics, Engineering and Technology Education.* VA: The National Science Foundation.

- Participants' self-reported data often exaggerate the positive effects of a given program because they have invested time and energy to participate.[9] Although this does not negate the value of probing participants about their perceptions of certain tactics, strategies or presentations, results need to be interpreted with caution.

- When data are collected over a considerable length of time, consideration may not be given to collecting the data with standardized instruments and interviews that will allow results to be pooled over time and allow correlations to be computed.

Nonetheless, some evaluation literature has been published despite these limitations. The following results from several programs are particularly worthy of mention. The HHMI study that queried its own program pool about evaluation practices also collected data on student motivation to study sciences. (See Table 1 for findings and a comparison with the national averages). Even though the motivating factors for students to pursue science in later educational levels are numerous, and sometimes even undetectable, HHMI did make an effort to include "the data only if they included a control group of similar participants or if results on the same students were collected before and after the intervention to demonstrate the change."[10]

Table 1—Percentage of students who became science majors post-program in selected STEM programs

Grantee	**%**
University of Cincinnati College of Medicine	83
University of Nevada School of Medicine	63
Robert C. Byrd Health Sciences Center of West Virginia University	59
University of Mississippi Medical Center	59
Cleveland Clinic	53
National average	32
National average for underrepresented minorities (most program participants)	5

It is interesting that many of these programs accept participants through a competitive recruitment process, tapping those who already have demonstrated aptitude or interest in the sciences. It is unclear how far along in their science studies the students were when each survey was taken.

[9] Cameron, J. & Pierce, D. P. (1994). "Reinforcement, Reward, and Intrinsic Motivation: A Meta-analysis." *Review of Educational Research, 64* (3), 363-423.

[10] http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=520842

Evaluation results from a 1993 study of the Dartmouth Thayer School of Engineering program showed that 75% of the 1993 teacher participants conducted an engineering experience or parts of that experience in their own classrooms and schools, using the pedagogy presented in the summer program. Further, 75% of participants made presentations to their colleagues about their program and classroom experiences within 16 months of the summer session, reaching an additional 974 teachers. The evaluation also found that 75% of student participants implemented the Dartmouth/Thayer problem-solving methods upon return to their high schools.[11] These findings show that because teachers were able to replicate this specific pedagogical practice, the goals and intent of this program were achieved.

In 1998, a multsite study of Scientific Work Experience Programs for Teachers (SWEPT) was funded with a four-year $1.6 million grant by NSF. The goals of this study were to measure the effect of SWEPT on students in the classroom, in a way that helps identify key variables, regardless of geographic location or particular facilities/personnel. The College of Physicians and Surgeons at Columbia University, coordinated this eight-site effort, summarized briefly below:

> Data has been collected on the more than 30,000 students who have been in the classes of participating teachers since 1993 and on approximately 600,000 students in the science classes of nonparticipating teachers in the same schools and science departments.
>
> The researchers found a three-fold increase in the number of students of participating teachers who undertake a competitive science project. The number of students participating in after-school science programs has grown from about 10 percent to about 13 percent in the classes of participating teachers, while the average in classes of non-participating teachers remained about the same at 3.5 percent. They also found a significant increase in the number of students of participating teachers who passed the science Regents exams. The researchers plan to submit their findings for publication.[12]

2.3 Resources

Program directors from the aforementioned HHMI study were asked to recommend print and online resources they found useful for planning and conducting their evaluation efforts, and these are footnoted here.[13] Another set of references, compiled by program directors and funders of SWEPT programs is also provided as a footnote.[14] A bibliography relevant to goal-setting, evaluation and effective professional development for science educators may also be useful.[15]

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[11] http://fie.engrng.pitt.edu/fie95/4b1/4b14/4b14.htm

[12] http://www.cumc.columbia.edu/news/in-vivo/Vol2_Iss13_aug18_03/science-outreach.html

[13] http://www.nahsep.org/study_results#sites and http://www.nahsep.org/study_results#assets

[14] http://www-ed.fnal.gov/trc/program_docs/biblio_trp.html

[15] http://demeter.hampshire.edu/~manual/back.html#Gibson,%20Helen%20L.%201998.

3. Evaluation Methodology

3.1 Approach and limitations

The purpose of this evaluation was to assess the extent to which the ARC-ORNL Summer Math/Science/Technology Institutes met the program's stated goals. ARC also asked that AED staff compare the evaluation findings with similar programs. In addition, ARC asked AED staff to make recommendations for establishing an ongoing evaluation capability for the ARC-ORNL Summer Institute.

This evaluation employed a mixed-methods approach, including surveys that collected quantitative data through questions with fixed-choice responses. Qualitative data were collected through open-ended survey questions and through interviews with former student and teacher participants. In this way quantitative data are illuminated by more in-depth perspectives offered by participants.

This evaluation is a first step for ARC and offers an objective assessment by an outside evaluator. It is important to keep in mind that the Summer Institute program is relatively modest in scope, in that it is a one-time, two-week program without connection to the sending schools or the institutions of higher education to which the students may apply. While we have explored outcomes that ARC hopes to achieve, these outcomes are incredibly ambitious given the scope of the intervention. The real strength of this evaluation lies in its attention to the program's impacts as perceived by the participants.

It is nonetheless important to note some of the limitations of this evaluation.

Absence of a comparison group. One of the major limitations is the absence of a comparison group that would have made it possible to say with a high degree of certainty that outcomes in this report can be attributed solely to the Summer Institute. Also, because baseline data were not available, we were unable to measure, over time, changes in participants' knowledge, attitudes, intentions, and behaviors.

Small sample size. Each year the group that attends the Summer Institute is small—no more than 60 participants. In order to conduct quantitative analysis and analysis involving subgroups (e.g. gender or length-of-time teaching), it is necessary to have a large sample. Because we were unable to locate many participants despite intense efforts, the sample size remained small permitting only a few subgroup analyses.

Time needed to measure long-term outcomes. Outcomes such as completing higher education and beginning a career may take many years. Thus it made sense to look at college completion outcomes and employment for students who had attended ORNL Summer Institutes in 1997 and 1998. For those in later cohorts, it was necessary to explore shorter-term, mediating outcomes, such as high school completion and college enrollment.

Uncertain reliability of self-report. The survey findings are entirely based on self-report which may not be completely reliable. Evaluation staff were unable to confirm these responses either through record review or observation.

3.2 Student and Teacher Surveys

Survey questions were adapted, where possible, from questions used in evaluations of other pre-college STEM programs. New survey items were added when needed. The questionnaires were reviewed by ARC staff and pilot-tested on 2005 student and teacher participants. Student survey questions were designed to obtain basic demographic information, as well as information on educational attainment, career and employment choices, and the perceived influences of the Summer Institute on student attitudes and college-going. Teacher surveys collected demographic data and included questions pertaining to teaching experience and how the Summer Institute directly influenced teaching practices. Both surveys had open-ended questions to allow participants to describe in greater depth the influence of the Summer Institute on them and the aspects of their experience (e.g., people, projects, cultural programming) that they considered to be most influential.

Survey data collection commenced October 2005 and concluded in December 2005. Participants were given the option of completing hard copies of the survey and returning it in a pre-addressed, stamped envelope or completing the survey on-line.

3.3 Student and Teacher Interviews

During December 2005 and January 2006, staff conducted semistructured, 15-30 minute telephone interviews to explore selected responses to the survey in greater depth. The student interviews covered recruitment, in terms of how the student heard about the institute; the application process and his/her decision to attend; the overall experience of the Summer Institute; how the institute influenced college decisions; perceptions of college-going attitudes in their school and community, as well as the perceived presence or absence of support structures; and recommendations for improving the effectiveness of the institute. The teacher interviews covered teacher recruitment, how the institute influenced their approaches to teaching and interacting with students, their perspectives on whether the institute had an impact on their career, and recommendations for improvement.

3.4 Study Population

All 254 student and 132 teacher participants who attended the Summer Institute during the eight years spanning 1997-2004 were eligible to complete the surveys. One of the greatest challenges to conducting the evaluation was locating the participants, many of whom, especially students, may have moved away from home. We expected that some young women had married and changed names. Because the survey was conducted during the fall, we also needed to be able to contact students who were away at college. Accordingly, we employed a variety of techniques to ensure the highest possible response rate. These included searching the Web to confirm or revise contact information; e-mailing to addresses provided to ARC by participants (in the 2003-04 cohorts) or found on the Web; phoning the participants or their families; or enlisting the assistance of the sending school. In some cases, we asked participants we located to help find others who had attended with them.

Through the exhaustive use of these techniques, we were able to successfully "find" 63% of the students and 80% of the teachers on the lists ARC provided AED. AED staff sent surveys to all participants but sought to obtain the highest possible response rate from the “found” participants. Two to three weeks after the initial survey mailing, we sent reminder postcards and emails to the participants. In addition, staff made follow-up phone calls to all the teachers and students who had not yet returned the surveys (and for whom we had correct contact information). We received surveys from 92 students and 71 teachers. Using a denominator of those with confirmed contact information, the response rates were 58% and 67%, respectively. Of the surveys returned, there were 89 usable student surveys and 67 useable teacher surveys. Response rates varied by cohort.[16] (See Tables 2 and 3.)

Interview samples were drawn from participants who responded positively to a question on the survey asking if they would agree to be interviewed. From these, we selected individuals who together would represent the diversity of participants on characteristics such as gender, year they attended the institute, and race/ethnicity. The student sample included students who had attended or were attending two- and four-year colleges, as well as those who were employed. The teacher sample included some who were early in their careers and others with many years of experience. (See Tables A2 and A3 in the appendix for a more detailed description of the interview samples.)

3.5 Response Bias

In order to determine whether there was response bias in our survey findings, we compared respondents with the "found" participants who did not complete the survey and with the entire group of participants on key variables, including gender, year attended, and the economic status of the county in which the sending school was located according to a classification system used by ARC.[17] A variety of statistical methods were used to determine whether there was any bias.[18] For students, there were no significant differences among groups by gender, but the more recent their entry into the program, the greater likelihood of their being found. However, cohort had no significant correlation with likelihood of responding to the survey. There were no significant differences among groups for teachers or students with regard to location of the sending school in a distressed county. With regard to teachers, there were no significant differences between the full group and those found or between found participants and respondents. (See Table 2 for data on students and Table 3 for data on teachers.)

[16] Our response rate based on the total number of attendees was 36% for students and 54% for teachers. As comparison, a response rate of 48% was achieved in a follow-up study reported in 1996 of 1985 participants of the Student Research Program, a science and engineering summer program for undergraduate students sponsored by the U.S. Department of Education. As reported in a U.S. Department of Energy Working Paper, "Impacts on Participants of DOE Research Participation Programs," prepared by Argonne National Laboratory and Oak Ridge Institute for Science Education (1996).

For another study, the STRIVE Teacher Research Associates Program, 1986-1991, a response rate of 83% of teachers was achieved one year following their participation in an eight-week program. By comparison, our response rate for 2004 teacher participants was 75%. Oak Ridge Institute for Science and Education (1992). *Assessment Summary, STRIVE Teacher Research Associates Program, 1986-1991*.

[17] ARC designates counties as economically distressed on the basis of low per-capita income and high rates of poverty and unemployment. The number of distressed counties changes from year to year, depending on conditions. For this evaluation, we used the county's ARC designation the year the participant attended the program. Between 1997 and 2004 the number of counties designated as distressed ranged from 90 to 120. The average number of counties in the region designated as distressed was 26%.

[18] Statistical methods included one-way ANOVA, bivariate Pearson correlations, two-tailed t-tests, and binary logistic regression (the latter because some of the variables were dichotomous).

Table 2—Comparison of respondents with all attendees and with attendees who were located but who did not respond to the survey–students

	All Attendees (n=254)		Located Attendees who were Nonrespondents (n=67)		Respondents (n=92)*	
	N	%	N	%	N	%
Gender						
Male	123	48%	30	45%	46	50%
Female	131	52%	37	55%	46	50%
Year						
1997	32	13%	5	7%	10	11%
1998	37	15%	10	15%	14	15%
1999	43	17%	7	10%	11	12%
2000	34	13%	10	15%	12	13%
2001	18	7%	6	9%	5	6%
2002	36	14%	10	15%	14	15%
2003	22	9%	7	10%	10	11%
2004	32	13%	12	18%	16	18%
Sending School in Distressed County**						
Yes	94	37%	26	39%	28	31%
No	160	63%	41	61%	63	69%

* Of the 92 respondents, 89 were used in analysis. Two students said they did not attend, and one returned home after attending for only a day or so.

** We could not identify sending school for one survey respondent who did not give a name.

Note: Some percentages in this table do not equal 100% due to rounding.

Table 3—Comparison of respondents with all attendees and with attendees who were located but who did not respond to the survey–teachers

	All Attendees (n=132)		Located Attendees who were Nonrespondents (n=35)		Respondents (n=71) *	
	#	%	#	%	#	%
Gender						
Male	48	36%	12	34%	28	40%
Female	84	64%	23	66%	43	60%
Year						
1997	17	13%	3	9%	10	14%
1998	22	17%	7	20%	9	13%
1999	10	8%	3	9%	5	7%
2000	18	14%	8	23%	3	4%
2001	15	11%	5	14%	8	11%
2002	16	12%	6	17%	9	13%
2003	14	11%	1	3%	12	17%
2004	20	15%	2	6%	15	21%
Sending School in Distressed County						
Yes	59	45%	15	43%	33	47%
No	73	55%	20	57%	38	53%

*The survey analysis in this evaluation uses data from 67 respondents. Four of the 71 respondents were listed in the database of participants more than once because they attended more than one institute between 1997 and 2004.

Note: Some percentages in this table do not equal 100% due to rounding.

4. Student Findings

4.1 Description of Student Respondents

Survey respondents were fairly evenly divided by gender. On average they were 16.5 years of age when they attended, and most were going into their junior or senior years in high school. The majority of respondents (88%) were white and 11% were minority. (See Table 4.) These proportions mirror the diversity in the region.[19] Thirty-one percent attended schools in counties designated by the ARC as "distressed." (See Table 2.); and 47% of respondents were from three states—Georgia, New York, and Ohio. (See appendix Table A1.) While quite a few of them (27%) had attended other STEM programs outside of school, most (73%) had not.

In general, student respondents lived in households with adults who had some college education (see Table 5). Almost three-quarters of the students (73%) reported that their mothers, or another female adult with whom they lived during high school, had some college education or more. Similarly, 60% of students lived with a father, or other male adult, who had at least some college education.

Approximately half the students (46; 53%) lived in households where one or both adults/caregivers had earned a bachelor's or graduate degree; 15% of students (13) lived in households where both the mothers and fathers had a high school diploma or GED or less.

4.2 Overall Assessment of the Summer Institute

Overall, student participants were enthusiastic about the Summer Institute, and fully 90% reported that they recommended the Summer Institute to other students once they returned home. "Motivating," "refreshing," and "liberating," were words used to describe their two-weeks at ORNL.

Survey responses and interviews revealed that participants benefited from the program in significant ways. They became more self-confident and approached their high school studies with renewed interest. Their aspirations for college were reinforced, and many pursued STEM majors in their post-high school studies. For once, one student reported, "I wasn't penalized for being smart." In short, students expressed a collective sigh of relief in a comfortable environment.

A large majority of students reported that they were challenged by the activities in which they participated: 29% reported activities at the Summer Institute as "very challenging" and 61% said they were "somewhat challenging;" 3% said they were overwhelmed by the activities and felt unprepared; and, 7% found the activities to be "not at all challenging."

[19] According to the U.S. Census for 2000 figures, the population was 88% white, 8% black, 2% Hispanic and 2% other. Kelvin Pollard (2004). *A "New Diversity": Race and Ethnicity in the Appalachian Region.* Washington DC: Population Reference Bureau.

Table 4—Selected characteristics of student survey respondents		
Mean age in years	16.5	
	N	%
Gender		
Male	46	52%
Female	43	48%
Highest grade in school completed prior to attending the Summer Institute*		
9th	2	2%
10th	34	38%
11th	51	57%
12th or above**	2	2%
Ethnicity***		
White	78	88%
Black or African American	6	7%
Hispanic or Latino	0	0%
Asian or Pacific Islander	3	3%
American Indian or Alaska Native	1	1%

* Does not total to 100% due to rounding.

**One respondent completed a community college course.

***Multiple answers were allowed. Only one respondent identified as more than one ethnicity (White and African American).

Table 5—Parents' highest level of formal education

	Mother		Father	
	N	%	N	%
Less than high school graduate	2	2%	8	9%
High school or GED	17	19%	17	19%
Post high school trade school	4	5%	9	10%
Some college	19	21%	11	12%
Associates degree	12	13%	8	9%
Bachelor's degree	19	21%	21	24%
Graduate degree	16	18%	13	15%

The next sections of this report outline the influence of the Summer Institutes on students when they returned to school, and with regard to college-going and to considering and pursuing STEM careers. The quotes from students scattered throughout this section illuminate the aspects of the Summer Institute that students found most influential with regard to these outcomes.

4.3 Influence of Peer Support

According to a report on strategies to increase postsecondary access for underrepresented youth by the National Postsecondary Education Cooperative, one of the most effective program practices is "providing a peer group that supports students' academic aspirations as well as giving them social and emotional support."[20] It is therefore not surprising that one of the major findings of this evaluation is that, for students, the most important and influential feature of the Summer Institute was their interactions with other students. These interactions also made their time at the institute enjoyable. The value of peer-to-peer learning and support echoed through responses to multiple questions on the survey and in the interviews. For example, one student said:

> *The interesting things you learn about science were all very fascinating, but for me, I will always remember the people I met. When you live for two weeks with other people, you learn a lot.*

Students also deeply valued the social experience of the institute. This was the first time many students had ventured outside their hometowns, traveled alone, and stayed with people they didn't know. Students' comments revealed that they felt challenged, learned more about themselves, and discovered that there were more opportunities and possibilities for further education and jobs than they had realized. Some characterized their two-weeks as an "eye-opening" experience:

> *The friendship and social enrichment that I received by interacting with the other students at the Summer Institute was priceless. It was very valuable to me to reach outside my home area, my friend group that I had known since childhood, to see what new people from different backgrounds had to say and teach me.*

In the course of student interviews, many students expressed satisfaction and relief when they realized they were not "the only one" their age with interests in science or plans to pursue their education. They were relieved and pleased to discover that outside their circle of acquaintances there were students who had similar interests and goals.

> *It made me realize that others my age truly cared about their futures and a global world rather than just the valleys they, and myself, grew up in. It made me feel like I didn't stick out . . . I fit in for a change.*

> *The students I met were terrific. What stood out about them was their high goals and expectations to succeed. I felt that I could relate with them, that I was one of them, and that all of us would be successful in education and in our careers. This confidence continued with me during high school and college.*

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[20] U.S. Department of Education, National Center for Education Statistics. *Paving the Way to Postsecondary Education: K-12 Intervention Programs for Underrepresented Youth,* NCES 2001-205, prepared by Patricia Gándara with the assistance of Deborah Bial for the National Postsecondary Cooperative Access Working Group. Washington DC: 2001.

When asked to describe the people at the institute who were influential, respondents mentioned students more frequently than teachers, and almost as often as mentors. While participants gained a great deal from seeing mentors and teachers in action, exposure to the decisions and goals of their peers had a profound impact.

> *There was another student there . . .with big dreams about a degree at WVU* [West Virginia University] . . . [she] *had a very positive attitude and made me feel more comfortable.*

> *Many of the students made me realize how many different opportunities there were and how much I still had to discover outside of the small town that I grew up in. They all gave me confidence and excitement about my future—to leave the familiar for the unknown!*

4.4 Influence of Mentors, Chaperones, and Teachers

Students also highly valued their relationships with mentors, chaperones and teachers. In fact, 46% of survey respondents answered "yes" in response to a question on the survey that asked: "Was there a particular person, or experience/activity that had an impact on your academic or professional development?" Approximately half of them mentioned someone from the institute (teacher, student, mentor, or chaperone). Responses indicated that the person influenced their career choice, increased their enthusiasm for scholarship and learning, and increased their level of self-confidence. While students did not always articulate what it was about these people that inspired their academic and professional development, many noted that the person(s) provided advice and/or encouragement.

> *There were several people who had an influence on me after the institute; however, one in particular stands out in my mind. He was a teacher, and I have remained in contact with him ever since the institute. He frequently speaks with me about what I am doing with my life. He gives me advice and encouragement as well. He has seriously been a huge aspect as to why I aspire to go into the medical field.*

One student expressed the importance of the people she met on her future plans:

> *The greatest highlight of all was meeting so many new people. Not only did I make friends that I still remain in contact with, but I also met many professors/mentors/chaperones that could give me great insight as to what it takes to be successful in a science career.*

4.5 Changes in Attitudes about School and Subjects Studied

Students reported that the Summer Institute had a reinvigorating effect on their attitudes and behaviors when they returned to high school that fostered their desire for academic success. A total of 57% of them answered "yes" to the question, "Did the Summer Institute have an effect on you when you returned to school, for example, grades and attendance; attitude toward school, teacher or courses; or involvement in math or science clubs or activities?"

Over half of these respondents stated that the experience increased their enthusiasm, drive, motivation, effort, involvement, and attitude toward school. Slightly less than half of respondents stated that they were more enthusiastic and interested in STEM subject areas. The following quotes are illustrative:

I cared more. Bottom line. I never would admit that or show it then, but for the rest of high school, I actually didn't sleep through class. I read non-fiction books to learn from outside the curriculum for the first time in 16 years. The following school year, I actually spent hours trying to solve geometry problems from a teachers' master's course book.

The Summer Institute gave me a different outlook on life. It made me even more excited to learn and go to college and meet new people. It helped me to experience the world at such a young age which in turn helped prepare me for college and independence.

I was always active in high school, but after I returned from the Summer Institute, I was so much more enthusiastic about it all, including school in general. I spent my senior year being very active with a teacher at my school, who also attended the institute, in many clubs such as the science club. Also, I buckled down on my studies and graduated valedictorian of my class.

The Summer Institute definitely had an effect on the way I acted around other students and teachers. It reassured me that I can speak my mind and people will listen to what I have to say. The Summer Institute didn't give me a voice, but it helped me find mine.

We asked students whether their experience at the Summer Institute influenced the science courses they took when they returned to school. Almost a quarter of the students (24%) reported that they took more science classes when they returned to high school. More than half (56%) indicated that the institute reinforced their prior decisions about the science courses they were scheduled to take and 20% said the institute had no influence. Of the 21 students who reported taking more science classes, six took an advanced or honors-level course, and approximately half (12) took two or more science classes. Students took science classes in a variety of disciplines—chemistry (13 students), physics (10), biology (7), anatomy and physiology (3), and physical science (1), environment (1), nutrition (1), and computer science (1).

Fewer students, 22% reported taking more math classes as a result of attending the institute; 52% reported that the institute reinforced prior decisions, and 26% said that the institute made no difference on the courses they took. Of the 19 students who said they took more math classes, four took advanced placement-level courses. The number of students taking various math course were as follows—pre-calculus (9), calculus (12), algebra I and/or II (4), trigonometry (3), geometry (2), and statistics (3).

Teachers also noticed that students profited from the institute in terms of their attitudes and behaviors. Of the 34 teachers who commented about changes they noticed in students either during the institute or when students returned to school, the highest percentage (29%) mentioned students' increased interpersonal or social skills, noting that they seemed more "personable," "self-confident," "proud," and "outgoing." A quarter of the teachers mentioned that, as a result of the institute, students were more dedicated to their studies and more serious about their future and motivated. The following quote illustrates the changes noted by teachers:

It seems that all five students from my school returned with a much more mature outlook on life and their future goals. I think the experiences in the workplace, the visits to different schools/businesses and the relationships with students different from them were really beneficial.

A quarter of the interviewed teachers also noted that students gained a deeper knowledge of the subject area they studied and a greater interest in math and science:

> *I think both students gained a greater appreciation for science. They have both gone on to major in some aspect of science.*

4.6 Pursuit of STEM Education and Employment

Findings displayed in Table 6, show that students reported that participating in the Summer Institute greatly influenced their views of STEM. More than two-thirds of students gave the two highest ratings to statements reflecting increased awareness of and improved attitudes toward STEM. Fully 88% reported that the institute positively increased their awareness of ways STEM can be applied. They strongly agreed with statements on the survey that said the Summer Institute had increased their interest in STEM and increased their confidence in their abilities in these fields. A small number of students (14) reported that the Summer Institute increased their interest in a field outside of STEM; however, when we asked them to specify these other fields, they named occupations that were in the sciences or computer fields, such as medicine, pharmacy, nursing, and computer software design and Web design.

Males and females held fairly similar opinions about the influence of the Summer Institute on them. However, females were significantly more likely than males to indicate that the program increased their awareness of job opportunities in STEM (p=0.63).[21]

Table 6—Students' ratings of the extent to which the Summer Institute influenced awareness, confidence and interest in STEM

	Percentage Distribution				
	Great extent				**Not at all**
	5	**4**	**3**	**2**	**1**
Increased their awareness of ways STEM can be applied.	48	40	9	1	2
Increased their interest in STEM.	34	35	24	5	2
Increased their confidence in their ability in STEM.	27	47	19	5	2
Increased their awareness of job opportunities in STEM.	33	40	16	7	5
Increased their interest in a career in STEM.	33	34	20	7	6
Increased their interest in another career or field.	9	9	23	13	45

Notes:
Students rated statements on a 5-point scale where the endpoints only were labeled.
Percentages in this table may not total 100% due to rounding.

[21] Two tailed t-tests were conducted to determine the significance of means. Because of the small respondent pool (n=88), a relaxed standard for significance was used (p≤ 0.10).

In addition, some students commented that the institute broadened their choices in the careers they were considering after high school. For example:

> *Growing up in a small town, many students marry and go into labor jobs immediately after high school. Meeting with students from around the Appalachian region, who all had interest in furthering their education challenged me to look past the typical career choices in my area. I wanted to challenge myself to do more, and now, that is exactly what I am doing.*

Many of the students' responses related to the project they worked on and their experience working in that topic area. Students enjoyed the "real world" research and recognized its applicability outside the laboratory setting. In addition, students commented on the value of gaining hands-on experience, and many cited their specific project assignment as the highlight of their stay at ORNL. One student commented on how a project directly influenced her career choice:

> *The field components of our study–collecting snails, fish, water quality and stream data–were my favorite part of the Summer Institute. Thanks to the time I spent with Mike and Art, I became certain that biology, with a strong field component, was the path that I wanted to pursue.*

Another prevalent theme of students' comments was the experience of working in the ORNL facility and touring the labs. Students enjoyed learning more about science, technology, engineering, and mathematics. Some students felt privileged to have access to equipment that "not just anyone" could use:

> *Scanning electron microscopes are multi-million dollar pieces of equipment, so, as a student, I was shocked by the amount of trust our supervisors at ORNL gave us when allowing us their SEM. That experience was the highlight of my trip there. I could have spent hours in that room studying specimens beneath the microscope.*

The specific project that the students were assigned to was a key determining factor in the lessons they took away from the Summer Institute. For example, one student selected a project that involved fieldwork and she enjoyed it so much that it confirmed her desire to be a biologist and conduct field work; this student is now leading outdoor tours at her university and will graduate in May 2006 with a degree in biology. Not being assigned to a chosen project caused some disgruntlement. One student said that he did not find his experience very influential on his thinking because he was not assigned the project he requested. Another expressed relief that she was on the project she desired and knew she would have been unhappy if she had not been on this project. The students reported different processes for selecting the projects that they could work on. Some remember ranking their choices whereas another, from 2001, said students in his cohort were assigned to projects without making any selections. Students who were interviewed felt that overall the selection process should be more tailored to the students' interests.

4.7 College Aspirations and Planning

Preparation for College

In general, in order to attend college, students and their families must mount a complex series of steps, beginning with identifying college as a goal. This usually starts with recognizing the importance of higher education for future careers, followed by taking and doing well in the requisite courses, selecting and applying to one or more colleges, and applying for financial assistance.

Ohio's *Appalachian Research and Success Project* identified several significant barriers to college-access in Appalachian Ohio. These included lack of information or misinformation among students. Other barriers were lack of guidance, assistance, academic preparation, and encouragement to help overcome low self-esteem. The research also found that students and their families lacked information about financial opportunities and the process for applying for aid.[22]

As has been found in other surveys administered in school settings, the current evaluation revealed that all of the student survey respondents reported that, even prior to attending the Summer Institute, they planned to attend college. Even so, students reported many ways that the Summer Institute reinforced their intentions to go to college and reduced some of the barriers. For example, more than 50% of Summer Institute students indicated that the program positively influenced their intentions to go to college. As shown in Table 7, they rated highly (i.e., a rating of 4 or 5) the contributions of meeting other college-bound students, as well as the high expectation on the part of mentors, chaperones, and other staff. Information about financial aid were seen as helpful by 37% of students, but, on average, played a lesser role in influencing their thinking about college. Because we had no way to measure students' families' economic status, we cannot ascertain whether this information might have been crucial for students from economically disadvantaged households. What we do know from interviews is that several students complained that their guidance counselors had not provided sufficient information about college-going.

Interviewed students described how the ORNL experience reinforced their decisions to attend college and helped guide them in a general direction of study. They reported feeling encouraged and inspired to pursue higher education. For example, one student reported that he was certain he was going to go to college "no matter what," but his experience at the Summer Institute helped him decide to go into mechanical engineering. Another student who was considering pharmacy training was assigned to a project that actually dealt with pharmaceuticals. This confirmed her decision and she is now a practicing pharmacist after recently completing her schooling and residency.

[22] Crowther T., Lykins D., and Spohn K., (1992). *Report of the Appalachian Access and Success Project to the Ohio Board of Regents*. Athens/Portsmouth: Institute for Local Government Administration and Rural Development, Ohio University/Shawnee State University.

Table 7—Students' ratings of the extent to which various aspects of the Summer Institute positively influenced their thinking about going to college.

	Percentage Distribution				
	Great extent 5	4	3	2	Not at all 1
Meeting other students with college plans	44	27	17	6	6
High expectations of mentors and other staff	32	40	18	3	7
Interaction with mentors	33	36	17	7	7
Interaction with other staff at ORNL	26	38	22	6	8
Learning about educational requirements for careers in science	27	35	22	7	9
Interactions with chaperones	24	29	28	7	11
Trips to local colleges	27	23	23	16	11
Information about financial aid	15	22	25	17	21

Notes:

Students rated statements on a 5-point scale where the endpoints only were labeled.

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

As already mentioned, many students found it especially beneficial to hear about other students' college plans. Another student who described the ORNL experience as a "big confidence-builder," said it pushed him to look to the future and consider schools that were a bit farther away from home. One student appreciated that the institute gave him a taste of college life. Several students reported that the institute positively influenced their thinking about college. One stated that the institute was extremely influential and helped her clarify what she "wanted to do for the rest of her life."

The evaluation explored steps students had taken to achieve their college goals. We found that although all planned to continue their education, approximately half the students (51%) had never toured a college campus before the institute. It is not surprising, then, that 50% of students reported that visiting the college campuses as part of the Summer Institute positively influenced their thinking about going to college. Further, when it came to applying to college, 85% of students who applied mentioned their experience at ORNL either in essays or interviews.

While most of the college-going process is out of the control of the Summer Institute, the evaluation asked students questions about other supports students needed to translate a desire to go to college into a reality. These findings have implications for the advisability of building school connections that ARC–ORNL might want to consider. It appears from student responses that schools could improve in terms of helping students apply, and gain admission to, college. Although 64% of students thought that their school gave them sufficient information regarding college choices, 32% said schools had not, and 4% were unsure. According to students, schools were less helpful providing what students considered sufficient information about college costs and financial aid. Half of students (50%) reported that their school provided enough information, 40% said schools did not, and 10% were unsure.

Table 8 shows that students consider parents and teachers as providing the most encouragement for their college plans.

Table 8—Mean scores for students' ratings of the extent to which they received encouragement to attend college from the following:	
Parents or guardians	4.73
Teachers	4.56
Siblings or friends	3.95
Guidance counselor	3.92
Community or religious organizations	3.14
Note: Students rated each on a 5-point scale where 1= Not at all and 5= To a great extent.	

4.8 College Enrollment

Fully 96% of student participants who had graduated from high school said that they continued their formal education. Of the 83 respondents who provided data:

- a great majority (79%) went to four-year institutions.
- fifteen percent went to community colleges or technical centers.
- two percent to military academies.
- three percent did not continue their education beyond high school.[23]

By comparison, these rates are much higher than rates for the U.S. population overall, where enrollment in four-year institutions is 37% for the white population, 26% for the black population, and 15% for the Hispanic population.[24] (As shown in Table 4, Summer Institute student-survey respondents were 88% white and 12% minority.) Among our participants, boys were more likely than girls to stop at high school and go to community colleges or technical centers. Girls were significantly more likely than boys to go on to four-year colleges ($p=0.51$). (See appendix Table A4.)

Because many student participants were still pursuing their educations, it is not possible to determine how many of them will ultimately complete their degrees and at what level. Table 9 shows their educational attainment at the time of the survey. Appendix Table A5 displays findings on the highest education that students had completed to date by cohort. As would be expected the earliest cohorts have achieved the most college and graduate degrees and the later cohorts appear to be in the process of completing their undergraduate degrees.

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[23] Two participants still in high school were excluded from the analysis.

[24] Forster, Greg (2006). Opinion. The Embarrassing Good News on College Access. *The Chronicle of Higher Education.* http://chronicle.com/free/v52/i27/27b05001.htm (accessed March 2006).

Table 9—Students' highest educational attainment		
	N	%
Some high school or high school graduate	18	20%
One or more years of college but no degree	32	36%
Associate's degree, certificate or technical diploma	7	8%
Bachelor's degree	19	21%
Some graduate work or advanced degree	12	14%
Note: Percentages in this table do not total 100% due to rounding.		

Considering only the 23 students in the two earliest cohorts—i.e. those out of high school long enough to have obtained a college degree—all reported having some higher education, with 26% having some college but no degree, 39% earning a bachelor's degree, and 35% going on to graduate work.

All students from households with at least one parent with a college degree continued their formal education after high school. Of the nine students who lived in families where both adults had no more than a high school education, seven (78%) continued their formal education after high school. At the time of the survey, the highest level of education attained to date, for two was an associate's and for five a bachelor's degree. One student who did not go to college entered the military service.

We estimate that approximately two thirds of students pursued STEM majors in college. Findings in Table 10 show the majors reported in the survey. Unfortunately, the survey did not ask students to name their first declared major at the postsecondary level. Rather, it asked students to list all of the educational institutions they were attending/had attended and their majors. Those who graduated gave the major for which they had fulfilled requirements. Those who were early in their undergraduate education gave current majors, which could change. Therefore, the data should be interpreted with caution.

Table 10—Major fields of study		
	N	%
STEM		
Biological sciences	20	28%
Engineering	10	14%
Computer & technology	6	8%
Mathematics	3	4%
Environment or ecology	3	4%
Chemistry	2	3%
Non-STEM		
Social Science	10	14%
Other	18	25%

Looking more closely at degrees earned from higher education institutions, we learned that 36 students had earned a total of 46 degrees: 54% of degrees earned were in STEM—38% of associate's degrees, 52% of bachelor's, and 86% of graduate degrees. (See Table 11.)

By comparison, 82% of students currently pursuing degrees at the time of the survey were majoring in STEM fields. Table 11 below also shows the distribution of STEM and other degrees attained at the associate's, bachelor's, and graduate levels.[25]

- Thirty-four students were pursuing four-year degrees, and of the 32 that indicated their field of study, 27 were majoring in STEM subjects.
- Of the six students attending a community college or technical center, five were pursuing STEM subjects.
- Of 10 students pursuing graduate degrees, six provided information about their field of study. Four of the six were in STEM fields.

Table 11—Degrees pursued or earned in STEM and other fields of study

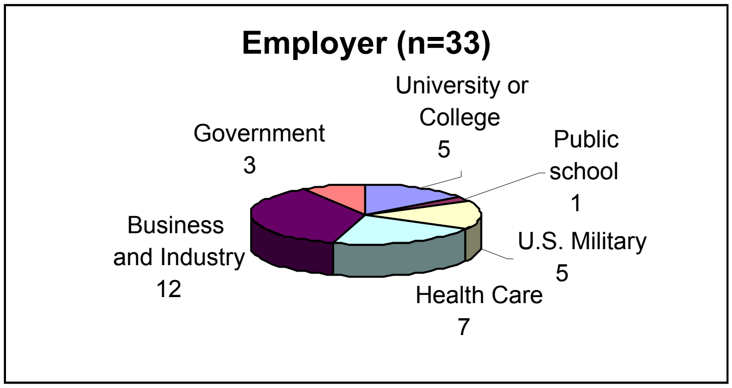
	STEM		Other	
	N	%	N	%
Completed degrees (n=46)	25	54%	21	45%
Students pursuing higher education (n=44)	36	82%	8	18%
Associates and technical degrees (n=8)	3	38%	5	62%
Bachelor's degrees (n=31)	16	52%	15	48%
Master's and doctorates (n=7)	6	86%	1	14%

[25] One respondent provided no information about the level of education or field of study.

4.9 Workforce Participation

Overall, 38% of student participants were employed full-time, 35% were part-time, 15% were unemployed but looking for work, and 12% were out of the workforce. Of the student respondents reporting full-time employment, the largest proportion (37%) worked in business and industry (see Figure 1). Asked whether proficiency in one of the STEM fields is a necessary requirement of their jobs, 55% of those working full-time responded "to a great extent."

Figure 1



Since some students were still in school at the time of the survey, we looked at workforce participation by cohort. As would be expected, those in the earlier cohorts had higher rates of employment. As shown in Table 12, approximately 60% of student participants in the 1997-2000 cohorts were working full-time, and most of the others were working part-time. Fewer students in the later cohorts were working full time; more were working part-time, and a sizeable percentage was unemployed and looking for work.

Table 12—Workforce status of student participants

Cohort	Working Full-time		Working Part-time		Not working-looking for work		Not working-not looking for work		Total	
	N	%	N	%	N	%	N	%	N	%
1997-1998	14	61%	7	30%	1	4%	1	4%	23	99%
1999-2000	13	59%	8	36%	1	5%	0	0%	22	100%
2001-2002	3	19%	4	25%	5	31%	4	25%	16	100%
2003-2004	3	12%	11	44%	6	24%	5	20%	25	100%
Total	**33**	**38%**	**30**	**35%**	**13**	**15%**	**10**	**12%**	**86**	**100%**

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

Asked if their current jobs (full- or part-time) required proficiency in STEM, close to half of student participants said a "great extent" and 31% said "somewhat." Asked to project ahead to their future careers, most participants indicated that proficiency in STEM would probably be a requirement. (See Table 13.)

Table 13—Students' opinions about STEM proficiency requirements of current jobs and future career				
	STEM proficiency is a requirement of current job		**STEM proficiency will be a requirement in future career**	
	N	%	N	%
To a great extent	29	46%	65	74%
Somewhat	19	31%	21	24%
Not at all	14	23%	2	2%
Total	**62**	**100%**	**88**	**100%**

To assess the extent to which the investment in students is likely to directly benefit the Appalachian region, we compared the percentage of student participants who were currently living in the region with the percentage who projected they would still be there in five years. At the time they attended the Summer Institute, all students lived in the Appalachian region. At the time of the survey, 59% lived in the region, and 53% of the total group of student participants thought they would be living in some part of the region five years hence. There was virtually no difference in the percentage of respondents who planned to remain in the region between those who majored in STEM and those who majored in non-STEM fields (66% vs. 65%, respectively).

As shown in Table 14, earlier (1997-2000), and later (2001-04) cohorts did not differ appreciably in terms of the proportion currently residing in the Appalachian region. However, compared with the early cohorts, a higher percentage of participants from the later cohorts thought they would be living in the region in five years. Because the number of participants who answered the question about future residence was low (N=49), findings should be interpreted with caution.

Table 14—Students who currently live in the Appalachian Region (AR) and those who plan on living there in 5 years, by cohort				
Cohort	**Currently lives in AR**		**Plans to live in AR 5 years from now**	
	N	%	N	%
1997-2000	25	59%	13	46%
2001-2004	26	62%	13	62%

4.10 Student Recommendations

While many students indicated that there should be no changes or that they had no recommendations for increasing the Summer Institute's effectiveness, others pointed out some specific things that they felt would have made their positive experience even better. The student recommendations can be broadly grouped into two major categories: recommendations based on program activities and projects and recommendations related to program logistics.

In terms of the activities and projects, the students overwhelmingly reported a desire to select the project they were assigned to for the two weeks. Although in some years students were allowed to rank their project choices, one student stated that he did not really understand what they would actually be doing and wished he had had more information in order to make a more appropriate choice. Some other recommendations from students that relate to projects and activities included:

- Offer more medical and math-related projects.
- Offer more hands-on projects.
- Increase communication between students working on different projects.
- Obtain participant feedback about the strengths and weakness of specific projects.
- Increase interaction between students and teachers.
- Continue access to the newest technology, especially computer technology.

The second group of recommendations focuses on the logistics and design of the entire program. Student recommendations for strengthening the program included the following:

- Operate the program for longer than two weeks.
- Invite more students to attend the program.
- Focus on low-income students with less support and expand the age range.
- Increase publicity to make students more aware of the program. Ensure that the person disseminating information at the school can explain the recruitment and application process as well as the target population. (For instance one student recommended targeting students "with potential who may not, themselves, see it.")
- Involve graduate student scientists or young professionals in the program as role models.

This last recommendation, which was suggested in various ways by many students, was an innovative recommendation to help "bridge the gap" between the professional scientists and high school participants. Some students recommended that graduate students could be invited to speak to the group or play a mentoring role. As one student pointed out, this would help students "see science as something that could be in their future," providing them the opportunity to "meet [college or graduate] students who were enthusiastic and interested in science." A few other students recommended bringing past attendees back to the institute as junior counselors who could serve this “bridging” role.

Regardless of whether some students are invited back as junior counselors or not, many students expressed the desire to have a reunion with others in their cohort or at least a more effective way of maintaining contact with each other. As one student stated, this could really “keep the excitement and energy going.”

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.[26] 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.

[26] 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		
Mean age in years (n=64)	42	
	N	%
Gender (n=67)		
Male	24	36%
Female	43	64%
Ethnicity (n=65)*		
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%
Years of teaching experience (n=65)		
1-5	14	21%
6-10	10	15%
11-15	7	11%
16-20	17	26%
>20	17	26%
Teaching position (n=68)		
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%
Total	**67**	**99%**	**10**	**100%**

* 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.[27] 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. Others 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

[27] 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.[28] 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

[28] 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.[29] 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.[30]

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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[29] 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.

[30] 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%*
Total	**66**	**99%****	

*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.

6. Recruitment

This evaluation explored the way students and teachers were recruited for the program because of its implications for who ultimately attends the program and the outcomes that can be expected. Questions about recruitment were included on both the student and teacher interviews. The analysis also considered the counties from which participants were drawn.

According to recruitment materials, ARC-ORNL mandatory criteria for selection are as follows:

- Student participants must be at least 16 years of age by the date the program begins.
- All participants must be U.S. citizens.
- Student participants must attend public school in a designated Appalachian county and plan to enroll in an eligible public school for the following school year.
- Student participants must have a letter of reference from a teacher, school counselor, or administrator.
- Teacher participants must plan to teach math, science and/or technology (e.g. Web design, computer programming) the following year in the ninth grade or higher in a public school in a designated Appalachian county.

Other considerations for selection include the following:

- Location in a distressed county or a distressed area in other Appalachian counties.
- Teachers and students do not have to be from the same school.
- Students and teachers who have not had an opportunity to participate in previous Oak Ridge or similar math and science programs are given priority.
- ARC has not established income levels for participation. However, ARC requests that recruitment focus on those students from families without the financial means to send their children to such a program.
- ARC has not established academic criteria requirements for participation. ARC requests that recruitment focus on “middle tier” students who show potential in math and/or science and who, with some encouragement, may improve their academic standing and consider college.
- ARC would like those who recruit applicants to target “middle tier” who have potential for success in math and science and who may be encouraged to take higher-level courses and/or to improve their academic standing by participating in the program.

On the basis of the ARC designations of counties’ economic status 1997-2004, we determined that 31% of students and 47% of teachers were from schools in distressed counties. According to teachers, schools were selected either by the state department of education, the school district, and, in one case, a Local Development District in the Appalachian region.[31] Within a school, teachers themselves choose whether to attend. In our small, and possibly unrepresentative sample, it appears that about one-third of teachers filled in when another teacher, either in their school or another, was unable to attend; 60% of teachers reported attending the Summer Institute with students from their schools.

6.1 Teacher Recruitment

The interviews with teachers revealed a range of ways of learning about the institute. Although all teachers completed applications, teachers who were invited or filled vacancies were sure they would be accepted, while the others assumed the process was competitive. The specific ways that teachers were recruited bulleted below account for 19 recruitment events for the 13 interviewed teachers because four of the interviewed teachers had attended more than one year.

- In five cases, staff at the state department of education invited the school to send a teacher and students.
- In four cases, the teacher said the school had been contacted directly by the school district.
- In another four, the principal contacted the teacher.
- In one case each, the invitation came directly to the school from a Local Development District office to the school; a student-teacher pair applied and learned that the school could send another teacher; and one teacher was contacted by a friend who had heard there was an opening.
- One respondent recalled that he filled an unexpected vacancy prior to 1997 and was invited back the following year.

The interview with teachers explored obstacles to recruitment and strategies for overcoming them. A few teachers who were involved with other summer teacher development programs confirmed that teacher recruitment was a common problem. Those who were interviewed posited numerous reasons that more teachers did not apply to the Summer Institute. Lack of information was by far the most common reason and mentioned by all interviewed teachers. One teacher who had received a program announcement felt that the projects to which teachers would be assigned were not clearly described. Other reasons included:

- scheduling conflicts and competition from other professional development options
- necessity for summer employment
- desire to spend the summer with family or pursue other interests
- pessimism—students and teachers do not believe a competitive program would select anyone from a “school like theirs”

[31] Local Development Districts are multicounty planning and development organizations.

- disinterest in professional development, particularly for teachers at the end of their careers.

- Teachers recommended a variety of actions that could be taken.

- Chief among these was more personalized outreach by past participants—for example, through conference presentations at meetings of the National Council of Teachers of Math and of the National Science Teachers Association.

- Other teachers thought it would help if teachers considering applying could contact a past participant.

- Other teachers suggested sending program announcements directly to teachers through listservs and mailings as well as to others (e.g., district personnel, principals, guidance counselors). They underscored the importance of timeliness of this outreach.

Seeking insights about the things that promotional materials might highlight, we asked teachers why they decided to attend the Summer Institute. Some attended to accompany promising students whom they were anxious to expose to this experience. Others mentioned that they enjoyed professional development because of the growth opportunity and because summer programs "rejuvenate" and "revitalize" them. Three of the teachers mentioned specifically being interested in working at ORNL. One suggested that flyers should emphasize that the institute is "fun," that teachers will have something to bring back to their classrooms and that there is a stipend.

6.2 Student Recruitment

The ways in which students were made aware of the Summer Institute varied:

- Of the nine students interviewed, seven were personally approached by a teacher or school staff member and asked to attend the institute.

- One student learned of the opportunity after a guidance counselor spoke to her sophomore class.

- One student received no information from his school but heard about the institute from his grandfather, a physics teacher, who had attended the Summer Institute a few times before.

Although this is a small sample of students, it appears that information regarding the institute is not made widely available to students but is targeted to a few students on the "radar" of teachers or guidance counselors.

Students' recollections of the application process confirm their impressions of the recruitment process. One student attending the 1999 Summer Institute reported that she did not have to apply because her science teacher was able to select two students. Five of the students didn't recall much about the application process but did not remember it as stressful. Another student, however, recalled that this was the first competitive program to which she had ever applied and recalled being anxious about whether she would be accepted. Another student stated that some students at the institute "were kind of wondering how they got there." In other words, for some students this process was competitive, whereas for others it was unclear to them how they were chosen to attend.

7. Review of Selected Pre-College STEM Programs

AED staff reviewed a wide range of pre-college STEM programs in the United States in an effort to identify attributes of successful pre-college programs and to provide descriptions that might benefit the continuing improvement of ARC-ORNL Math/Science/Technology Summer Institute. The programs described here do not comprise an exhaustive review, but rather a representative sample of programs that are compelling to participants, attractive to funders, and sustainable for the organizations that develop and deliver them.

The review revealed a veritable smorgasbord of approaches, goals, resources, academic scope, target population, and program duration. Because evaluations of these programs have either not been undertaken or are unpublished, it is difficult to make claims about "what works" across all such programs. Nonetheless, this review offers an opportunity to compare approaches used by the Summer Institute with those of similar programs. The programs described below were chosen because they demonstrate the following criteria:

- They have garnered funding through multiple sources over time, perhaps indicating favorable reviews by participants and past funders, though such data are unpublished.

- They have strong program leadership, as indicated by the growth, longevity or general reception of the program.

- They represent a range of geographic locations across the United States.

Programs are grouped according to similar theories of action or modes of operation that strive to meet goals similar to ORNL goals. Within the groupings, programs are discussed in alphabetical order. The grouping titles may indicate a specific target population.

College Bridge Programs for At-Risk Youth Who Show Promise

College and universities that offer scholarships for minority students in the sciences often provide summer programs that bridge high school and undergraduate STEM experiences, in an effort to decrease attrition rates in college STEM majors among this target population. Such programs are often successful because they target students who show promise, because these same students often matriculate to the institution, and because program goals align with the goals of the parent institution/department. The AMP/Pre-College Summer Program at Fisk University was a three-week summer program targeted minority students with GPAs of 2.5 or higher, competitive ACT/SAT scores, and teacher recommendation. In other words, this is an example of a program that seeks to increase the success of minority students who already show academic motivation and promise. Academic instruction in science and mathematics, laboratory work, communications classes, field trips, and seminars on learning strategies were offered. Students enrolling in Fisk University who successfully completed this program were eligible for future stipends and undergraduate research posts. The program's evaluation included an assessment of students' academic progress via pre- and post-program written and oral exams. Participants also completed surveys to offer feedback on each aspect of the program. No results were available.[32]

[32] http://www.fisk.edu/index.asp?cat=49&parent=384&pid=385

Another program targeting minority youth for a two-week summer program is the Build a Human Project at the Creighton University School of Medicine in Nebraska.[33] The University of Cincinnati offers competitive summer programs for local high school students interested in health careers and the biomedical sciences.[34]

Programs in Informal Science Institutions

The Arizona Bioengineering Collaboration (ABC) is run by the Arizona Science Center and offers middle school science teachers the opportunity to enroll in each of four six-hour courses on various topics and applications in biotechnology over the course of the school year. Teachers also receive curriculum materials.[35] The Center provides similar opportunities in biotechnology targeting students and parents in the form of afterschool and weekend programs. This approach is used at several other informal science institutions around the country, mainly because it is easiest to bring teachers to the institution where resources are readily available and because teachers and students appreciate experiencing something new at a prestigious or cutting-edge science institution. Receiving curriculum materials is often appealing to teachers in schools where curricular resources are limited or not well-coordinated throughout the county or school district. No evaluative data was available for this program. The California Academy of Sciences in San Francisco has run BioForum, a similar series.[36] Other sites of similar programs include the Chicago Botanic Garden,[37] the Boston Museum of Science,[38] and the Fairchild Tropical Botanic Garden.[39]

Institution-School Partnerships

Many current grant programs require partnerships between organizations and school districts. This direct link with schools provides assistance with participant recruitment and follow-up communications, and allows program staff to gain insight into the immediate and long-term needs of local teachers. The Baylor Science Leadership Program/HU-LINC partners with the Houston Independent School District (HISD) to reform the science education practices of 177 elementary schools. In addition, the program works to involve parents, scientists, school administrators, and other local community organizations, acting as the coordinator of these efforts. This institution is well known for its high-quality and ever-expanding outreach programs, mainly because staff form strong partnerships directly with school districts and maintain relationships over time. The program currently serves elementary, middle and high school science teachers, students, and their parents.[40]

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[33] http://www.biomedsci.creighton.edu/education/outreach.html

[34] http://www.med.uc.edu/admissions/summerenrich.cfm

[35] http://www.azscience.org/investigating_biotech.php

[36] http://www.calacademy.org/education/course_catalog/spring_summer_2002/teacher_workshops.html

[37] http://www.chicagobotanic.org/explorations/

[38] http://www.mos.org/doc/1812?id=666

[39] http://www.fairchildgarden.org/education/n_education.html

[40] http://www.cc.bcm.tmc.edu/ceo/

The Baylor programs have been extensively evaluated; however, results are unavailable to the public. Other programs with similar theories of action are located at the Cleveland Clinic Foundation in Florida and Ohio,[41] and the Duke University School of Medicine.[42] BioEd Online is a web-based resource designed to enhance the skills of high school biology teachers. This resource provides state-of-the-art information through streaming videos, slide libraries, and nature science updates.[43]

Programs in Organizations Focusing on Single Issues or Specialized Areas

Such programs have the advantage of a single issue-based focus that aligns naturally with the missions of their organizations. Further, they have ready access to experts who can demonstrate fieldwork techniques and science "in action," thus providing a science immersion experience for students and teachers.

For example, the Boston Waterfront Learning Project at the Children's Museum joins forces with Save the Harbor, Save the Bay and the Urban Harbor Institute at UMASS Boston to provide educational programs highlighting the Boston harbor and local wharves.[44] This project is strengthened through a partnership with Boston Public Schools, through which a regular rotation of classrooms is arranged. Similarly, the Chesapeake Bay Foundation, whose mission is to improve local water quality, invites classes of students to collect samples and observe marine life.[45] The Children's Discovery Museum of San Jose has created BioSITE, a program for students in grades 4 through middle and high school, to build awareness of the environmental issues of the local Guadalupe River.[46]

The Centers for Ocean Science Education Excellence (COSEE) offer week-long teacher professional development programs in the summer where marine fieldwork methods are practiced. Approximately 20 teachers from North Carolina, South Carolina and Georgia are selected.[47] The DNA Learning Center at Cold Spring Harbor Laboratories, New York provides field trips to local schools, where students can use state-of-the-art equipment to perform biotechnology techniques. The Center draws on its long history of DNA science, hosting exhibitions as well as online resources for teachers.[48] A program with a similar biotechnology focus is CityLab at Boston University's School of Medicine.[49]

Programs Promoting a Specific Method or Practice

A report covering 1990-95 describes how the Dartmouth Thayer School of Engineering created a summer course for K-12 science and math teachers that "represents a distinctive pedagogical

[41] http://cms.clevelandclinic.org/body.cfm?id=204

[42] http://www.duke.edu/~dbc4/boost/teachers/sci-immersion.html

[43] http://www.bioedonline.org/site/about.cfm

[44] http://www.waterfrontlearning.org/

[45] http://www.cbf.org/site/PageServer?pagename=edu_home

[46] http://www.cdm.org/biosite/about.htm

[47] http://www.scseagrant.org/se-cosee/teacher/06_leadership.htm

[48] http://www.dnalc.org/home.html

[49] http://www.bumc.bu.edu/Dept/Home.aspx?DepartmentID=285

strategy which mimics the actual practice of engineering." Teachers spent seven days at this institute, first experiencing immersion in this approach, and then determining ways to adapt this approach to their classrooms. At the time of the report, 155 teachers in 35 states had participated in the program.[50] This was the only example we found of a program that demonstrates a particular academic strategy that teachers are expected to reproduce in the classroom. Translation to the classroom works well because there is a concrete, successful pedagogical mode that can be presented effectively by the institution and replicated by participating teachers. It suggests that when teachers have time during the session to consider issues of classroom adaptation, it is more likely that they will follow through once school begins.

Collaborative Programs with Local, Rural and Native Populations

Scientists at the Dakota Science Center are making connections with local Native American tribes and rural populations to bring science and technology to students in grades 6 to 9 in the Science Circle of Life Program. A unique aspect of this program is its efforts to staff the program with tribal elders and Native American counselors, as well as with members of the Dakota Science Center. Though funding limitations are not allowing an expansion of this program, it has served 36 Native American and rural students.[51]

Several other programs work directly with Native American/Alaskan populations. A well-regarded program with a mission to serve Native American students is located at the Fred Hutchinson Cancer Center in the state of Washington; the Science Education Partnership at the center has expanded to include the provision of curriculum kits to local schools.[52] Another program, the Imaginarium, bridges native communities in Alaska through cultural and science events.[53] By working directly with community members to appreciate the cultural and lifestyle differences of Native American and rural populations, these programs report long-term relationships with not only participants, but with those connected to them (e.g., family members, community leaders, teachers, etc.).

Scientific Work Experience Programs for Teachers (SWEPTs)

As of 2000, there were approximately 72 SWEPT programs serving upwards of 1,300 teachers each summer around the country.[54] Pioneer institutions include the Columbia University College of Physicians and Surgeons,[55] offering laboratory experiences for teachers only, and Rockefeller University,[56] offering laboratory experiences for high school students and teachers of all grade levels. Several students from Rockefeller University have developed their research projects through the Westinghouse and Intel science competitions, earning awards in the finalist rounds.

[50] http://fie.engrng.pitt.edu/fie95/4b1/4b14/4b14.htm

[51] http://www.dakota-science.org/

[52] http://www.fhcrc.org/science/education/educators/sep/

[53] http://www.imaginarium.org/types%20of%20programs.html

[54] Bacon, W. S., ed. (2000). *Bringing the Excitement of Science to the Classroom.* Tucson, AZ: Research Corporation.

[55] http://www.scienceteacherprogram.org/indexorig.html

[56] http://www.rockefeller.edu/outreach/

The FoxChase Cancer Center in Philadelphia is another example of an institution that provides teachers and students an opportunity to conduct authentic research.[57] The opportunity for teachers and students to spend between four and nine weeks working in a research laboratory under the supervision of practicing scientists is considered by participants to be invaluable in helping students and teachers understand the nature of research and the scientific enterprise.[58]

Summary

A search of the literature for evaluations of pre-college STEM programs for comparison with findings of the current evaluation revealed that either evaluation is not conducted or programs have chosen not to publish evaluation findings. The few evaluations we reviewed and referenced earlier in this report were conducted by ORISE for Department of Energy projects. Findings of the Summer Institute with regard to variables, such as using the experience at Oak Ridge in teaching and satisfaction with the program, compare favorably.

The programs described in this section of the report can be considered best practices on the basis of their longevity and perceived effectiveness by administrators, funders and participants. Like the ARC-ORNL Summer Institute, many of the programs reviewed offer immersion experiences for both students and teachers. Programs are administered by higher education institutions and medical programs as well as informal science institutions, such as science museums and botanic gardens.

A positive attribute of these programs, like that of the ARC-ORNL Summer Institute, is their location at a prestigious institution where participants can use state-of-the-art equipment and work on meaningful, relevant projects. Unlike ARC's wide geographic reach, other programs have chosen to target populations in cities. When this occurs, local programs facilitate the development of ongoing partnerships with local school systems, which assists recruitment, ongoing assessment of participant needs and interests, and parent involvement. While some programs reviewed were longer, others were of similar duration to the Summer Institute. The programs that target student populations underrepresented in STEM appear to demonstrate a more sustained commitment to participants.

[57] http://www.fccc.edu/research/education/index.html

[58] For more insights into recently funded programs (2005), refer to the compendium of Math Science Partnerships funded by NSF and available online at http://www.ed.gov/programs/mathsci/nsfabstracts.doc

8. Conclusions and Recommendations

The Appalachian Regional Commission–Oak Ridge National Laboratory Summer Institute for Math/Science/Technology is a program that addresses national goals to meet the needs for a skilled, highly scientific and educated workforce, particularly in science, technology, engineering and math. Building human capital through education is one of ARC's core economic development strategies.

The three main goals for the Summer Institute are:

1. Encourage more high school students to continue their studies beyond high school.
2. Encourage more students to pursue careers in the projected shortage areas of math, engineering, science, and technology.
3. Raise the level of math, science, and technology instruction in high schools throughout the region to facilitate the first two goals.

This evaluation was commissioned to assess the extent to which the three main goals for the institute are being achieved. In addition to measuring long-term outcomes, the evaluation also focused on short-term results and sought to examine participants' perspectives on the aspects of the Summer Institute experience that were particularly meaningful in relation to the program's overall goals.

Evaluation findings are based on data collected through self-administered questionnaires and interviews conducted in 2005 with students and teachers who attended the Summer Institute between 1997 and 2004. One of the key limitations of this evaluation, as stated in the beginning of this report, is the absence of a comparison group, which would have allowed for the attribution of outcomes to the program, and of data which would have provided pre-post comparison of knowledge, attitudes and intentions.

Recommendations below begin with the issue of program definition and recruitment and then separately address student- and teacher-specific issues. Three key policy issues emerge from these findings: 1) clarify and widely disseminate recruitment objectives, criteria and process, 2) build on the current strengths of the Summer Institute and consider increasing the intensity of the program, and 3) strengthen the evaluation of the institute for the purpose of ongoing improvement.

8.1 Recommendations about Program Objectives and Recruitment

The purposes of the Summer Institute program are laudable and address a critical need. The recommendations below are offered to help the institute fulfill these purposes more deliberately and effectively. Recommendations include:

Review specific program objectives and target population. One of the most important recommendations, and one that drives several of the recommendations that follow, is that Summer Institute revisit and formalize its specific objectives regarding program purpose and the target population. In defining objectives, the program must take into account what can reasonably be accomplished in two weeks or consider what steps could be taken to increase program intensity.

Make the recruitment criteria and process more transparent. A clearer definition of the program's specific objectives would help **clarify the target populations of students and teachers** who should be recruited. Formalized criteria would help generate a uniform and transparent process for recruitment and dissemination to those recruited would clarify the selection process. Because virtually all students reported plans to attend college prior to the institute, and the majority of students were from families where parents/guardians were college educated, it appears that student recruitment is targeting highly motivated students from households likely to be providing support for college-going. Similarly, teachers who were recruited tended to be highly motivated and experienced. If the program wishes to continue to recruit teachers with such characteristics, expectations regarding their leadership role upon returning to school might be made more explicit. The involvement of newer teachers, on the other hand, might increase the possibility that they would reach a larger number of students over the course of their careers and continue their professional development in STEM. Additionally, clearer recruitment criteria would address teacher uncertainty, given the limited number of spaces in the program, about whether the institute seeks to involve students and teachers from different schools each year or whether they should encourage others from their schools to apply.

Recruit teachers directly. Teachers, noting the vagaries of receiving announcements sent to principals or district administrators, suggested that recruitment strategies be broadened and more directed at them.

The number of students and teachers who can be reached by this program is relatively small, given that the program has openings for 52—26 students and 26 teachers each year—plus an additional eight openings for states that will pick up the costs. From an analysis of the data from all participants 1997-2004, all 13 states in the Appalachian region sent participants, but three states—Georgia, New York, and Ohio—were overrepresented. The gender distribution of student participants is fairly evenly divided between females (52%) and males (48%). Approximately 31% of students and 47% of teachers came from schools in ARC-designated distressed counties, which comprised on average 26% of counties in the region between 1997 and 2004. While ARC does not collect data on the race/ethnicity of program participants, diversity of the student and teacher survey respondents reflected the racial and ethnic diversity in the region, where approximately 12% of the population in 2000 were racial and ethnic minorities.[59]

Increase the number of youth from underrepresented groups in STEM. If the Summer Institute chooses to more closely align its objectives for its target population with federal goals to increase the number of individuals from underrepresented racial, ethnic, and socioeconomic groups in STEM, the Summer Institute should make its purposes **explicit in recruitment materials and outreach to agencies and organizations** that play a role in recruitment.[60]

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[59] http://www.arc.gov/index.do?nodeId=1842

[60] National Science Board (2003). *The Science and Engineering Workforce, Realizing America's Potential.* Washington DC: National Science Foundation, http://www.nsf.gov/nsb/documents/2003/nsb0369/nsb0369.pdf

NSF publications relating to STEM and:

Gender equity: http://www.nsf.gov/pubs/2002/nsf02107/nsf02107.pdf , Another outreach strategy, addressed again below, would involve **partnerships with other college-access programs already reaching underrepresented populations.**

In a two-week, one-shot program, an argument can be made that it is acceptable to target students who may "make it" without the program but who can still benefit from the "extra push" in terms of their self-confidence and interest in STEM majors and careers that the Summer Institute provides. Certainly student surveys and interviews suggest that the institute does play a role in giving students this push. However, if the institute seeks to target a more diverse population, improving access to college and STEM careers for students from racial, ethnic, and socioeconomic groups not traditionally represented in these areas, then this goal will have to be made an explicit part of the recruitment process. Further, recruiting a more diverse population may mean making changes in the institute itself—the programming and staff, the approaches, and the supports, such as tutoring and mentoring, available during the two weeks.

Another recruitment issue is the assignment of students and teachers to specific ORNL projects. A number of participants from both groups noted that there was a mismatch between their interests and their assignment. This seemed to be a particular problem for non-science teachers. According to a conversation with the program coordinator, we understand that it is difficult for ORNL to commit to mentors/projects well in advance of the time recruitment announcements go out to prospective participants. Nevertheless, it seems important to obtain commitments from ORNL staff earlier in the year, even if it means broadening the number of ORNL staff invited, for example, graduate students and young professionals.

Recruit fewer non-STEM teachers. Another possible solution is for the program to recruit and accept fewer nonscience teachers unless it is known for certain that there will be an appropriate project for them.

Match student interests with projects, even if it means rejecting a student's application and substituting someone else whose interests will be better served by the projects available that year. Another possibility would be to limit the institute to two or three subject areas per year but rotate the subject areas, for example, physics and mathematics one year, biology and computers the next.

Constitute a "general" group. Another possibility, if students or teachers feel the match between their interests and the available projects is not good, is to constitute a group that spends a day or more visiting and working with all the projects to give participants a broad exposure to ORNL activities. If members of each project group were asked to describe their work to the members of the visiting "general group," it would reinforce participants' understanding of the significance of their work and give them the opportunity to practice explaining their activities to others when they returned home.

Native Americans: http://www.nsf.gov/pubs/2002/nsf02072/nsf02072.pdf ,

Black populations: http://www.nsf.gov/pubs/2002/nsf02160/nsf02160.pdf .

8.2 Student-Specific Recommendations

Overall, students who attended the Summer Institute appear to have been highly motivated and interested in STEM prior to attending the program. Nonetheless, the institute appears to have had an important influence on reinforcing students' decisions about college and inspiring their interests in STEM. Students and teachers interviewed attributed students' gains in confidence and maturity to the institute. Upon returning to school, many were more serious about their studies and motivated to achieve. About a quarter of them reported taking more science and math courses in high school than planned.

Fully 96% of student participants went on to higher education. Somewhat more than half of degrees earned by student participants at the time of the survey have been in STEM fields and 82% of those currently pursuing degrees are majoring in STEM fields.

While the program appears to be beneficial and certainly highly appreciated by participants, there are ways programs can be strengthened. Possible avenues are found in the appraisal of programs models reviewed in this report. Of particular relevance are programs that create partnerships with school districts and develop sustained relationships with communities, teachers, and parents. Moreover, it is constructive to consider the elements of college-access programs believed to be most effective in increasing college-going rates, particularly if the Summer Institute wants to reach out to more underrepresented students. The recommendations that follow the list below, derive from survey and interview findings, but they specifically address the first four items on the list. Effective college-access programs have been found to:

- Provide a peer group that supports students' academic aspirations and provides them social and emotional support.
- Provide a key person who reviews students' progress and guides them over a long period of time.
- Make long-term investments in students rather than short-term interventions.
- Pay attention to the cultural background of students.
- Provide high-quality instruction.
- Provide financial assistance and incentives.[61]

Student-related recommendations include:

Fostering peer communication: Students described multiple ways in which their peer group exerted a positive influence. Some interviewed students reported being in contact with others in their cohort after the institute. Computer networks and Internet-based communications make this easier each year. However, cross-cohort communication does not appear to be occurring. To strengthen the connections that students stated were so valuable, Summer Institute administrators might consider using **on-line groups to create a bulletin board or other more formal website** to encourage communication among past participants. Such a site, for example, could link

[61] U.S. Department of Education, National Center for Education Statistics. See footnote 20.

students exploring college options with past participants at colleges which current or recent participants are considering. Students working on science projects or interested in knowing requirements for specific types of jobs might be able to find help from former institute participants. An ORNL–ARC Summer Institute website could also facilitate connections between those students thinking of applying to the Summer Institute with past participants who identified themselves on the survey as willing to provide information about their experience.

Bridging the age/experience gap: Another peer-related suggestion made by students was bridging the age/experience gap between mentors and students. Students recommended that at some time during the institute, students should have **opportunities to meet graduate students or past program participants to talk to them** about education and career choices. Graduate students and young professionals in STEM can also be recruited to assist mentors with the groups throughout the two-weeks.

Creating connections between the Summer Institute, sending school and parents: The Summer Institute might consider ensuring that staff members from the sending school (e.g., current STEM teachers and guidance counselors) are aware that the student attended the institute so that they can continue to encourage participants' progress. If students give the names of these school staff to the program, **a follow-up letter or phone call to the school from a Summer Institute staff member** could be used to describe the student's experience and offer suggestions about ways to reinforce his/her college-going ambitions. Because students indicated on the survey that parents were most influential in students' college-going decisions, **outreach to parents** that reinforces connections between parents and school or district resources could also benefit students.

Creating connections with college-access programs in the region. Finally, acknowledging that the Summer Institute may not have the resources to create a program that establishes a long-term relationship with students, it may be useful to create connections with college- access programs in the region that do. Such collaboration could provide an applicant pool of underrepresented students and follow-up and support for students over a longer period. Another possibility would be **to build relationships with specific high schools** in the region. High school-STEM program partnerships such as the Baylor Science Leadership Program, reviewed in section 7 of this report, are considered promising practices.

8.3 Teacher-Specific Recommendations

The Summer Institute appears to be attracting highly motivated and experienced teachers who find it to be a valuable experience, and several have taken the opportunity to attend more than one year. Teachers stated that they felt revitalized by the program, which both increased their STEM knowledge and their awareness of opportunities in applied science to help them prepare students for careers in STEM fields. Teachers reported that the institute gave them concrete examples of science applications to share with students and the majority reported they integrated aspects of their Summer Institute projects into their classes. While many interviewed teachers said that they had always encouraged their students to pursue education beyond high school, their experience at ORNL increased their awareness of career opportunities. In this regard, several indicated that they were better able to instruct lower-achieving students and encourage them to pursue careers in STEM fields because they now were more aware of the variety of jobs requiring different levels of STEM education.

Like the students, teachers mentioned the important influence of their peer group during their time at Oak Ridge. Specific recommendations reflecting the value teachers place on their peer group and addressing teachers' concerns about ways to integrate their lab experience in the classroom include:

Give more attention to curricular issues: The program might provide more structured time for teachers to discuss both specific curricular implications as well as ways to continue to promote interest in STEM education and careers among their students. Ultimately teachers need to be involved designing any improvements to this component. The following is a suggestion that could be raised in a planning session. As part of their assignment at the lab, teachers might create a **three-part notebook:** the first would contain one lesson plan related to each project; the second part would contain concrete suggestions about encouraging student interests in STEM; and the third part could contain references and descriptions for resources that teachers learned about at the Summer Institute or that they have found useful. Each year's notebook could be posted on a Summer Institute Website. This notebook would be a way to share information with colleagues in the sending schools and districts and could be the centerpiece of a districtwide workshop for teachers that would expand the impact of the Summer Institute program. Provision of a small amount of funding to duplicate the notebook and provide refreshments, might increase the number of such workshops teachers conduct.

Foster networking among teachers. Enlist the assistance of teachers to suggest ways to enhance communications between teacher participants from multiple years of the Summer Institute. The website would be most useful if it addressed curricular issues. As was recommended with regard to students, the website could contain contact information for teachers willing to tell new applicants about the program. Another way to foster networking would be to host a mid-year conference call for teachers to talk about their experience with strategies they have tried to foster college-going and STEM studies among students or other professional development opportunities they have learned about.

Make explicit expectations that teachers share their experience with other teachers. Teachers reported that they shared their Summer Institute experience with other teachers, but few did so in a formal way that would reach significant numbers. If more than one teacher per school or school district were selected to attend the institute, they could jointly develop a presentation for their colleagues. Small grants to cover refreshments and other meeting costs would be incentives. Another approach would be to encourage selected teachers from each cohort to describe their experience at statewide or national professional association meetings. Again, reimbursement for travel or conference registration would help.

Summary

Findings of this evaluation indicate that ARC-ORNL Summer Institute Program has been of benefit to student and teacher participants and has helped ARC achieve its goal of increasing college-access and graduation in STEM fields in the Appalachian region. More rigorous evaluation, as proposed in the appendix to this report, will provide the program's stakeholders with more scientifically accurate evidence of program strengths and weaknesses to inform decisions about program improvement and continuation.

8.4 Recommendations for Future Evaluation

The following are recommendations for ongoing evaluation of the Appalachian Regional Commission (ARC)–Oak Ridge National Laboratory (ORNL) Summer Institute for Math/Science/Technology. These recommendations were requested as part of the Request for Proposals (2005) for the evaluation of the Summer Institute.

AED's proposed evaluation is grounded in 10 principles of effective evaluation included in the appendix. Following these principles, the first step in designing an ongoing evaluation plan is reaching agreement about the purpose of the evaluation and the use to which it will be put. This plan assumes that ARC is seeking to determine the extent to which the program is reaching its objectives, both for the purposes of quality improvement and to obtain a sense of whether the government's continued investment in the program appears to be worthwhile. With this in mind, we would recommend an evaluation that explores how the program is implemented (e.g. one that assesses the program's recruitment process and activities) as well as the program's outcomes. Agreement about the purpose of the evaluation would need to be decided before the evaluation design was finalized.

The second step for the evaluation is establishing realistic objectives (and associated outcomes) in light of the current scope of the program. While a small number of the student participants we interviewed claimed that the Summer Institute was a life-changing experience, it is unrealistic to expect that a two-week intervention will have an impact on college-going and STEM careers for the group as a whole. Nonetheless, it is reasonable to expect that the institute contribute, along with other influences, to encouraging youth to have higher academic expectations for themselves and to steer them toward college. Rather than measuring outcomes such as college persistence and pursuit of STEM careers, the evaluation should measure attitudes, behaviors, and intentions that mediate the achievement these long-term outcomes.

- AED recommends ongoing evaluation to address questions such as the following, many of which were studied in the current evaluation. The final evaluation questions will need to be aligned with the objectives:

    Is the Summer Institute recruiting/serving the type of students and teachers it seeks to reach?

    Are targeted populations recruited and attending the institute?

Is the application process reaching students who are promising but not bound for a four-year college?

Are teachers who are early in their careers attending the institute?

If more experienced teachers are being recruited, do they influence other teachers once they return to their school districts?

- To what extent does the Summer Institute have an impact on students' attitudes, intentions, and behaviors related to college-going and careers in STEM?

  Upon return to high school, do students take the STEM classes than will prepare them for college?

  Are students more confident of themselves and their abilities in STEM?

  Do students prepare for college in terms of taking college entrance exams (SAT and ACT) and visiting colleges?

  Are students more likely to apply to a four-year college rather than a community college?

- To what extent do teachers incorporate their experiences into the classroom and to what extent and in what ways do they encourage students to pursue their education in STEM fields?

  Do teachers draw on the Summer Institute experience for explanations and examples, classroom demonstrations or laboratory exercises?

  Do teachers change their teaching methods, or use materials and other resources in their classrooms that they obtained at the Summer Institute?

  Do teachers encourage more students to pursue higher education and STEM studies after they attend the institute and do they do so in different ways?

  Do teachers take part in more professional development opportunities in STEM after the Summer Institute?

- What are the aspects of the program that participants, mentors, and chaperones believe are the most influential for achieving the program's objectives?

  What are the strengths and weaknesses of the program from the perspectives of participants, mentors, and chaperones?

  What are participants' and other staff members' recommendations for improvement?

Design

We propose an evaluation in which data are collected from participants, before the institute and at two times post-participation, once immediately after and one nine-month follow-up; which will lessen sample attrition and is sufficient time to observe change. The post-test at the end of the institute will provide information about immediate outcomes and allow evaluators to obtain feedback about any new improvements to the program. A nine-month follow-up will also allow evaluators to assess ways the program may influence students in light of decisions they will be making when they return to school, as well as to determine the extent to which effects persist over time. If students enter their senior year in high school when they return, at the nine-month follow up (April), most will know where they will be going to college, and juniors will have selected their courses for the following year. Teachers will have had the opportunity to schedule and possibly conduct workshops for other teachers and to have planned further professional development. If resources permit, students who are juniors when they return to school after the institute can be surveyed in April of their senior year.

We propose that the same evaluation instruments be used with new Summer Institute cohorts so that responses for two or three years can be grouped to provide a larger sample size and to permit subgroup analyses.

A pre-post design will allow evaluators to observe change in the participants but it will not allow us to attribute any of this change to the Summer Institute. If possible, a comparison group should be used to allow for comparison between student participants who attend the program and those who do not. One possibility would be to create a larger applicant pool. Youth who are selected but are unable to attend or those not selected as participants, but who are similar to those who do attend, would be asked to complete both follow-up surveys. In order to gain their cooperation, the comparison group should receive some mild intervention such as information about STEM career opportunities in the region or resources about college-going. Also, members of the comparison group should receive a small monetary incentive for completing both surveys.

AED also recommends two qualitative methods for the evaluation. The first is a site visit by an objective third party during the second week of the institute to observe each activity group and interview staff. The second method is personal (telephone) interviews or group discussions (conference call), with a small number of participants each year. These discussions can offer invaluable insights about how the Summer Institute influences participants and can elicit useful suggestions for program improvement.

The Study Population

Because the Summer Institute serves approximately 26 students and 26 teachers each year (and an additional eight participants if states pick up the costs), any evaluation will need to include the entire population of participants rather than a sample. In addition, it would be useful to include mentors, chaperones, and any other staff closely associated with the program, such as the ORISE project director.

One of the difficulties encountered in AED's evaluation was finding program participants. The time-frame for the recommended ongoing evaluation will obviate the need for intense tracking. However, these strategies are recommended in order to ensure that participants can be found:

- To obtain accurate contact data from students and teachers accepted into the program, have participants enter street and email addresses directly into an electronic database and then have them check the information on hard copy. This will minimize difficulties in interpreting handwriting or data-entry errors.

- Obtain contact information (names, addresses, phone numbers) for a variety of individuals including parents' names and addresses (students only); sending school; and one additional contact who would know where to find them should they move.

- Send postcards to participants 3 months after the program. Any returned postcards will have forwarding information up to 60 days of a move. Ask participants to update contact information by email or by return postcard. Participants can also enter updated information on a Web page.

Consent for Participation in the Evaluation and Confidentiality Protections

During the application process, students and teachers should be advised that ARC conducts an evaluation as part of the Summer Institute for the purpose of program improvement. Applicants should be advised that participation in the evaluation is not considered a prerequisite for selection into the program. Applicants should be asked for their informed consent to take part in the evaluation, assured of confidentiality of their data, and advised of the possibility that findings will be published.

Consent from student participants will need to be obtained a second time if the evaluators track college access and persistence forward, for example using the National Student Clearinghouse (NSC) database. Social security numbers, collected for security clearance, can be used with consent of the participants 18 years of age or older. Because NSC data will be accessed after the participant has turned 18, consent will have to be obtained subsequent to the summer of their participation. It is recommended that the evaluators obtain consent from as many students as possible who will have turned 18 years old at the 9-month survey and from others at a later point (which can also afford an opportunity to update contact information).

Dissemination of Evaluation Findings

The full report should be shared with program stakeholders and a summary of the evaluation should be shared with participants from whom data were collected.

Appendices

1. Appendix Tables
2. Ten Principles of Effective Evaluation

Appendix Tables

Table A1—Percentage of students and teachers residing in Appalachian states when they attended the Summer Institute

	Students		Teachers	
	N	%	N	%
AL	4	5%	5	8%
GA	10	11%	5	8%
KY	2	2%	1	1%
MD	8	9%	2	3%
MS	4	5%	5	8%
NC	2	2%	1	1%
NY	15	17%	7	11%
OH	17	19%	13	20%
PA	7	8%	3	5%
SC	4	5%	4	6%
TN	5	6%	6	9%
VA	4	5%	3	5%
WV	6	7%	11	17%
Total	**88**	**98%**	**66**	**102%**

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

Table A2—Selected characteristics of student interviewees (n=9)

	N	%
Gender		
Male	3	33%
Female	6	67%
Year Attended		
1997-1998	2	22%
1999-2000	3	33%
2001-2002	3	33%
2003-2004	1	11%
Use of STEM in current occupation		
To a great extent	4	67%
Somewhat	2	33%
Unemployed	3	N/A
Highest level of education completed since attending the Summer Institute		
One or more years of college but no degree	6	67%
Associate's degree	1	11%
Bachelor's degree	0	0%
Some graduate work	1	11%
Advanced degree (Master's or Ph.D.)	1	11%
Ethnicity		
White	8	88%
White and African American	1	11%

Table A3—Selected characteristics of teacher interviewees (n=13)

	N	%
Gender		
Male	6	46%
Female	7	54%
Year attended		
Multiple years	4	31%
1997-1998	1	8%
1999-2000	2	15%
2001-2002	2	15%
2003-2004	4	31%
Number of years teaching experience at time of the institute		
1-5	3	23%
6-15	2	15%
16+	7	54%
Missing data	1	8%
Ethnicity		
White	9	69%
Black or African American	1	8%
Hispanic or Latino	1	8%
Missing data	2	15%

Table A4—First educational institution attended after high school				
	Male		**Female**	
	N	%	N	%
No post HS education	2	5%	1	2%
Community college or Technical Center	8	19%	4	9%
Military Academy	2	5%	0	0%
4-year school	29	71%	37	88%
Total	**41**	**100%**	**42**	**99%**

Table A5—Highest level of education attained										
	High school or less		Some college but no degree		Associate's degree or technical diploma/ certificate		Bachelor's degree		Graduate work	
	N	%	N	%	N	%	N	%	N	%
1997& 1998 (n=23)	0	0%	5	22%	1	4%	9	39%	8	35%
1999& 2000 (n=23)	1	4%	5	22%	3	13%	10	43%	4	17%
2001& 2002 (n=16)	3	19%	11	69%	2	12%	0	0%	0	0%
2003& 2004 (n=26)	14	54%	11	42%	1	4%	0	0%	0	0%
Total (n=88)	**18**	**20%**	**32**	**36%**	**7**	**8%**	**19**	**22%**	**12**	**14%**

Ten Principles of Effective Evaluation

1. Evaluators ideally should be involved in systematic inquiry with the reform leaders in the early stages of project conceptualization; in assessing current conditions and capacities and needs for improvement; in identifying the performance gaps and other problems, and in envisioning program designs that seek to close the gaps, solve problems, and meet identified needs.
2. Evaluators should work with project designers and proposal writers to develop a project logic model to ensure that an internally consistent program is designed to respond to the needs and problems identified, with a set of project activities or interventions likely to impact the original conditions, problems, and performance gaps favorably.
3. Evaluators should combine quantitative and qualitative methods and employ a comparative evaluation design where feasible.
4. Evaluators should seek a comprehensive understanding of the important contextual elements of the evaluation. Contextual factors that may influence the results of a study include geographic location, timing, political and social climate, economic conditions, and other relevant activities in progress at the same time.
5. Evaluators should involve all stakeholders in a participatory process that builds future internal evaluation capacity and also communicate their values, assumptions, theories, approaches and analytic methods accurately and in sufficient detail to allow the stakeholders to understand, interpret, and critique their work and evaluation findings.
6. Evaluators should conduct the evaluation and communicate its results in a way that respects the stakeholders' dignity and self-worth.
7. Evaluators should seek to ensure that those who bear the burden of collecting data have full knowledge of, and opportunity to use for program improvement, the evaluators' findings, analyses, and recommendations.
8. Evaluators should make explicit their own interests, their clients' interests, and other stakeholders' interests concerning the conduct and outcomes of an evaluation.
9. Evaluators should allow all relevant stakeholders access to evaluative information in forms that respect people and honor promises of confidentiality.
10. Evaluators should make clear to clients when client interests and requests conflict with the obligation of evaluators for objective inquiry, competence, integrity, and respect for people. In these cases, evaluators should discuss the conflicts with the client and relevant stakeholders, resolve them when possible, determine whether continued work on the evaluation is advisable if the conflicts cannot be resolved, and state clearly any significant limitations on the evaluation that might result if the conflict is not resolved. The public interest in professional, objective inquiry and evaluation for the welfare of society should be upheld as a higher value than a particular client's or other stakeholder's interests.

The Academy for Educational Development (AED) is an independent, nonprofit organization committed to addressing human development needs in the United States and throughout the world. As one of the world's foremost human and social development organizations, AED works in five major program areas: U.S. Education and Workforce Development; Global Learning; Global Health, Population and Nutrition; Leadership and Institutional Development; and Social Change. At the heart of all our programs is an emphasis on building skills and knowledge to improve people's lives.

The AED **Center for School and Community Services** is part of AED's U.S. Education and Workforce Development Group. The Center uses multidisciplinary approaches to address critical issues in education, health, and youth development. To achieve its goals, the center provides technical assistance to strengthen schools, school districts, and community-based organizations. It conducts evaluations of school and community programs while striving to provide the skills and impetus for practitioners to undertake ongoing assessment and improvement. The center also manages large-scale initiatives to strengthen practitioner networks and accelerate systems change and uses the knowledge gained from this work to advocate for effective policies and practices and disseminate information through publications, presentations, and on the World Wide Web. In the past 27 years, the Center has undertaken over 125 evaluation, technical assistance, and dissemination projects in 90 cities and 40 states.

In 2005, the Educational Equity Center at AED (EEC) was formed.. The Center is an outgrowth of Educational Equity Concepts, a national nonprofit organization with a 22-year history of addressing educational excellence for all children regardless of gender, race/ethnicity, disability, or level of family income. EEC's goal is to ensure that equity is a key focus within national reform efforts to ensure equality of opportunity on in schools and afterschool settings, starting in early childhood.

AED is headquartered in Washington, DC, and has offices in 167 countries and cities around the world and throughout the United States. The Center for School and Community Services is in AED's office in New York City. For more information about the Center's work, go to the Center's website at www.aed.org/scs or contact Patrick Montesano or Alexandra Weinbaum, co-directors, at 212-243-1110, or e-mail sweinbau or pmontesa@aed.org.

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