UTIG Final Project Report

Water Exploration: An Online High School Water Resource Education Program

Prepared by Dr. Katherine Kelly Ellins, August 25, 2010.

Please cite as Ellins, Katherine K., 2010. UTIG Final Project Report, *Water Exploration: An Online High School Education Program*, unpublished report.

Introduction

The Institute for Geophysics in the Jackson School of Geosciences at The University of Texas at Austin and 4empowerment.com, a Texas-based for-profit educational enterprise, teamed up with support from the Texas Water Development Board to develop and implement a Web-based water resources education program for Texas high school students that we have named *Water Exploration: A High School Water Resource Education Program* (October 2008 – August 2010).

The Legacy Cycle Approach

Water Exploration uses an innovative project-based learning approach called the Legacy Cycle model to permit students to conduct research and build an understanding about water science and critical water-related issues. Legacy Cycles are a way of organizing lessons and activities to enhance student learning by making use of the Internet and computer technology to engage students in extended inquiry learning (Schwartz, et al., 1999). The three Legacy Cycle modules in the *Water Exploration* curriculum are: Water Basics, Water-Earth Dynamics and People Need Water. Within each Legacy Cycle there are three different challenges, or instructional modules, laid out as projects with clearly stated goals for the students to carry out. Each challenge address themes that map to the water-related "Big Ideas" and supporting concepts found in the new *Earth Science Literacy Principles: The Big Ideas and Supporting Concepts of Earth Science* (2009). These principles were created through a community effort representing current state-of-the-art research in Earth sciences. They have been written, evaluated, shaped, and revised by leading Earth scientists and geoscience educators. As students work through a challenge they follow a series of steps, each of which is associated (i.e., linked online) with a manageable number of corresponding, high quality, research-based learning activities and Internet resources, including scholarly articles, cyber tools, and visualizations intended to enhance understanding of the concepts presented. The culmination of each challenge is a set of "Go Public" products that are the students' answers to the challenge. These products serve as the final assessment for the challenge.

In addition to the *Earth Science Literacy Principles*, each Legacy Cycle is aligned with the National Science Education Standards (NRC, 1996) and the Texas Essential Knowledge and Skills (TEKS) for the new capstone Earth and Space Science course that serves as an option for fulfilling Texas's graduation requirement for four years of science, as well as Environmental Systems and Aquatic Science (Texas Education Agency, 2009).

Development Process

4empowerment supervised the design and creation of the project web site, working with a web design company, J3web.net. During the development process, the TWDB provided feedback on the design, technical and accessibility specifications for the site to

4empowerment. UTIG provided feedback on the design of the site and the layout of the web pages.

The water resources education program was linked to the TeXas Earth and Space Science (TXESS) Revolution—a five-year program of teacher professional development program that Katherine Ellins is leading to provide high quality geoscience professional development to 8th – 12th grade minority-serving science teachers and teacher mentors throughout Texas. The TXESS Revolution is funded by the NSF's Opportunities for Promoting Diversity in the Geosciences, the Texas Regional Collaboratives, and the Jackson School of Geosciences. Ellins recruited five exemplary TXESS Revolution high school teachers--Catherine Ryan, Rachel Fahrig McGowan, Brenda Paloski, and Allison Mote--and a science education specialist, Kathleen Negrito, to help guide the identification of content at the level of high school seniors and develop inquiry-based curriculum activities; to review the materials pedagogically; to implement the water resource modules in their classrooms; and, with Ellins, to lead professional development activities for other teachers to show them how to implement the activities. Teachers worked in two-person teams with supervision from Ellins to develop (or adapt from existing sources) engaging, inquiry and/or problem-based water resource learning activities relevant to Texas. Online resources include scholarly articles, lab activities, visualizations, animations, data resources, and mapping tools with an emphasis on appropriate TWDB online resources. Linda Ruiz McCall, TWDB Program Specialist for Education and Outreach, helped guide the project assisted by an advisory board of TWDB scientist and engineers. The TWDB advisory board reviewed an outline and first draft of the proposed curriculum, providing feedback on the challenges and resources selected. TWDB staff, Linda McCall and Bridget Cameron, developed a service-learning project for the third Legacy Cycle collection. In fall 2009, UTIG Ellins modified the web site content to incorporate the feedback and the service–learning project, *Put Some Blue in Your Green School*, using Adobe Contribute. In spring 2010, the TWDB reviewed the web site content and technical elements. Final approval for the web site and content was received in June 2010 and the site was transferred to the TWDB. The web-based Water Exploration web site now resides at the TWDB, which has sole control over content. UTIG and 4empowerment expect that the TWDB will submit the *Water Exploration* program for inclusion as part of the National Science Digital Library (NSDL), as agreed at the start of the project.

In August 2010, UTIG held a two-day workshop for twenty-two high school teachers, education service center science specialists or school science coaches, informal educators, and water resource managers who wish to use *Water Exploration* in the professional development that they offer technical staff, to introduce them to the Legacy Cycle approach and provide training on the implementation of the *Water Exploration* curriculum. TWDB and LCRA experts were on hand to help participants with access to TWDB water resource data and resources, and with mapping applications. Workshop participants worked collaboratively in two or three-person teams to carry out one of the nine *Water Exploration* Challenges. The teachers responses to the curriculum was overwhelming positive. The project PI Ellins compiled their feedback in a table (appended), following the workshop.

Merit, Significance and Broader Impacts of *Water Exploration*

The intellectual merit of the *Water Exploration* project lies in three main areas. First, its contribution to online teaching and learning, an important area of development in the 21st

Century as students' use of cybertechnology increases. Second, it emphasizes experiential, project-based learning to help students achieve a deeper understanding about a particular topic, in this case water resources. Specifically, *Water Exploration* addresses the need for rigorous curriculum in a vitally important area of high societal relevance, water resources, for the new Earth and Space Science Capstone course. Elements of the educational resources developed are also applicable to other high school science course, including Chemistry, Physics, Biology, Environmental Systems, and Aquatic Science. Third, the interdisciplinary nature of the challenges that we have developed compels students who use the *Water Exploration* Legacy Cycle curriculum to explore the connections between water resources and economics (water planning, water as a commodity), history (water affects human settlement and migration), and biology (water is essential for life; contaminated water affects living organisms). The ability to integrate information from different disciplines and weigh the perspectives of multiple experts is particularly important for solving complex problems in the geosciences (e.g. contaminant remediation, flood control, or climate change).

The *Water Exploration* curriculum is available online; thus, it has the potential to enhance diversity in the geosciences by exposing high school students in rural, urban and suburban communities throughout Texas to this branch of Earth science, as well as reach communities with large Hispanic and African American populations who are traditionally underrepresented in the field. Sixty-six percent of students in Texas are members of ethnic minority groups, including Hispanic, African American and Native American (Texas education Agency, 2010). Furthermore, the *Water Exploration* website meets all accessibility requirements for visual and hearing-impaired learners.

The principal investigator, Katherine Ellins, expects to publish on the *Water Exploration* curriculum and data in peer-reviewed journals and at professional meetings in partnership with the Linda Ruiz McCall and the teacher developers.

References Cited

Earth Science Literacy Principles: The Big Ideas and Supporting Concepts of Earth Science (2009) http://www.earthscienceliteracy.org, accessed February 28, 2010.

Ellins, K., H. C. Olson, M. Willis, 2007. The TXESS Revolution: A Partnership to Advance Earth and Space Science in Texas, *Eos Trans. AGU, 88*(52), Fall Meet. Suppl., Abstract ED24A-01.

National Research Council, 1996, *National Science Education Standards*, National Academy Press, Washington, DC, 262p.

Schwartz, D.L., Brophy, S., Lin, X., and Bransford, J.D. (1999). Software for Managing Complex Learning: Examples from an Educational Psychology Course. Educational Technology Research and Development 49(2): 39-59.

Texas Education Agency, 2009, Texas Administrative Code (TAC), Title 19, Part IIChapter 112. Texas Essential Knowledge and Skills for Science, http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html, accessed February 27, 2010.

Texas Education Agency, 2010, Performance Reporting Pocket Edition <http://ritter.tea.state.tx.us/perfreport/pocked/2009/pocked0809.pdf>, accessed June 29, 2010.

Services and/or Deliverables Provided

UTIG has developed an engaging, relevant, research-based water resource curriculum that incorporates graphics and animations as well as hands-on/minds-on inquiry and problem-based instructional approaches to learning. The water resource curriculum is organized in the framework of the Legacy Cycle, which is an Internet-based pedagogical approach to learning.

Specifically UTIG has accomplished the following:

1. Created three Legacy Cycles on Texas water resources. Each Legacy Cycle has three challenges; the challenges incorporate student exercises that include inquiry activities, animations, testimony from experts, video clips, and background reading. The Legacy Cycle pages include "teacher" pages for teaching notes, background information and grading rubrics.
2. Legacy Cycles designed to encourage students to explore, research, analyze real data/ resources from the Texas Water Development Board to build an understanding about water science and the critical water-related issues of Texas.
3. Ensured that the learning activities within the Legacy Cycles are aligned with state standards (Texas Essential Knowledge and Skills) in order to fulfill some of the requirements of the following Texas high school science courses: environmental systems, aquatic science, and the new Earth and space science course.
4. The development of curriculum that meets the needs of a diverse population of Texas students by including a variety of activities to serve visual, auditory and kinesthetic learners.
5. The curriculum teams used the Adobe Legacy Cycle templates developed by 4empowerment and to add/revise content on 4empowerment's web site using Adobe Contribute.
6. Teacher developers used the TXESS Revolution Virtual Café as a forum to interact with each other, Ellins and the TWDB advisory committee; discuss progress and issues related to Legacy Cycle development; share information; and solicit feedback on the activities from participants in the TXESS Revolution program.
7. UTIG provided representatives of the Texas Water Development Board with access to the TXESS Revolution Virtual Café High School Water Resource Education Program discussion forum.
8. UTIG organized and delivered a two-day workshop (August 2-4, 2010) on the Legacy Cycles to 22 educators who will in turn implement the curriculum in their classrooms or train other teachers on how to implement these activities in the classroom.
9. UTIG provided the TWDB with progress reports.

OTHER OUTCOMES

There are a number of additional outcomes that merit recognition although these were not a requirement of the terms of the TWDB award to UTIG.

Scholarly Works (abstracts / Papers)

European Geophysical Union Meeting 2009

Ellins, K., E. Abernathy, K. Negrito, and L. McCall, 2009. The application of Legacy Cycles in the development of Earth Science curriculum, Geophysical Research Abstracts, Vol. 11, EGU2009-0, EGU General Assembly 2009

American Geophysical Union Fall Meeting 2010

Two or three abstracts are planned for submission to the following AGU sessions:

ED19: Using Water Resource Issues to Engage and Educate

ED22: The Future of Cyber-Education in the Geosciences: New Directions and Opportunities

ED09: Enhanced Geoscience Learning Through Community Interaction

A scholarly article is in development for submission to the *Journal of Geoscience Education*.

Research in Learning Science

1. A PhD candidate in Hydrology from Virginia Tech has submitted a proposal to NSF's Earth Science Postdoctoral Program to conduct research on the classroom implantation to the Water Exploration Legacy Cycles and develop additional Legacy Cycles on water resources. If successful, the postdoctoral researcher will be hosted at UTIG for two years.
2. UTeach masters student, Elizabeth Mueller, is conducting research on the implementation of the Water Exploration Legacy Cycles. She will track five teachers who participated in the summer workshop to observe how they implement the challenges and to monitor students' reactions and gains in content knolowedge. This research will serve as the basis for her thesis, which will be completed summer 2011, and her findings will be shared with the TWDB. The UTeach program is a joint program at UT-Austin administered by the College of Natural Sciences and the College of Education. Ms. Mueller's degree will be a Masters in Science Education with a Concentration in Geocience.

Web Presence

One of the teachers who attended the summer workshop has created a Facebook group, *Water Exploration Legacy Cycles*, to permit the Legacy Cycle "Go Public" products for each challenge to be available to any educators who joins the group. In fall 2010 a graduate student in Science Education will work with teachers who participated in the workshop to provide help to those who would like to post their products to the Facebook page.

FEEDBACK ON WATER EXPLORATION ONLINE CURRICULUM, Workshop August 2 - 4, 2010.			
Questions / Responses	Please list at least two things you learned in this workshop.	Please write down a question about water resources and/or water conservation that you would like to know about.	How will you use the activities from this workshop with your students? Please explain.
	In this workshop, I learned about water conservation and watershed. Both of these Workshops [challenges] were in depth knowledge that I want to continue learning more about them.I know my students will learn a lot from this workshop.	I do [want to] know where to find more resources on the web.	This workshop does fit on the New TEKS 7.8C, I will share all the information I learned with the 7th grade teachers.
	One of the first things learned was how to take a snapshot of a diagram that I needed for my powerpoint. I also learned how to use Google Earth much better. Learning how to use technology better will help me in the classroom!	How do I encourage my students to want to conserve water in our school?	I plan to use the watershed and groundwater activities for sure this school year. This training has been very beneficial!
	Thank you for allowing me to attend. Two things I learned:1. The process of the Legacy Cycle. Thinking about how to place other lessons into a Legacy Cycle. 2. Had Cycle 2, Challenge 1 project (Texas Panhandle Whodunnit). At first it was overwhelming until we narrowed our focus. Learned a lot about the formation of the Llano Estacado, Texas Panhandle area, through working this project [challenge].	Since I work with a municipal government, one of the areas we are often asked to provide presentations about our water distribution system, starting from the surface water withdrawal and ending with the water being returned to the surface water to reuse, along with information about water conservation, water quality, and storm water runoff. One question to further explore would be, “What effects do prescription drugs have on our water?”	I will share the information with other city educators to hopefully take to their school districts. I will discuss possible implementation of the Legacy Cycle and the challenges with the curriculum staff at my ISD, as well as some of the home school groups in my area. I will take some of the challenges and work them into smaller segments for use with scout groups and school classroom presentations and activities. I will utilize the Legacy Cycle Model to work up additional lessons in other environmental areas like storm water runoff, illegal dumping, recycling, household hazardous waste and trash.
	I learned how a Legacy Cycle works and the value of using them in my Aquatic Science classes. I also learned/reviewed hydrogeology concepts concerning groundwater and aquifers.	I would like to know more about desalination methods and devices. I have a contact with someone who has a method she is developing and marketing in the Middle East and I would like to have her come and speak to my classes about her work.	I will definitely use portions of all of the Legacy cycles in my Aquatic Science classes. **The activities and resources are excellent!!** I will also do a teacher in-service with other teachers in my district to show them how they can implement them as well.

	I learned that making a movie is more difficult than I thought, and that just because two things are the same kind of geological feature (i.e. aquifer), doesn't mean that they share much in common.	It would be interesting to investigate further the ways that cities, businesses, and households could reuse water that would otherwise be lost in water treatment plants.	Since I do not currently have students (Education Service Center Science Specialist), I will introduce the concept of the Legacy cycles to the teachers on my campus and in my district. I will also share the resources available on the website with the district science coordinator for use in the 4th year science courses.
	I learned new ways for students to be creating maps and interpreting maps. Understanding of what the "legacy" part is ! Got new ideas for BIG projects.	Is there a list of agencies and products for the entire state or is this something we have to gather info on separately.	Our students are TEACHERs, 4th year science course teachers, we will use all of these activities with them as we work together to build a scope and sequence with activities. THANK YOU! THANK YOU!
	I learned how to develop learner-centered challenges or summative assessments; and that the Legacy Cycle is another curriculum framework used by scientist in the field.	Who is directly in charge of monitoring contaminants in the Rio Grande River area in South Texas.	These lessons will be integrated in our IB science planners.
	1. I learned about the legacy cycle. I had never heard about it before but I do believe it correlates precisely with the style of learning I prefer to engage my students in and my administration requires. 2. I learned more about Aquatic Science and what it has to offer.	Do companies, corporations, and businesses have to be audited? If not why? What can be done to make them be more water conscious, example: watering during the heat of the day using mist sprinklers	I plan on incorporating as much as Legacy A in my curriculum as possible this year. I will be teaching PreAP chemistry so the properties of water will be an engaging set of activities that will push my students to think deeper. If I am lucky enough to be allowed to teach Aquatic Science next year, I would like to incorporate all of them.
	a. I learned how the legacy cycle works and how to implement it in my classroom; b. I learned more about water systems in Texas; and c. I learned more about how reservoirs are used in Texas.	How can water usage during times of drought be better managed and controlled in a private residence?	I will be able to use more of the challenges my aquatics class and pull out pieces from various challenges in my IPC class to reinforce TEKS.
	I learned that the Lower Rio Grande river area is growing at twice the rate of other areas of the state and that the water supply is static and that the area is already at or near capacity for useage.	Where is the money going to come from to actually make the changes needed in the infrastructure to have truly conserve.	I will have my students do the water audits, and my science club will continue with the xeriscaping project we started and begin working on a rainwater collection project.
	a. using the Texas Water Development Board as a teaching resource; and b. learning about the Legacy cycle	I would like more information about the Brazos river around the Waller and Austin county areas.	I know that I will be using these legacy cycles in my Aquatic Science course, and also plan to conduct a water audit for our campus…possibly our district.

	I experienced actually going through the process of the legacy cycle process and how I could incorporate this approach into my classroom. I very much learned about water resources globally and those present in Texas. There seems to be a lot of challenges associated with water that everyone should be educated about.	I think my question would be more of a concern about my local water supply and where are we overusing our water in our community currently. I would like to know how long we are projected to use our current reservoir and after that then what will we do, how residents will be affected.	I will definitely use some of these activities in my Aquatic Science class. I notice that several of the activities flowed from [one] topic to another and were enhanced at the same time. I will use the Water Basics activities to incorporate into my properties of water curriculum. I may not be able to do all the activities because, like the students, I found some more interesting than others, but many are very beneficial despite the complexity or content. I will also most likely try to test out some activities that I might be more hesitant about with my AP Environmental Science class at the end of the year when they are done with taking their exam and have lots of class time left before school ends.
	I learned :1. about the geography and hydrology of Texas. 2. the legacy cycle and how to use the legacy cycle. 3. about available water resources for Texas. 4. …..and much, much more!	I would like to know what type of agencies would be willing to come into my classroom and talk to my students about jobs and future jobs in water related fields.	I will definitely use a few of the legacy cycles in my class and even if I don't use the entire lesson I definitely will use all the links and resources provided. I am not sure if time will permit me to use all of the cycles. I might even try and do a service learning project in the coming years.
	1. I learned a lot about water conservation. One thing I did not know was that sediment builds up against the bottom of a dam and puts pressure on the dam wall. It is also impossible to remove at this time. 2. I learned that there are lots of different ways to modify these activities so that they fit the area you live in.	How is the 100-year flood level calculated that is used to determine where people can build along a lake?	I will use the Legacy C, challenge 2 (Texas reservoirs and dams) in my class room but I will change the lake system and compare Lewisville Lake with Caddo Lake (only natural lake in Texas). Students will concentrate on how populations will affect water usage and conservation issues.
	Using the USGS websites, like http://waterwatch.usgs.gov/, and what exactly are aquifers.	What are the available technologies that people can use for water conservation?	I will share all of the material covered with the environmental teacher at my school and I will use the water properties challenge.
	Excellent demonstrations for properties of water and aquifers. WIID and ArcGIS mapping tools from which other lesson can be built. The extent to which atmosphereic circulation phenomena affect precipitation patterns, not just volume.	To what degree evaporation during warm summer months make reservoirs a less desirable format to store water. Also, what steps are taken to purify lake water for drinking and the amount of energy/resources water treatment plants use. How and how much grey water is used in Texas? Is increasing gray water use a feasible method to continue lowering water use.	As an Earth and Space Science teacher where water resources is only a small part of the curriculum, I will like do a one-grading-period project, perhaps choosing three of the challenges and letting students choose from among those. The project will require one group product (poster, powerpoint, video) and one individual product, likely an essay or well-captioned series of diagrams.

	The information regarding the hurricanes was extremely interesting and beneficial. Also, I really enjoyed the historical information regarding the plains, given the fact that's where I'm originally from.	I would love to learn more about Texas water law.	I'm really excited about using portions of this curriculum in the development of my own curriculum in my Ph.D. dissertation.