

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

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-science 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 program 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 that 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.