Culturally relevant ecology, learning progressions and environmental literacy

John C. Moore [1,D], Charles W. Anderson[2,B], Alan Berkowitz[3,A], Sarah Haines[4,A], William Hoyt[5,D], Robert Mayes[6], Raymond Tschillard[7,D], Robert Waide[8], and Allison Whitmer[9,C]

Colorado State University[1], Michigan State University[2], Cary Institute of Ecosystem Studies[3], Towson University[4], University of Northern Colorado[5], University of Wyoming[6], Poudre Learning Center[7], LTER Network Office[8], Georgetown University[9]

B KBS LTER

D SGS-LTER

A BES

C Santa Barbara Coastal Long Term Ecological Research

1) Student Success, Defined

Student success is defined as students developing *environmental science literacy*, which includes:

- the capacity to participate in and make decisions through evidence-based discussions of socio-ecological systems
- the ability to use scientific knowledge to understand the consequences of our personal and collective choices, policies and practices
- the confidence and motivation to use scientific knowledge and arguments from scientific evidence in political discourse and personal decision making

Student success can be described as progress through levels of achievement in learning progressions:

Level 4: Correct accounts of processes based on scientific principles at multiple scales.

Level 3: Incomplete attempts to develop accounts based on scientific principles such as conservation of matter and energy or principles of genetic inheritance. Awareness of multiple scales but limited success in connecting accounts of events across scales.

Level 2: Elaborated accounts of actors and needs (e.g., different functions for different organs), cause-effect connections among events

Level 1: Student accounts emphasize individual actors and their needs at macroscopic scales

2) Project Research Design related to Student Success.

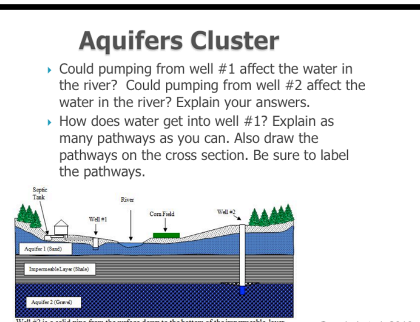
Our research design includes:

- Assessment of large numbers of students across all middle and high school grades, across diverse geographical locations, and across socio-economic status and culture.
- Use of large numbers of student responses to develop Learning Progression Frameworks (i.e., space-for-time substitution). That is, describing learning based on identifying accounts and reasoning of increasing sophistication across students.
- Pre- and post-assessment of students around teaching experiments to gauge learning.
- Collection of additional information that might help explain variation in student performance and success, e.g., socio-economic status, performance on standardized tests, prior course record, etc.

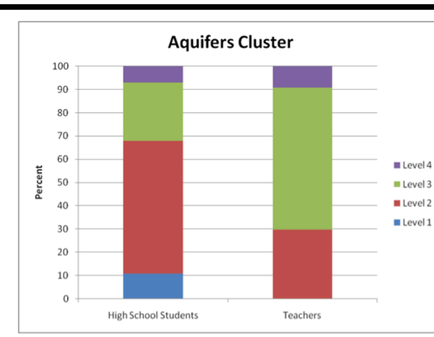
Student responses to assessment questions reveal levels of scientific understanding:

Q: If the playing fields were treated with fertilizer, do you think that some of the fertilizer could get into the river? If you think yes, describe how fertilizer could get into the river. If you think no, describe why fertilizer would not get into the river.

A1: NO The grass is not touching the water. (lower level)
A2: Because of the close proximity of the fields to the river, there would be some runoff if there was precipitation in the area or as the fertilizer gets broken down into the soil it could eventually get into the ground water supply. (higher level)



Gunckel et al. 2010



LTER Network Our partnership works with four sites within the NSF Long Term Ecological Research (LTER) Network and the LTER Network Office. The network as a whole has a K-12 outreach component that serves >375 Schools/Districts with over 500,000 students from diverse backgrounds. These connections provide us the opportunity to conduct our research and professional development activities on a national scale.

3a) Related to student success, what challenges, including unanticipated ones, has your project overcome, how did you do so, and what challenges remain ahead?

Challenges	Trying to meet or Remains
Lack of general literacy (i.e. language skills)	**Trying to meet** by writing questions in simple language and providing materials written at a fairly easy level (this creates other challenges of alienating students who are offended by the apparent affront to their higher skill level).
A general lack of experience in making scientific observations by both students and teachers.	**Trying to meet** by creating teaching units based around observations, data collection and analysis, and explanations.
Teachers, in attempting to meet standards and testing requirements, have little remaining time for science curriculum and the implementation of our teaching experiments. This is particularly true for elementary teachers who spend more time on language arts and math.	**Remains**
Large class sizes (e.g. 35-40 kids/class), making hands on activities difficult.	**Trying to meet** through careful design of teaching experiments and supporting materials.
Unanticipated administrative support problems from some of the districts. The constraints administrators are working with make them less likely to let the teachers miss days for PD or cannot financially support student field trips.	**Met** by paying full sub costs for teachers going to our PD. **Remains**: The lack of funding/support for field trips issue is one that still exists (and probably will for a long time).

3b) Questions our project has regarding student success:

- How do students understand and give accounts of processes and changes in socio-ecological systems?
- How do students investigate and make decisions about courses of action in socio-ecological systems?
- What is challenging for students as they learn about practices of investigating, explaining, predicting and deciding with respect to socio-ecological systems and issues?
- What instructional tools and supports can help teachers and students achieve environmental science literacy needed for informed decision-making?
- Does student and teacher success vary by the economic dynamics within their school district?
- Does student and teacher success vary by culture, socioeconomic status and region?
- If students are to become environmentally literate citizens capable of making informed decisions about grand challenges facing their generation, how do we improve necessary quantitative reasoning skills to help them move between microscopic and macroscopic scales (e.g., atoms to landscapes)?

4) What are the roles of your project's partners (including STEM faculty, K-12 districts, education faculty, evaluators) related to student success?

Our project partners fill various roles aimed at supporting K-12 teachers and students in developing environmental science literacy needed for informed decision-making in the 21st century. For example, our project scientists, science education researchers, professional development specialists, and K-12 teachers collaborate on activities including:

- Synthesizing research from science, social science, and policy arenas to identify key practices and understandings that are essential for environmental science literacy (i.e., developing an upper anchor for environmental science literacy).
- Conducting grounded research exploring how teachers and students engage in relevant practices of investigating, explaining, predicting and deciding about socio-ecological systems and issues.
- Developing and testing pedagogical practices and instructional tools aimed at helping teachers and students achieve environmental science literacy.
- Using all of the above in continuing cycles of refining our learning progression frameworks, assessment systems, and instructional tools in an effort to improve science education experiences and support teachers and students in achieving environmental science literacy.

Contact Kim Melville-Smith: Kimberly.Melville-Smith@ColoState.edu
John Moore: jcmoore@nrel.colostate.edu

This project is supported by a Math Science Partnership Grant from the National Science Foundation DUE 0832173. Any opinions, finding, and conclusions or recommendations are those of the authors and do not necessarily reflect the views of the National Science Foundation.

NSF