

**Annual Report for Period:**09/2007 - 08/2008  
**Principal Investigator:** Hemingway, Claire A.  
**Organization:** Botanical Soc of America  
**Title:**  
 Planting Science Research in Education

**Submitted on:** 05/31/2008  
**Award ID:** 0733280

### Project Participants

#### Senior Personnel

**Name:** Hemingway, Claire  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Stuessy, Carol  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

**Name:** Dahl, William  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

#### Post-doc

#### Graduate Student

#### Undergraduate Student

#### Technician, Programmer

**Name:** Brandt, Rob  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

BSA IT Manager Rob Brandt has overseen computer programming and database management of the PlantingScience website and implemented major website revisions following extensive review of the website by Brandt, Hemingway, and Dahl.

#### Other Participant

**Name:** Cacanindin, Heather  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**

Heather Cacinindin temporarily assisted in communicating with teachers and managing the website until a permanent project coordinator could be hired. Jennifer Potratz filled this position in mid May, 2008.

#### Research Experience for Undergraduates

### Organizational Partners

#### American Society of Plant Biologists

At the time of the award, the American Society of Plant Biologists (ASPB) was the primary

Scientific Society partner. Since the award, the ASPB increased commitment to the project by sponsoring five graduate student members of the Master Plant Science Team. The ASPB offers in-kind support in the form of free membership for the year's mentoring service as well as 50% off meeting registration fees.

### Other Collaborators or Contacts

In August 2007, the BSA hosted an inquiry writing retreat, supported by the Monsanto Fund, at our St. Louis headquarters. Hemingway coordinated and facilitated the inquiry writing retreat and subsequent classroom testing and reflection on progress. The participants included:

- ò K-12 teachers (Valdine McLean, Toni Lafferty, Jane Metty)
- ò Plant scientists (Drs. Paul Williams, Gordon Uno, Marshall Sundberg, Larry Griffing)
- ò Curriculum/science education specialist (Dr. Ethel Stanley, Director BioQUEST Curriculum Consortium) and Internal Evaluator Carol Stuessy

The Society for Economic Botany is now partnering to provide scientist mentors. We anticipate that, like the ASPB, they will increase their commitment to the project by sponsoring members of the Master Plant Science Team.

A formal letter of support has been exchanged between PlantingScience and the Georgia College and State University Early College Program <http://info.gcsu.edu/tip/archives/2005/EarlyCollegeprograminitia.html>. Attending the August PlantingScience Summer Institute will be Lisa Thompson, a high school teacher with a botany degree. In the fall Lisa Thompson and Dr. Melanie DeVore, a paleobotanist, BSA member and mentor to teachers and students in the Early College Program, will work together to implement PlantingScience in Lisa's classroom.

Hemingway has been invited to speak about PlantingScience at NSF-funded meetings and workshops (these are detailed in the Outreach section below).

Hemingway has also been invited to serve on advisory boards of NSF-funded projects:

ò iPlant Collaborative <http://iplantcollaborative.org/>

ò Life Sciences for a Global Community

[http://www.so.wustl.edu/life\\_sciences/index.htm](http://www.so.wustl.edu/life_sciences/index.htm)

She also serves as an advisor to a collaboration between BioQUEST and Institute for the Study of Knowledge Management in Education ôCollaboratories for Scientific Investigation and Teachingö, which has been submitted to the NSF DRK12 panel.

At the upcoming Botany 2008 meeting where Judy Skotchmoor is an invited speaker in the past-president's symposium focusing on science literacy, Hemingway and Skotchmoor will discuss ways PlantingScience and the Understanding Science project can work together. <http://www.ucmp.berkeley.edu/understandingscience/index.php>

The Botanical Society of America is participating in COPUS <http://www.copusproject.org/>.

### Activities and Findings

#### **Research and Education Activities:**

## Major research and education activities and deliverables

Project overview: PlantingScience brings plant scientists into classrooms as online science mentors and creates new opportunities for students and teachers to learn how science works and how scientific research is conducted. Specific goals are to: bridge cultures of research and education, infuse classroom science with the excitement of scientific discovery, provide open-ended plant inquiry materials, and enhance understanding of science and increase students interest in and awareness of plants. The Botanical Society of America (BSA), the American Society of Plant Biologists (ASPB), in partnership with Texas A&M University and K-12 teachers, are forging a nationwide science learning community ([www.plantingscience.org](http://www.plantingscience.org)). The project will deliver engaging instructional resources, with rich open-ended directions, that allow teachers to teach core biology standards in the context of doing science. Online mentors, communication, thinking, and formative assessment tools will scaffold student investigations. This project provides opportunities for teachers to implement standards-aligned, technology-supported inquiries during the school year, and to work with scientists and science educators in professional development workshops during the summer.

## Major accomplishments in the first year:

- ò negotiated subcontract with TAMU, consulting contracts with D. Dickson, Beloit
- ò doubled participation in the PlantingScience fall and spring sessions
- ò significantly expanded the mentor base, including ASPB members of the Master Plant Science Team
- ò began extensive improvements to project website [www.PlantingScience.org](http://www.PlantingScience.org)
- ò began development and field-testing of three new inquiry modules
- ò identified and began training of TAMU graduate students
- ò site visit by Hemingway to TAMU to plan summer program
- ò organized and hosted Steering Committee meeting (see attached report)
- ò invited scientists and teacher leaders; secured logistics for summer program
- ò recruitment of teachers and students for summer program
- ò selection of and communication with teachers and students participating in summer program (including consent forms, school authority approval letters)
- ò advertised and offered position for BSA project assistant

## Meeting project goals for the first year:

- ò Plan and deliver summer professional development ù Our first summer institute for teachers to be held this August will include 15 teachers, including 2 Teacher Leaders, 2 plant scientists who wrote existing inquiry modules, 4 graduate students, and project staff.
- ò Develop and field test 2 new inquiry modules ù Three new inquiry modules are in various stages of development, with a preliminary field testing of all.
- ò Develop and integrate new web tools and resources ù Substantial revisions will be unveiled in June.
- ò Recruit and train new mentors ù Over 120 scientists registered, grew Master Plant Science Team (trained, compensated graduate students) from 10 to 17
- ò Dissemination at national meetings ù presented at 4 national meetings thus far
- Evaluate summer professional development session ù pending August session
- ò Conduct classroom observations ù pending teacher selection in August session

What worked and what did not: As the summer program for students and teachers is not scheduled until August, we do not have measures of the impact of our activities. We do have lessons learned, particularly regarding recruitment strategies. Regarding teacher and student recruitment, we found that collaborating closely with a key school representative greatly facilitated the effort. Another successful tactic for student recruitment was through StuessyÆs connections across Texas to rural schools, which are part of the PRISE (Policy Research Initiatives in Science to Improve Science Teaching and Learning NSF ESI-

0455679). We learned, however, that the timing of our recruitment deadline was inopportune, as it coincided with school testing.

### **Findings:**

#### Major findings

Progress to date, Schedule, Changes or additions, Difficulties and solutions: As the project has only completed the recruitment and selection phases of the professional development component, the majority of our lessons learned relate to project management and participant recruitment and plans for summer professional development. The Botanical Society of America is a new awardee organization and Hemingway a new PI. Negotiating contracts and establishing internal reporting protocols took longer than expected, which delayed disbursement of funds to Co-PIs. Moreover, a change in TAMU policies required that the TAMU subcontract passed through the Research Foundation to adjust TAMU indirect costs from 5% to 15%. This delayed the contracts and disbursement to Stuessy and TAMU graduate students, but has not affected project recruiting or participant costs. A fortunate burden strained the project's ability to stay on schedule, as last September Hemingway became responsible for both an ITEST and a DRK12 grant. This month, Jennifer Potratz accepted the project coordinator position.

Recruitment and planning for summer professional development session is on schedule and meeting our targets. We aimed to include teacher leaders, who have prior classroom experience with PlantingScience and can model inquiry teaching and learning to other participants. Two teacher leaders for the upcoming August session will be Allison Landry of Louisiana School for Math, Science, and the Arts and Toni Lafferty of C.H. Yoe High School.

This year, we made significant improvement to the project website, most of which were made to the back end (installing a new version of the relational database, converting old data to new formats, developing queries of the database). We greatly improved the online student registration and team creation process, but we are slightly behind schedule on a few revisions to look and function of website, including integrating online pre- and post-tests and concept maps, but we have made great progress in designing features that will enhance the community connections.

An intensive web review and revision planning session took place at the BSA headquarters in March. These will be unveiled this summer and field tested at July and August meetings.

The development sophisticated queries of the database underlying the PlantingScience website to facilitate tracking of impact on and participation by member of the online community. This effort has allowed us to establish valuable baseline data, which we will use to compare how teacher participation in the summer professional development sessions enhance their facility of implementing open-ended inquires in the classroom. Examples of two of the queries are given in Table 1 and 2 in the attached Steering Committee Report.

Materials development processes: Three new inquiry modules are in various stages of development and field-testing. During the first writing retreat, we began by reviewing the criteria for writing new inquiries that had been circulated prior to the meeting to ensure that the community of contributors had a common understanding of the project goals. We also sought feedback on the format and presentation of the inquiry materials and discussed an overall scheme for developing a full range of plant inquiries and illustrating the connections between them and the underlying theme of evolution across them. We then identified three new inquiry units accessible to learners of different levels of

investigation experience and biology content knowledge. The inquiry writing teams were formed, the frameworks for the investigations planned, and text drafted. As the inquiry chosen modules represent three levels of difficulty, they, not surprisingly, have progressed to various stages since the August writing retreat. Each of the new units, contributors, and activities associated with writing and field-testing are described below.

Genetics û intended for students ready for sophisticated, extended investigations  
 Scientist-teacher writing team: Paul Williams, Wisconsin Fast Plants; Larry Griffing, Texas A&M University; Valdine McLean, Pershing County High School, Lovelock, Nevada.  
 Curriculum Specialist: Ethel Stanley, BioQUEST Curriculum Consortium

The aim of this unit is to introduce students to genetic and environmental components of heritability and natural and artificial selection. Two options will be available: using markers in Rapid Cycling Brassica rapa (RCBs) ûextending the materials available on Qualitative and Quantifiable Mendel content on [www.fastplants.org](http://www.fastplants.org)-- or recombinant inbred lines of Arabidopsis Columbia and Landsberg parent lines. Students also learn how to use digital images and JImage software to record and analyze plant growth. In the initial concept draft, an option using dwarf barley was also considered, but this did not grow well in either the classroom or greenhouse. Alpha testing: 2 high school classrooms, 2 high school teachers, 54 students, 11 scientist mentors: Alpha classroom testing took place with V. McLean's honor's biology class working in 6 teams, with Griffing and Williams each connected as mentors to the teams. T. Lafferty also conducted the genetics inquiry with her freshman biology students; these 9 teams were mentored by regular PlantingScience mentors. In both cases, the investigations spanned >10 weeks. V. McLean's class investigated both RCBs and Arabidopsis. T. Lafferty's class investigated RCBs only. On April 18, 2008 the Genetics writing team reassembled to begin revising the two routes of the genetics units. Williams and Griffing are currently experimenting with new lines using markers that will be evident to students at the seed and seedling stage and growth conditions to bullet proof the system and develop ~5- and 8-week options. Another classroom test is planned for fall.

Respiration û intended for intermediate students  
 Scientist-teacher writing team: Marshall Sundberg, Emporia State University; Toni Lafferty, C.H. Yoe High School, Cameron, Texas. Curriculum Specialist: Ethel Stanley, BioQUEST Curriculum Consortium

This unit will be connected with the current Power of Sunlight inquiry on photosynthesis within an energy and carbon cycle inquiry thread. The aim of the unit is to explore cellular respiration and quantify using a simple constructed respirometer the net difference of carbon dioxide produced less the oxygen consumed. Alpha testing: 1 high school classroom (30 freshmen biology students) communicating 9 scientist mentors and 1 undergraduate botany classroom. Both T. Lafferty and M. Sundberg conducted respiration projects in their respective classrooms. The high school students gained proficiency with the technique after the initial trial and demonstrated feasibility and promise for this unit to be ready for broad dissemination in the next academic year. E. Stanley is currently reviewing the current draft and incorporating appropriate supporting resources. This summer, T. Lafferty and M. Sundberg will participate in the first PlantingScience Teacher Institute, to be held at Texas A&M University, and will demonstrate the technique and open-ended student-directed possibilities to participating teachers.

Corn Competition û intended as an introduction to experimental design  
 Scientist-teacher writing team: Gordon Uno, University of Oklahoma, and Toni Lafferty.  
 Curriculum Specialist: Ethel Stanley, BioQUEST Curriculum Consortium

Alpha testing: 1 high school classroom (30 freshmen biology students) communicating 9 scientist mentors and 1 undergraduate biology classroom. Both T. Lafferty and G. Uno conducted the corn competition in their respective classrooms. This ûinvitation to inquiryö

was readily accepted by the high school students. The unit will be polished and formatted for a PlantingScience module and, we expect, released for the Fall 2008 session. We anticipate this will be a very popular unit by first-time PlantingScience teachers.

The initial writing and classroom testing experiences have proved to be valuable learning experiences, and new writing templates, helps, and procedures for team communication, such as regular telephone conversations prior to, during, and after the classroom field testing, are now in place. A major lesson learned by Hemingway is that writing teams require more structure and support than anticipated. Additional time will be devoted to working closely with the writing teams and curriculum specialist to ensure steady progress. Planning is underway for the next round of inquiry writing retreats.

Impact: Demographic data on teachers accepted to the summer program are available to address who will be impacted by the professional development and science education research components. Teachers come from 11 states (Georgia, Wisconsin, Illinois, Massachusetts, Michigan, North Carolina, Oregon, Kansas, Missouri, Louisiana, and Texas (4). These teachers are responsible for students in grades 7(1), 6&8 (1), 10 12), 10-12 (5), and 9-12 (7). Teaching experience ranges from 3 years to 23 years, with the majority of teachers in mid-career: 2 teachers have been in the classroom 1-4 years; 3, 5-8 years; 7, 9-15 years; 0, 16-20 years; 3 >20 years. Additional data on

We have been collecting baseline data on the PlantingScience online community. Please see the attached Annual Progress Report submitted to the Steering Committee this April for tables, figures and additional narrative on tracking progress.

To date, the PlantingScience project has reached 2,486 students from 25 states across the nation working in 705 teams with online scientist mentors. And over 400,000 visitors have accessed the project website. The 2007-2008 Academic year was a year of a tremendous growth for the project, compared to the relatively stable status from Fall 2005 to Spring 2007. During that two year period, a given PlantingScience session involved on average 274 students from 7 schools working in 74 online teams. Fall 2007 saw a doubling of participants (n = 23 schools, 649 students, 210 online teams). Spring 2008 participation sustained the growth spurt (n = 25 schools/classes, 584 students, 158 online teams).

Sessions prior to this academic year saw an average of 2.25 middle schools taking part, whereas 7 middle schools enrolled in the Fall 2007 session and 6 in Spring 2008. High school participation likewise jumped from an average of 4.75 classes taking part to 11 enrolled in the Fall 2007 session and 18 in the Spring 2008. Thus, it appears that we are reaching our initial target audience of high school teachers and students and increasing the pool of middle school participants. Teachers participating in the online community include 16 repeat teachers, who return to participate with new classes, and 22 first-timers.

Over 120 scientists have signed on as scientist mentors since the project began. In a given session, the average number of mentors taking part has climbed from 56.2 per session (between fall 2005 and spring 2007) to 70.5 (during this academic year). Note that the dramatic increase in the number of participating schools and student teams has been accommodated by rather modest increases in the number of mentors. This has been possible due to contributions of the Master Plant Science Team, which was sponsored by both the BSA and ASPB this year (17 graduate students).

Recruitment processes: Application forms and program brochures were available for download from [www.PlantingScience.org](http://www.PlantingScience.org) and the Botanical Society of America. To advertise to teachers nationally, we posted information on the National Association of Biology Teachers (NABT) and National Science Teachers Association (NSTA) websites

beginning in January. The NSTA Report Vol. 19 No. 7, circulated March 2008, profiled the summer program on page 23. Information about the summer institute for teachers was also posted on Plant-ed list serve, [plant-ed@net.bio.net](mailto:plant-ed@net.bio.net), which includes K-12 members. Letters of invitation were sent directly to K-12 members of the Botanical Society of America. Contacts of project PIs also proved helpful in recruiting teachers from Georgia, Louisiana, and Texas.

Recruitment procedures for mentors have been driven primarily through the partner Scientific Societies. Project updates and call for mentors are regularly distributed to mentors through the BSA Education News and Notes section in the quarterly Plant Science Bulletin and Newsletters from Dahl. This year, a check box for PlantingScience was added to the membership form. Applications for the 2008 Master Plant Science Team are currently available for download on the front page and outreach pages of the BSA website. At this year's annual Botany meeting, mentors in the program will be recognized by ribbons on their name tags, and there will be a social mixer for current and potential mentors. Marshall Sundberg will profile PlantingScience in the past-president's symposium, which will focus this year on Scientific Literacy. Beverly Brown will receive the CE Bessy Award for her contributions to PlantingScience and education leadership in the BSA. Posters and workshops at the BSA and ASPB meetings are additional means of recruiting new mentors (see Outreach section).

Dahl has spoken about the project to a wide array of groups: Economic Botany, Council of Scientific Society Presidents, NSTA, NATB, Agronomy Society of North America, Phytopath Society of North America, North American Phytochemical Society, AIBS, American Society of Plant Taxonomist, American Fern Society, American Bryological and Lichenological Society, Carnivorous Plant Society, Society for the Study of Evolution, 4-H Science, Engineering & Technology (SET).

Evaluation activities: Internal and external evaluation plans have been discussed among the project PIs and external evaluator. See the evaluation plan attachment for details. Results of internal and external evaluation of the first summer's program will be provided in an interim report submitted this fall.

Additional support: The Monsanto Fund partnered with PlantingScience to fund initial inquiry writing retreats. Individuals contributing to this effort are included in the collaborator/contact section above. The partnership with Monsanto appears strong, and will likely continue beyond the initial two-years of funding.

In fall 2007, the BSA and the Missouri Botanical Garden partnered with the Department of Education-funded St. Louis GEAR-UP program of the University of Missouri-Saint Louis and Saint Louis Community College <http://www.stlgearup.org/> to offer PlantingScience as a resource to GEAR-UP affiliated schools. BSA staff attended GEAR UP partner meetings. Two teachers attended a January workshop at the BSA office, but none participated in the Spring session. Lack of technology, scheduling conflicts, and inadequate classroom facilities are proving to be large obstacles to participation. This partnership will likely not continue.

### **Training and Development:**

During weekly meetings, Stuessy has been providing ongoing training for the graduate students who will participate in the summer programming for teachers and students and the classroom cases studies that will take place during school-year implementation. The students are building a rich library of literature on case-based and inquiry-based learning and assessment tools, which is accessible to the entire project through a Sharepoint internal coordination site, hosted by TAMU.

The summer programming for teachers and students is in the final stages of preparation in anticipation of the August event. The detailed daily calendar of activities involving the teachers, plant scientists, and science education specialists is provided as an attachment file. The agenda is generally described here. In the first week, plant scientists Marshall Sundberg and Beverly Brown will lead teams of teachers, each with a Teacher Leader, in extensive hands-on time exploring the plant biology underlying the germination/growth and photosynthesis/respiration units and possible experimental designs that would work in their classrooms. Each day will include time for reflection and sharing. The second week will focus on skills, techniques, and teaching strategies that further support student-centered open-ended investigations. Teachers have been provided with a selection of topics to rank, and these will determine which customizable sessions are offered.

### **Outreach Activities:**

#### Outreach activities

November 2007. National Association of Biology Teachers (NABT) Meeting. Atlanta, GA  
Hemingway attended the NABT K-12 Outreach Symposium and Poster Session and distributed flyers advertising the summer program. ~30 symposium attendees, poster session open to all NABT attendees.

Stanley and Hemingway presented a Hands-on Workshop "Solve mini-mysteries with plant investigations" (Stuessy attending) to secondary school teachers and distributed flyers advertising the summer programs. ~40 teachers attended.

Flyers were distributed at booths hosted by our colleagues at the American Institute of Biological Sciences and the American Society of Plant Biologists. ~500 flyers.

January 12, 2008. BSA Headquarters. St. Louis, MO

Dahl and Cacinidin offered an in-house workshop targeted to St. Louis GEAR-UP participating schools and their science teachers. Two teachers attended.

March 2008. SCOPE Workshop. San Diego, CA

Hemingway introduced SCOPE participants to the PlantingScience program. SCOPE is an NSF-funded Phase 1 Course Curriculum, and Laboratory Improvement project, and a collaborative venture among the BioQUEST Curriculum Consortium, OER Commons, The San Diego Supercomputing Center Educational Program, and the Center for Science Education at Emory University to link existing e-science resources, web-based productivity and communication tools, and open educational resources in ways that promote communities of inquiry. [http://bioquest.org/scope/march\\_2008.php](http://bioquest.org/scope/march_2008.php) ~20 participants.

March 2008. National Association of Science Teachers Meeting. Boston, MA

500 flyers advertising the summer program were distributed at booths hosted by our colleagues at the American Society of Plant Biologists. ~500 flyers

May 2008. AAAS/AIBS Education Summit. Washington, DC

Hemingway presented PlantingScience to the participants. Hemingway and Sam Donovan (University of Pittsburg and BioQUEST) co-led a session "Best Practices in Undergraduate Biology Education: Promoting Disciplinary Problem Solving with Dynamic E-Science Resources". ~80 leaders in education from Scientific Societies and organizations from across the US attended.

#### Upcoming scheduled outreach activities:

June 2008. BioQUEST 2008 Workshop. St. Louis and Cape Girardeau, MO

Hemingway will introduce participants to PlantingScience. A number of the workshop attendees are mentors in the program, which will likely serve to recruit additional scientist



mentors from this group of undergraduate faculty. ~ 30 participants.

June 2008. Plant IT Careers, Cases and Collaborations. Texas A&M University, TX  
Hemingway, Stuessy, and collaborator Stanley are co-PIs on an NSF ITEST project, which serves as a companion to PlantingScience. Teachers will be introduced to PlantingScience, as the Plant IT project offers two successive phases of classroom engagement for teachers, the capstone event being a PlantingScience-like collaboration. ~14 teachers.

July 2008. Plant Biology 2008. Merida, Mexico  
Larry Griffing and Hemingway submitted a poster to the annual ASPB meeting.

July 2008. Botany 2008. Vancouver, BC  
Hemingway will lead a mentorship workshop for botanists 'Mentoring: What does it look like in the Science Community, the PlantingScience Online Community?'

October 2008. NABT Meeting. Memphis, TN  
Hemingway, Stuessy, and Barber's abstract for a hands-on workshop has been accepted. Barber is a scientist mentor in the program. Hemingway has also secured a booth to enhance dissemination throughout the meeting.

November 2008. School Science and Mathematics Association Meeting. Durham, NC  
Stuessy, Hemingway, Stanley and TAMU graduate student Peterson workshop.

November 2008. National Science Teachers Association. Regional. Portland, OR  
Hemingway and C. Packard (a successful middle school teacher in the program) will present a hands-on workshop.

March 2009. National Science Teachers Association (NSTA) Meeting. New Orleans, LA  
Hemingway, Stuessy 'Making meaning of science investigations with online PlantingScience mentors' workshop abstract submitted.

### **Journal Publications**

### **Books or Other One-time Publications**

### **Web/Internet Site**

### **Other Specific Products**

### **Contributions**

#### **Contributions within Discipline:**

As the first summer program will not take place until August 2008, significant results and contributions are yet to be realized.

#### **Contributions to Other Disciplines:**

#### **Contributions to Human Resource Development:**

**Contributions to Resources for Research and Education:**

**Contributions Beyond Science and Engineering:**

**Special Requirements**

**Special reporting requirements:**

Although we have not made changes to the scope of the project, we are slightly behind our desired schedule, primarily in website development and planning for the next series of inquiry modules to be developed, and have significant carry-over of funds. The carry-over for funds is partly due to the timing of our summer program and the fact that major financial outlay for the participant costs has yet to be spent.

**Change in Objectives or Scope:** None

**Animal, Human Subjects, Biohazards:** None

**Categories for which nothing is reported:**

Any Journal

Any Book

Any Web/Internet Site

Any Product

Contributions: To Any Other Disciplines

Contributions: To Any Human Resource Development

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

## Supporting Attachments

1. Annual Progress Report submitted to PlantingScience Steering Committee

### Committee Members attending:

Beverly Brown, Larry Griffing, Claire Hemingway, Sandy Honda, Valdine McLean (Friday), Barbara Schulz, Susan Singer, Ethel Stanley, Carol Stuessy, Marsh Sundberg, Gordon Uno, Paul Williams, Teresa Woods. David Dickson (External Evaluator)

Not present: Peggy Skinner, Carol Packard, Jane Ellis, Jeff Osborn

2. Detailed daily calendar for August PlantingScience Teacher Institute to be held at Texas A&M University
3. Internal evaluation plan



## 2008 PROGRESS REPORT

Submitted to the PlantingScience Steering Committee  
by Claire Hemingway

*Circulated for review April 17, 2008*

### I. AGENDA FOR APRIL 19, 2008 MEETING OF THE STEERING COMMITTEE

- 8:30 Welcome, Introductions, Amendments to Agenda
- 8:45 Overview of Relationship between PlantingScience and Plant IT
- 9:00 Review Annual Report and Progress
- 10:45 - Break -
- 11:00 Report on / Discussion of New Inquiries in Development
- 12:00 - Lunch -
- 1:30 Partnerships: ASPB, Gear-UP, iPlant Collaborative, GC Early College, and others
- 2:30 - Break -
- 2:45 Discussion of Lessons Learned / Major Challenges
- 3:15 Plans for Summer and Coming Years, including Internal and External Evaluation
- 4:00 Questions. Recap of Day. Next steps

### II. OVERVIEW OF PROJECT PROGRESS

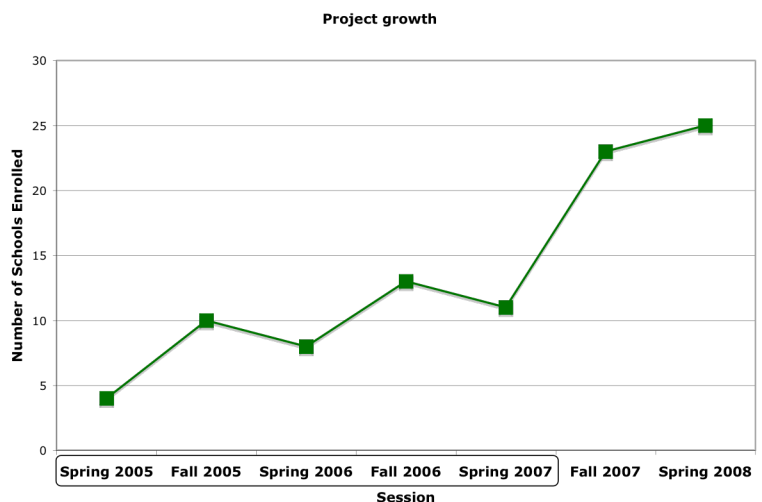
The 2007 Annual Report summarized progress and detailed participation data per session from the Spring 2005 proof-of-concept to the Spring 2007 session. For reference, that report may be accessed online at [http://www.botany.org/PlantingScience/PS\\_AnnualRev\\_07.doc](http://www.botany.org/PlantingScience/PS_AnnualRev_07.doc). This report will (1) review PlantingScience activity in summer 2007 and the 2007-2008 academic year, (2) relate recent activity to overall goals, and (3) outline projected progress for near future.

A timeline of Project Major Milestones is provided in Appendix 1.

#### II a. Participation Tracking

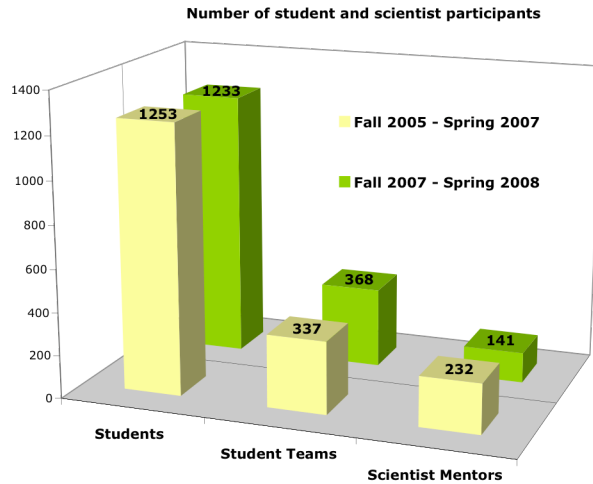
To date, the PlantingScience project has reached 2,486 students from 25 states across the nation working in 705 teams with online scientist mentors.

The 2007-2008 Academic year was a year of a tremendous growth for the project, compared to the relatively stable status from Fall 2005 to Spring 2007. During that two year period, a given PlantingScience session involved on average 274 students from 7 schools working in 74 online teams.



Fall 2007 saw a doubling of participants (n = 23 schools, 649 students, 210 online teams). Spring 2008 participation sustained the growth spurt (n = 25 schools/classes, 584 students, 158 online teams).

To put this year’s growth spurt in perspective, the figure at right compares the cumulative number of participants during the two-year period from Fall 2005 to Spring 2007 with participant numbers during the current academic year. We communicated with, accommodated, and supported online similar volume of participants this academic year as in the two years previous.



Fueling the growth was increased enrollment by both middle schools and high schools. Sessions prior to this academic year saw an average of 2.25 middle schools taking part, whereas 7 middle schools enrolled in the Fall 2007 session and 6 in Spring 2008. High school participation likewise jumped from an average of 4.75 classes taking part to 11 enrolled in the Fall 2007 session and 18 in the Spring 2008. Thus, it appears that we are reaching our initial target audience of high school teachers and students and increasing the pool of middle school participants.

Fewer colleges are now taking actively part, and the fate of the PlantingScience College Collaborations will be further discussed under Lessons Learned and Major Challenges.

Additional support from scientist mentors and project staff was required, and thankfully supplied, to address the larger volume of communication and coordination. Heather Cacanindin did a remarkable job of communicating with teachers, preparing materials to send to them, managing online student registration, coordinating St. Louis collaborations, and as well as many other support tasks. Without her efficiency and good humor, we would not have been able to support the increased activity. The process of hiring a coordinator, which must go through Missouri Botanical Garden Human Resources, began last October. The first offer was delayed and eventually declined. I have just completed a series of six phone interviews and seek to have a coordinator in place in May or June at the latest.

**Participation by teachers:** Maintaining a core for each inquiry session is a set of “repeat” teachers, who return to participate with new classes. The majority of the repeat teachers have taken part twice thus far (n=8). But other teachers return regularly (6 teachers have participated 4 or 5 times thus far) and one (Marshall Sundberg) has participated in all seven sessions with out fail.

|                   |             |
|-------------------|-------------|
| “repeat” teachers | 42%<br>n=16 |
| “first-timers”    | 58%<br>n=22 |

Several of the repeat teachers have taken on teacher leader roles. V. McLean is actively involved in the development of new inquiries, as is T. Lafferty. C. Packard is active in promoting the role of middle schools in the project and disseminating the project at national science education meetings. P. Skinner has actively promoted the project to her colleagues. A. Landry and T. Lafferty will join the first PlantingScience Teacher Institutes in Teacher Leader roles.

First-time teachers in PlantingScience commonly relay the value of their initial experience and how it has opened their eyes to their students' understanding and the potential of the PlantingScience project. Comments from several first-time teachers follow:

Just a brief note to thank you for the neat t-shirts. More importantly I thought you would like to know that last month we had a science/interest fair at our school and plant experiments were well represented. Some of the students did extensions to the Planting Science project. The most exciting though were the number of 6th grade students who did their project on some aspect of plant growth. I encouraged them to hang onto their materials in case we get to participate in Planting Science again. We are very encouraged to try again next fall. We will be more experienced and we know that we already have a few interested students.

Thanks again for such a wonderful program.

Susan W. Haninger, Technology Coordinator, Trinity Catholic Elementary School

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Just wanted to let you all know that we really had a great time doing PS this year. I plan to start it up in the Fall, so count me in. It will go even better next time because I already understand the potential of PS and how to implement it. Things got crazy around our school in mid-march due to state testing and then spring break. However, next Thursday, we're having a big press event celebrating Earth Day. The Mayor and several city commissioners from Miami Beach will be there. Planting Science will be definitely mentioned in a very positive light. I'll get photos to you.

Again, thanks for everything and definitely count Nautilus Middle School "in" next fall.

Everett Evansky, Science Department Chair, Nautilus Middle School, Miami Beach, Florida

//

Thanks to you, as well. We were very slow on the uptake and I was totally shocked at the difficulty my students (mostly 12th graders) had in creating real experiments. They're so used to cookie cutter "labs" that they idea of discovering something on their own was foreign to them. Good to know for next year in the way that I present opportunities for real inquiry in my classes.

The good news now is that I'm able to talk with my students about how their experiments worked. Most consider their experiments total failures. I'm excited to see the students rethinking their original plans and trying new things. The use of seeds worked well because several of the groups have been able to completely revamp their projects and "start over." Overall, it's been a great experience for me and a worthwhile challenge for my students. Thank you for the opportunity.

Dick Willis, Bayless High School St. Louis, Missouri

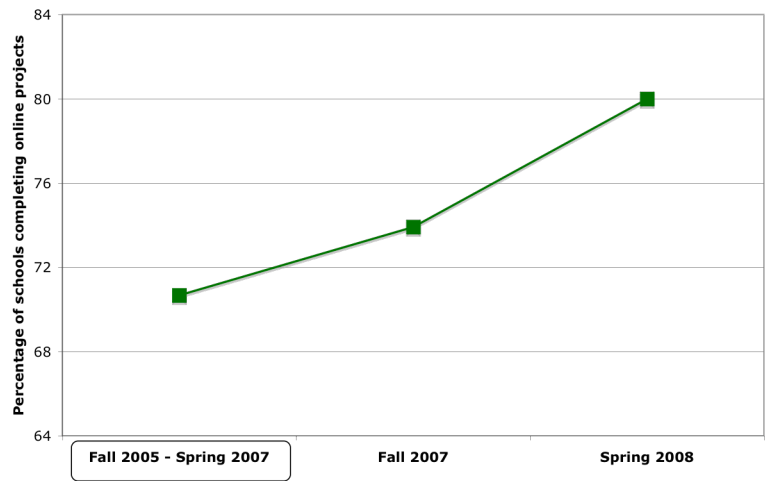
**Participation by mentors:** Over 120 scientists have signed on as scientist mentors since the project began. In a given session, the average number of mentors taking part has climbed from 56.2 per session (between fall 2005 and spring 2007) to 70.5 (during this academic year). Note that the dramatic increase in the number of participating schools and student teams has been accommodated by rather modest increases in the number of mentors. This has been possible due

to contributions of the Master Plant Science Team, which was sponsored by both the BSA and ASPB this year.

Last year’s inaugural Master Plant Science Team comprised 10 BSA members, primarily graduate students and post-doctoral students, with a couple of mid-level scientists as well. The 2007-2008 Master Plant Science Team comprised 5 graduate students sponsored by the ASPB and 12 members (some but not all graduate students) sponsored by the BSA. Members of this team commit to mentoring 3-4 teams in each the fall and spring sessions, where as most mentors communicate with 2 teams and many volunteer in only one semester. Comparisons of the quality of the dialog of members of the team to “regular” mentors are needed to confirm my impression, as a close observer of the online discourse, that members of this team form deeper mentorship relationships that the average mentor.

**Class completion of online inquiry projects:** In keeping with the previous rough estimates in last year’s report, I include here the percentage of schools enrolled in the project that actually make it to the stage of registering online and students posting at least a research question and communicating at least once with a mentor online.

As shown at right, more schools that sign on for a session are increasingly able to perform, at least the minimum. While the range of “completeness” is wide within and between school levels, and even among teams at a school. Additional screening and preparation via emails and phone conversation with teachers at the outset might explain the trend. Although the minimum criterium reported here does not adequately describe completed projects, we will continue to report this figure for comparative purposes.



To better document what information student teams are posting and quantify project completion, we have developed queries of the database. Like other items included in this report, these figures will serve as baseline data to evaluate the project before and after the addition of professional development workshops.

| Team Postings                              | Photo           | Research question | Prediction     | Research Design | Conclusion     | Research Journal | Data Sheets   | Final Presentation | Images        | Movie        |
|--|-----------------|-------------------|----------------|-----------------|----------------|------------------|---------------|--------------------|---------------|--------------|
| <b>Fall 2007</b><br>(total of 226 Teams)   | 89.4 %<br>n=202 | 85.4%<br>n=193    | 79.2%<br>n=179 | 75.2%<br>n=170  | 45.6%<br>n=103 | 40.7%<br>n=92    | 30.5%<br>n=69 | 19.5%<br>n=44      | 25.7%<br>n=58 | 1.33%<br>n=3 |
| <b>Spring 2008</b><br>(total of 150 Teams) | 96.7 %<br>n=145 | 91.3%<br>n=137    | 87.3%<br>n=131 | 72.7%<br>n=109  | 40.7%<br>n=61  | 44.0%<br>n=66    | 24.0%<br>n=69 | 13.3%<br>n=36      | 42.7%<br>n=20 | 0.67%<br>n=1 |

**Community interactions:** The 2007-2008 Academic year saw an increase in the use of the discussion forums, which were initially seeded with comments by me, but individuals voluntarily posted. The Mentor forum now has a total of 88 posts, and particular threads such as the Friday Reflections are heavily viewed (n= 11 replies, n=102 views). The Schedule thread of the Teacher and Mentor Forum has 32 posts and 243 views. The Teacher to Teacher Forum, the least used thus far, has 5 postings, 42 views.

The table below summarizes comment posted on team research web pages over the last year.

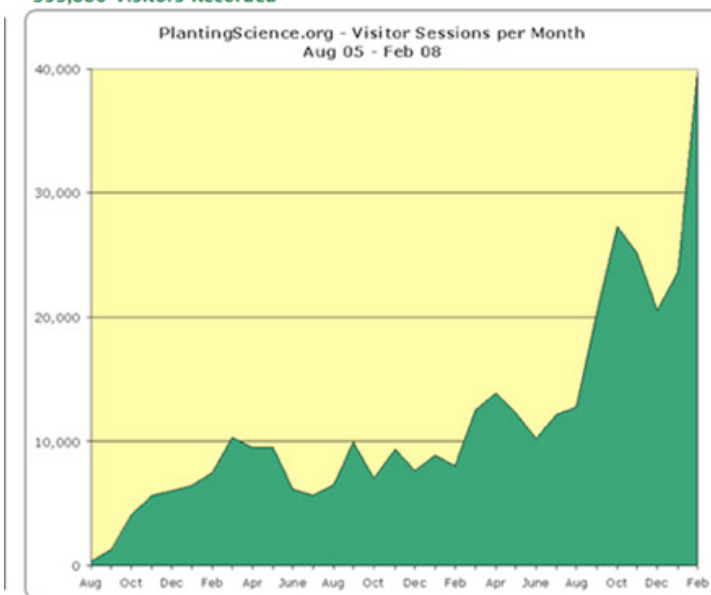
| Postings on Student Team Web Page |                | Middle School   |                      |                   | High School     |                      |                   |
|-----------------------------------|----------------|-----------------|----------------------|-------------------|-----------------|----------------------|-------------------|
|                                   |                | By Team members | By Scientist mentors | By Other students | By Team members | By Scientist mentors | By Other students |
| <b>Fall 2007</b>                  | Average number | 5.4             | 4                    | 1.6               | 5.1             | 4.2                  | 2.6               |
|                                   | Maximum number | 17              | 18                   | 4                 | 22              | 20                   | 14                |
| <b>Spring 2008</b>                | Average number | 14.9            | 7.5                  | 3.6               | 10.8            | 6.4                  | 2.9               |
|                                   | Maximum number | 58              | 29                   | 21                | 58              | 29                   | 21                |

## Website Developments and Public Website Access

Most website improvements in the last year have been made to the back end (installing a new version of a relational database, converting old data to new format, developing queries).

Public Access. The website is widely accessed. As expected, visitor sessions peak during the fall and spring online sessions. The rapid growth in project participation is mirrored in general visits to the website during 2007. Thus, more individuals are both accessing the website and choosing to participate in the project.

359,886 Visitors Recorded



## Funding

We were indeed fortunate last year, and our activities in the next year can shift from primarily proposal writing to project implementation. W. Dahl continues to make contact with prospective funders and corporate sponsors, particularly with an eye to cover web development costs.

**Monsanto Fund — Submitted 28 March 2007 / Awarded 18 May, 2007.** *Inquiry Plant Science: Innovations in High School Biology Curricula.* W. Dahl. 2 year. \$81,730. Inquiry writing retreats.

**NSF Discovery Research-K12 — Submitted 9 March 2007 / Awarded 24 Sept. 2007.** *Planting Science Research in Education.* C. Hemingway, C. Stuessy, and W. Dahl. 2 year's funds granted (\$576,996), with additional 3 years contingent on project progress and funds available. Comprehensive support. Professional development workshops at TAMU and education research.



**NSF Information Technology Experiences for Students and Teachers (ITEST) — Submitted 15 May 2007 / Awarded 24 Sept. 2007.** *Planting IT Careers, Cases and Collaborations.* C.

Hemingway, E. Stanley, and C. Stuessy. 3 year. \$932,323. Using plant investigative cases; participating in PlantingScience-like collaborations. (65) teachers and (70) student at TAMU.

**Gear-UP — Subcontract for 2008-2009 to BSA and Missouri Botanical Garden Education Department.** W. Dahl. \$66,912. 10<sup>th</sup> grade GEAR-UP students for the 2008-2009 school year.

**Presentations and Workshops (since summer 2007 and planned 2008)**

Meeting presentations and workshops presented since summer 2007 and planned

NABT National Meeting Nov. 2007 – (1 workshop) C. Hemingway, E. Stanley, C. Stuessy

In-house workshop targeted to GEAR-UP participating schools and their science teachers. January 12, 2008 – (1 workshop) W. Dahl, H. Cacinindin. Two teachers attended.

SCOPE March 2008 – C. Hemingway spoke informally at this workshop for undergraduate faculty

AAAS/AIBS Education Summit May 2008 – C. Hemingway participating in one session

Botany 2008 – (1 workshop) C. Hemingway, (1 PlantingScience Mentor Mixer)

NABT National Oct. 2008 – (2 workshops) C. Hemingway, C. Stuessy, E. Stanley, M. Waterman

NSTA Regional Meeting Portland Nov. 2008 – (1 workshop) C. Packard & C. Hemingway

**III. NEW INQUIRY DEVELOPMENT, TESTING, AND REVIEW**

The first inquiry author retreats took place summer 2007 (see milestones), and inquiries have progressed to a range of stages. The initial writing and classroom testing experiences have proved to be valuable learning experiences, and new procedures will be put into place in the future. Topics and teams have yet to be identified for the next inquiry writing retreat.

**IV. PARTNERSHIPS**

The **American Society of Plant Biologists** <http://www.aspb.org/> has partnered with PlantingScience Fall 2006. During the 2007-2008 academic year, the ASPB stepped up their involvement in the project (1) to sponsor 5 graduate student members of the Master Plant Science Team through their Good Works funds and (2) to display brochures at their booths at the NABT and NSTA meetings. A request to double their sponsorship of graduate student members of the Master Plant Science Team for next year is under consideration. Two of the five currently supported MPSTeam members provided testimonials of regarding how the benefits of the ASPB sponsorship:

Kelly Gillespie wrote, On 3/25/08 9:04 AM:

Hi Claire,

I would definitely recommend increasing the ASPB graduate student participation in the PlantingScience Program. While online mentoring can be challenging, my mentoring roll has allowed me a chance to reach out to students and schools I would have never had contact with otherwise. The classrooms I've been involved with ranged from 7th grade to high school, and even though we were all once junior high and high school students, it is easy to forget how challenging it was the first time a teacher wanted us to set up an experiment on our own. I feel like I have really helped the students understand that science isn't always about getting the 'correct' results, and that there are always things to learn from 'failed' experiments. I also feel like I've also inspired some of these students to look at plants more closely and maybe they've realized just how 'cool' plants can be!

Thank you for sponsoring my position as a member of the Master Plant Science Team, I look forward to continuing my involvement with this program in the future.

~ Kelly Gillespie

//

Emily Indriolo wrote, On 3/11/08 6:17 PM:

Hello Claire,

Here are my points in regards to the importance of Planting Science.

- 1.) This has given me an opportunity to really understand how misunderstood science is for most individuals. As the fall session indicated there is a poor understanding of the scientific method and choosing a research question and why it is valid. This is very important for the broader impacts for scientists as well. I think it is also very important for many middle school and high school students to have a positive encounter with a scientist. I know that most were not raised in the environment that I was – both my brother and I are in graduate school in science currently and my mom used to run and electron microscope. I am very well aware that it is not the norm for most individuals who could go into science with a positive attitude.
- 2.) By talking to my mom about planting science, we realized that this was an excellent way to get middle school students interested in science. My mom was shocked how excited the kids were. High school students appear to be more hit and miss from my experience in the fall session.
- 3.) Involvement in this program helped me get a fellowship for the next school year through Purdue! Wooo! No more TA for me.
- 4.) I appreciated the free membership for ASPB, however, the location of the meeting this year in Mexico was way to expensive for me to go to even with a reduced registration fee. I also opted to go to the Gordon Conference instead, but I will talk to several PIs who I've meet at past ASPB meetings at the Gordon Conference.
- 5.) Personally, I feel plant biology is underrated and unappreciated even at the university level in biology. Again, I was lucky to be in a very well rounded department at Penn State where plant biologists were 50/50 with animal biologists. Any interest we can stir in plant biology is really important.

Okay, hope this is enough!

regards,  
emily

Due to scheduling conflicts this summer, C. Hemingway will not be able to attend the ASPB Plant Biology 2008 meeting in Mexico to disseminate information and recruit ASPB members. However, we will assist L. Griffing in preparing a poster for the 2008 meetings and plan to attend the 2009 meetings.

Conversations with additional societies (including the Society for Economic Botany and the International Carnivorous Plant Society) have been initiated. We will continue to seek broad participation by individual scientists and partnerships from diverse societies and organizations.

In fall 2007, the BSA and the Missouri Botanical Garden partnered with **St. Louis GEAR-UP**, co-sponsored by the University of Missouri-Saint Louis and Saint Louis Community College <http://www.stlgearup.org/>, to offer PlantingScience as a resource to GEAR-UP affiliated schools. BSA staff attended GEAR UP partner meetings. Two teachers attended a January workshop at the BSA office, but none participated in the Spring session. Lack of technology, scheduling conflicts, and inadequate classroom facilities are proving to be large obstacles to participation.

Last week we were contacted by Dr. Melanie DeVore regarding possibility of incorporating PlantingScience in the Georgia College and State University **Early College Program** <http://info.gcsu.edu/tip/archives/2005/EarlyCollegeprograminitia.html>. Formal letter of support has been exchanged and the high school teacher (with a botany degree) with whom Dr. DeVore will work has submitted an application to the PlantingScience Summer Institute.

The **iPlant Collaborative** <http://iplantcollaborative.org/> offers immense potential as a partner in coming years. At last week's informational meeting at Cold Spring Harbor, Susan Singer (Chair of the Education, Outreach, and Training Advisory Committee and iPC Board of Directors) took the opportunity to inform participants about PlantingScience.

### Appendix 1. Major Project Milestones

| Date                               | Event   |
|------------------------------------|---|
| 2003                               | Bruce Alberts' challenge to the Society   |
| 2005 – Apr.                        | Development Committee Meeting St. Louis   |
| May                                | Proof-of-Concept: 1 middle school, 2 high school, and 1 college hand-picked classrooms<br>Subsequent fall and spring sessions with Wonder of Seeds inquiry  |
| Oct.                               | Carol Stuessy joins project as Internal Evaluator   |
| Nov.                               | Claire Hemingway assumes BSA Education Director position  |
| 2006 - Apr.                        | Strategic Plan reviewed at Steering Committee meeting   |
| Sep.                               | Scientific Inquiry through Plants ( <i>Sip</i> <sup>3</sup> ) ( <a href="http://www.plantbiology.org">www.plantbiology.org</a> ) becomes PlantingScience<br>( <a href="http://www.plantingscience.org">www.plantingscience.org</a> )<br>ASPB formally accepts invitation to partner |
| Oct-Nov.<br>fall session           | Final field testing of Power of Sunlight inquiry (M. Sundberg & V. McLean)<br>Inaugural Master Plant Science Team, with 10 BSA members  |
| 2007<br>Feb-Mar.<br>spring session | Case study of Carol Packard's classroom<br>Pilot of college-college peer mentoring<br>Monsanto Fund —2 years of funds to support inquiry writing retreats.  |
| summer                             | Inquiry Author Retreat funded by Monsanto (V. McLean, T. Lafferty, P. Williams, L. Griffing, M. Sundberg, G. Uno, E. Stanley, C. Stuessy, J. Metty, C. Hemingway)   |
| Sep.                               | <b>NSF DRK12 awarded DRL-0733280</b> —5 years; <b>NSF ITEST awarded DRL-0737669</b> —3 yrs:<br>to support programs, professional development, and education research  |
| Oct-Nov.<br>fall session           | Fieldtests: Respiration (M. Sundberg & T. Lafferty), Corn Competition (G. Uno & T. Lafferty)<br>Partnership with GearUP St. Louis   |
| 2008<br>Feb-Apr.<br>spring session | Initial trial of Genetics inquiry (P. Williams, L. Griffing, V. McLean)   |
| summer                             | <b>First Summer Institutes held at TAMU</b><br>July 7-18 Plant IT<br>August 4-13 PlantingScience (M. Sundberg & B. Brown)   |

|                 | Monday   | Tuesday            | Wednesday                          | Thursday            | Friday                 | Saturday   | Monday  | Tuesday   | Wednesday  |
|-----------------|--|--------------------|------------------------------------|---------------------|------------------------|--|---|---|--|
| 8:30-10:00      | Introduction<br>Housekeeping<br>Receive Thumb<br>Drives;<br>Expectations and<br>Options: Case<br>Study Teachers,<br>Returning<br>Teachers,<br>Teaching<br>Portfolios                                 | Bev and<br>Marsh I | Bev and<br>Marsh I                 | Bev and<br>Marsh II | Bev and<br>Marsh II    | PodCast<br>Share                                   | Student Skill<br>Development<br>For Acting<br>and Thinking<br>Like A<br>Scientist:<br>Electronic<br>Journals +<br>Options | Scientific<br>Thinking Skills:<br>Asking Good<br>Questions and<br>Making<br>Hypotheses                | Teaching<br>Skills:<br>Establishing<br>the Inquiry<br>Environment;<br>Sequencing<br>Activities;<br>Allowing<br>Time for<br>Immersion;<br>Maintaining<br>Momentum |
| 10:00-<br>10:15 | Break  | Break              | Break                              | Break               | Break                  | Break  | Break   | Break   | Break  |
| 10:15-<br>11:45 | Thinking &<br>Acting Like A<br>Scientist -<br>Overview(making<br>observations to<br>generate<br>questions: seeds<br>in various<br>conditions, seeds<br>of different<br>growth stage, )               | Bev and<br>Marsh I | Bev and<br>Marsh I                 | Bev and<br>Marsh II | PodCast<br>Instruction | Deciding<br>Your Focus –<br>Portfolio<br>Templates | Journal Skills:<br>Recording<br>observations  | Scientific<br>Thinking Skills:<br>Designing<br>Good<br>Experiments                                    | Evaluating<br>Student<br>Work on the<br>Web  |
| 11:45-1:00      | Lunch Break  | Lunch Break        | Lunch Break                        | Lunch Break         | Lunch Break            | Lunch Break  | Lunch Break   | Lunch Break   | Lunch Break  |
| 1:00-2:30       | Bev&Marsh<br>Overview<br>Together<br>(arrange groups<br>so that there are<br>individuals of<br>constructivist<br>perspective, low<br>inquiry<br>experience etc—<br>maintain same<br>small groups for | Bev and<br>Marsh I | Bev and<br>Marsh II<br>(Flip-flop) | Bev and<br>Marsh II | Teacher<br>PodCasts    | Portfolio<br>Templates                             | Journal Skills:<br>Importing<br>images  | Scientific<br>Thinking Skills:<br>Making<br>Conclusions<br>and<br>Supporting<br>them with<br>Evidence | Concept<br>Mapping and<br>Pre-Post Test<br>Design  |

|           |                              |                              |                              |                              |                              |           |                              |   |   |
|-----------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------|------------------------------|---|---|
|           | the first 4 days)            |                              |                              |                              |                              |           |                              |   |   |
| 2:30-2:45 | Break                        | Break                        | Break                        | Break                        | Break                        | Break     | Break                        | Break   | Break   |
| 2:45-4:15 | Bev&Marsh                    | Bev and Marsh I              | Bev and Marsh II             | Bev and Marsh II             | Teacher PodCasts             | Time Away | Journal Skills: Using Excel  | Scientific Thinking Skills: Communcating Thoughtfully with Scientists | Value Added: Collaborating with the Research Team |
| 4:15-5:00 | Journaling/ Daily Assessment | Journaling/ Daily Assessment | Journaling/ Daily Assessment | Journaling/ Daily Assessment | Journaling/ Daily Assessment | Time Away | Journaling/ Daily Assessment | Journaling/ Daily Assessment  | Journaling/ Daily Assessment                      |

## Internal Evaluation - Research Plan

### Research Questions

1. (a) How well do teachers' incoming proficiencies, perceptions, and practices predict their levels of reception of the summer intervention (i.e., BioQuest and PlantingScience)?  
  
(b) Are there differences in the relationships between incoming variables and levels of reception between BioQuest and PlantingScience teacher participants?
2. (a) How well do teachers' incoming proficiencies, perceptions, and practices predict their levels of classroom implementation of the intervention (i.e., BioQuest and PlantingScience)?  
  
(b) Are there differences in the relationships between incoming variables and levels of classroom implementation between BioQuest and PlantingScience teacher participants?
3. (a) What is the relationship between teachers' levels of classroom implementation and student involvement and learning in the intervention? (BioQuest and PlantingScience)  
  
(b) Are there differences between teachers' levels of classroom implementation and student involvement and learning between BioQuest and PlantingScience teacher participants?
4. (a) What is the relationship between the level of classroom intervention and high school students' interests in plant- or science-related careers? (BioQuest and PlantingScience)  
  
(b) Are there differences between the relationships between level of classroom intervention and high school students' career orientations between classrooms of BioQuest and PlantingScience teacher participants?
5. What are the effects of the summer intervention on high school students' interests in plant- or science-related careers? (BioQuest only)

### Constructs, Variables, and Instruments

#### Incoming Proficiencies, Perceptions, and Practices

**Proficiencies** – content knowledge: concept maps of underlying prior knowledge regarding concepts required for full understanding of the intervention; “ideal” concept maps will be drawn by workshop presenters; a short excursion on conventions of concept mapping will be presented to teachers, and then teachers will be asked to draw a concept map of their understanding of basic concepts and principles underlying the workshop; an electronic program will “grade” teachers' incoming conceptual understanding of the

concepts required for full understanding of the content associated with the implementation

#### Concept Map Analysis of Teachers' Incoming Conceptual Understanding

**Perceptions** – teachers' beliefs: instruments designed to measure teachers' beliefs about teaching, about their abilities to teach science, and about their ideas about the role of technology in teaching science

Context Beliefs about Teaching Science (CBATS)  
Science Teaching Efficacy Belief Instrument (STEBI)  
Role of Technology in Teaching Science

**Practices** – classroom teaching strategies: instruments designed to measure teachers' preferred teaching strategies and the frequencies with which they use constructivist-mediated teaching strategies

Modified Best Practices Survey (M-BPS-BSCS)  
Constructivist Learning Environment Survey – Teachers (Time 1) - CLES-T1

#### Levels of Reception of the Intervention

**Daily evaluation forms** – completed every day by teacher-participants to assess teachers' levels of satisfaction and concerns about the intervention

Open-ended Concerns Form

**Pre- and post-interviews of teacher-participants** – completed at the beginning and end of the summer intervention by graduate student mentors, aimed specifically at perceived barriers to full implementation, what the teachers did and did not like about the intervention, and the adaptations that they will make to the recommended intervention in order to meet expected levels of performance in the classroom

Interview Protocol

#### Levels of Implementation

**All teachers:** an instrument to measure the frequencies with which they use constructivist-mediated teaching strategies; analyses of teacher-written products associated with their implementations

Constructivist Learning Environment Survey – Teachers (Time 2) - CLES-T2  
Qualitative analysis of teachers' electronic responses to questions regarding their implementations

**Subset of Co-researcher/teachers:** classroom observations using two instruments: (1) the MSCOPS (Mathematics and Science Classroom Observation Protocol System,

Stuessy 2003), that (a) records the frequencies of complexity levels with which students are receiving and using information in the classroom, (b) records the frequency with which student-centered strategies are used in the classroom, and (c) visualizes via a colored profile the flow of the teacher's orchestration of the activities chosen by the teacher to create the learning environment; and (2) the RTOP (Reformed Teaching Observation Protocol, Piburn & Sawada, 2000), which allow classroom observers to characterize an observed classroom on a quantitative scale of reform.

Mathematics and Science Classroom Observation Protocol System  
Reformed Teaching Observation Protocol

### **Student Involvement and Learning**

**Students of all teachers** -- teachers' reports of involvement and learning – segmentation, coding, and analysis of electronic reports to reveal trends in student involvement; analysis of student products offered by teachers as evidence of learning to assess students' levels of scientific activity and accuracy – these data will be used in the first year to develop a teacher ranking scale for Year 2 of the project

Qualitative Analysis of Teachers' Reports  
Qualitative Analysis of Student Products

**PlantingScience students** – assessment via rubric of students' electronic journals to measure levels of scientific activity and accuracy; assessment via segmentation, coding and analysis of electronic dialogues with scientists to measure levels of scientific communication among students

Laboratory Journal Rubric  
Qualitative Analysis of Electronic Dialogue

### **Student Career Orientation**

**BioQuest summer students' career orientations** – pre- and post interviews of summer students' interests in science and/or plant-related careers, conducted by graduate student mentors

Student Career Orientation Interview

**All students** -- school-year pre- and post questionnaires administered by the teacher regarding their students' interests in science- and/or plant-related careers

**Student Career Orientation Questionnaire**



**Administration Schedules**

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| To Whom and When                              | Instrument   |
|---|--|
| <b>Teachers</b>                               |  |
| <u>All Teachers</u>                           |  |
| Pre-Summer Workshop                           | CBATS – electronic<br>STEBI – electronic<br>Role of Technology – electronic                      |
| Day 1 Summer Workshop                         | Concept Map<br>Pre-Interview Barriers, Adaptations   |
| Evening 1 Summer Workshop                     | M-BPS-BSCS<br>CLES-T1  |
| Daily during Workshops                        | Open-ended Concerns Formative Evaluations  |
| Post-Summer Workshop                          | Post-Interview Barriers, Adaptations   |
| Post-Classroom Intervention                   | CLES-T2<br>Electronic implementation surveys   |
| <u>Subset of Co-Researcher/Teachers</u>       |  |
| During Classroom Intervention                 | Classroom Observations – MSCOPS<br>Classroom Observations – RTOP                                 |
| <b>Students</b>                               |  |
| <u>All Students</u>                           |  |
| Teachers’ Reports of Involvement and Learning | Segmentation, coding, analysis to reveal trends of involvement and learning in both environments |
| Teachers’ Submissions of Student Work         | Analysis to reveal trends in student work submitted by teachers                                  |
| Pre-Classroom Intervention                    | Student Career Orientation Questionnaire administered and collected by teacher                   |
| Post-Classroom Intervention                   | Student Career Orientation Questionnaire administered and collected by teacher                   |
| <u>Bioquest Summer Students</u>               |  |
| Pre-Summer Intervention                       | Student Career Orientation Interview   |
| Post-Summer Intervention                      | Student Career Orientation Interview   |

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