Future Scientists Program

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"Sowing the seeds of science success"

Document for School Districts

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USDA/Hispanic Serving Institutions National Program (HSINP)

USDA/Agricultural Research Service (ARS)

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Research background:

“From the moment students enter a school, the most important factor in their success is not the color of their skin or the income of their parents, it’s the person standing in the front of the classroom” (New York Times, March 10, 2009). These words were spoken by President Obama as he addressed the Hispanic Chamber of Commerce last year and highlighted the need for better teachers. The Future Scientists Program has always focused on this critical need with the goal to improve teacher effectiveness and the impact that has on positive student progress. The majority of teachers are committed to student success but those teaching in schools with high percentages of minority students need additional support to become highly effective and that includes high quality professional development opportunities (Chait, 2010). In addition, there is increased need for effective teachers of color and different ethnic backgrounds to serve as role models to help their students to thrive in a multicultural environment (National Education Association, 2002).

Future Scientists is a Project-based science (PBS) curriculum that inspires the teachers and students to conduct research projects around the corn earworm insect (Helicoverpa zea) with in-quiry-based aspects. Kanter and Konstantopoulos (2010) conducted a research program on PBS that found that students from groups underrepresented in science courses had improved science achievement and attitude towards science and thus their college and career plans. But, this improvement was conditional upon three factors all related to their teacher: increased teacher use of inquiry-based science activities; increased teacher science content knowledge; and increased teacher science pedagogical content knowledge. Future Scientists attends to all three of these requirements in addition to interacting with the teachers. This is an essential and integral part of the curriculum implementation process (TERC, 2010) as is having the teachers learn in a community of scientists, pedagogical experts and other teachers (Sutman, 2010). This is particularly important for alternatively certified teachers who, according to the National Center for Alternative Education (NCAE) make up 30% of new teachers in Texas and California and 40% in New Jersey (Garcia and Huseman, 2009). Often, these teachers enter the classroom with little or no knowledge regarding child development, learning styles, classroom management, or methodology. Professional development, especially for new teachers should be developed around what they need (Claycomb and Hawley, 2000). The Future Scientists Program does just that.

Program background:

The Future Scientists Program is designed to assist USDA/HSINP reach out to communities and schools (grades K-12) with hands-on, inquiry-based activities that link them with USDA/ARS scientists, laboratory sites and current agricultural science research. It can be said of USDA/ ARS research laboratories, of which there are over one hundred nationwide, that they are the best -kept secret in a community. All too often, the world-class research being undertaken and the benefits to local communities and society in general go unnoticed. The pilot program, Federal Laboratories' Involvement in Research in Science and Technology for Science Teacher Enhancement Project (FIRST STEP) had a proven track record of getting information out into the local communities by inviting teachers, students and their parents to become directly involved in the research. The program initially targeted middle level teachers and students, as this is the age when students traditionally lose interest in science and addresses the National Science Education Standards by emphasizing cutting edge research and scientific processes using appropriate technologies. It is currently being expanded under the auspices of the USDA/HSINP to a national model, with a K-12 focus on insect life cycles using the USDA/ARS research on the corn earworm (*Helicoverpa zea*) as the model at each laboratory site plus a secondary focus on one area of local research e.g. Honey Bee (*Apis mellifera*) research at the USDA/ARS Tucson lab, Arizona.

The aim of the program is to help teachers to become more effective and so inspire students (K12) to continue their studies in science. It is based out of the USDA/ARS Area Director's Office in College Station, Texas and the Center for Mathematics and Science Education (CMSE), within the College of Science at Texas A&M University. It is being expanded into states with large Hispanic populations during the coming years: Arizona and California, 2009; Florida and Puerto Rico, 2010; New York, 2011; Illinois, 2012; and Colorado, 2013. The program provides an opportunity for local laboratories to reach out to their surrounding communities. Local teachers receive a stipend for their yearlong involvement in the program and their students benefit from materials supplied at no cost to their school by the laboratory plus the loan of equipment. In addition, the laboratories become available as educational resources for their communities as teachers, students and their parents visit the site and are welcomed back. The program increases student engagement in science and improves their scientific knowledge and skills, developing their potential to pursue science courses in college and, from there, enter the science career pipeline.

Figure 1: Students at Bonham Elementary School in Bryan, TX, display various stages in the life of the Corn Earworm having presented their research earlier

Teachers can access the program web site to order worms for use with their students delivered free to schools: **http://www.science.tamu.edu/usda/CornEarWorm/**. This site also contains detailed procedures on how to raise and study the insect; provides an e-mail link where students can ask questions of the collaborating scientists; and provides examples of previous student research projects conducted on the corn earworm. In addition, materials and equipment can be supplied or loaned at no cost to each school by the USDA/ARS laboratory in their community. Since 2005, a total of 234,685 students have been involved in the program. 20,765 students have been directly impacted through 197 teachers attending Future Scientists institutes and interaction with the program director. An additional 2,674 teachers have attended workshops to impact another 213,920 students, calculating that on average each teacher has 80 students. A total of 71,115 corn earworms have been shipped nationwide since 2006, the number increasing annually so that from 2008-2010: 51,290 worms were grown and studied by 38,067 students in 26 states.

The goal: Of the Future Scientists Program is to strengthen the instructional capacity and competence of participating teachers thereby helping them to become more effective and directly impact student progress positively. To that end, the Future Scientists summer institutes and conference workshops are aligned with the **National Standards for Professional Development for Teachers**:

Standard A, Learning essential science content through the perspectives and methods of inquiry…

At the summer institute, teachers collaborate as a group and with the research scientists while being exposed to cutting edge research. They then conduct research with their students during the year on aspects of the corn earworm's life cycle; an agricultural pest that causes losses of over $1Billion annually in damage and control efforts.

Figure 2: Teachers at work with Dr. Wilson during a Future Scientists summer institute in Mayaguez, PR

Standard B, Integrating knowledge of science, learning, pedagogy and students before they apply that knowledge to science teaching…

Best teaching practices are modeled by the Program Director who has a Ph.D. in Science Curriculum and Instruction, both at the summer institute and when he teaches for a day for each teacher during the school year. Teachers are exposed to sample research projects and then collaborate to design new ones.

Standard C, Building understanding and ability for lifelong learning…

Teachers learn about current Agricultural science research taking place within their community at the local USDA/ARS laboratory. They are encouraged to keep in contact with the scientists who are all selected for their positive mentoring skills; to arrange fieldtrips to the laboratory with their students; invite scientists to visit their classrooms. In short, they are encouraged to make use of the USDA/ARS laboratory as an educational resource.

There are over 100 of these laboratories nationwide.

Figure 3: USDA/ARS scientist Stewart Reed explaining how he conducts some research by growing plants hydroponically and encouraging teachers to replicate the method in their classrooms

Standard D, The program should be coherent and integrated…

Teachers come together during the summer institute and are then supported during the year by classroom visits by staff; a listserv; a program web page; and they come together at the end of the year, bringing students back to the USDA/ARS laboratory for a Student Research Presentation Day. There is ongoing evaluation both formative and summative.

The Learning Objectives for Future Scientists Teachers who attend a Future Scientist Program summer institute or conference workshop:

1) Handle the corn earworm (*Helicoverpa zea*) and so learn about its life cycle

2) Go through the stages of raising the corn earworm in the classroom

3) Examine examples of previous student research projects conducted on the corn earworm and then brainstorm and collaborate to develop new research projects

4) Become familiar with and comfortable using the Future Scientists web site, http://www.hsi.usda.gov/CornEarWorm/main.htm and make suggestions for additions/ improvements

5) Practice with a digital microscope and develop ways to use the technology to increase student interest and involvement in science

6) Become involved in current research projects with USDA/ARS scientists at the local research center; learn how to arrange fieldtrips; and how to make use of it as an educational resource within their community

Corn Earworm Curriculum

Goal:

Through strengthening the instructional capacity and competence of Future Scientists teachers, the goal is to positively impact student progress in science and inspire students (K-12) to successfully continue their studies in science. Research on the corn earworm will help students understand the complexity of the living world as they study the functions and processes of the organism as it interacts in and with its environment. They will learn to respect and be intrigued by the living world.

Content:

(Note: State specific learning objectives e.g. Texas TEKS, are being made available at: http://www.hsi.usda.gov/CornEarWorm/main.htm):

Future Scientists 'student learning objectives' align with the learning objectives of each state and the National Assessment of Educational Progress (NAEP, 2005). By studying and conducting research on the corn earworm (*Helicoverpa zea*), students can be assessed:

A. In the area of *science knowledge and skills*:

1) Students will learn facts about the corn earworm and use the tools, procedures and reasoning processes of science to increase their understanding of this part of the natural world

B. In the area of *Life science*:

1) CHANGE and EVOLUTION, students will learn about diversity of life on earth, genetic variation, adaptation, and natural selection

2) ORGANISMS, students will learn about reproduction, growth and development; life cycles; and functions and interactions of systems within organisms

3) ECOLOGY, students will learn about interdependence of life, including populations, communities and ecosystems

C. In the area of *knowing and doing science*:

1) CONCEPTUAL UNDERSTANDING, students will learn facts by interacting with the corn earworm (a part of their natural environment); be able to explain and predict observations of the natural world; be able to conduct scientific inquiries; begin to understand the nature of science; and see the interaction between science, technology and society.

2) SCIENTIFIC INVESTIGATION, students will acquire new information; plan appropriate investigations; use scientific tools; and communicate their results to a variety of audiences

3) PRACTICAL REASONING, students will start to think in abstractions and develop hypotheses; consider several factors/variables simultaneously; become objective; and realize the importance of practical reasoning and experience.

Instructional Approach:

The choice of approach is left to individual teachers but, one model suggested and demonstrated during the Future Scientists summer institutes is the 5E Learning Cycle:

Engagement	Object, event or question used to engage students. Connections facilitated between what students know and can do.
Exploration	Objects and phenomena are explored. Hands-on activities, with guidance.
Explanation	Students explain their understanding of concepts and processes. New concepts and skills are introduced as conceptual clarity and cohesion are sought.
Elaboration	Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

Adapted from Bybee, R.W. et al. (1989).

The teacher is initially a facilitator, guiding the students towards independent research and inquiry learning using the corn earworm, a real world problem, costing farmers in the USA alone over $1 billion dollars in annual control costs and crop losses. Taking prior student knowledge into consideration, teaching and learning strategies that teachers might employ include direct instruction, laboratory experiments, cooperative learning, problem solving and demonstrations. Technology is incorporated through student use of a digital microscope provided to some teachers and/or accessing the program web page and asking questions via e-mail of the collaborating scientists.

Assessment is on-going and linked directly to the student learning on the corn earworm. The teacher is responsible for student evaluation but it is recommended that it incorporate rubrics and include pre-, formative, and summative assessment. The ideal form of evaluation should be the culminating activity where the students would be assessed on oral presentations they make on their research, much like scientists presenting at a scientific symposium and/or poster presentation.

Figure 4: 5th grade students from the California School for the Deaf Riverside (CSDR) display their certificates after presenting their research at the Student Research Presentation Day, 20 May, 2010

Future Scientists Program, alignment with the National Science Education Standards:

Life Science content:

Grades K-4 1) The characteristics of organisms 2) Life cycles of organisms 3) Organisms and environments

Grades 5-8 1) Structure and function in living systems 2) Reproduction and heredity 3) Regulation and behavior 4) Population and ecosystems 5) Diversity and adaptation of organisms

Grades 9-12 1) Biological evolution 2) Interdependence of organisms 3) Matter, energy, and organization in living systems 4) Behavior of organisms

Science as Inquiry:

Grades K-12 1) Abilities necessary to do scientific inquiry 2) Understandings about scientific inquiry

Program Evaluation:

The content evaluated will reflect the learning objectives listed in the curriculum. The evaluation will occur in three forms:

1) The Program Director will ask teacher participants to complete an on-line survey at the conclusion of their initial training e.g. at a summer institute

2) The Program Director will send out a follow-up survey electronically to participating teachers, 6-9 months after their initial training

3) A report generated by the participating institution (campus, school district, or other) reflecting student progress.

   In order to avoid the possible ethical or legal complications of collecting data on K-12 students, the responsibility of data collection is delegated to the partnering institution so that they share information on terms with which they are comfortable. Most school districts have an Office of Accountability that tracks student progress by content area over time and in comparison to their local and state cohorts. The information requested will:

   a) Not include any identifiable information, such as names and SSNs

   b) Show student progress using the indicators of the participating school district's choice

   c) Be reported at the end of the academic year

References:

Bybee, R.W. et al. (1989). Science and technology education for the elementary years: Frameworks for curriculum and instruction. Washington, D.C.: The National Center for Improving Instruction.

Chait, R. (2010). Removing chronically ineffective teachers, Barriers and opportunities. Center for American Progress, March. Retrieved July 22, 2010 at, http://www.americanprogress.org

Claycomb, C. & Hawley, W.D. (2000). Recruiting and retaining effective teachers for urban schools: developing a strategy plan for action. Washington, DC: National Partnership for Excellence and Accountability in Teaching (NPEAT), Office of Educational Research and Improvement (ED).

Garcia, R. & Huseman, J. (2009). Alternative certification programs: meeting the demand for effective teachers. Brief analysis No. 675, National Center for Policy Analysis (NCPA). Retrieved July 29, 2010 at: http://www.ncpa.org/pub/ba675

Kanter, D.E., & Konstantopoulos, S. (2010). The impact of project-based curriculum on minority student achievement, attitudes, and careers: the effects of teacher content and pedagogical content knowledge and inquiry-based practices. *Science Education*, 1-33. Retrieved July 23, 2010 at, http://www.interscience.wiley.com

National Education Association (2002). 2002 Tomorrow's teachers: help wanted. Available at: http://www2.nea.org/tomorrwteachers/2002/helpwanted.htm

National Research Council (NRC). (1996). National science education standards (NSES). Washington, D.C.: National Academy Press.

"President Obama's remarks to the Hispanic Chamber of Commerce," The New York Times, March 10, 2009. Retrieved 22 July, 2010 at, http://www.nytimes.com/2009/03/10/us/ politics/10text-obama.html?pagewanted=4&_r=1

Sutman, F. (2000). We need a better understanding of inquiry in instruction. *Harvard Education Letter, 16 (5).*

TERC and Tufts University. (2010). Professional development for teachers, overview: professional development vision. Retrieved July 20, 2010 at, http://inquiryproject.terc.edu/prof_dev/