A CASE STUDY OF THE OPPORTUNITIES AND CHALLENGES PRESENTED BY INTEGRATING AUTHENTIC DATA INTO DIVERSE HIGH SCHOOL CLASSROOMS. L. Arino de la Rubia[1], J. Butler[2], T. Gary[3], S. Pfiffner[4], S. Kuner[5] [1,3]Tennessee State University (3500 John A. Merritt Blvd, Research & Sponsored Programs Building, Nashville, TN 37209), [2]Dragonfly Enterprises, Nashville, TN [4]University of Tennessee, Knoxville, TN [5]Topaz Canyon Group, LLC, Alameda, CA

Introduction. The goal of the Astrobiology in the Secondary Classroom (ASC) curriculum development project is to establish a successful model for increasing the use of authentic scientific data to connect non-mainstream high school students to the real world of science and scientists. The web-based ASC modules are being developed by Tennessee State University in partnership with the Minority Institution Astrobiology Collaborative and the NASA Astrobiology Institute to create a high-quality curriculum available for free via the Internet. The seven curriculum implementation sites are in public schools or after-school programs in which 90% or more of the participants are African American, Hispanic, and/or Native American. The curriculum is being field-tested at eight sites: two after-school programs and high schools in six school districts around the country. Three of the seven sites are designated as NASA Science, Engineering, Mathematics and Aerospace Academies (SEMAA).

The ASC curriculum emphasizes interdisciplinary connections in astronomy, biology, chemistry, geoscience, physics, mathematics, and ethics for students and teachers to better understand scientific endeavors. The ASC project team is translating data from NAI team researchers into scientific data sets suitable for analysis by high school students, helping to revolutionize Secondary science education by making the applications interesting to students and practical for teachers. The ASC Project, by applying the principles of effective pedagogy outlined by CREDE [1] seeks to create a culturally-aware high school curriculum that works in any classroom of diverse learners. This is possible by applying the principles of CREDE (the Center for Research on Education, Diversity and Excellence) located at UC Berkeley as well as educating teachers on how to bring areas of interest to astrobiologists or geochemists into the classroom, allowing for the customization of the curriculum specific to the local area. These areas are often overlooked by students and teachers because they are such a part of the regular local landscape, and students are then able to see the potential for science research in their own backyards.

Challenges in using Data in the Classroom. In their work with the NSF funded VISIT Teacher Enhancement Project, Hunter and Xie detailed the barriers for teachers accessing and using the vast amounts of data on the Internet. There are institutional and logistical obstacles, cognitive challenges for students addressing complex real-world problems, and the often-limited experience of non-expert teachers in guiding students in using existing scientific research data [2]. Although teachers are interested in introducing their students to sophisticated concepts and analysis, their training and access to the appropriate computational tools may be beyond their knowledge base and skill-set. Research scientists, as experts in their area, have a broader repertoire of techniques in developing and interpreting data sets. The ASC project has partnered curriculum developers and teachers with astrobiology researchers to develop data sets that are user-friendly in the high school classroom.

Data Integration within the Classroom. In one of the ASC curriculum modules students learn about Dr. Sue Pfiffner's research as an astrobiologist, and how she examines extreme organisms that exist in environments two kilometers below land surface inside a gold mine in South Africa. Dr. Pfiffner has contributed data collected from water samples in these deep-earth mine fissures. Teachers have learned how to assist their students in looking at critical research variables including sample location, pH, temperature, and concentration of oxygen, sulfate, and nitrates. The students organize and manipulate the data, perform analyses, and interpret the results. Students then collect water samples near their school and compare that data to the data from the South African mines to better understand how extreme conditions impact organisms. Students are then led through a discussion of how this research on Earth is an analogue to the exploration of Mars as scientists try to discover if life exists below the surface of that planet. There are also activity extensions for students where partial DNA sequences and membrane lipid profiles are used to phylogenetically characterize the microorganisms in an environment. Teachers and students can learn to use the Basic Local Alignment Search Tool (BLAST) program to compare each of the samples to the sequence data in a databank (GenBank) maintained by the National Center for Biotechnology Information at the National Institutes of Health in the United States [3].

Our Challenges and Goals. The enhancements to the ASC curriculum that are the highest priority for this year concentrate on two areas: strengthening the alignment of ASC with standards for effective pedagogy and student outcomes with diverse student groups proposed as a part of the CREDE Project [1] and increasing student use of data sets provided by research scientists in the field of astrobiology. Although teachers appear to be very interested in introducing their students to sophisticated concepts and

analysis, their training and access to the appropriate computational tools may be beyond their knowledge base and skill set. The research scientists who are supplying the data are experts in their area and have a broader repertoire of techniques in developing and interpreting data sets. Working with these scientists to organize the data in a way that teachers and students can be of meaning to them is one of our greatest challenges.

Desired Outcomes from ASC Participation.

There are six outcomes for students participating in curriculum activities, particularly activities involving authentic scientific data.

1. Increase student understanding of and comfort with the nature of science and the scientific process through the context of interesting real-world scientific investigation.
2. Demonstrate cognitive gains in science in the areas of biology, chemistry, geology, and astronomy through the integration of scientific disciplines in a manner relevant to each student.
3. Demonstrate skills needed to work in diverse groups to complete challenging investigations using real-world research.
4. Be able to communicate scientific concepts to others through informal conversation and discussion as well as through formal scientific discourse.
5. Engage in dialogue about ethics and controversial issues that face scientists and have conversations about the relationship of science and their culture (e.g. evolution and ethics in space exploration).
6. Increase student awareness and interest in science careers through shared learning experiences and exposure to role models from their culture.

There are a separate set of seven goals for teachers involved in the ASC project:

1. Use of themes in astrobiology to teach complex thinking and challenge students with current issues and investigations from developing scientific areas.
2. Improve understanding and use of effective science inquiry methods focused on interdisciplinary science.
3. Contextualize science in students' lives by embedding instruction in their interests, experiences, and skills.
4. Work together with students to apply computer software and interesting technological tools in the analysis of scientific data sets.
5. Develop language and literacy across the curriculum in a way that promotes student competence in science.
6. Teach through instructional conversation and engage students in discussion though dialogue.
7. Motivate high school students from diverse communities to pursue science and math courses by identifying and promoting traditional and non-traditional career opportunities in the STEM areas.

During this last year of the project we will continue pilot-testing the ASC curriculum with diverse audiences, finalize activities and data sets, and prepare the curriculum for the NASA review process in order to become an official NASA educational product.

References. [1] Tharpe, et al. (2003) *Research Evidence: Five Standards for Effective Pedagogy and Student Outcomes* [2] Hunter, B., & Xie, Y. (2001). *Learning & Leading with Technology*, *28*(7), 18-24. [3] Altschul, et al. (1997) *Nucleic Acids Research*, *25*, 3389-3402.