Astrobiology in the Secondary Classroom Project

An interdisciplinary curriculum developed by a collaboration of scientists and educators from three different minority communities

T. Gary[1], L. Ariño de la Rubia[1], D. Robinson[2], S. Kuner[3]

[1]Tennessee State University, Nashville, TN [2]Dragonfly Enterprises, Inc, Nashville, TN [3]Topaz Canyon Group, Alameda, CA

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 have been 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. Our six curriculum field-testing 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 has been field-tested at six sites: two after-school programs including Tennessee State University and the Consortium of Paiute Shoshone Indian Reservations in Owens Valley, California, and high schools in four school districts around the country. Three of the six sites are designated as NASA Science, Engineering, Mathematics and Aerospace Academies (SEMAA). During this last year of the project we will continue incorporating teacher feedback into the ASC curriculum, analyzing collected student and teacher data, and preparing the curriculum for the NASA review process to become an official NASA educational product.

Overview

The Astrobiology in the Secondary Classroom project consists of a research based curriculum framework that is being implemented in three different minority communities. Addressing the ASC research questions, helping teachers with implementation and examining curriculum-teacher-student interactions lead us to the creation of a diagram of factors influencing teacher implementation of the ASC curriculum and scientific data in classrooms of Native, African-American and Latino students.

Unique Aspects of the ASC project

There are many unique aspects to the ASC Curriculum Development project.
- The development process has occurred mostly in diverse minority communities
- Three different communities in six different geographic locations contributed to its' development
- The curriculum will potentially be adopted by NASA & used within the national SEMAA network
- The activities were developed in the spirit of an interdisciplinary science using actual scientific data

Research Questions

Does the Astrobiology in the Secondary Classroom Curriculum:

(1) Have a coherent content framework that is aligned with research-based pedagogy for diverse groups of students?

(2) Support student understanding of core STEM content and basic STEM concepts in formal educational settings (high school classrooms) as well as in informal educational settings after school?

(3) Increase the science literacy of diverse groups of students?

(4) Contain activities and professional development opportunities that allow teachers to effectively educate diverse groups of students?

(5) Infuse methodologies enabled by "cyber-infrastructure" that expands teachers and students access to real-world scientific data?

(6) Provide unique questions that increase student interest in STEM areas?

(7) Promote sustained collaborations between students, scientists, teachers, and universities?

Research-Based Curriculum Framework

Astrobiology is a known interdisciplinary framework for teaching science (Slater, 2006; Staley, 2003), and cultural competence is key for successful, engaging science teaching (Aikenhead, 2001; Lee & Luykx, 2006; Lynch, et al., 2005, among many others). Our design rationale has been sculpted by key educational theorists such as research on how people learn (Donovan & Bransford, 1999), the standards proposed as a part of the CREDE Project that characterize the dynamics of learning in diverse cultures (Tharp, et al., 2003), and the backward design principles of Wiggins and McTighe (1998). Differentiated instruction and assessment options are also incorporated to assist teachers in meeting the needs of students with varying abilities (Tomlinson & McTighe, 2006). Flexible goals, methods, materials, and assessments accommodate learner and teacher differences in the ASC curriculum (Center for Applied Special Technology, 2002).

Student Participants - Year 3

Variable	*N*	Percent
From Student Data Collected (*N*=474):		
Student Grade		
8th	35	7.4
9th	116	24.5
10th	246	51.9
11th	30	6.3
12th	39	8.2
Not provided	8	1.7
Student Gender		
Male	224	47.3
Female	247	52.1
Not provided	3	0.6
Data Provided by Instructor (*N*=572):		
Project Site Location		
Las Cruces, NM	89	15.5
Chinle, AZ	48	8.4
Miami, FL	405	70.8
Branchville, SC	30	5.4

Curriculum Modules & Activities

The modules under development are built on recent research-based strategies designed to diminish achievement gaps and increase the participation of diverse students in STEM activities.

Module 1: What is Astrobiology?
Sample Activity: Four Corners: Where are you?

Module 2: Astrobiology & the Search for Life in the Universe
Sample Activity: Conway's Game of Life

Module 3: Extreme Organisms
Sample Activity: Geomicrobiology Data Analysis

Module 4: Astrobiology and Planetesimals
Sample Activity: Simulating Mars Exploration via Rovers

Module 5: Spectroscopy and its Applications
Sample Activity: Taking a Reflectance Spectrum

Module 6: Ethics of Astrobiology
Sample Activity: Class Debate on Sample Return

Factors Influencing Teacher Implementation of ASC Curriculum

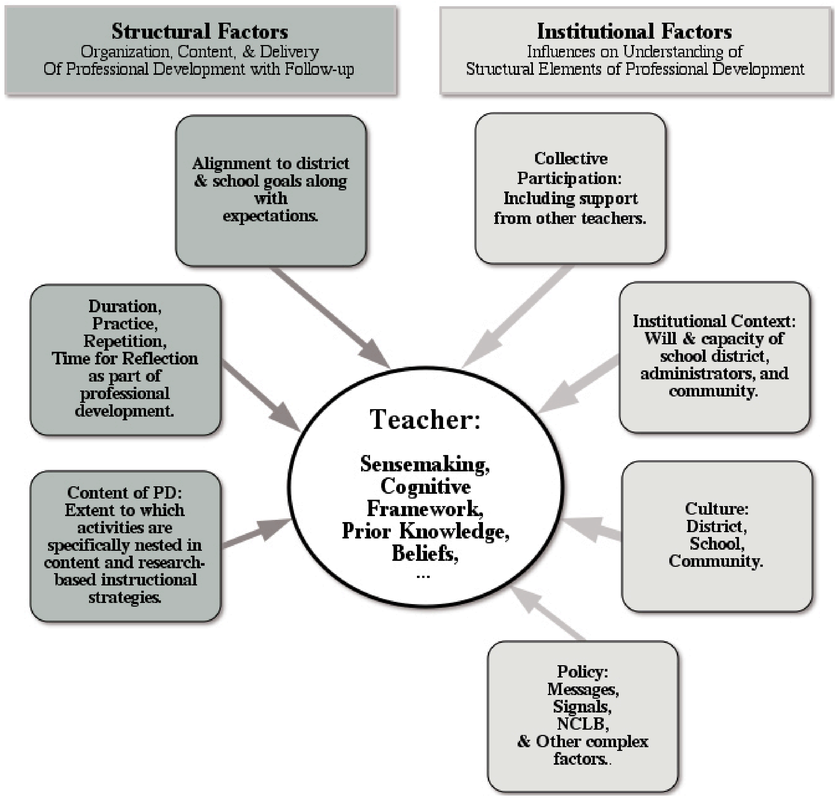

Diagram adapted from materials developed by Dr. Kate Donnelly of Williamson County Schools and used with permission. Also referenced: Desimone, 2002, 2009, Garet 2001, and Firestone, 2004.

Helping Teachers with Implementation

In addition to the iterative changes to the curriculum, visits were made to all of the six implementation sites over the three years to assist pilot teachers, gain feedback, and provide additional training and supplies. Each year, sites new to the project received a 'traditional' professional development workshop. Sites with a follow-up visit were involved in:

-*Team teaching* ASC lessons with ASC staff in the pilot teacher's classroom

-Small group *reflection and discussion* sessions regarding implementation of the ASC curriculum

- *Implementation-based training* on technology and concepts related to astrobiology topics

-*Assistance* with materials, supplies, curriculum integration, and the teacher learning community

Curriculum-Teacher-Student Interaction

There were a wide variety of students in the classes of teachers implementing lessons from the ASC curriculum, allowing the development team to assess the ways in which diverse groups of students interact with both their teacher and the topic of astrobiology.

- Participating students are given pre-and post-session surveys of perceived knowledge and interest levels in addition to pre- and post-session measures of science reasoning.
- Teachers are asked to rate their confidence in various areas of teaching related to the ASC curriculum and the impact the curriculum has had upon their teaching practice.

All measures collected during the first three years showed positive interactions between teacher and ASC curriculum.

During the Next Year...

We will be finishing up curriculum modifications in order to produce a strong, research-oriented interdisciplinary curriculum that is geared towards diverse student audiences. We will continue to help pilot teachers with implementation through the relationships we have built over the first three years, and analyze our collected teacher and student data to answer our research questions.

References

Aikenhead (2001). Integrating Western and aboriginal sciences: Cross-cultural science teaching. *Research in Science Education*, 31(3)
Center For Applied Special Technology. *Universal Design for Learning*. http://www.cast.org/research/udl/index.html
Donovan & Bransford (2005). How students learn: History, mathematics, and science in the classroom. Washington, DC: National Academy Press.
Lee & Luykx (2006). *Science Education and Student Diversity*. New York: Cambridge University Press.
Lynch, Kuipers, Pyke, & Szesze (2005). Examining the Effects of a Highly Rated Science Curriculum Unit on Diverse Students: Results from a Planning Grant. *Journal of Research in Science Teaching*, 42, 912-946.
Slater (2006). Capturing Student Interest in Astrobiology Through Dilemmas and Paradoxes. *Journal of College Science Teaching*, 35, 42-45.
Staley (2003). Astrobiology, the transcendent science: the promise of astrobiology as an integrative approach for science and engineering education and research. *Current Opinion in Biotechnology*, 14, 347-354.
Tharp, Doherty, Echevarria, Estrada, Goldberg, Hilberg, & Saunders (2003). *Research Evidence: Five Standards for Effective Pedagogy and Student Outcomes*. Santa Cruz, CA: Center for Research on Education, Diversity, & Excellence.
Tomlinson & McTighe (2006). *Integrating Differentiated Instruction and Understanding by Design: Connecting Content and Kids*. Alexandria, VA: Association for Supervision and Curriculum Development
Wiggins, G., & McTighe, J. (1998). *Understanding by Design*. Alexandria, VA: Association for Supervision and Curriculum Development.