Draft Proposal for an Outdoor Time Lab

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Abstract

The Outdoor Time Lab is a time capsule repository and time-keeping structure reminiscent of Stonehenge and our local Great Serpent Mound effigy earthworks, and will serve as a physical focus for our continuing astronomy outreach activities. Composed of a horizontal sundial of masonry and lawn with a gnomon of stainless steel, no electrical wiring is required since solar cells are integrated within the green (one of two school colors) gnomon marker light. Our design proposal is a 33-foot curved mesh enhanced air entrained poured concrete sidewalk that circumscribes a sundial with a combined 50-year time capsule repository and gnomon positioned in the middle of the circle on a 10-foot diameter poured concrete circular base. Most of the structure will be composed of a grass-covered plaza with twelve concrete benches aligned along the outside of the 33-foot circle suitable for students. The structure is to be harmonious with existing school structures, not obstruct vehicular traffic, and not be a nuisance attractant (birds, opossums, etc.) It has components simple enough for Kindergarten and components complex enough for high school calculus; it is loaded with possibilities for scientific investigation by students and community learners.

This project provides a centralized time capsule repository available for use by each student entering our district schools. It will be registered with the International Time Capsule Registry (ITCR) through Oglethorpe University in Atlanta, Georgia, allowing an International component to our work. Lesson plans based on the Sheltered Instruction Observation Protocol (SIOP) have been developed by North Adams High School science, math, language arts and history teachers following the suggestions of the ITCR that will inform teachers on how and what to include in the capsule. The SIOP model was chosen to recognize and address a major barrier to student success in science and math: inadequacy of vocabulary. Elementary teachers are developing their own time capsule lesson plans appropriate to the age groups served.

The time lab site will be a timekeeping and a season-predicting device for increasing student understanding of our planet's motions as they relate to our Sun. The "reason for the seasons" and an understanding of time and planetary motion are common weaknesses in our students' understanding of science, as is reflected in their recent scores on the Ohio Graduate Test. The combination of structured and inquiry-based activities planned and the concomitant data acquisition from the Outdoor Time Lab will strengthen our students' understanding of the nature of science and of science research.

We envision the final construct to be a source of interest and pride to the students and their community. It is a project that can easily be reproduced in different locales and situations, as we want sister schools to join us in our study of time. We have agreed to

partner with Sn. Riveiro's Bilingual School in Comayaguela, Honduras, a school that will soon move to its new school and campus where they will build their own outdoor time lab using similar dimensions as ours but reflecting their local Mayan culture.

Math, science, history and language standards reflecting the Ohio Graduation Test curricular interests are incorporated within the curriculum accompanying the Outdoor Time Lab, but we will actively pursue involvement with our outdoor lab from all disciplines and from all district schools.

The North Adams High School Outdoor Time Lab Proposal Team has identified a location on our campus where the Outdoor Time Lab is to be constructed. The site has been evaluated with respect to proper drainage and ease of access by students, is not an obstruction to vehicular traffic, and is harmonious with the existing campus architecture. In September of 2010, the Masonry students from the Ohio Valley Career and Technical Center (OVCTC) will begin the physical layout of the Outdoor Time Lab with instruction from North Adams High School science instructors. Pouring of the concrete required for the structure might be complete as early as the first of October, but unfavorable late summer and early autumn weather conditions could delay the completion date by as much as several weeks.

The estimated date of total project completion offered by the OVCTC Masonry instructor is November 30, with additional landscaping for beautification to follow in the early Spring of the 2010-2011 academic year. We also plan to have engraving additions to the concrete circle at a later time from our art students that will reflect local plant and animal life of specific interest, as our school district is home to the largest privately-owned prairie preserve east of the Mississippi River. That preserve, known locally as the Edge of Appalachia Preserve, houses many rare and endangered plant and animal species that are holdovers from before Ohio's last ice age.

The overall design for the Outdoor Time Lab is in the form of a giant sundial, with the centralized gnomon serving a dual purpose: as the shadow-forming object and as a time capsule repository. The construction of the gnomon will follow the pouring of the concrete, and will incorporate a metal time capsule inside it that is rated for 50-year use. The metal time capsule will be placed inside the gnomon and welded shut for the duration of the 50-year wait to its release. There will also be individual time capsules residing inside the gnomon as well, but they will largely be virtual ones (DVD+RW disks) so that there will be more than enough space for all district students to house their individual time capsules inside the stainless steel cylinder. A backup copy of the virtual time capsules will be housed in the school vault. The digitization and storage of all capsules on our district server will also allow easy recovery of the capsules should damage to the gnomon's contents occur. Since nothing of a significant monetary value is to be housed inside the gnomon and since it will be advertised as such, the gnomon will not serve as an enticement for vandals and thieves. Its location is presently protected against harm by security lighting, regular campus security personnel, and security video cameras.

At the point of construction completion, students will begin their investigation into the nature of time as measured by the Sun. Students will take measurements of the gnomon's shadow at a specific time and compare their measurements against the Chronos Atomic Clock Synthesizer 4.1 that is resident on our laptop computers. They will strive to make these measurements on a daily basis (or as near as can be accomplished in the face of weather and school schedules) and will compare their findings to Eastern Standard Time or Eastern Daylight Time dependent on the time of year. Students will report any differences in local time as compared to standard time, and will investigate the differences as either constant or changing throughout the year. What they will be calculating is called the Equation-of-Time, which is the difference in time between what their watches read and the position of the sun (clock time vs. sun time).

Students will also take time measurements throughout the day, and report any differences as either constant or changing throughout the day. The results from both types of measurements will be tallied as a group and averaged so as to minimize measurement error. The results will also be compared against the reported standard values so that a discussion of differences between reported and accepted values is generated. In an attempt at holding their measurements to a high degree of accuracy, students will measure the gnomon shadow on each day that a shadow is available for measuring by using the "Disto A6" distance meter with a software package that allows users to transmit measured values to the cursor position in Windows program via a Bluetooth wireless interface. The hope is to reduce input errors and save significant data entry time. The final data will be graphed to serve as a tool for predicting the local time on specific days and at specific times in lieu of using standard time. It will also serve to deduce the nature of the Sun's relation to the Earth as the Earth orbits the Sun throughout the year and as the Earth rotates on its axis.

One of the interesting tests of the data collected by students will be their attempt at predicting the local time of the 2010 vernal equinox. Another longer-term project is to reveal the Sun's path through the sky from readings taken at the same time throughout the year, producing what we expect to be an analemma. Once determined, we have the option to make our analemma a more permanent component of the Outdoor Time Lab through applying an outdoor polymer concrete topping especially created for protecting scribed information on concrete surfaces.

Around the time of the vernal equinox, students will attempt to reconstruct Eratosthenes famous experiment of estimating the circumference of Earth through measuring the angular difference between the shadows cast at two different cities whose distance apart is known. A difference between the experiment of Eratosthenes and ours will be that our students will not have the luxury afforded Eratosthenes of having one of their locations experiencing the Sun as shining directly overhead. But there is still a method available to them for attaining the desired result. This project will be accompanied by a Web Site dedicated to the project, although we are aware that similar projects already are in residence on the Web. We will have our sister school in Comayaguela, Honduras involved in this particular project, and we will recruit additional schools from around the globe in order to obtain several measurements for comparison. Our sister school in

Comayaguela will also have a full set of data from the previous experiment that we can compare with our own data and graphical representations.

A third component of the project is the development and the collection of time capsules from all students who enter our school district at the time they enter the district. High school students will be serving as liaisons to the elementary schools for assisting in the collection of student time capsules; high school students will introduce the project, and explain the purpose of the project to the elementary level students. After the sealing ceremony, these time capsules will be kept until high school graduation when they will be opened and returned to the students at a special ceremony involving students, parents, and teachers. To prevent loss of data, our time capsules are first scanned into a digital format for safekeeping, stored on our school servers, and then locked in the metal safe until graduation. This offers an opportunity for teachers who want to personalize the effects of their disciplines on individual lives by having these time capsules opened at various time intervals by the capsule keeper during the school career of the student. Discussion is ongoing as to whether or not a copy of these digital time capsules should be housed in the community library permanently after the opening ceremony and how access will be managed. Many of our students do not have access to a computer on which to conveniently view the contents of the capsule. Regardless, having both parents and students view the time capsule together at the opening ceremony certainly will illuminate the subjective way time is perceived by persons in different age groups. It should also illuminate the value of keeping good records, scientific or otherwise.

This project began from concern over our students' low scores in earth and space science on the Ohio Graduation Test (OGT). We tried various instructional strategies, but they did not have the desired positive effect on student performance with the OGT and did not allow for engagement of students through both structured and inquiry-based approaches. One of our teachers attended an astronomy workshop where he learned about how ancient peoples used earthworks to tell time. It seemed a perfect fit for us.

The instructional goals of our project are to increase science and math knowledge and skills in our students, especially in the area of astronomy and earth science, and to celebrate interest and achievement in academics. We want students not only to improve their performances on Ohio's Graduation Test, but to take that increased knowledge and skill with them into post-secondary institutions and careers. At present, we are in need of improvement in this particular area of effort as the Integrated Post-secondary Education Data System reflects; 24% of our students are in need of remediation in either language arts or mathematics.

The problem we must still address in teaching Appalachian students is the image they have of themselves as compared to the world outside of their small rural communities. We want students to envision themselves as capable of performing as scientists, capable of discovering and elucidating interesting facts about their world, and capable of contributing to the community at large. The physical and highly visible Outdoor Time Lab will continue to serve as a monument to that discovery of human potential. Students will gain an understanding of how small our planet really is, and how we can link with

people in other countries to benefit all concerned. In our present conflict-oriented world, that is a goal to be highly valued.

We envision the number of students involved in this particular activity to be 412, and the number of teachers who will be directly involved to be 12 in the first year of this activity. Our plan is to increase the scope of the project to include more students and especially more teachers in the second year. The number of students and teachers directly involved in the project together should total to 412. However, that number grows significantly if you factor in every single student that creates a time capsule to be stored in the time capsule repository, every teacher assisting in the development of that time capsule, and the parents who are also benefited from the project. Add to that the unknown number of students and teachers from around the world that could answer our Web-based call for collaboration and the number of schools that decide to pursue the construction of their own outdoor time lab, and the number of people impacted by our project could easily number into the thousands. As David Brower, founder of Friends of the Earth was quoted as saying, "Think globally; act locally." In all three components of this project, we have given heed to his mantra.

Our community is known for leading the State of Ohio in welfare expenditure, unemployment, and teen pregnancies. The nearest university is approximately forty miles from the county seat. There are no scientists, engineers, and few technically educated individuals that students can use as role models, so they do not believe in their ability to find success in these careers. We need a vehicle that is visible, that we envisioned and built ourself, and a vehicle that allows us to learn the skills and the nature of science as it is pursued by the professionals. We are badly in need of a way to increase our student performance on the Ohio Graduation Test, especially in the areas of astronomy and earth science, as many graduating seniors still believe that we are closest to the Sun in the summer and have no idea as to why our planet has seasons.

We believe that our Outdoor Time Lab will give us a powerful tool to increase our student test scores on the Ohio Graduation Test while giving them a different image of who they are and what they can become. Add to this the time capsule repository that records who our students are and how far they have come at the moment of graduation from high school, and you have a community building activity that provides our students with knowledge, skills, self-esteem, and a way out of poverty through science and technology-based careers.

Multiple methods of evaluating student learning with the Outdoor Time Lab project are planned. Informal feedback from students and staff members is always valued, but we choose to use the Einstruction Classroom Performance System (CPS) for a daily formative evaluation of what students have understood from the previous day. Before the CPS is utilized, continual formative evaluations are continually being effected by the teacher emulating the SIOP approach. At the beginning of the following class period, each student receives a response pad or "clicker" that has an LCD screen allowing students to view questions and the answers they have entered anonymously. The results

of the daily evaluation are electronically recorded and can be exported in several spreadsheet formats to the grade book.

The same Einstruction CPS will also be used at various times to measure student progress towards mastery of the principles involved in our project. A summative analysis of the project effectiveness in the form of a final post-test will also be pursued at the end of the semester, and will be compared to the initial pretest given to out students over their knowledge of earth and space science. We will also compare the scores on the Ohio Graduation Test for these students as compared to last year's students even though it is not an entirely useful measurement to evaluate the effectiveness of the outdoor time lab. We are interested in students' knowledge about methods of data acquisition, reduction, and analysis, and so we will test students accordingly.

The importance of having a strong presence for science in front of our school (initial plans call for a sundial with a diameter of 33 feet and positioned in the turnaround traffic island) should not be downplayed, as we want to use it as a vehicle for connecting our school to the parents of the students and to the community it serves. Family and community involvement that is linked to student learning has a greater effect on achievement than more general forms of involvement (Invernizzi, Rosemary, Richards & Richards (1997), Dryfoos (2000), Clark (2002). Combining the academic uses of the time lab (astronomy, star parties, etc.) with the time capsule pursuits and ceremonies (sealing and opening) will serve as a living visual reminder to the community-at-large that we indeed value academic achievements; we value them and so we celebrate them.

Other elements can be easily incorporated into the outdoor structure I envision, including depictions of local history and instructional displays that celebrate local flora and fauna. Located in a county with five geologic time periods evidenced, three geophysical regions, glaciated and unglaciated soils, the oldest Prehistoric effigy mound in North America (with its own archeoastronomic connections), and with the Ohio river as its southern border, the unique elements that compose this community could be inventoried and appreciated as well at the time lab site.

Guidance and mid-course corrections will be decided upon by the project team members in consultation with our school principal, participating representatives from participating schools and community project advisers. Adjustments may be needed throughout the project, as an incipient project generally requires. During the project, the instructional team will meet on a regular basis to optimize methods, develop activities, and address concerns that may develop. We will also be observing any changes with respect to our students' performance on the Ohio Graduation Test (OGT) with respect to the areas of earth and space science.

To a dispassionate observer, it might appear as though the science and math involved in the outdoor time lab is far from the cutting edge of modern scientific research, but this perception belies the expected conceptual knowledge and rigorous analytical tools that we expect students to gain from constructing their own knowledge through an artful combination of structured lessons and different levels of inquiry. From these

understandings, the student can travel to the frontiers of modern research and perhaps offer something to its further development.

Ohio University Professor Barry Oches has agreed to serve as an independent evaluator of our project. According to Professor Oches understanding of the Toyota Tapestry grant, it is a modest-sized grant that dictates a modest budget for evaluation of that project. Professor Oches will inspect the objectives we hope to accomplish and the activities we will implement, and then he will write a paragraph about the documentation that we will collect and send to him. Professor Oches involvement is described as piecing together the documentation we send him and writing up a brief report as an external, non-based reviewer. Based on Professor Oches feedback and observations by the NAHS faculty, the project will be analyzed for further improvements so that it can effectively serve as a sustainable project-based curriculum.

Approximate costs of materials and labor needed to construct the outdoor time lab as proposed are to be computed upon the return and with the assistance of Rene Laufer, Associate Research Scientist in residence at Baylor University. This costing of materials is a necessary component for grant applications to be secured from institutions offering the requisite funding.

References

Invernizzi, M., Rosemary, C., Richards, C. J., & Richards, H. C. (1997). At-risk readers and community volunteers: A 3-year perspective. *Scientific Studies of Reading, 1*(3), 277–300.