TEACHING AND LEARNING PORTFOLIO

by

Sarah D. Wright

December 2007

Learning

Research Teaching

This portfolio submitted in partial fulfillment of the requirements for the Delta Certificate in Research, Teaching, and Learning.

Delta Program in Research, Teaching, and Learning
University of Wisconsin-Madison

DELTA
Integrating Research, Teaching, and Learning

CIRTL

The Delta Program in Research, Teaching, and Learning is a project of the Center of the Integration of Research, Teaching, and Learning (CIRTL—Grant No. 0227592). CIRTL is a National Science Foundation sponsored initiative committed to developing and supporting a learning community of STEM faculty, post-docs, graduate students, and staff who are dedicated to implementing and advancing effective teaching practices for diverse student audiences. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

For more information, please call us at 608-261-1180 or visit http://www.delta.wisc.edu.

2007

Teaching & Learning Portfolio

Sarah Dorothy Wright

TABLE OF CONTENTS

Acknowledgements

My Delta experience was certainly the result of a great deal of collaboration and much-appreciated support from a number of people. I am grateful to the faculty and staff of Delta for providing these rich learning opportunities for STEM graduate students, many of whom ultimately plan to teach and relish the training and camaraderie we find through Delta. I am particularly thankful to Don Gillian-Daniel for his guidance through the Delta internship and beyond, and to Chris Pfund for her invaluable insights on mentoring and learning-through-diversity.

I am forever grateful to have had the pleasure of working with and learning from Dolly Ledin at the Center for Biology Education. She astutely matched me with my Delta partner, Jeff Maas, and I have enjoyed reaping the benefits of her many connections with the education community ever since. She is the very embodiment of outreach, understanding the needs of K-12 students inside and outside the classroom setting, and meeting those needs by enlisting the resources of university scientists. Whether working on an art exhibit about climate change, designing science activities for third graders, or carpooling to an environmental education conference, I have thoroughly enjoyed and learned multitudes in Dolly's company.

Jeff Maas is, simply put, a teaching dynamo. Anyone seeking to understand the words 'integrated,' 'differentiated,' or 'inquiry-based' need only visit his classroom for a day to internalize these as not just education buzz-words, but ways of living and learning. 'Compassion' and 'energy' are ones he sums up, too. Witnessing his teaching emboldened me to think that I might be able to handle an elementary classroom, too…and that it's the most important job there is, in any case. If I go into teaching myself, Jeff will always serve as the model I will strive to emulate. I am so proud to have been a part of several cohorts of Team Kids!

I am proud to count the incredible Nina Leopold Bradley among my inspirations. In many ways, she was the inspiration of my Delta project and my growing interest in education. Nina had kept meticulous records of over 300 phenological events near the famous 'Shack' since 1976, and continues to this day. It was through Nina that I became interested in the potential of phenology as a simple, meaningful way to engage students in the science of climate change, and in ecology in general. She introduced me to the idea of 'Nature Deficit Disorder,' coined by author Richard Louv and motivated me to become an educator above all else. Nina's warmth, enthusiasm, and foresight are just a few of her exceptional qualities; she is also brilliant, witty, and a marvelous swimmer. And she, perhaps better than anyone I have ever met, personifies the importance of learning-by-doing and building community.

Finally, I am grateful to my advisor, Don Waller, for his support and enthusiasm for biology education. He strives to engage teachers, undergraduates, and children alike in conservation through citizen science—and through getting outside and enjoying nature. He has even provided me with wonderful opportunities to write and educate when I should have been doing research! For his marvelous patience with my meanderings as a graduate student and his support of my decision to leave in pursuit of educational work, I will always consider him my advisor.

Everything Is Connected: Ecology as Jazz in an Elementary Classroom
Education Philosophy and a Note to the Gentle Reader

I must begin by explaining how my Delta experience was very different from that of most other participants. While many of my fellow Delta participants intend to teach at the college level and so used their experiences to inform their philosophy of teaching in a university classroom, my purpose was different in both setting and target audience. I have discovered through my involvement in the Center for Biology Education's Adult Role Models in Science program that I am most interested in working in an outreach setting, cultivating partnerships between the University and K-12 schools (in the spirit of the Wisconsin Idea) AND that I particularly enjoy working with elementary-aged students. Thus, my internship experience entailed implementing a phenology-based learning plan in a $2^{nd}/3^{rd}$ grade classroom, under the guidance of CBE's Ms. Dolly Ledin and in close partnership with award-winning, veteran teacher Mr. Jeff Maas. I am grateful to the Delta program for the flexibility they have granted me in pursuing what is currently a somewhat atypical project; I believe there is enormous opportunity to engage STEM graduate students in outreach partnerships similar to mine and Jeff's, broadening Delta's very meaningful work into more venues.

My education philosophy has been profoundly shaped by my experiences with Jeff and his students over the past several years. Jeff epitomizes what Carol Ann Tomlinson calls 'teaching as jazz.' Tomlinson draws parallels between effective teaching and jazz music: "Like jazz, great teaching calls for blending different cultural styles with educational techniques and theories. It requires recognizing that there are independent rhythms in the classroom. Most of all, great teaching demands improvisation in how teachers invite an array of young lives into the music with us." Like Delta's three pillars, 'teaching as jazz' recognizes teaching as an ongoing process akin to research, embraces a diversity of learning styles and strengths, and validates the importance of the classroom community cultivated by the teacher.

I believe that the partnerships fostered in outreach settings lend themselves to the rich sort of learning Tomlinson writes about. I believe that my scientific knowledge, combined with Jeff's deep pedagogical knowledge, cultivated a humptious, dynamic learning environment in which all students excelled. This environment embodied the three core principles of my philosophy, which are again very similar to Delta's three pillars (Teaching-as-Research, Learning-through-Diversity, and Learning Communities):

1. **Learning-by-Doing**. I believe that learning is most meaningful and lasting for students when it is directly related to their own 'real world.' This sort of applied learning is most robustly assessed through authentic performance tasks, showcasing students' abilities to apply their learning in ways useful to them and their communities. Learning-by-Doing may be referred to as 'Learning-as-Research': essentially, it engages students in discovering how they learn most effectively by facilitating 'real-world' learning opportunities.
2. **Differentiated Learning**. Inclusive, 'jazz-like' teaching not only *recognizes* that each student contributes a unique rhythm and style to the learning environment; it *embraces* such differences as integral to the shared process of learning. Like Delta's 'Learning-through-Diversity' pillar, the concept of Differentiated Learning promotes the heightened

success of ALL learners by supporting EACH of their distinctive needs and abilities. Differentiated Learning environments allow students the freedom and flexibility to pursue their interests in their own ways and at their own levels, while providing them with the support they need to succeed.
3. **Building Communities of Learners**. Just as Delta promotes exchanging knowledge and experiences through Learning Communities dedicated to exploring shared interests, so do such communities nurture learning in K-12 settings. Jeff invests enormous time and effort from the first day of school onward to cultivate a positive team environment; in fact, the students and Jeff collectively referred to themselves as 'Team Kids 4.' Jeff, then, is not the 'central authority' of the classroom, but a member of it who enlists his expertise to help students reach team and individual goals. Moreover, the success of differentiated learning depends upon effective relationships among students and teachers, wherein individual learning goals and needs may be identified and met.

I believe that pursuing learning with the guidance of these three pillars is vital to boosting scientific literacy in young students. Scientific literacy, as defined by the National Research Council, refers to a set of skills rather than a specific set of knowledge. A scientifically literate person has the training and skills to develop scientific questions, define ways to gather and interpret information to answer questions, and to think critically about and convey conclusions drawn from that information. In short, a scientifically literate person is curious about the world in which we live, and capable of engaging in rigorous discourse to make sense of the world for him/herself. The National Science Education Standards help to advance scientific literacy for all U.S. students by emphasizing science education as a *process* aimed at developing a "toolkit" for understanding rather than a specific body of 'knowledge'. Developing these 'toolkits' for critical thinking benefits students not just in science, but in all of their learning pursuits.

Outreach partnerships between University scientists and K-12 educators provide rich opportunities for enacting Learning-by-Doing and Differentiated Learning, integrating scientists into K-12 Learning Communities. Combining the content knowledge of trained scientists with the pedagogical knowledge of seasoned educators is a sure recipe for success, discovering innovative ways to make science experiences accessible and lasting for all students.

References:

Tomlinson, C.A. and A.Germundson (2007). Teaching as Jazz. *Educational Leadership* 64 (8): 27-31.

National Research Council (1996). *National Science Education Standards*. Washington, D.C.: National Academies Press.

About this Teaching and Learning Portfolio

What follows is a collection of items which I selected to exemplify my beliefs in learning-by-doing, differentiated learning, and learning communities as essential elements of meaningful educational experiences, particularly in ecological disciplines. Most of the items included here emerged from my participation in a $2^{nd}/3^{rd}$ grade classroom, collectively referred to by teacher Mr. Jeff Maas and his students as 'Team Kids 4' (the fourth cohort of classrooms to choose the name 'Team Kids').

The first item is a summative report which chronicles our year-long studies in phenology, or the timing of life cycles, in the Sandburg School Woods. Students worked independently to keep phenological journals in their 'research spots' of the Sandburg Woods, and convened as a team to 1) conduct observations of budburst in the spring and 2) convey the importance of their investigations to others at the Children's Science Symposium. We believe student learning was enhanced by the 'real-world' nature of their investigations, the meta-cognitive skills they developed through their work, and the authentic learning goals expected of them (i.e. explaining the main ideas of their research to others in a symposium setting).

Following the report are a collection of photos and other images which demonstrate learning-by-doing, differentiated learning, and community building. Most of these images were gathered from Team Kids 4, tracking their progress throughout the year. Among them are photos of the students 'in action' in their research spots and at the Children's Science Symposium. Other images include excerpts of students' responses to open-ended essay questions to assess their learning gains mid-way through the school year, a sample research journal entry and data sheet, and thank-you cards made for me by members of Team Kids 4. I have also included two items that were not developed through my Delta internship, but demonstrate learning-by-doing and building community in a college-level course for which I served as a Teaching Assistant in 2005. I have included them because I believe that the same core elements of effective teaching and learning drive student success in all settings, from the elementary classroom to the university and beyond.

These elements of learning-by-doing, differentiated learning, and building community are especially pertinent to approaching and solving environmental problems. The inevitably interdisciplinary and 'real-world' nature of environmental problems, such as climate change, requires that people with varied (differentiated) expertise come together (build community) to apply their knowledge, identifying the origins of problems, and devising and implementing solutions (learning-by-doing).

The famous Leopold family, who pioneered ecological restoration in the 1940s through their work at 'the Shack,' embodied these components of meaningful, applied learning. They learned, through experimentation and trial-and-error on their own beloved land, how to cultivate a vibrant, diverse ecosystem on abandoned farmland. In so doing, they contributed and nurtured their own unique interests, so that the Leopold children each developed into prominent ecologists in a range of fields: palynology, plant ecology and physiology, hydrology, and zoology. And perhaps the most important prerequisite to their success was that they worked together, overcoming challenges and sharing successes as a family--who were also close friends and co-founded the Aldo Leopold Foundation.

Nina Leopold Bradley is an eloquent advocate of merging ecological and educational experiences; always on the cusp of ecological issues, she recognized long ago what now has become a movement, embracing the vital role of the outdoors in shaping children's learning and development. Richard Louv's book, *Last Child in the Woods*, documents an increasing separation between children and nature and illustrates the detriments of this separation, including depression and obesity. Indeed, it is through unstructured play outside that children often make unanticipated discoveries (learning-by-doing), develop and nurture individual fascinations like birding, journaling and building forts (differentiated learning), and come together with other children in their neighborhood (community building). What better way, then, to boost children's confidence in their own abilities, stoke their interests, and encourage them to form positive social bonds than to facilitate the real, bumptious, and collaborative sort of learning that naturally emerges in the outdoors? Such learning not only supports children's development into scientifically literate, healthy, and confident young people; it is prerequisite to our ability as a society to address current and future environmental problems.

I invite you to peruse these appendices and join me in celebrating the accomplishments of the wonderful students featured here. I have learned more than I ever would have fathomed from my time with my project partners, Dolly Ledin and Jeff Maas, and each of these students. I hope you might find some inspiration here as well!

Summative Report

Delta Internship 2007

Sarah Wright

Partners: Dolly Ledin, UW Center for Biology Education; Jeff Maas, Sandburg Elementary School

Exploring the effectiveness of phenology as a vehicle for science learning in an elementary-aged classroom

Abstract:
We implemented a pilot project in a 2nd/3rd grade classroom to explore opportunities for studying ecology through phenology, or the study of life cycles, with elementary-aged children. Our studies were driven by three major themes: 'Being a Scientist,' 'Cycles,' and 'Form fits Function.' Students chose individual 'research areas' in their school woods, where they recorded weekly observations to address their own research questions. In doing so, students learned to formulate a research question, gather and interpret data, and share their findings with others; drew connections among the timing of seemingly separate ecological events (e.g. the melting of lakes and return of migrating birds) and how these may be altered by climate change; gained an aesthetic appreciation for their local landscapes; and noted their own progress as budding scientists. We discovered that phenology lends itself well to integrative learning with elementary students, providing a vehicle to enhance science literacy in general and understanding of climate change in particular, and hone skills in writing, art, and math. However, its effectiveness depends upon successful acclimatization of young students to the outdoors as a place for learning, detailed instructions on tasks to be completed and their importance, and training in quiet observation.

Introduction

Over the past several years, a number of educators and ecologists have recognized the potential for studies of phenology, or the timing of life cycles, to connect student learning to real-world research on climate change (e.g. Schwartz 1999, Bombaugh et al 2003). While several online databases have been designed for students to enter phenological observations (Journey North, www.journeynorth.org; Earth Alive!, www.naturenet.com/earthalive) and curricula prepared which align studies of phenology to state and national science standards (GLOBE Plant Phenology Protocols, www.globe.gov; Madison Metropolitan School District 2004), we are aware of no studies which investigate the effects of a phenology-based science curriculum on

student learning outcomes. To address this quest we used a teaching-as-research strategy to assess student learning in 'Team Kids 4,' Mr. Jeff Maas' 2nd/3rd grade classroom, related to year-long inquiry-based studies of phenology in the Sandburg School Woods. We targeted the following learning objectives through these studies:

1. Students will be able to define phenology.
2. Students will be able to practice phenology, i.e. identify changes in life cycles in the Sandburg Woods.
3. Students will show favorable attitudes toward science and nature.

We introduced the concept of phenology as 'changes in our woods over time,' and discussed the relationship between cycles of weather and cycles of organisms. Students each located their own 'research areas' in the school woods. Based on initial observations (and discussion of 'what makes a good research question'), students formulated their own 'I wonder' research questions. Once weekly, they visited their research areas, recording both 'Daily Observations' (i.e. weather) and 'Changes in My Research Area' (i.e. phenology) in their research journals. In the spring, we used this model of record-keeping to address 'team research questions,' collaborating to note events such as budburst of trees and first bloom of flowers. Students presented their findings at the Children's Science Symposium in May 2007. These activities supported an array of learning styles and strengths, exemplifying Learning-through-Diversity; students contributed through writing, drawing, speaking, designing displays and presentations, making observations, and interpreting data. Each weekly session of research in the Sandburg Woods followed a very deliberate routine: discussing important events to note for that day and reminding students of tasks to be completed, going to the woods and making

observations in research journals, and re-convening as a class indoors to share and reflect on the day's findings.

This learning program was designed to be **inquiry-based**, propelling students to develop and address their own questions. It included **authentic performance tasks**, in which students practice science and present their work in ways similar to those practiced by scientific researchers (National Research Council, 1996). We evaluated the effectiveness of the phenology program using continuous informal **formative assessment** to check for student understanding and a **mid-year assessment** consisting of student essays, and observed students' performance at the Children's Science Symposium near the end of the school year. Our conclusions regarding student gains in science literacy and writing were independently affirmed by undergraduate visitors to Sandburg Elementary. We are using this information to modify the learning program, which is being implemented again in Mr.Maas' classroom (Team Kids 5) during the present 2007-2008 school year. The 2006-2007 cohort of 2nd/3rd graders included 22 students from diverse backgrounds, including six English Language Learners and two students with special needs.

Discussion of Evidence

In February 2007, we implemented a 'half-time' assessment, during which we asked students to look back through the journal they had kept since September. Students were asked to write short answers to four questions designed to unveil their understanding of phenology and to enlist their meta-cognitive skills to describe their own progress as learners (Stewart et al 2005):

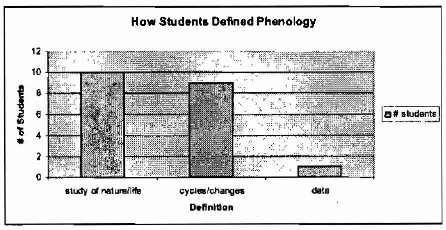
1) What is phenology?
2) How has your research spot changed?

3) How have YOU changed as a researcher?

4) Now what? (i.e. what are your goals for the rest of the school year?)

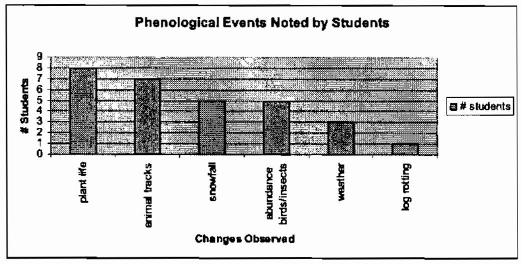
The first two questions illuminated the extent to which students achieved our first two learning goals: defining and practicing phenology. The last two questions indirectly demonstrated students' attitudes toward science and nature by highlighting what students viewed as their achievements through practicing phenology. Nineteen students responded to the assessment questions; some of them generated multiple responses to a single question, and in some cases a question went unanswered. The results are as follows:

1) Almost all students demonstrated a working knowledge of the concept of 'phenology.' Ten of them defined phenology as the 'study of nature' or 'study of life,' 9 students identified phenology as 'cycles' or 'changes over time,' and one student equated phenology with collecting data. Though this latter student's view of phenology is incomplete, all students understood phenology as directly related to the tasks they practiced in the Sandburg Woods.

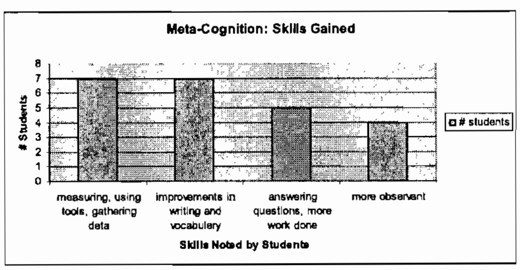


2) All students were able to identify and convey one or more changes observed in their research area from September to February. Changes in plant life (leaves dropping, bark

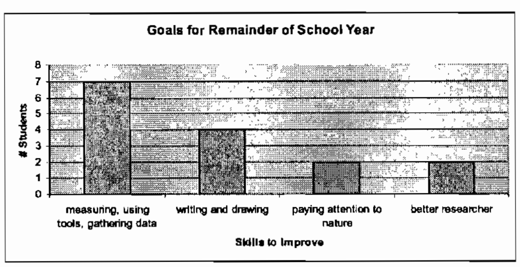
peeling) were most commonly noted (8 students), followed by appearance of animal tracks (7), snow falling (5), changes in abundance of insects and birds (5), changes in weather/temperature (3), and changing colors as fallen logs rotted (1). Students thus identified a variety of seasonal changes according to their own interests and observations.



3) Perhaps the most exciting evidence to witness from a teacher's perspective was students' self-assessments of their own progress as researchers, when questioned how they had changed based on changes in their journals. Seven students reported developing their skills in measuring, using tools, and collecting data; 7 as well noticed improvements in their writing skills and vocabulary over time, 5 said they 'got better at answering questions' and 'got more work done;' and 4 noticed they became more astute at 'paying attention' to and 'observing' nature.



4) Students then articulated goals for the spring season and skills to continue to focus on. Seven wanted to improve their skills in measuring, collecting data, and taking samples; 4 focused on drawing and writing in their journals; 2 said they would 'pay more attention to nature,' and 2 generally intended to become 'better researchers.'



The springtime marked a transition to team research, wherein all students focused on a single event: budburst. Each student was given 3 colored ribbons, which they used to mark 3 different buds in their research areas. They then measured the length of each bud during each weekly visit to the woods, and noted the date of budburst (see Budburst Data Sheet, Appendix C). This task was useful in unifying the students, and to illustrate the research process for students who may have been unable to fully articulate their own individual research question in the fall.

Students seemed to vastly improve their skills in identifying and recording pertinent phenological events throughout the spring months, on the heels of the Budburst activity. Events which were commonly noted included return of chickadees and hawks, emergence of jack-in-the-pulpits and mayapples, and renewed activity of small mammals like squirrels and chipmunks. When we reconvened as a class, students often orally reflected on the connections among events; for example, they noted that if waterfowl such geese could be seen flying overhead, sufficient ice must have melted to provide open water habitat for the birds. Furthermore, Mr. Maas and I were proud, but not surprised, when Team Kids 4 astonished the leader of their Madison School Forest 'naturalist tour' with their plant identification skills and broad ecological knowledge.

The culmination of the year's phenological studies was a class presentation at the Children's Science Symposium at the Madison Children's Museum in May 2007. Students worked as a team to develop an interactive exhibit that would convey their phenological studies to other students at the Symposium. Students shared responsibility for creating and running 3 different 'stations' in their allotted space at the museum. Some students showed their research journals to exhibit visitors to explain their research projects. Another station, called 'Create-a-Critter,' emerged from our theme of 'form-function-ecosystem,' challenging students to choose a forest, ocean, or desert habitat and construct an organism whose body suited it for living in that habitat. Finally, 'What Bird Is Real?' featured pairs of habitat scenes with birds, in which one scene was 'real' and the other featured a bird with improper features for the given habitat type. By this point in the school year, students began to understand the concept of adaptation, envisioning the timing of life cycles as one among many 'forms' which enable organisms to perform a particular function which facilitates survival in their environment. Students effectively conveyed these foundational concepts of biology to their peers and adults (See Appendix D).

Another form of assessment included written responses from 8 biology undergraduates who visited our Sandburg Woods project as part of a 'Ways of Knowing Biology' field trip. These undergraduate biology majors were provided with an overview of the project and educational context from Mr. Maas and then given 'tours' of research spots by 8 members of Team Kids 4 (not all students were present, since the field trip occurred after school hours). These UW-Madison undergraduate students chose to visit Sandburg School as one of a menu of options to witness 'biology in action' on campus and beyond, and were required as part of their course to write a brief, open-ended essay on what they did and learned during such field trips. It was especially gratifying for 'third-party' observers—particularly university students who are themselves active participants in various learning environments—to validate our own assessments by drawing many of the same conclusions we had. All of the undergraduates raved about how enthusiastic and bright the young students were, and how much fun they all had making observations in the Sandburg Woods. They recognized the enormous value of learning-by-doing, and expressed regret that their own elementary education experiences were not more like that of Team Kids 4. Selected observations from these undergraduate biology majors follow:

- "I enjoyed seeing how the students prided themselves in their work."
- "I learned how to observe much more carefully, as well as to reason why things happen the way they do in nature. For example, in one area, there was a minimal amount of budding, and the children figured that maybe this was due to a lack of sunlight in that area. The children were excellent at observing what many people might not even notice."
- "It was fascinating to me to see how much more these students have been able to learn by going out in the woods and exploring on their own than those students whose teachers focus more on book and in the classroom learning."
- "The kids were very smart for their age and used words and literature that I hardly have ever heard kids their age say. I really wish more kids would have this opportunity, or that I would have had classes like that."
- "Their presentations of their studies were very well organized and enlightening. The teacher explained to us how this method of learning was superior to other forms and I believe he is right. A hands-on approach is much more rewarding compared to straight out of the book learning."

Taken together, these observations confirm that our practices of Learning-by-Doing in the Outdoor Classroom propelled students to practice science as scientists do, in meaningful and authentic ways easily identified by undergraduate biology majors. They also attest to the effective, integrative nature of our phenological studies, which enhanced students' proficiency in speaking about their work to others as well as conducting scientific investigations.

Reflection

The very flexible, differentiated learning plan we implemented fostered a deep level of inquiry, and instigated much independent and creative learning in students. For example, one

student cleared the leaf litter from one half of her research area, in order to compare the timing of plant emergence in the presence and absence of leaf litter (she predicted that more light would penetrate to the bare soil, creating warmer temperatures and faster plant growth there). Because we refrained from directing students toward observing a particular organism or event, students were likely to follow their own interests and curiosity to initiate such investigations on their own.

However, some students (particularly the second graders) seemed to require further guidance to focus their attention. While some students articulated original research questions (e.g. "How does a rotting log change color over time?" or "How does the number of insects change over time?), some students never quite formulated their own question, and finally thrived once we began 'team observations' during the Budburst activity. This year, we have reversed the order of events somewhat, so that students began the school year doing 'team research' activities, such as taking responsibility for particular climate measurements. We believe that beginning with a team-centered approach to forming a question and collecting data will propel a greater proportion of students toward framing their own research questions, boosting their comprehension of the scientific process.

The classroom atmosphere cultivated by Mr. Maas and the students definitely maximizes the success of the learning plan we implemented. There was very little 'traditional' assessment in the form of individual tasks or tests, and students primarily evaluated their own journals rather than receive, for example, written feedback from Jeff. The principal form of assessment was the completion of performance tasks, especially the students' contributions to the Children's Science Symposium. Though we did not formally assess student performance at the Science Symposium, the Symposium coordinator, Dolly Ledin (also my Delta partner) was among the visitors to Team Kids 4's exhibit. She and students from other participating schools remarked

how much fun they had and how much they learned from Team Kids 4's creative ways of engaging others in understanding 'form-function-ecosystem' relationships and the importance of the timing of cycles. Indeed, the students performed superbly, communicating the meaning and significance of phenology to their peers and adults, clearly enjoying their presentations and confident in the ecological knowledge they had developed over the course of the year. The students stood just outside their 'exhibit space' actively inviting visitors and proudly escorting them through the exhibit's stations.

The success of Team Kids 4 is at least in part a tribute to the enormous effort Team Kids 4 invested in team-building from the first day of school onward. I believe that the sense of teamwork instilled in this classroom is a prerequisite to successful execution of performance tasks such as these. Thus, other classrooms wishing to pursue a similar learning should devote special attention to learning community as an important component of 'real-world' scientific research.

Finally, with our ambitious research schedule embedded in a busy $2^{nd}/3^{rd}$ grade learning program, we did not quite have time to devote to introducing the students to databases. While there are computing facilities available near the classroom, and online databases may provide a rich means of 'sharing with others' as a part of our research framework, we simply ran short on time during the 2006-2007 school year. With limited time available, we chose to allocate whatever we could to our Outdoor Classroom practice. If time permits during the 2007-2008 school year, visiting an online database such as Project BudBurst (www.budburst.org) or Journey North (www.journeynorth.org) would be an effective approach to linking our students' efforts with that of other classrooms and with broader phenological research questions.

I am so grateful to Jeff and the students of Team Kids 4 for making me a part of their learning community. Having the opportunity to learn from a seasoned teacher like Jeff was the richest and most gratifying teaching experience I could have hoped for. By following his lead, I developed my own skills in cultivating the 'structured chaos' of a dynamic classroom, becoming more comfortable with improvising and responding to students' emerging interests. I look forward to celebrating and documenting the coming of spring with the 2007-2008 cohort.

Literature Cited

Beaubien, EG and M Hall-Beyer (2003). Plant phenology in western Canada: trends and links to the view from space. *Environmental Monitoring & Assessment* 88: 419-429.

Bombaugh, R., E. Sparrow and T. Mal (2003). Using GLOBE plant phenology protocols to meet the National Science Education Standards. *The American Biology Teacher* 65(4): 279-285.

Fortier, JD, SM Grady, SA Lee and PA Marinac (1998). *Wisconsin's Model Academic Standards for Environmental Education.* Wisconsin Department of Public Instruction, Madison, WI. 24 pp.

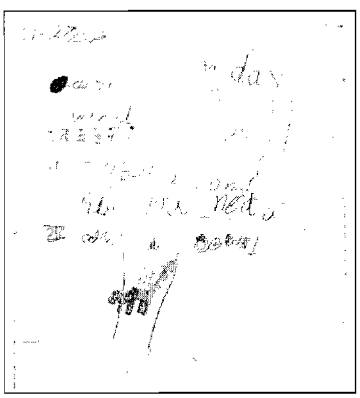
Madison Metropolitan School District (2004). Connecting Classroom Science & the School Forest. http://www.madison.k12.wi.us/forest/docs/EEIC_document_112204.pdf

National Research Council (1996). *National Science Education Standards.* Washington, D.C.: National Academies Press.

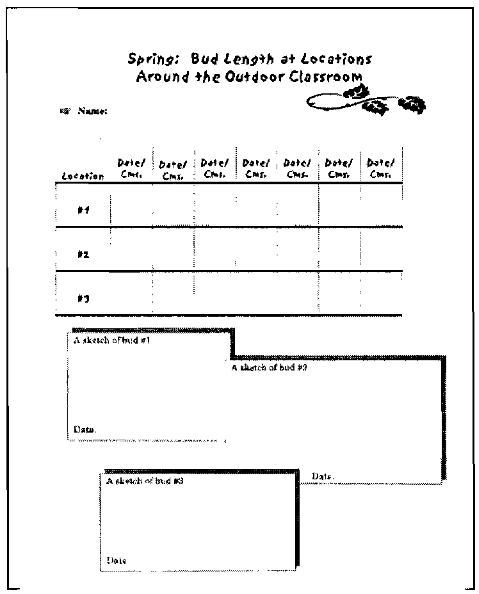
Schwartz, MD (1999) Advancing to full bloom: planning phenological research for the 21st century. *International Journal of Biometeorology* 42: 113-118.

Stewart, J., J.L. Cartier, and C.M. Passmore (2005). Developing understanding through model-based inquiry. *How Students Learn: Science in the Classroom.* Washington, D.C.: National Academies Press.

Appendix A. Learning-by-Doing in the Outdoor Classroom. The Sandburg Woods provided an authentic, 'real-world' venue for studying phenology, or the timing of life cycles. I believe that the outdoor setting epitomizes 'teaching as jazz,' drawing upon each individual students' interests and abilities and the improvisation inherent in nature—every day is different and differentiated!



Appendix B. Learning-by-Doing: An example of a research journal entry. This entry includes both 'Daily Observations' about the weather (cloudy, low wind, temperature cold enough to need a coat) and 'Changes in My Research Area' (i.e. events on a given day; this student focused on squirrel activity).



Spring: Bud Length at Locations Around the Outdoor Classroom

Name:

Location	Date/ Cms.	Date/ Cms.	Date/ Cms.	Date/ Cms.	Date/ Cms.	Date/ Cms.	Date/ Cms.
#1							
#2							
#3							

A sketch of bud #1

Date

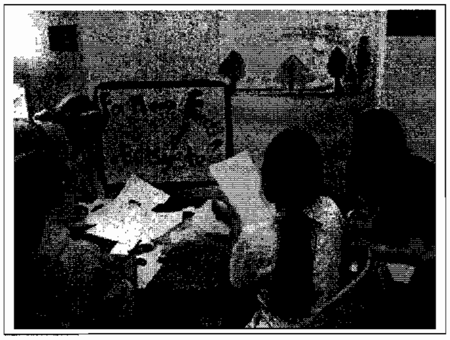
A sketch of bud #2

Date

A sketch of bud #3

Date

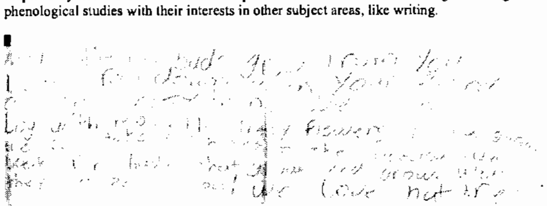
Appendix C. Learning-by-Doing: Team research on budburst. Students conducted phenological observations as a scientist would, including 3 replicate plants, taking metric measurements at regular intervals, and noting the date of budburst.



Appendix D. Learning-by-Doing: Authentic Performance Tasks at the Children's Science Symposium. Members of Team Kids 4 designed and implemented interactive 'Create-a-Critter'(above) and 'What Bird Is Real?' (below) exhibits at the Children's Science Symposium, held at the Madison Children's Museum in May 2007. Visitors were invited to choose a habitat and then construct an organism whose body would enable it to survive there, illustrating 'form-function-ecosystem' relationships (above) and choose between two 'bird scenes' to determine which depicted a bird with appropriate forms (i.e. adaptations) for its habitat.

Appendix E. Learning-by-Doing in a University Course. This photo shows me (as a Teaching Assistant) with a group of students from Botany/Zoology 260, an introductory ecology course for non-biology majors, at the conclusion of a work party at the University of Wisconsin Arboretum. Students were given the option to earn extra credit by participating in the Saturday morning work party, removing the invasive species buckthorn from a rare tortoise's habitat near Teal Pond. Students had the opportunity to participate in 'real-world' restoration activities for a sensitive species; the results of our work were visible by morning's end, as an area formerly crowded by buckthorn saplings was newly cleared.

Appendix F. Differentiated Learning: Karla's Leaf Litter Experiment. This student independently chose to remove leaf litter from one half of her 'research spot' in the Sandburg Woods in order to investigate the effects of leaf litter on the rate of plant emergence. She demonstrates the success of a differentiated learning plan, which afforded students the flexibility to follow their own interests, and propelled the most skilled students to develop advanced investigations in addition to completing the required 'Daily Observations' and 'Changes in My Research Area' journal tasks. The class would be called together from time to time to showcase such examples of creativity, outstanding work, or the day's most intriguing observations. Students thus participated in peer teaching and shared research. **Below: a poem by Amber inspired by her Outdoor Classroom experiences.** Students were encouraged to integrate their phenological studies with their interests in other subject areas, like writing.

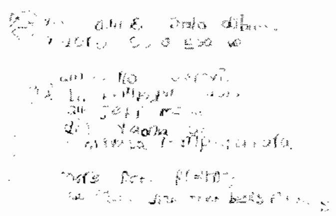


Appendix G. Differentiated Learning: a sample of students' responses to four essay questions follow, demonstrating a range of responses. For example, an English Language Learner writes in a mixture of Spanish and English. A student with less proficiency in writing composes a pictorial response. Four other students demonstrate a range of writing skills as well as very different perspectives on what phenology means to them and how they have progressed as researchers throughout the school year. One student offers rather terse but astute observations, another admits to having 'no clue' when we began research but developing 'strategies,' while one waxes philosophical about 'paying attention to nature,' and still another strives to write more nature-inspired poetry while still keeping up on measurements.

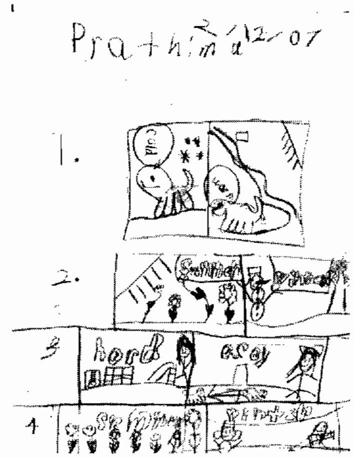
These questions were posed in February 2007, roughly mid-way through the school year, inviting students to look back through the research journals they had kept since September. The questions consisted of the following:

1. What is phenology?
2. How has your research spot changed over time?
3. How have you changed over time?
4. What's next? (i.e. what are your goals for the rest of the year?)

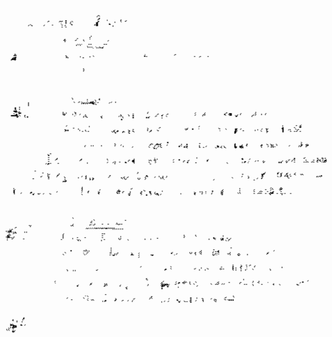
Nearly all students were able to define phenology as 'changes in nature' or 'the study of changes,' and each of them offered examples of changing events in their research spot (i.e. leaves dropping, weather changing, departure of birds and insects). Perhaps most gratifying was the skillful meta-cognitive reflection students demonstrated in their answers to 'Question 3,' identifying gains in their research skills (measuring, observing), writing skills, and affective appreciation for nature and research (please see Summative Report for more detailed information).



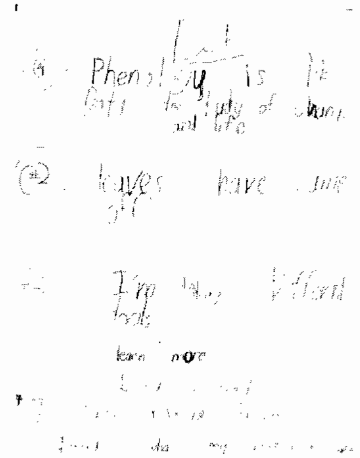
Appendix G1. Differentiated Learning: In a response composed in Spanish and English, this student identifies changes in weather and phenology, and reflects on his growing awareness of and ability to measure temperature.



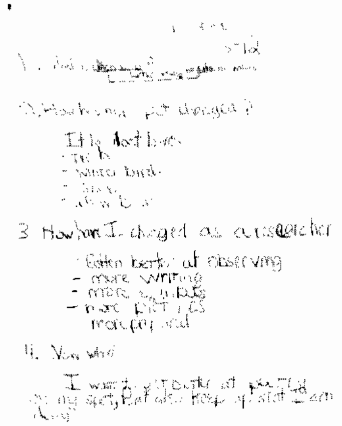
Appendix G2. Differentiated Learning: A response composed in pictures demonstrates that this student understands the broad concept of phenology and feels that research tasks have become 'easier.'



Appendix G3. Differentiated Learning: This student cannot remember how to define 'phenology,' but describes the concept very well by identifying changes in ecological events throughout the year. She also demonstrates a high level of meta-cognitive reflection on her growth as a researcher.



Appendix G4. Differentiated Learning: This student's responses are brief, but demonstrate his firm grasp of phenology and ability to reflect on his own development.

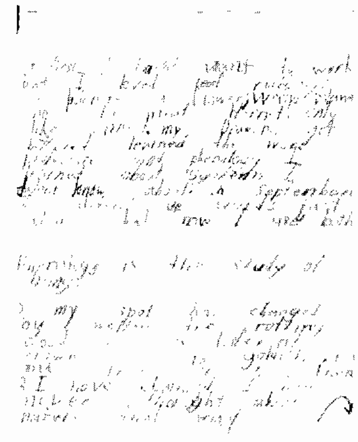


2. How has my spot changed?

3 How have I changed as a researcher

- better at observing
- more writing

Appendix G5. Differentiated Learning: This student's special area of interest is writing poetry; she enlisted her skillful powers of observation to hone her writing talent throughout the year.

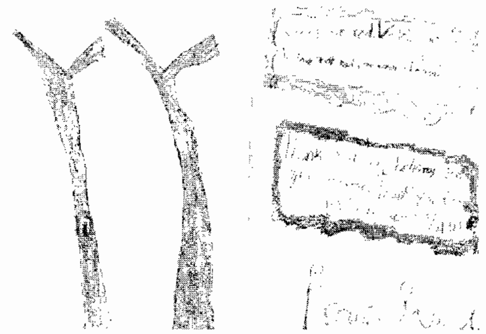


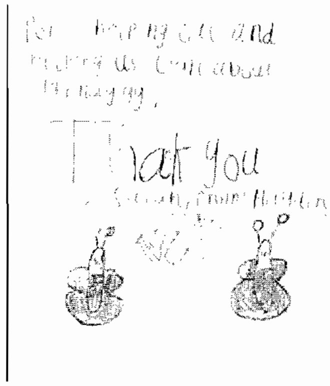
Appendix G6. Differentiated Learning: This student writes in great detail about both his growth as a researcher (studying changes in the color of a rotting log) and his growing awareness of and affective appreciation for nature.

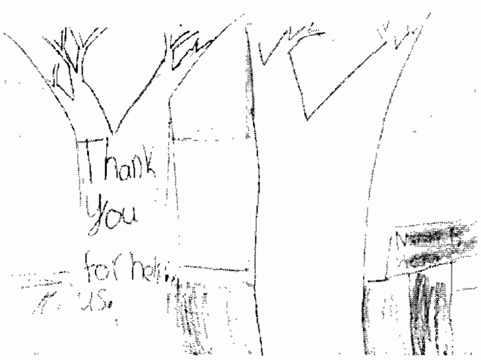
Appendix H. Building Relationships: Team Kids 4 Winter Assembly. This 2nd/3rd grade classroom has a team name, matching team shirts, and most importantly, the training and skills to work collaboratively. Students decided as a team, for example, how best to synthesize everyone's individual research into ideas that could be conveyed to others at the Children's Science Symposium.

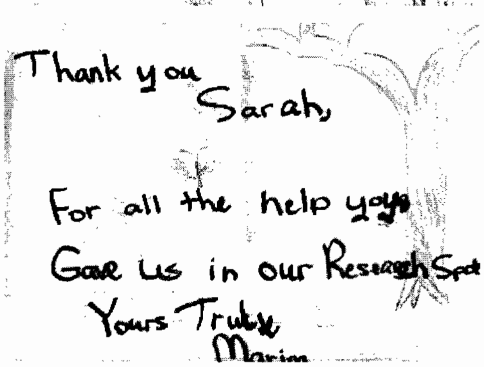
Appendix I. Building relationships with and among students. Students in the optional discussion section for Botany/Zoology 260 expressed interest in visiting 'The Shack,' the site which inspired Aldo Leopold to write one of our course readings, *A Sand County Almanac*. Our flexible course arrangements allowed me to respond to their interests by arranging an optional field trip to The Shack through the Aldo Leopold Foundation, whose Education Director gave us a tour and engaged us in flagging populations of garlic mustard, an invasive plant. Students enjoyed each other's company outside of the classroom setting, and saw first-hand the site where the Leopold family practiced 'learning-by-doing' through their pioneering restoration work.

Appendix J. Building Relationships: Forming Bonds with Team Kids 4. A sample of thank-you cards from members of Team Kids 4 follow, which include lovely drawings, poetry, and notes of thanks for 'helping with research' and 'teaching us about nature.' I am so proud of how these students grew over a school year, and will always treasure these cards as mementos of all the times we learned in the Sandburg Woods together.









The Leopold Legacy in the Sandburg School Woods: Learning as Jazz

Sarah Wright
UW-Madison Dept of Botany
December 17, 2007

With Many Thanks to Jeff Maas, Dolly Ledin, Nina Leopold Bradley, and the students of Sandburg Elementary

Outline

- Leopold Legacy: Phenology
- Delta pillars in an outreach setting
- What we did in the Sandburg Woods
- What we learned about teaching with phenology

Learning-by-Doing: Building a Land Ethic

"There are two spiritual dangers in not owning a farm. One is the danger of supposing that breakfast comes from the grocery, and the other that heat comes

The Leopold Phenology Legacy

- Phenology="science of appearance"
- Includes date of first bloom of flowers, first arrival of birds, freezing/thawing of lakes, etc.
- Observations made by Aldo Leopold, 1935-1945

"The hibernating skunk...uncurls himself and ventures forth to prowl the wet world, dragging his belly in the snow. His track marks one of the earliest datable events in that cycle of beginnings and ceasings which we call a year."
–*A Sand County Almanac*

The Legacy Lives On...

Phenological observations were resumed by Charlie & Nina Leopold Bradley, 1976-present.

...and in elementary schools, too!

Delta Pillars: Tweaked for Outreach in an Elementary Classroom

Teaching-as-Research → Learning-by-Doing

Learning-through-Diversity → Differentiated Learning

Learning Community → Building Relationships

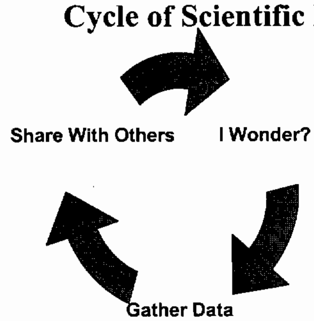
Same & Different

- Both interested in assessing student learning gains
- Both use information to modify plans

In our setting….

- A lot more formative assessment (kids are very honest)
- Heavier time constraints
- Integrated learning
- Learning how to learn as important as any content

What we Did: Cycle of Scientific Inquiry



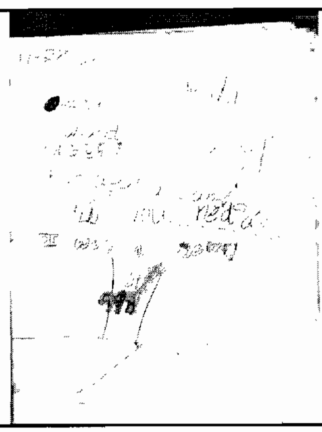
ENCOURAGING kids to see and discover for themselves, a la Aldo & Nina.

Reflects 3 Pillars!

Establishing a Phenology Routine

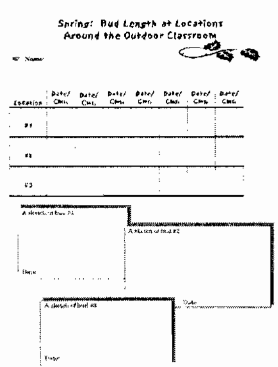
- Students choose their own individual ***'research spots'***
- Develop their own *'**I wonder**'* questions
- Each research day includes *'**Daily Observations**'* and *'**Changes in My Research Area**'*
- We reconvene in the classroom to reflect and share

Using "the eye of the scientist and the heart of the artist" –Mr. Jeff Maas



Learning-by-Doing:

'Daily Observations' & 'Changes in My Research Area'



Learning by Doing: Tracking Budburst as Team Research

Learning by Doing: Authentic Performance Tasks

"Create-a-critter" presentation at Madison Children's Museum

"What Bird Is Real?" activity

Differentiated Learning ↕ Learning Community

Karla's Leaf Litter Experiment

Mid-year assessment questions

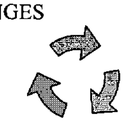
1. What is phenology?
2. How has your research spot changed?

------

1. How have YOU changed?
2. What are your goals for the rest of the year?

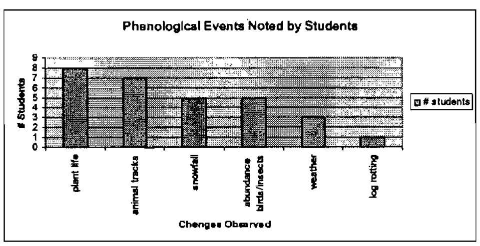
Student Gains from Phenology

- Able to define and practice phenology (study of nature, cycles, changes)
- They learn to make MEASUREMENTS
- They OBSERVE and understand CHANGES
- They MAKE CONNECTIONS for themselves among things and ideas



"The months of the year, from January up to June, are a geometric progression in the abundance of distractions." – 'January Thaw', *A Sand County Almanac*

Student Gains: Differentiated



….and poetry, pictures, liking science & being outside….

Meta-cognitive Skills

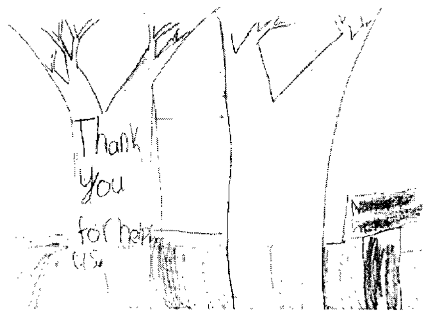
- "First I didn't know what to do. Now I write a lot and a little bit of drawing. I measure now. Getting better at data."
- "I wasn't interested in weather. Now I do."
- "I'm taking different tools."
- "I have gotten better at observing. I'm more prepared."
- "I have changed. I never thought about nature that way. I am going to try to pay more attention to nature."

"Things hoped for have a higher value than things assured." -- 'The Choral Copse'

Views from Undergraduate Visitors

- "I enjoyed seeing how the students prided themselves in their work."
- The children were excellent at observing what many people might not even notice."
- "The kids were very smart for their age…I really wish more kids would have this opportunity, or that I would have had classes like that."
- "A hands-on approach is much more rewarding compared to straight out of the book learning."

Building Relationships: With Each Other & Nature



Building Community

- "All ethics evolved so far rest upon a single premise: that the individual is a member of a community of interdependent parts."

--Aldo Leopold

Teaching-as-Research: What did we learn?

- Kids love the outdoors…great place for authentic learning!
- Team-building and routine-building essential
- Reverse order: team research first
- Make time for databases?
- www.budburst.org, www.journeynorth.org

Project BudBurst A National Phenology Network Field Campaign for Citizen Scientists

Acknowledgements

Nina Leopold Bradley
Don Gillian-Daniel
Dolly Ledin
Jeff Maas
Team Kids 4 & 5
Sandburg School
Community of Delta Interns

Suggestions? Thanks!