Annual Report for Period: 01/2008 - 12/2008
Submitted on: 10/01/2008
Principal Investigator: Heatherly, Sue A.
Award ID: 0737641
Organization: AUI/Nat Radio Ast Obser
Submitted By:
Heatherly, Sue - Principal Investigator
Title:
The Pulsar Search Collaboratory-A Comprehensive Project for Students and Teachers

Project Participants

Senior Personnel

Name: Heatherly, Sue
Worked for more than 160 Hours: Yes
Contribution to Project:
Sue Ann Heatherly was in charge of recruiting participants, organizing summer and academic year activities, and overseeing those activities. She has worked closely with the project evaluator to develop an assessment strategy, and to implement that strategy with teachers and students. She works with the Project Director on a day-to-day basis to plan and carry-out project activities.

Name: McLaughlin, Maura
Worked for more than 160 Hours: Yes
Contribution to Project:
Maura McLaughlin has participated in all facets of the project from leading the development of the data reduction software, assiting in the development of the user interface and database for the PSC to development and implementation of the content instruction during PSC institutes for teachers and students.

Name: Lorimer, Duncan
Worked for more than 160 Hours: Yes
Contribution to Project:
Duncan Lorimer has participated in all facets of the project from leading the development of the data reduction software, assiting in the development of the user interface and database for the PSC to development and implementation of the content instruction during PSC institutes for teachers and students.

Post-doc

Name: Rosen, Rachel
Worked for more than 160 Hours: Yes
Contribution to Project:
Rachel Rosen joined the PSC team in the role of our Project Director.
She helped organize and teach the Summer Institutes for teachers and students. She acts as the resident science expert and is the day-to-day contact with teachers and students, providing feed back and training.

Graduate Student

Name: Yun, Maunghee
Worked for more than 160 Hours: Yes
Contribution to Project:
Ms. Yun is a graduate student in computer science at West Virginia University. She has been the primary developer in creating the Pulsar Search Collaboratory Database/website.

Undergraduate Student

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

West Virginia NSF/EPSCoR Office

West Virginia EPSCoR provided financial assistance to the PSC project during this fiscal year by granting funds to purchase a database server for the project ($4948.00).

Other Collaborators or Contacts

Other collaborators/contributors to the PSC include:

Patricia Obenauf (West Virginia University) assisted teachers in developing strategies for conducting PSC activities in their classrooms during the Education Hour segment of the PSC teacher institute.

Bonnie Thurber (Northwestern University) provided instruction to teachers on the use of the Northwestern Collaboratory website.

Many people outside the formal arrangements made through the PSC project contributed to the PSC last summer. Of note, University of Virginia graduate student Ryan Lynch, authored an excellent tutorial on pulsar science and how to search for new pulsars. In addition to his written work, he contributed many hours of his own time to help teachers and students during our summer institutes.

We invited teachers and students from the University of Texas Brownsville to participate in our student institute. They have launched a project with some similarities to the PSC under the NSF funded Partnerships in Astronomy & Astrophysics Research and Education (PAARE) program. These students are veterans at analyzing pulsar data from the Arecibo telescope. They were very helpful in assisting our high school students in conducting data analysis. We think our students benefited in many ways from the participation of the UT Brownsville students, not the least of which was the addition of diversity.

Activities and Findings

Research and Education Activities:

Findings:

Training and Development:

Outreach Activities:

Journal Publications

Books or Other One-time Publications

Web/Internet Site

Other Specific Products

Contributions

Contributions within Discipline:

It is very early in our three-year project cycle, but we have, in our first year, demonstrated that esoteric pulsar data can be understood and successfully analyzed by non-experts. And just as important, that this process is fulfilling and enjoyable to teachers and students. This is step one in our process to broaden participation in authentic science research, by making these data available and accessible for analysis by a wider group of students and citizen-scientists-- without having to obtain extensive 'in situ' training.

Contributions to Other Disciplines:

Contributions to Human Resource Development:

The PSC is a completely unique experience for the students (and teachers) who participate, and especially for students in rural Appalachian counties and districts in West Virginia a and surrounding states:

Students and teachers who participated in our summer institutes were granted time on the world's most sophisticated single-dish radio telescope. The worked hand-in hand with well-known scientists. They left feeling like part of a scientific team.

It remains to be seen if we can confer this excitement to our larger group of student who will join PSC research teams during the school year.

Contributions to Resources for Research and Education:

Contributions Beyond Science and Engineering:

Special Requirements

Special reporting requirements: None

Change in Objectives or Scope: None

Animal, Human Subjects, Biohazards: None

Categories for which nothing is reported:

Activities and Findings: Any Research and Education Activities
Activities and Findings: Any Findings
Activities and Findings: Any Training and Development
Activities and Findings: Any Outreach Activities
Any Journal
Any Book
Any Web/Internet Site
Any Product
Contributions: To Any Other Disciplines
Contributions: To Any Resources for Research and Education
Contributions: To Any Beyond Science and Engineering

Pulsar Search Collaboratory Progress Report
September 30, 2008

Pulsar Search Collaboratory Students and Teachers, July 2008

A. Activities

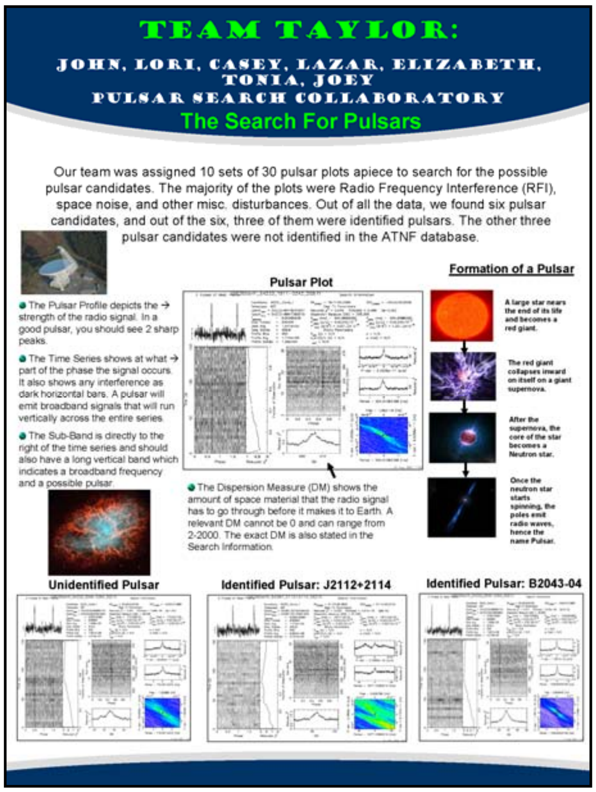
The Pulsar Search Collaboratory is a joint three-year project between the National Radio Astronomy Observatory and West Virginia University. Its aim is to stimulate student interest in STEM related careers by involving high school students in authentic research—to analyze data for the purpose of discovering new pulsars. The PSC is a comprehensive ITEST project comprising summer instruction for teachers and students, and academic year activities as well.

In summer 2008 we held two institutes at the NRAO in Green Bank—a 12 day research institute for teachers, and a 5-day student leader institute. Fifteen teachers from 4 states (11 of the 15 were from West Virginia) participated in our research institute, and 34 students participated in our student leader institute. The students were selected by their teachers.

In addition, we were fortunate to have a group of undergraduate students from the University of Texas, Brownsville joined us for the Student Institute. They are participating in a program called Partnerships in Astronomy & Astrophysics Research and Education (PAARE) (NSF 08-562), and are working with pulsar data from the Arecibo Telescope. These students were a great addition to our group.

The project goals (as stated in the ITEST proposal) are to:

- Advance high school science teachers' and students' understanding of the nature of science and the relationship between science and technology.
- Prepare teachers to implement authentic research with students.
- Promote student use of information technologies.
- Build collegial scientific partnerships between schools around the state.
- Increase student interest in and awareness of STEM career pathways.



Our summer programs placed us well on our way toward meeting these goals for our first group of teachers and students: We have successfully advanced teachers and students' understandings about the nature of science; we have prepared teachers to implement pulsar research with their students, as evidenced by significant pre-post gains in teachers conceptions of research (RSA Instrument) and at least for our student leaders who participated in the student institute this summer we have promoted their use of information technologies including scientific software and web-based collaboration tools.

Teachers first, and then their high school students worked in small research teams to master the skills necessary to analyze pulsar data, by successfully analyzing data sets. They also mastered the scientific language necessary to communicate their findings with others. Students shared the results of their data analysis during a research colloquium held during the last day of the student institute. These presentations were distilled into posters for their parents to view. The student posters are located on our Northwestern University Collaboratory website, and are also posted here: http://www.gb.nrao.edu/epo/psc08posters/

Our summer institute activities are summarized in our institute schedules shown in Appendix I.

Long-term measurements of the success of our program will come later as our academic year activities are just now beginning. Teachers are introducing their students to astronomy, radio astronomy and pulsars as we speak. School based pulsar search teams are being formed. But, only 14 students have taken our online data analysis practice test so far, so we have little to report with regard to our school-based initiatives.

B. Findings and Lessons Learned (So Far):

During our summer programs, we collected a lot of feedback from teachers and students through daily evaluations we called “How’s our Driving?”. Teachers were asked to comment on the specific activities of the day, whereas students were asked two questions: “what was the best activity of the day?” and “what could have been better?” In addition, teachers completed an overall institute evaluation which revealed areas that could be improved. Lastly, our external evaluator honed in these aspects of our summer program that were not highly rated and asked teachers for suggestions for improvement (see Appendix II). This feedback as well our own observations are reflected in the findings, lessons learned and ideas for improvement offered below:

1. Summer Institutes: Overall, Teacher and Student institutes went very smoothly. The students from the Brownsville University were a great addition, as they used their experience to help mentor our students in a gentle manner. The database worked well and the teachers and students quickly became adept at using it to analyze pulsar plots. We liked how teachers and students used their results in the database to create a pulsar candidates list to observe with the GBT.

NRAO granted GBT observing time (totaling 24 hours) to teachers and students; both teachers and students were extremely excited to use the big telescope. We like how the groups used pulsar data to "determine" follow-up sources. Students also used part of their observing time to add to the drift survey. This was a good idea as it encouraged the students to think about their science objectives and the best way to achieve those goals. Having the student groups argue about what portion of the sky to survey, and to justify their choices was exciting and a good impromptu assessment of their grasp of pulsar science. We felt like the students came away with a good grasp of observing with a radio telescope, understanding pulsars and how they work, and using the database to quantify diagnostic pulsar plots. Most of all, they left Green Bank excited about astronomy and eager to start searching for new pulsars.

Tolsia High School Students and Teacher at the controls of the GBT.

Next year, we will make the experience more interactive. We think the groups should create their own observing scripts (we have tested this idea with students in a different project, and it worked well).

a. Improvements to the Teacher Institute:

Mini-Course.

The astronomy mini-course was very intensive. In the future, the astronomy mini-course should mix inquiry-based instruction with lecture and be more interactive. This would include having the teachers work through the CLEA lab exercise earlier during the mini-course. CLEA is useful as it graphically illustrates important radio observing ideas, like pulsar period, intensity vs. frequency, pulse time-of-arrival and dispersion measure. The teachers may find having this knowledge at the start of the mini-course to be useful. Another way to make the mini-course more interactive would be to give the teachers more short projects and small group tasks.

We need to create a physics primer, including a list of equations and provide this to teachers ahead of time—many teachers were not physics teachers and had not encountered some of this content since college days. However, it was as if we'd offered manna from heaven when, after slogging through the difficult content, teachers were able to get to the business of searching for pulsars. The teachers found this aspect of the institute to be incredibly rewarding (more so because of the hard work that preceded it??).

Northwestern University Collaboratory Website (and training).

This component of the institute was ranked at the bottom of the scale by teachers in the overall institute evaluation. The instructor from Northwestern made learning how to use the website needlessly difficult. The instruction was scattered and disorganized. Teachers were frustrated. We had to spend some time un-doing the damage by re-teaching the essentials of the website, on subsequent days. It is really quite easy to use, if a bit clunky and old-fashioned. The teachers did a great job teaching the students how to use the site during the student institute. We have since experimented with "Google Apps" as a replacement for the Collaboratory website, and find that it has a lot of potential to integrate all aspects of our online work. We will investigate this further. (An aside: Independently, Northwestern Collaboratory staff have also been experimenting with Google Apps as a replacement for their site!).

Education Hour.

This component of the institute was also less highly ranked than others. While teachers enjoyed sharing ideas with each other, and reflecting on their practice as teachers, work needs to be done to make the education hour less theoretical and more practically related to implementing PSC activities in the classroom.

b. Improvements to the Student Institute.

We would like the student week to be one day longer (by making the teacher institute one day shorter). This will facilitate parental involvement if we begin or end on the weekend. We may also want to include a more general, short astronomy project using our small educational telescope. The teachers indicated that this was a useful exercise for them (but one that we cut from the shorter student institute)

The student teacher ratio was about 2:1. We divided the different teaching tasks among the teachers.

This meant that at times some teachers had no role to play but to be present. While this enabled teachers to experience the core content again, one of the teachers complained that she wasn't busy enough during the student week. Additionally, teachers commented that smaller groups would allow for a more inquiry-based approach to activities such as the "Introduction to Pulsar Observing" exercise. Next year we will restructure the week slightly so that the teachers get to lead multiple activities and gain experience teaching a range of astronomy topics—by breaking the large student group into smaller groups for concurrent activities.

2. Improvements to our web-based interface.

At this point, we have two websites: one for the pulsar database, where the students analyze the pulsar plots, and one for communication (Northwestern University Collaboratory website). The teachers, and to some degree the students, found it cumbersome to have two distinctly separate websites. It is our goal this year to merge the sites into one unified site where the students can analyze pulsar plots, discuss them with the teachers, ask astronomers questions, watch follow-up observations, and extract science from their pulsar discoveries. Google Apps may be the answer to this issue.

3. Improvements in Recruiting.

Although we had funds for 20 teachers, we were able to recruit only 15. We wonder if the structure of the institute, IE 3 consecutive weeks for teachers, had a negative effect. We are contemplating whether we should break that up in some way, while maintaining the contact hours required by the ITEST program.

In addition, we will widen our pool of applicants by recruiting teachers from districts in surrounding states (Virginia, Ohio, Pennsylvania, Maryland).

4. Improvements to Evaluation:

In our view, implementation of the evaluation plan got off to a rough start this summer. Some evaluation instruments (such as the Nature of Science Scale) were still being proposed by our evaluator while the teacher institute was in progress. As such we're not sure that we completely achieved a good fit between our goals, and the instruments we used to measure achievement of these goals. Our external evaluator spent only a brief time with us during the beginning of the student institute, and got an incomplete picture of the process. None-the-less, the evaluation was carried out as planned, much data was collected, and we have a good plan moving forward. See Appendix II for the evaluation plan, and listing of instruments used this year. Appendix III contains the report from our external evaluator.

Using MOSART , an external validated astronomy instrument, to measure pre-post gains in astronomy content knowledge is a great idea, but upon close inspection of the test we find very few test items that assess the content that we actually taught during the institutes. We will ask the creators of the MOSART tests to show us their physics and perhaps their math tests to see if we could create a new test by combining items from each.

In general, we should take a critical look at the instruments we did use during this first summer, and see if items need to be tweaked to give us a better assessment of our core goals.

C. Training and development.

Outside of our Summer Institutes, we continue to offer training opportunities through monthly real-time communication sessions with our teachers. Our first session (October 6) will consist of a toll-free teleconference coupled with a powerpoint presentation that teachers can download ahead of time. We have learned that some teachers do not have internet at home, and slow connections at school, so low-tech solutions to communication are preferable. In our first session, we will demonstrate our new integrated google PSC website and get feed back from the teachers.

D. Outreach activities.

Dissemination activities during our first year included presentations, two direct mailings to all high school science teachers, and school superintendents across West Virginia, and print and radio news coverage of the PSC.
Presentations included:

- September 2007 presentations at the WV EPSCoR Leadership Conference
- October 2007 presentation to the West Virginia School Counselors Association
- November 2007 Presentation at the West Virginia Science Teachers' Association
- January 2008 Presentation to the West Virginia Department of Education

News Coverage included (but may not be limited to):

1. NSF Announcement: http://www.nrao.edu/pr/2007/pulsarcollab/
    a. Statewide (WV) coverage by newspapers, WV Public Radio
       --Charleston Gazette (WV) - September 27, 2007

       W.Va. students, teachers to help astronomers search for pulsars
       rsteelhammer@wvgazette.com Starting next fall, about 600 West Virginia high school students and 60 teachers will join West Virginia University researchers and astronomers at the National Radio Science Observatory at Green Bank in a search for new pulsars. An $892,838 grant from the National Science Foundation to the NRAO and WVU will cover expenses involved in the three-year Pulsar Search Collaboratory project."The students in this program will be partners in frontier...
    b. Sky and Telescope, "Students to go Pulsar Hunting", October 5, 2007
       http://www.skyandtelescope.com/news/10259722.html
    c. Out of state news outlets such as: Harrisonburg, VA TV station WHSV:

       GREEN BANK, W.Va. (AP)
       Posted: 4:43 PM Sep 27, 2007
       Last Updated: 4:43 PM Sep 27, 2007

       West Virginia high school students are getting a chance to make groundbreaking discoveries in the study of pulsars. About 600 students and 60 teachers will participate next fall in a search for pulsars with researchers from West Virginia University and astronomers at the National Radio Science Observatory at Green Bank.

       The program is being funded by an $892,838 grant from the National Science Foundation. The students will analyze data compiled by husband-and-wife astronomers Maura McLaughlin and Duncan Lorimer. McLaughlin and Lorimer conducted a scan this summer that produced 120 terabytes of data. McLaughlin says every student is likely to discover a new pulsar because of the scope of the data.

2. After the 2008 summer program, a boilerplate press release (customized for each school and sent to their local newspaper outlets http://www.gb.nrao.edu/~sheather/psc/pressreleases/).

The following papers carried the story:

   a. The Wayne County News

   b. The Nicholas Chronicle, "Local Students Join Cutting-Edge Scientific Project", August 7, 2008.

c. The Herald Mail, “They're reaching for the stars. Hedgesville High teacher, student complete training at National Radio Astronomy Observatory”, September 15, 2008, http://www.herald-mail.com/?cmd=displaystory-email&story_id=203489&format=html

d. The Elkins Intermountain “EHS Students, Teachers Train at NRAO:, , Monday, August 19, 2008. http://www.theintermountain.com/page/content.detail/id/509825.html

e. VA: Roanoke Times online, “Pulsar Boys have 30 Terabytes of Info to study”, September 9, 2008.

f. PA: Johnstown Tribune Democrat, “Area Students Turn Eyes to the Skies”, August 25, 2008, Somerset Daily American and The Meyersdale Republican

g. OH: Canton Repository, “Perry students will search for pulsars”, Monday, July 21, 2008.

h. NRAO eNewsletter, “Pulsar Search Collaboratory Underway” September 21, 2009

APPENDICES

APPENDIX I : Summer Institute Activity Schedules.

Schedules for the Teacher Research Institute and the Student Leadership Institutes are included below. The Teacher Research Institute agenda is in an overview form. The blocks have been color-coded to represent instruction in astronomy content and research skills (blue), activities supporting classroom applications (green), and activities supporting the team research projects (gray) which utilized first the 40 Foot educational telescope, and later, data collected by the Green Bank Telescope. (These divisions are somewhat false as activities that provided content knowledge to participants were also part of the team research project. Activities that centered on analyzing pulsar data, also formed the foundation for classroom pulsar data analysis.)

The Student activity schedules were organized differently. We did not provide the students with schedules or agendas outlining the activities for the whole week. Rather, we employed a "carpe diem" philosophy and encouraged them to participate fully in each day, "in real-time" as it were without worrying about their final presentations and the like. Therefore, the day's schedule as provided to students at the start of each day. The daily schedules are included here, as well.

Teacher Research Institute Schedule

Day	DATE	8:30 - 9:30 AM Classroom applications	10:00 -12:30 Foundations	1:30-5:00 Research and Related	7:00 - 8:00 Research Talks
Su	6			Welcome, Orientation **NRAO-WVU staff** NRAO Site Tour	*Intro to the Radio Sky* **Jay Lockman,** **NRAO Staff Scientist**
M	7	**Education:** Beginning Where Students Are: EM Spectrum Activity **Pat Obenauf, WVU**	40 Foot Lesson **Sue Ann Heatherly** participant teams receive 40' research project	Research Team Meetings 40 Foot Observing **Project Teams**	*Pulsar Adventures* **Scott Ransom** **NRAO Staff Scientist**
Tu	8	**Education:** Emission Mechanisms **Sue Ann Heatherly**	**Astronomy Mini Course** *Core Concepts for Pulsar Astronomy* *Stellar Evolution* **Duncan Lorimer** **Maura Mclaughlin**	Radio Frequency Interference **Wes Sizemore** Quiet Skies Activities **Ron Maddalena- NRAO**	*Searching for Supernovae* **Crystal Brogan** **NRAO Staff Scientist**
W	9	**Education:** Elements of Inquiry **Pat Obenauf, WVU**	**Astronomy Mini Course** *Pulsar Properties* **CLEA Lab exercise** **Rachel Rosen**	**Tour the Electronics Lab** **NRAO Staff** Quiet Skies Activities **Ron Maddalena**	*The GBT* **Karen O'Neil** **NRAO Site Director**
Th	10	Research Talks *40 Foot projects* **Project Teams**	**Astronomy Mini Course** *The Milky Way and ISM* **CLEA Lab exercise** **Duncan, Maura, Rachel**	Tour GBT **NRAO Staff** **Astronomy Mini Course** *Searching for Pulsars* **Duncan and Maura**	**Analyzing Pulsar Plots** Computer Lab **Rachel Rosen**
F	11	**Education:** Elements of Inquiry II **Pat Obenauf, WVU**	**Team Work PSC projects**	**Collaboratory Training** **Bonnie Thurber** **Northwestern University**	roundtable discussion **staff/participants**
Sa	12		planning for GBT observing **Vlad, Rachel, Ryan**	Collaboratory Training **Bonnie Thurber**	GBT Observing begins at 7 PM-- 11 hours **Vlad and Rachel, Ryan**

Day	DATE	8:30 - 9:30 AM **Classroom applications**	10:00 -12:30 **Foundations**	1:30-5:00 **Research and Related**	7:00 - 8:00 **Research Talks**
Su	13		zzzzzzz	*Now for Something Completely Different:* Hike to ?	Research Team Meetings
M	14	**Education:** Content standards and the PSC **Pat Obenauf, WVU**	Research Team Meetings new GBT data reduction **Ryan and Rachel**	data analysis **Research Teams** **Project Staff**	*Pulsars as probes of the ISM* **Toney Minter**
Tu	15	**Education:** the PSC in your classroom **Pat Obenauf, WVU**	**Astronomy Mini Course** *Pulsar Timing* **Duncan and Maura**	data analysis **Research Teams** **Project Staff**	*Pulsars as probes for Gravitational waves* **Paul Demorest**
W	16	**Education:** Planning for Student Week **Pat Obenauf, WVU**	**Teams Plan for Student Week**	**Teams Plan for Student Week**	*Pulsars and General Relativity* **Duncan Lorimer**
Th	17	Research Talks *PSC Project Talks* **Teacher Teams**	Research Talks *PSC Project Talks* **Teacher Teams**	**Teams Plan for Student Week**	**Teams Plan for Student Week**
F	18	**check out**	**Wrap Up Planning** **debrief**	See you Monday!	

Monday 21 July 2008

Welcome to the PSC. Your discovery is here!

12:00 PM	Check-in and Lunch in the Cafeteria
1:00 PM	Exhibit Hall Concept Quest
2:00 PM	Opening Ceremony
2:45 PM	Radio Astronomy and the NRAO *Lead: Sue Ann Heatherly*
	Tour of Site and Telescopes. *Lead: NRAO staff, Rob McClain*
5:30 PM	Dinner in the Cafeteria (Family Style)
6:15 PM	Get to know your colleagues whole group activities.
7:00 PM	Wild Wonderful Pulsars: *Dr. Maura McLaughlin, WVU*
8:00 PM	Teams receive research project statements.
	Evaluation pre-tests
9:00 PM	Snacks on the Star Party Patio, Free Time
10:00 PM	Bathroom Time
10:30 PM	Lights Out

Tuesday 22 July 2008

"Six or eight weeks after starting the survey I became aware that on occasions there was a bit of scruff on the records..."

Jocelyn Bell Burnell, Cosmic Search Magazine (vol.1,no.1)

7:00 AM	Wake-Up *Today's Meal Crews: Disney, Lyne*
7:45 AM	Breakfast in the Cafeteria (Family Style): *Please enter the cafeteria quickly at breakfast and dinner – you can go back up to get fruit, desserts, and drinks after passing the food. Please clean up after yourself after meals.*
8:20 AM	Announcements in the Jansky Laboratory Auditorium
8:30 AM	Foundations: *Astronomy data Sue Ann Heatherly*
9:30 AM	Directed Studies: *Virtual Pulsar Telescope: Computer Lab*
	Lead: Glenn Birkhimer
10:30	StarLab. *Leads: Kurt Woolslayer, Betty Wasiluk*
	E.Lab Tour. *Lead: Sue Ann Heatherly with GB staff*
	Groups switch!
12:30 PM	Lunch in the Cafeteria (Cafeteria Style)
1:15 PM	Intro to the Collaboratory. *Lead: Roger Spry*
3:00 PM	Inquiry Activity: Pulsar Data. *Lead: Shawn Weaver*
3:30 PM	Intro to Pulsar Observing. *Lead: Ryan Lynch, Rachel Rosen*
5:30 PM	Dinner in the Cafeteria. (Family Style)
6:30 PM	Small Group Activities – *Star Game with Betty Wasiluk*
8:00 PM	Small Group Meetings with Teachers and Mentors
8:30 PM	Snacks on the Star Party Patio
9:00 PM	GBT Observing, by teams: *Rachel, Ryan et al.*
10:00 PM	Star Party?
11:30 PM	Lights Out.

Wednesday 23 July 2008

"The world of man lies midway in scale between the inner space of atoms and particles, and the outer space of stars and galaxies. The exploration of both these regions stretches our imagination to its limits."

Antony Hewish, 1974 Nobel Prize Banquet Speech

7:00 AM	Wake-Up
7:45 AM	Breakfast in the Cafeteria (Family Style)
	Please enter the cafeteria quickly at breakfast and dinner – you can go back up to get fruit, desserts, and drinks after passing the food. This will reduce congestion at the door. Please clean up after yourself after meals.
8:20 AM	Announcements in the Jansky Laboratory Auditorium
8:30 AM	Foundations: *Properties of Pulsars Dr. Duncan Lorimer*
9:45	Analyzing Pulsar Data: *Dr Rachel Rosen, Ryan Lynch*
11:30	RFI and Quiet Skies Activities
	Lead: Gail Sinsel
12:30 PM	Lunch in the Cafeteria (Cafeteria Style)
1:15 PM	Practice Plot Scoring. Computer Lab. *Lead: Bill Dimsdale*
3:00 PM	Recreational Activities. *Lead: Kurt Woolslayer*
	Team Project Work
5:30 PM	Dinner in the Cafeteria
6:15 PM	Whole Group Activities:*Wah!, Knots and other mysteries*
7:00 PM	What's UTB Up To? Andy
	Meet REU RET students-- Science Center Auditorium
8:15PM	Snacks on the Star Party Patio
8:45 PM	Team Meetings/Free Time
10:00 PM	Bathroom Time
10:30 PM	Lights Out

Thursday 24 July 2008

We were young, well-prepared, and receptive, but not yet wise. We were playing a detective game, gathering clues and solving logical puzzles as they presented themselves. We were enjoying the privilege of doing what we like best: satisfying our own curiosities, by asking and answering questions.

Joe Taylor, 1993 Nobel Prize Banquet Speech

7:00 AM	Wake-Up
7:45 AM	Breakfast in the Cafeteria (Family Style)
	Please enter the cafeteria quickly at breakfast and dinner – you can go back up to get fruit, desserts, and drinks after passing the food. This will reduce congestion at the door. Please clean up after yourself after meals.
8:20 AM	Announcements in the Jansky Laboratory Auditorium
8:30 AM	Foundations: *Q and A Session--Pulsar Scientists*
9:30 AM	Project Work: Teams
	Fossil Hunt. *Lead: Kurt Woolslayer*
12:30 PM	Lunch in the Cafeteria (Cafeteria Style)
1:15 PM	Project Work: Teams
	Fossil Hunt. *Lead: Kurt Woolslayer*
5:30 PM	Dinner in the Cafeteria
6:15 PM	Teams prepare to share
7:00 PM	PSC Research Colloquia: Teams share results
9:00 PM	Snacks on the Star Party Patio
10:00 PM	Bathroom Time
10:30 PM	Lights Out

Friday 25 July 2008

"In '68 January or February of that year—I remember myself meeting at the airport a friend who just returned from Great Britain, an astronomer. And he said, "Have you heard the latest?" And I said, "Well, what's that?" He said, "They've got something that pulses every second—a stellar signal that pulses every second." I said, "Oh, that couldn't be true!"
Philip Morrison, Professor of Physics at the Massachusetts Institute of Technology

7:30 AM	Wake-Up
8:15 AM	Breakfast in the Cafeteria (Family Style) *Please enter the cafeteria quickly at breakfast and dinner – you can go back up to get fruit, desserts, and drinks after passing the food. This will reduce congestion at the door. Please clean up after yourself after meals.*
8:45 AM	Evaluation. Construct Posters for display.
10:30 AM	Leadership Activities. *Lead: Sue Ann Heatherly*
	Meet with Teachers.
12:30 PM	Lunch in the Cafeteria (Cafeteria Style)
1:15 PM	Outdoor Activities: Rec area
3:00 PM	Clean Up, Pack up!
4:00 PM	Graduation, and Cookout

APPENDIX II. Detailed Evaluation Plans and Instruments

Population: TEACHERS

Name/Description of Survey or Assessment	Dimension(s) addressed	Pre	Post	Post-post	Notes/Comments
Daily feedback	Institute quality *Formative Evaluation*	N/A	N/A	N/A	Short-loop internal evaluation feedback to monitor all aspects of the Institute
RSA Instrument	Research self-assessment related to the group research project at summer institute *Formative Evaluation*	X	X		Formative evaluation information on changes related to research competencies/confidence
MOSART + pulsar questions	Content knowledge *Outcome Evaluation*	X	X	Not sure at this time	Pre at beginning of summer Post at end of institute. Depending on results we may do a post-post after the capstone course
Conceptions of the Nature of Science: NOS	Attitudes toward science and image of science *Formative and Summative Evaluation*	X	X	X	Pre at beginning of summer Post at end of summer Post-post at end of project participation. A way to summarize change over time. Use this after capstone instead of adapted VOST.
Adapted Horizon Research Survey	Characteristics of good science as reflected in teachers' classroom instruction. Assesses Kirkpatrick Model Level 2: How did the institute increase improve skills? Level 3: What changes in individual performance resulted from what was learned? Level 4: What were the final results? *Formative and Summative evaluation*	X	X	X	Formative in that it informs project leadership on what teachers report they do instructionally as a result of their understandings and professional development. Summative in that it is consistent with the National Science Education Standards
Institute Evaluation by Teachers (adapted from GSMS survey)	Assesses Kirkpatrick Model Level 1: What did the participants think of the institute? Level 2: By how much did the institute increase		X		Informs project implementation

Name/Description of Survey or Assessment	Dimension(s) addressed	Pre	Post	Post-post	Notes/Comments
	knowledge, skills and/or change attitudes? *Formative evaluation*				
Use of Collaboratory website	Teacher collaboration *Formative and summative evaluation*	ongoing	ongoing	?	Tracked by Project Director
Drafted survey?	STEM careers *Formative and summative evaluation*	X		X	At the beginning of the project and after the capstone
External evaluation surveys designed by External Evaluator, PI and other project leadership. There might also be phone interviews. Surveys administered on online by External Evaluator.	These will address the Kirkpatrick Model dimensions: Level 1: What did the participants think of the institute? Level 2: What changes in knowledge, skills and/or attitudes? Also, some SWOT analysis (strengths, weaknesses, opportunities, threats)		X	Ongoing as appropriate	This is the survey where the teachers will evaluate the instructors and institute components in detail. These are formative surveys that will also inform the summative evaluation in regard to changes over time. One of these surveys will be at the end of the teachers participation in the project.

Population: STUDENTS

Name/Description of Survey or Assessment	Dimension(s) addressed	Pre	Post	Post-post	Notes/Comments
Daily feedback	Quality of NRAO experience *Formative Evaluation*	N/A	N/A	N/A	Short-loop internal evaluation feedback to monitor all aspects of the Institute
The PSA Research Project	Research self-assessment related to the group research project at NRAO. *Formative Evaluation*	X	X		Formative evaluation information on changes related to research competencies/confidence
MOSART + pulsar questions	Content knowledge *Outcome Evaluation*	X	X	For PSC team members	Pre at beginning of summer Post at end of institute. Depending on results we may do a post-post after the capstone course
Instructors Feedback (ability to pass a pulsar	Goal 1: first hand experience in research	Practice test	Test		Tracked by Project Director via PSC database.

Name/Description of Survey or Assessment	Dimension(s) addressed	Pre	Post	Post-post	Notes/Comments
search test)					
Conceptions of the Nature of Science: NOS	Attitudes toward science and image of science *Formative and Summative Evaluation*	X	X	X	Pre at beginning of summer Post at end of summer Post-post at end of project participation. A way to summarize change over time. Use this after capstone instead of adapted VOST.
Page two of The PSA Research Project	Student demographics (including first generation), career interests and enrollment in STEM courses *Formative and Summative Evaluations*	Page 2	N/A	Last two questions on page 2	Provides information needed for evaluation reporting. Will also need to track students into college enrollment.
Online Pulsar ID Test	Pulsar algorithm assessment *Formative and Summative Evaluations*		X		An internal assessment administered online
Short student essay: Topic determined by project team	Students' **scientific writing** *Formative and Summative Evaluations*	X		X	At the beginning and end of the project. (No comparison group)
Number of student communications	Student PSC team collaborations *Formative and Summative Evaluations*	Ongoing			This is tracked by Project Director
Drafted survey	STEM careers *Formative and summative evaluation*	X		X	At the beginning of the project and after the capstone
External evaluation surveys designed by External Evaluator, PI and other project leadership.	These will address the Kirkpatrick Model dimensions: Level 1: What did the students think of the project? Level 2: What changes in knowledge, skills and/or attitudes?		X	Ongoing as appropriate	These are formative evaluation surveys and some information might be used for summative purposes.

Conceptions of the Nature of Science

I am ____ a teacher _____ a student.

For each of the statements listed below, indicate whether the statement is true, false, or you don't knowIn the space below each statement or on the other side of this paper, feel free to add clarifying comments.

Statement	True Statement	False Statement	I don't know
Scientific theories turn into laws after enough supporting evidence is accumulated.			
Theories and hypotheses are different types of knowledge.			
Scientific theories are always based on direct evidence such as observation.			
Scientific laws are always based on empirical evidence.			
Observations of the natural world are subjective.			
Experiments are designed in order to find a particular outcome.			
Scientific knowledge is based on observations of the natural world.			
Biology, chemistry, and physics comprise different kinds of knowledge.			
Science and nature are the same thing.			
The end goal of scientific activity is truth about the natural world.			
Science as a process has the ability to answer all questions, assuming that the technological ability for data collection exists.			
Regardless of the quality and amount of evidence supporting a scientific claim, if the community of scientists rejects it, the claim will not be included in the canon of scientific knowledge.			
Political and social factors govern the development of scientific knowledge.			
All questions about the natural world are valued by the scientific community.			
A scientific claim displays the creativity of the scientist making the claim.			
Scientific knowledge is discovered, not invented.			
Systematic collection and accumulation of evidence results in true scientific knowledge.			
Scientific knowledge arises primarily from experimentation.			
There may be major changes to scientific understanding of the natural world in the future.			
Once scientific knowledge is well-supported with evidence, scientists stop working on that area.			
All scientists follow the same method for testing claims.			
Probabilistic thinking is essential for developing scientific claims.			
Scientific activity (or inquiry) begins with a question or hypothesis.			

NSF ITEST PULSAR SEARCH COLLABORATORY INSTITUTE EVALUATION

Please rate the **quality** of the following aspects of the Pulsar Search Collaboratory 2008 Summer Institute for Teachers. (conducted via survey monkey)

	Poor	Fair	Good	Excellent
Living accommodations				
The food				
Access to the 40-foot telescope				
Access to scientists				
Access to NRAO personnel				
Access to equipment				
Access to scientific facilities				
Tours of NRAO facilities				
The Astronomy mini-course				
The Education hour				
Institute organization				
Coordination of the Institute				
Pulsar Data Analysis Training				
Other teacher groups' presentations				
Enrichment lectures				
Collaboratory training				
Planning for student week				

How valuable were each of these components of the research process to you?

	Not valuable -1-	Fairly Valuable -2-	Valuable -3-	Extremely valuable -4-
Learning to use the equipment				
Consulting NRAO staff				
Developing preliminary questions				
Arriving at group consensus				
Reading relevant research				
Group sharing of energy and ideas				
Collecting and interacting with data				
Separating facts from inferences				
Interpreting results				
Giving presentations				
Interacting with other groups				
Applying my knowledge toward developing student activities				

How well did the Institute prepare you for your work with students in 2008-09?

Would you recommend this Institute to colleagues?

Please use the back of this sheet for any comments you have that would help improve the Institute.

Horizon Research, Inc. National Survey of Science Education Science Questionnaire – Selected Items for the NRAO ITEST

In what state is your school located? ____________________________

1. Please provide your opinion about each of the following statements

	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
Students learn science best in classes with students of similar abilities	O	O	O	O	O
The testing program in my state/district dictates what science content I teach	O	O	O	O	O
I enjoy teaching science	O	O	O	O	O
I consider myself a "master" science teacher.	O	O	O	O	O
I have time during the regular school week to work with my colleagues on science curriculum and teaching.	O	O	O	O	O
Science teachers in the school where I teach regularly observe each other teaching classes as part of sharing and improving instructional strategies	O	O	O	O	O
Most science teachers in the school where I teach contribute actively to making decisions about the science curriculum.	O	O	O	O	O

2. How familiar are you with the National Science Education Standards, published by the National Research Council?

____Not at all familiar
____Somewhat familiar
____Fairly familiar
____Very familiar

3. How familiar are you with the Modeling Method of High School Physics Instruction?

____Not at all familiar
____Somewhat familiar
____Fairly familiar
____Very familiar

4. About how often do you do each of the following in your science instruction?

	Never	Rarely (a few times a year)	Sometimes (once or twice a month)	Often (once or twice a week)	All or almost all science lessons
Introduce content through formal presentations	O	O	O	O	O
Pose open-ended questions	O	O	O	O	O
Engage the whole class in discussions	O	O	O	O	O
Require students to supply evidence to support their claims	O	O	O	O	O
Ask students to explain concepts to one another	O	O	O	O	O
Ask students to consider alternative explanations	O	O	O	O	O
Have students use white boards to report to the group	O	O	O	O	O
Help students see connections between science and other disciplines	O	O	O	O	O
Require your students to maintain lab notebooks	O	O	O	O	O

During the 2007-08 school year about how often did students in your science classes use computers to:

	Never	Rarely (a few times a year)	Sometimes (once or twice a month)	Often (once or twice a week)	All or almost all science lessons
Did drill and practice	O	O	O	O	O
Demonstrated scientific principles	O	O	O	O	O
Played science learning games	O	O	O	O	O
Did laboratory simulations	O	O	O	O	O
Collected data using sensors or probes	O	O	O	O	O
Retrieved or exchanged data	O	O	O	O	O
Solved problems using simulations	O	O	O	O	O
Took a test or quiz	O	O	O	O	O

5. About how often during the 2007-08 school year did students in your science classes take part in the following types of activities?

	Never	Rarely (a few times a year)	Sometimes (once or twice a month)	Often (once or twice a week)	All or almost all science lessons
Listened and took notes during a teacher presentation	O	O	O	O	O
Watched a science demonstration	O	O	O	O	O
Worked in groups	O	O	O	O	O
Read from a science textbook in class	O	O	O	O	O
Read other (non-textbook) science-related materials in class	O	O	O	O	O
Did hands-on/laboratory science activities or investigations	O	O	O	O	O
Followed specific instructions in an activity or investigation	O	O	O	O	O
Designed or implemented their ***own*** investigation	O	O	O	O	O
Participated in field work	O	O	O	O	O
Answered textbook or worksheet questions	O	O	O	O	O
Recorded, represented and/or analyzed data	O	O	O	O	O
Wrote reflections (e.g., in a journal or lab notebook)	O	O	O	O	O
Prepared written science reports	O	O	O	O	O
Made formal presentations to the rest of the class	O	O	O	O	O
Worked on extended science investigations or projects (a week or more in duration)	O	O	O	O	O
Used computers as a tool (e.g., spreadsheets, data analysis)	O	O	O	O	O
Used mathematics as a tool in problem-solving	O	O	O	O	O
Took field trips	O	O	O	O	O
Watched audiovisual presentations	O	O	O	O	O

The PSC Research Project

Student Self-Assessment **(NB: RSA Instrument for teachers is identical to pg 1 of this assessment)**

Soon you will be given a group research project to complete. Indicate to what extent you agree or disagree with the following statements when you think about the research project. It is extremely important that you respond to each statement honestly. **Your responses will never be connected to you personally.** Please be sure you answer all items on the lines provided.

When I think about the research project I feel…	**Strongly agree**	**Agree**	**Disagree**	**Strongly Disagree**	**I'm not sure**
Challenged					
I can do this					
Scared					
I have the background I need for this research project					
My teammates know more than I do					
Exhilarated					
Overwhelmed					
Like I would like to know more math than I do					
I really want to succeed					
Afraid of making a fool out of myself					
My team will be able to get the right answer					
I am good at working in a team					
I could do it better myself instead of with a team					
The scientists will help me when I need it					
We will be doing valuable research					
I'm a valuable member of a team					
Doing this research will help me in other areas of science					
I know how to answer a research question					
Comfortable using scientific instruments					
I really want to do this research					
The scientists are too smart for me					
Afraid to ask the scientists questions					
If we don't replicate previous results it's "no big deal"					
I understand the scientific method					

Following the steps of the scientific method is essential					
Getting the right answer is important					
We could make an important discovery					

1. What grade in school will you be in 2008-09? 9 10 11 12
2. Which are you? Girl Boy
3. Did your Mother graduate from high school? Yes No
4. Did your Father graduate from high school? Yes No
5. Did your Mother graduate from college? Yes No
6. Did your Father graduate from college? Yes No
7. Have any of your brothers or sisters attended college? Yes No N/A
8. Do you plan to go to college? Yes No Not Sure
9. Are you Hispanic/Latino/Mexican? Yes No
10. Please check your race (if appropriate, check more than one):

Caucasian_____ African American_____ American Indian_____ Asian American_____

What science courses did you take in school last year (2007-08)?

What are your career interests?

APPENIDIX III.
External Evaluation , September 2008
NRAO ITEST Project

A. GOALS and OUTCOMES

Participation: Formative Evaluation

Targeted participation: 60 teachers and 90 students over the three years with the anticipation that 600 students will join the PSC over the lifetime of the grant period

Participation: Fifteen teachers participated in the summer 2008 program. Their opinions about the summer program were summarized in an external evaluation report (Appendix A). All 15 (100%) of the participating teachers indicated they would recommend the NRAO ITEST institute to their colleagues.

Continuing Recruitment: Since word-of-mouth is typically an effective recruiting tool for programs like this one, it is important to note that all 15 teachers reported that they would recommend the Institute to colleagues.

Participation Level: As of September 22, 2008, twelve (80%) of the 15 participating teachers have requested MOSART Astronomy pretests for students. For the three teachers who are not pretesting in the near future one teacher is involving students in the framework of a club activity with meetings outside the school day so testing is not feasible, the second teacher will teach the unit later, and the third teacher will be working with students who are members of the school's Science Honorary rather than a traditional class and at this time doesn't know how many students will be involved. One of the teachers reported on 9/21/08 that the unit is already being taught.

Information Technology (IT) Applications: Formative Evaluation

Rachel Rosen, Program Coordinator, responded to the External Evaluator's questions about how the project used these Information Technology applications in the summer of 2008:

1. **Simulations:** Project CLEA "Radio Astronomy of Pulsars" software is used to simulate pulsar observing sessions with a radio telescope
   http://www3.gettysburg.edu/~marschal/clea/CLEAhome.html
   Users: Teachers and students used the CLEA software in the summer: teachers used the CLEA software during the first week of the workshop and, in the third week, teachers led the students through using the CLEA software. Installation of the software on school computers will make it possible for teachers to lead students in their classes through the activity. As of September 30, 2008 nine teachers reported having and five reported not having the CLEA software on school computers (a tenth teacher has the software on his personal computer but not on the school computers). One of the teachers who does not have the software on the school computer does have it on the teacher's personal computer. One teacher did not respond to the email question.
   Types of Uses: The CLEA software simulates the Green Bank telescope and is a useful tool in teaching about positions of objects in the sky, when these objects are visible, and if they are observable with the GBT.

2. **Custom data reduction software and databases:** The custom graphical database was developed by pulsar astronomers http://psrsearch.wvu.edu specifically for this project.
   Users: Teachers and students at the workshop used the database and PSC students will continue to use it through the entire year. This database allows for the formation of teams at each school.

Each team is linked to a particular teacher and has a student leader. Project leadership has asked PSC teams to meet once a week to discuss their potential pulsar candidates and evaluate their rankings. The student leader can then submit all their pointings and their rankings to the astronomers.
Types of Uses: Data are already processed and the SkyMap on the main page of the database has a list of pointings, or parts of the sky. For each pointing, there are 35 diagnostic plots that were created by the processing pipeline. The user can choose any pointing and is then shown the series of diagnostic plots. The user then ranks different sub-plots of the diagnostic plots using the graphical interface on a scale of 1-3, where "3" is most likely a potential pulsar candidate and "1" is noise or RFI.

3. **Virtual Environments Laboratory**: Based at WVU, the VEL will provide the use of its computing clusters for data reduction.
   Users: While students and teachers do not have direct access to the processing pipeline, they use this laboratory indirectly (e.g., they used the resulting plots during the workshop and will continue to use them throughout the year). In addition, during the teacher workshop, teachers tried the processing software for a single pointing so they could gain a feel for how it works.
   Types of Uses: The data in raw form cannot be analyzed by students. A processing pipeline is in place on the cluster at WVU and on the computers at the Science Center in Green Bank. For each pointing, these computers search different trial values of period and dispersion measure and create diagnostic plots of the highest signal-to-noise pulsar candidates. It is these plots that are then placed on the database (http://psrsearch.wvu.edu). The processing of the data started this summer and will continue over the next three years.

The External Evaluator observed the use of the **online collaboration and documentation tools** by teachers (http://collaboratory.nunet.net.)

- **Users:** Teachers and students
- **Types of Uses:** Student team group posters and Power Point presentations are posted from this summer. Templates were available on the site which resulted in high quality presentations and posters. A discussion for teachers was started by the PI (July 13, 2008) with the question: We have had a lot of Physics this week. Which concepts and/or mathematical calculations are the most important for our students to learn-- in the context of understanding pulsars and the plots they will analyze? There was one respondent (July 24, 2008): Waves and harmonics play an important role in pulsar studies. One must understand the parts of a wave or pulse, wavelength, frequency and velocity and their relationship to one another. Angular momentum and its conservation, relativity, gravity, quantum mechanics, light and magnetism are also important concepts in pulsar studies.
- **Evaluator's Comment:** It is apparent that this tool is flexible and can serve many purposes. It is likely that an obstacle to use by teachers and students is constraint on time. As of September 23rd when this is being written use of the online collaborative has been limited to the summer, but this could easily be because school has been in session for only a few weeks.

Goals and Anticipated Outcomes

The ultimate aim of the PSC is to engage students with information technology through the conduct of scientific research. The main goals and anticipated outcomes are listed below and findings are displayed in three reports (Appendices B, C and D).

1. **Advance high school science teachers' and students' understanding of the nature of science and the relationship between science and technology.**

2. **Prepare teachers to implement authentic research with students**.

3. **Promote student use of information technologies.**

4. **Build collegial scientific partnerships between schools around the state.**

5. **Increase student interest in and awareness of STEM career pathways.**

Project Activities: Formative Evaluation

The External Evaluator's site visit report is included in Appendix E.

B. Evaluation Results
Summer 2008

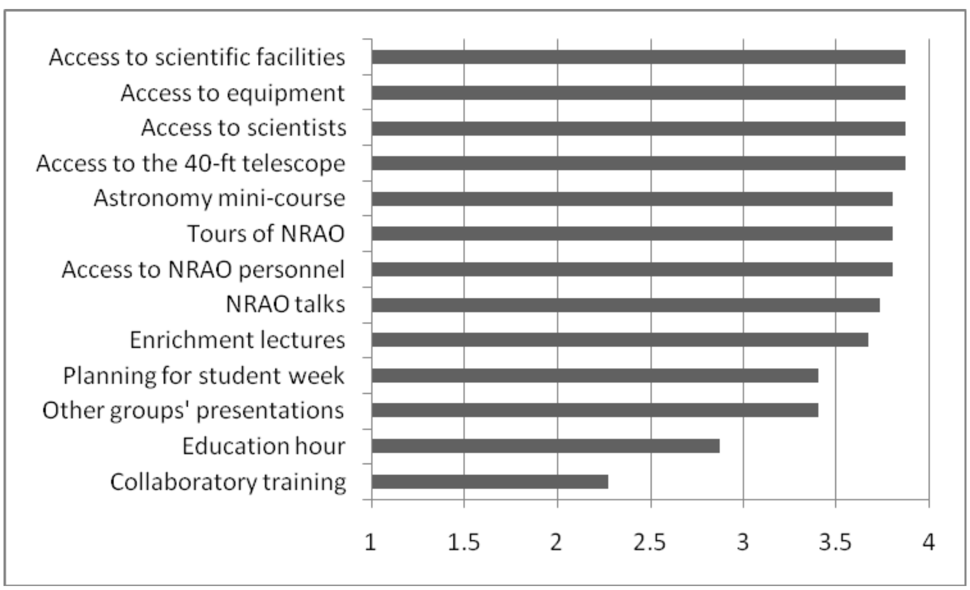
The PSC 2008 Summer Institute for teachers was held July 6 – 18, 2008 at the National Radio Astronomy Observatory in Green Bank, WV. The summer institute evaluation form was administered through NRAO using Survey Monkey. **All 15 (100%)** of the participating teachers (one from Pennsylvania and 14 from West Virginia) reported that they **would recommend the Institute to their colleagues.**

> A teacher wrote: This has been the best educational experience I have ever had.

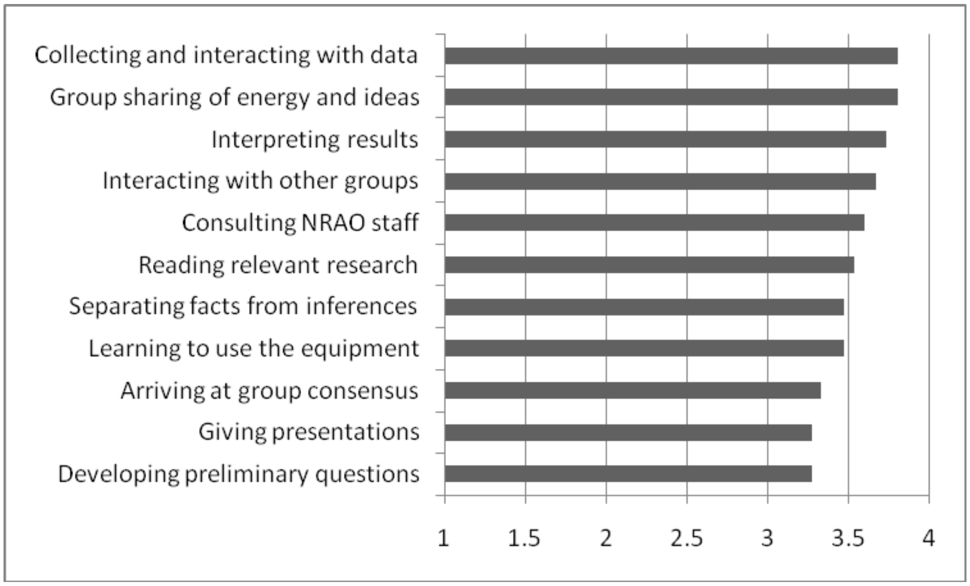
Fifteen teachers rated (Excellent-4, Good-3, Fair-2, and 1-Poor) the quality of 17 aspects of the institute.

- The living accommodations and food were rated either "good" or "excellent" by all 15 respondents; the mean ratings of living accommodations and food were 3.60 and 3.80, respectively.
- The organization and coordination of the institute were both rated (means 3.73) "excellent" by 12 respondents, "good" by two respondents and "fair" by one respondent.
- Means of the ratings of access to the 40-foot telescope, scientists, equipment and scientific facilities were all 3.87; the mean rating of access to NRAO personnel was 3.80.
- The mean rating of the tours of the NRAO facilities was 3.80 (12 "excellent" ratings and 3 "good" ratings).
- The Astronomy mini-course was rated "excellent" by 13 of the 15 respondents (mean 3.80); there was one "good" rating and one "fair" rating.
- The enrichment lectures were rated (mean 3.67) "excellent" by 10 respondents and "good" by 5 respondents.
- The four lowest mean ratings were for other groups' presentations (mean 3.40), planning for student week (mean 3.40), the Education hour (mean 2.87) and the collaboratory training (mean 2.27).

The bar chart below displays the mean ratings for 13 institute aspects (accommodations, food, organization and coordination are not displayed).



Teachers evaluated the value (extremely valuable – 4; valuable – 3; fairly valuable – 2; and not valuable – 1) of eleven components of the research process. The mean ratings of the eleven components are displayed in the bar chart below. There was only one "not valuable" rating recorded and it was for "developing preliminary questions." The mean ratings were 3.27 or greater.



Six teachers reported that the institute prepared them very/extremely well for working with students and two teachers reported that the institute prepared them "pretty well". Three teachers commented on the benefits of the institute:

Interesting approach for teaching astronomy
Opened my eyes for the need to use more technology in the classroom
A great way to do real-world research and inquiry with students

Teachers commented on the Institute's Student Week:

- Student week was very well received in the sense that the students are very excited to take part in this project as well as share this wonderful opportunity with others at their school.
- It showed me what I lack in technology and also gave me good ideas to get more astronomy covered using physics concepts like wavelength, frequency, etc
- Great! The kids were excellent to work with and I enjoyed working with the other teachers' students.
- I always learn more when I have to teach a concept. After the student week, I feel better prepared to teach the concepts to students at my school.
- It helped me know where some of my weaknesses were, regarding the data plots.
- I think it will help me to be successful with the students in the upcoming school year.
- The student week gave me an overview of how to begin. I can model this on a daily basis for my classroom.

Teachers suggested ways to improve the Institute:

- Perhaps providing some pre-reading material or internet links for teachers to become more familiar with before there arrival may better prepare them for the concepts that will be covered.
- Don't mix collaboratory training with other concepts on the same day.
- Open it up to more of a regional program if you can't fill it up locally.

- Add time for the students from a school to meet with their cooperating teacher to begin designing how to best implement the program once everyone returns to school.
- Make sure the scientists know that the teachers are not physics teachers. Don't assume that we know anything. I know that I didn't.
- I found the student week disorganized. Granted there were things that had to be adapted on the spot, but there should have been more useful things the teachers could be doing when not teaching or mentoring

These were other comments:
- I am excited to see my students work with the pulsar plots and discover a pulsar.
- Since the press release in the local paper, I have had students approach me wanting to join the team.

After processing the survey data the External Evaluator posted a web-based survey with four questions: What were the strengths of the (1) Education Hour and (2) Collaborative Training, and how can the (3) Education Hour and (4) Collaborative Training be improved? The results are summarized below.

The Education Hour	
Strengths	**Improvement Suggestions**
• It was a time to reflect at a pace different from the rest of the day. • It challenged participants to defend and evaluate their beliefs. • The best parts were when we were taught how to teach skills or interact with our students, or when the instructors modeled how to teach. • Sharing ideas on how to improve instruction. • The ability to interact with colleagues....always valuable to teachers • Learning the "cutting edge" information about pulsars • Guest lectures and demonstration/activities • Lectures by the scientists were absolutely the best part. Being exposed to the information they gave us was great. • The WVU instructor is such a deep thinker and always gives me something to ponder.	• Make it more interactive - a monologue is not always the best way to increase learning. • The time with WVU for the most part was not as useful. • Although it was good to see the different viewpoints of some professors much of what they talked about is not useful to teachers. Our students' greatest need is to learn how-to-think, not what-to-think. • Make it more practical • Make it more relevant to what teachers do in the classroom. • Make it more relevant to what teachers are doing in class. • I believe it was well-organized and appropriate, therefore I would not improve upon it. • Sometimes I did not always know the point the WVU instructor was trying to make. Would like to see the education hour learn more towards astronomy and how we, "star stuff" are contemplating the universe.

The Collaborative Training	
Strengths	**Improvement Suggestions**
• It allowed more bonding among participants.	• Have a well trained leader along with a well

The Collaborative Training	
Strengths	**Improvement Suggestions**
• Exposure to the software • Communication among teachers-teachers and teachers-students. • The idea of the collaboratory is the strongest aspect. The idea of being able to share information with other schools and work on projects is interesting.	thought out plan for the process along with a working (and easily understood) platform. • More direct instruction • Part of the problem is the software itself, which is not as good as others of its type. • Give us a list of technical requirements for computers before attending the workshop. • The collaboratory training had many downfalls. It appeared that there was little communication before hand with the collaboratory instructor. She seemed unprepared with no practice materials on which to work. We had to improvise with the pulsar data to practice and, I thought, that the plan was to work on this information at a later time. • Was done at too fast of a pace, mixed in with astronomy training the same day. We should spend a day or more just learning how to use the collaboratory alone and do pulsar training on separate days. Don't mix them.

These were other comments made either on the paper-and-pencil survey or the follow up electronic survey:

- I am excited to see my students work with the pulsar plots and discover a pulsar.
- Since the press release in the local paper, I have had students approach me wanting to join the team.
- Need more time for solving mathematical problems
- I learned so much in such a short amount of time and I believe it was an amazing training/learning opportunity.
- Give us a list of technical requirements for computers before attending the workshop. For example I am having trouble getting our IT person to download programs for our computer lab, because they are so busy.
- It was great. They gave us so much time to learn new and exciting material and see and discover for ourselves.
- One of the strongest things about this was that students are involved with real data and they are able to interact with scientist and other students across several states. Teachers got to team teach with other teachers of several disciplines.
- A strength: 1) Meeting with pulsar astronomers in informal as well as formal settings 2) Having nothing else we were expected to do except think, work, learn about Pulsars
- Make sure everyone has a good calculator. Then give more practical problems to determine pulsar information, preferably worked out with the group and then practice alone. Also, more basic information about plots. Students received simple but very clear information about how to read plots.
- A strength was learning the real calculations needed to locate pulsars and their movement

External Evaluation Recommendations and Comments

In its first year the Institute delivered meaningful professional development in a friendly environment. The administration, organization and facilitation of the Institute were high quality and there is a process in place for the PI and the Program Director to consistently record ideas for improving and refining the project. This is a PI who knows how to successfully administer a complex institute and continually process feedback from teachers, students, facilitators, scientists and other staff.

It became apparent during the follow-up phase of this evaluation that many of the teachers did not know which Institute activities comprised the Education Hour, the Enrichment Lectures and Collaboratory Training. The forms on which the teachers evaluate the Institute need to be more specific the next time they are administered. Additionally, the survey should be posted on the External Evaluator's website in the interest of increased anonymity.

It would be helpful if each aspect of the Institute had explicitly stated learning objectives available to the External Evaluator before next summer's Institute. Displaying the learning objectives on an evaluation form would allow teachers to self-assess their "before" and "after" knowledge and skills pertaining to the objectives; the form should be posted on External Evaluator's website. The Astronomy Mini-Course is used here as an example:

Rate your skills and knowledge BEFORE the Institute				**Astronomy Mini-Course Learning Objectives**	**Rate your skills and knowledge AFTER the Institute**			
Poor 1	Fair 2	Good 3	Excellent 4		Poor 1	Fair 2	Good 3	Excellent 4

The preliminary online introduction to the PSC, which was an introduction to the Institute, was not a strength this summer. It appears that this introductory component would benefit from being re-conceptualized in terms of time (Should it be before the Institute or one of the first things that is done during the Institute?), instructor (Should the Program Director be the instructor?), content (Should assessment of participants' readiness to incorporate IT into their core courses be included? How can the Institute build on the national and state standards researched and documented?), technology (Can the technology delivery of this introductory component be improved?), and contact time (Since the average time teachers reported spending on the introductory piece was ~4 hours – times ranged from one hour to 10 hours – is there a way to adapt this component so that the projected contact requirement of 10 contact hours between staff and teachers is met for all teachers?)

Shaw (9/10/08)

C. Pre/Post Assessments Summer 2008

Pre/Post Testing Obstacles

It became apparent during the processing of all the pre/post tests that teachers were probably tired when they completed the post-tests. The reader is cautioned to not over-interpret the results. The MOSART and *Conceptions of the Nature of Science* instruments will be administered post-post at the end of the project year. The External Evaluator anticipates that the pretest to post-posttest change will be more reliable than the pre to post change.

MOSART reporting at this time is limited because the MOSART psychometrician at Harvard who does the analysis was in a serious accident and is on leave. The complete results are expected in the next six months. At this time a total score was computed from raw data that were sent from Harvard to the External Evaluator.

Teachers: Pulsar Facts

A seven question multiple choice test was designed by the instructional team and administered pre and post. There was a statistically significant gain from pre to post in total score (one-tailed $t = 3.39$, $p < .0049$, $n=14$). The total possible score was 7.

	N	Mean	Std. Dev.	t	p
Pretest	14	4.79	1.85	3.39	.0049
Posttest	14	6.14	0.86		

Six of the 15 teachers (one of these teachers didn't take the pretest) who took the post-test scored "7" on the posttest; two of them also scored "7" on the pretest. Seven teachers scored "6" on the posttest.

Teachers: Astronomy MOSART

The following note is posted on the MOSART website.

> ***Note for Astronomy Tests:*** *Test items for the K-12 astronomy and space science standards were developed with funding from NASA's Science Mission Directorate, via the Universe Education Forum at the Harvard-Smithsonian Center for Astrophysics.*

The pre/post test scores are displayed below for all the teachers. There was a "ceiling effect" for two teachers who responded correctly to all items (a perfect score) on the pretest. One teacher answered all items correctly on both the pre and posttests. Four (31%) of 13 teachers made significant gains from the pretest to the posttest.[1] The pretest mean was 16.52 (Std. Dev. = 3.08) and the posttest mean was 16.46 (Std. Dev. = 2.82).

[1] Post-score > Pre-score + (1/3 * $StdDev_{pretest}$)

ID CODE	Pretest Astronomy MOSART	Posttest Astronomy MOSART	Change from Pre to Post	Significant Increase?
071350	20.00	20.00	0	
012751	20.00	19.67	-0.33	
040557	19.00	16.50	-02.5	
110350	18.33	16.67	-1.66	
010867	18.00	18.33	+0.33	
103167	17.83	18.67	+0.84	
101637	17.33	18.67	+1.34	Yes
052063	17.17	15.17	-2.00	
082546	16.83	16.83	0	
011064	15.67	17.00	+1.33	Yes
082851	15.67	16.50	+0.83	
041156	15.50	17.17	+1.67	Yes
121662	15.50	10.00	-5.50	
031166	13.50	14.33	+0.83	
092879	7.50	11.33	+3.83	Yes

Pretest and posttest mean scores for the seven women and eight men differed, but the difference was not statistically significant.

	Astronomy MOSART Assessment					
	Female Teachers			Male Teachers		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Pretest	7	15.45	3.94	8	17.46	1.86
Posttest	7	15.83	2.35	8	17.00	3.23

Teachers: Pre/Post *Conceptions of the Nature of Science (CoNS)*

Conceptions of the Nature of Science was administered pre-Institute and post-Institute to assess attitudes toward science and image of science. It will be administered (delayed-post) at the end of the school year. Five (33%) of the 15 teachers made significant gains from pretest to posttest. The pretest mean was 5.07 (Std. Dev. = 5.39) and the posttest mean was 3.53 (Std. Dev. = 4.79).

ID CODE	Pretest CoNS	Posttest CoNS	Change from Pre to Post	Significant Increase?
010867	19	5	-14	
011064	7	11	4	Yes
012751	1	2	1	
031166	8	-3	-11	
040557	3	-3	-6	
041156	7	3	-4	
052063	3	3	0	
071350	11	13	2	Yes
082546	-3	3	6	Yes
082851	-2	1	3	Yes

092879	5	9	4	Yes
101637	1	-1	-2	
103167	5	5	0	
110350	7	6	-1	
121662	4	-1	-5	

Pretest and posttest mean CoNS scores were higher for men than women but because of small numbers of scores statistical power was very little so analysis was limited.

	Conceptions of the Nature of Science					
	Female Teachers			Male Teachers		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Pretest	7	2.71	4.22	8	7.13	5.67
Posttest	7	1.71	4.57	8	5.13	4.67

Teachers: Research Self-Assessment

Teachers completed the Research Self-Assessment both before the Institute and at the end of the Institute (pre/post). Total scores were computed with negative items numerical ratings reversed when integral rates were assigned to the rating scale: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1. There was a statistically significant increase in total score from pre to post
($t = 1.59$; $p < 0.0674$) for the 15 teachers and there was a statistically significant difference in difference in pre to post scores for men and women ($F = 4.77$; $p < 0.0479$).

	Teachers: Research Self-Assessment								
	All Teachers Pooled			Female Teachers			Male Teachers		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Pretest	15	82.53	8.37	7	82.14	9.41	8	82.87	8.01
Posttest	15	87.67	10.55	7	80.57	10.42	8	93.87	5.91

In the interest of thoroughness the distributions of responses to all the items both pre and post are displayed below.

	PRETEST Responses				POSTTEST Responses			
	SD	D	A	SA	SD	D	A	SA
1. I am comfortable using the telescope.		2	5	8			9	6
2. I am scared.	8	4	2	1	11	3	1	
3. I don't have the background I need for this.	7	4	4	0	7	7	1	
4. My teammates know more than I do.	2	6	4	3	1	6	8	
5. I am exhilarated.	1	1	5	8		2	5	8
6. I am overwhelmed.	8	4	1	2	7	6	2	
7. I need more math competence.	4	9	2		4	2	6	3
8. I really want to succeed.			2	13			3	12
9. I am afraid of making a fool out of	8	1	5	1	11	4		

	PRETEST Responses				POSTTEST Responses			
	SD	D	A	SA	SD	D	A	SA
myself.								
10. I know how to answer a research problem.		4	6	5		2	7	6
11. I will be able to apply this research to other areas of science		2	8	5	1		5	9
12. My team won't be able to get the right answer	11	3	1		8	6	1	
13. I don't know whether I can get it done.	7	6	2		8	4	3	
14. I don't like depending on other people.	4	9	1	1	2	10	1	2
15. I know I could do it better myself.	7	6	1	1	6	6	3	
16. The scientists will help me when I need it.		1	7	7			2	13
17. I feel like I don't know anything.	6	7	2		8	6	1	
18. I really want to do this research.	0	0	3	12	1		4	10
19. The scientists are too smart for me.	4	7	3	1	1	11	2	1
20. I am afraid to ask the scientists questions	9	6			11	4		
21. I'm afraid we won't replicate earlier results.	4	11			5	10		
22. I am looking forward to working in a group.		1	7	7			6	9
23. Using the scientific method is essential.		1	7	7			5	10
24. I am worried about getting this project completed on time.	6	9			5	6	3	
25. I feel confident about doing research	0	1	8	6		1	7	7
26. Getting the right answer is important	1	10	4		3	7	3	1
27. I don't have the necessary computer skills to do this research	7	7	1		7	4	2	2

Exploratory Analysis: MOSART and Teacher's Research Self-Assessment

The Best Subset Regression procedure was used to compute the best subset regression model that contains all the potential predictor variables of interest. For this group of 15 teachers, the best subset of items from the Research Self-Assessment for predicting the MOSART pretest score ($MOSART_{PRE}$) are Item #17, Item #22, Item #15 and Gender (male or female) represented algebraically as $\mathbf{X_{17}}$, $\mathbf{X_{22}}$, $\mathbf{X_{15}}$ and **G**, respectively. The R-squared and adjusted R-squared for this model are $R^2 = .9116$ and $R_{adj}^2 = .8763$. The regression equation is:

$$\mathbf{MOSART_{PRE} = -6.11475X_{17} - 3.68569\,X_{22} - 1.13638\,X_{15} - 3.19105G}$$

Teacher Pretest Results: Classroom Instruction

The classroom instruction survey consists of selected items from the Horizon Research, Inc. National Survey of Science Education. This pretest provides formative information in that it informs project leadership on what teachers report they do instructionally as a result of their understandings and professional development. Consistent with the National Science Education Standards, it provides summative information pertaining to characteristics of good science as reflected in teachers' classroom instruction. Three evaluation questions are related to the administration of this survey:

How did the institute increase improve skills?
What changes in individual performance resulted from what was learned?
What were the final results?

The posttest will be administered at the end of the school year. The results are displayed here as frequency distributions. All 15 teachers (12 from WV schools, one from PA , one from VA and one from OH) completed the survey.

Teachers' Opinions					
	Percentage of Responses				
	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
Students learn science best in classes with students of similar abilities		40	7	53	
The testing program in my state/district dictates what science content I teach		33	7	53	7
I enjoy teaching science		7		13	80
I consider myself a "master" science teacher.		31	15	31	23
I have time during the regular school week to work with my colleagues on science curriculum and teaching.	33	47		20	
Science teachers in the school where I teach regularly observe each other teaching classes as part of sharing and improving instructional strategies	60	40			
Most science teachers in the school where I teach contribute actively to making decisions about the science curriculum.	13	33	7	40	7

Question: How familiar are you with the National Science Education Standards, published by the National Research Council?

13% Not at all familiar
40% Somewhat familiar
27% Fairly familiar
20% Very familiar

Question[2]: How familiar are you with the Modeling Method of High School Physics Instruction?

60% Not at all familiar
13% Somewhat familiar
27% Fairly familiar
None Very familiar

[2] This question is not on the Horizon Research Inc. Survey.

Classroom Practice: How often do you do each of the following in science instruction?					
	Percentage of Responses				
	Never	Rarely	Some-times	Often	Always or almost always
Introduce content through formal presentations		7	20	60	13
Pose open-ended questions		13	33	33	20
Engage the whole class in discussions			20	40	40
Require students to supply evidence to support their claims		7	20	33	40
Ask students to explain concepts to one another			20	73	7
Ask students to consider alternative explanations		13	33	33	20
Have students use white boards to report to the group	20	13	33	33	
Help students see connections between science and other disciplines			27	40	33
Require your students to maintain lab notebooks	13	13	13	13	47

Note: Rarely (a few times a year); Sometimes (once or twice a month); Often (once or twice a week)

Classroom Practice: How often did the students in your science classes use computers in 2007-08 to…					
	Percentage of Responses				
	Never	Rarely	Some-times	Often	Always or almost always
Do drill and practice	27	40	20	7	7
Demonstrate scientific principles	7	7	53	20	13
Play science learning games	13	40	40		7
Do laboratory simulations		21	50	29	
Collect data using sensors or probes	33	7	47	13	
Retrieve or exchange data		40	20	33	7
Solve problems using simulations	7	27	60	7	
Take a test or quiz	20	33	20	20	7

Classroom Practice: Frequency of learning activities in 2007-08					
	Percentage of Responses				
	Never	Rarely	Some-times	Often	Always or almost always
Listened and took notes during a teacher presentation			20	20	40

Classroom Practice: Frequency of learning activities in 2007-08					
	Percentage of Responses				
	Never	Rarely	Some-times	Often	Always or almost always
Watched a science demonstration			53	40	7
Worked in groups			20	53	27
Read from a science textbook in class	7	40	20	27	7
Read other (non-textbook) science-related materials in class	13	20	40	27	
Did hands-on/laboratory science activities or investigations			13	60	27
Followed specific instructions in an activity or investigation		7	13	47	33
Designed or implemented their ***own*** investigation		40	40	20	
Participated in field work	33	40	20	7	
Answered textbook or worksheet questions		7	20	60	13
Recorded, represented and/or analyzed data		7	20	67	7
Wrote reflections (e.g., in a journal or lab notebook)	20	33	7	27	13
Prepared written science reports	7	29	7	43	14
Made formal presentations to the rest of the class		71	21	7	
Worked on extended science investigations or projects (a week or more in duration)	7	67	20	7	
Used computers as a tool (e.g., spreadsheets, data analysis)		20	33	40	7
Used mathematics as a tool in problem-solving			33	20	47
Took field trips	60	33	7		
Watched audiovisual presentations		27	40	20	13

Students: Pre/Post PSC Research Project Self-Assessment

Students completed the Research Self-Assessment form before the Institute and at the end of the Institute (pre/post). Total scores were computed with negative items numerical ratings reversed when integral rates were assigned to the rating scale: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1. There was a statistically significant increase in total score from pre to post
(one-tailed $t = 4.04$, $p < 0.0002$, $n = 31$). The total possible score was 108.

	N	Mean	Std. Dev.	t	p
Pretest	31	75.58	12.31	4.04	.0002
Posttest	31	83.71	9.22		

Students: Pre/Post *Conceptions of the Nature of Science*

Conceptions of the Nature of Science was administered pre-Institute and post-Institute to assess attitudes toward science and image of science. The pretest mean was 2.82 (Std. Dev. = 4.40) and the posttest mean was 1.88 (Std. Dev. = 3.73) for 33 students who took both the pretest and posttest.

Perhaps consideration should be given to administering the Pulsar Facts (7-question test) to next year's students instead of the *Conceptions of the Nature of Science*.

Shaw (9/11/08)

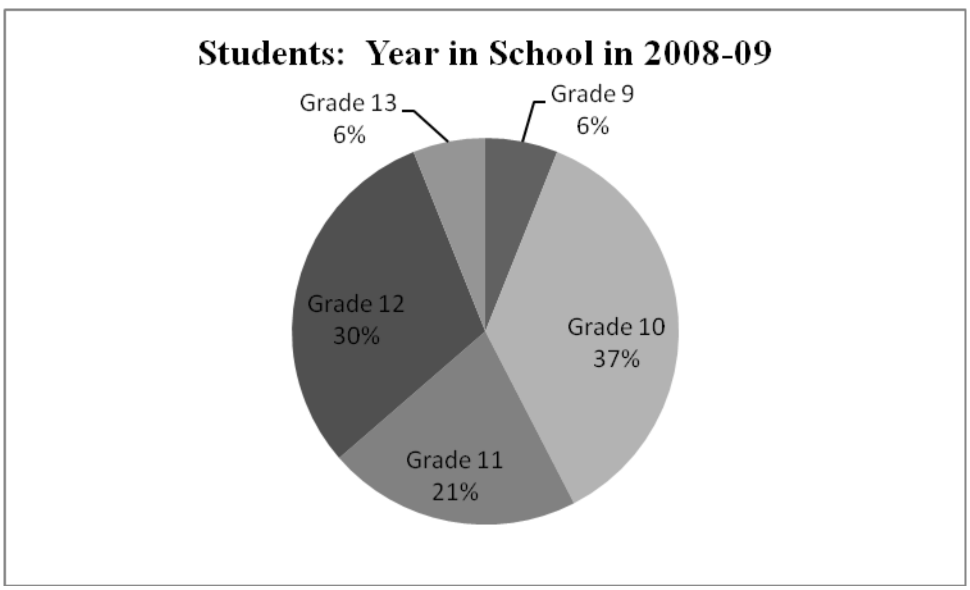
D. Student Self Assessment Results
Summer 2008

This report is a summary of the information gathered from the 34 participating students (15 girls and 19 boys) at the beginning of the week when they first attended the Institute. Four students identified themselves as Hispanic/Mexican/Latino (Caucasian race) which is an under-represented minority group in science, mathematics, technology and education (STEM). Two of the other 30 students are Asian American and 28 are Caucasians.

The parents of 28 (82%) of the 34 students graduated from high school; for the other 6 students the mothers of two students did not graduate from high school, the fathers of three students did not graduate from high school and one student reported that neither mother or father graduated from high school. Thirty of the students indicated that they plan to attend a four-year college or university after graduating from high school; two students don't know what they will do after high school and two students plan to attend a two-year community college after graduating from high school. The student whose mother and father did not graduate from high school plans to attend college after graduating from high school.

For the 28 students with siblings, 10 of the participating students have brothers or sister that are attending or have attended college. The following display additional demographic data.

	Father Graduated from College	
	YES	NO
Mother Graduated from College YES	14 students	8 students
NO	3 students	9 students



Students recorded their level of agreement (strongly agree, agree, disagree, strongly disagree) with 27 statements (Appendix). Integral weights were assigned agreement levels with 4=strongly agree, 3=agree, 2=disagree and 1=strongly disagree. Based on mean ratings the highest agreement levels were for the following displayed in descending order of agreement.

I really want to succeed
We will be doing valuable research
We could make an important discovery
Doing this research will help me in other areas of science.
I really want to do this research
Following the steps of the scientific method is essential.
I understand the scientific method.

The lowest agreement levels were for the following items displayed in descending order of agreement.

Afraid of making a fool out of myself
Scared
The scientists are too smart for me
Overwhelmed
If we don't replicate previous results it's "no big deal"
Afraid to ask the scientists questions
I could do it better myself instead of with a team.

Additional exploratory data analysis revealed for students who were sure about how they felt that 100% of the students agreed (AGREE or STRONGLY AGREE[3]) with these six statements:

- **I really want to succeed** (71% recorded SA)
- **We will be doing valuable research** (58% recorded SA)
- **We could make an important discovery** (53% recorded SA)
- **Doing this research will help me in other areas of science** (47% recorded SA)
- **I understand the scientific method** (44% recorded SA)
- **The scientists will help me when I need it** (41% recorded SA)

A total score was computed with "I'm not sure" responses coded "zero". Negative statements (numbers 3, 7, 10, 13, 21, 22, and 23 were transformed with $x_n = 5 - x_n$. The total possible score was 108 (4 X 27); the mean score was 76.5 (Std. Dev. 12.34; N = 34). There was not a significant statistical difference between total scores for boys and girls.

	N	Mean	Std. Dev.	t	p
Girls	15	75.67	12.13	0.35	0.7323
Boys	19	77.16	12.80		

External Evaluation Comments and Recommendations

Based on self-assessment results, the student participation selection process was excellent. A majority of the students wanted to succeed and viewed science as valuable. Only 9 (26%) of the students reported being scared and/or overwhelmed while 73% felt exhilarated; 97% of them agreed (A or SA) with the statement, "**I can do this**."

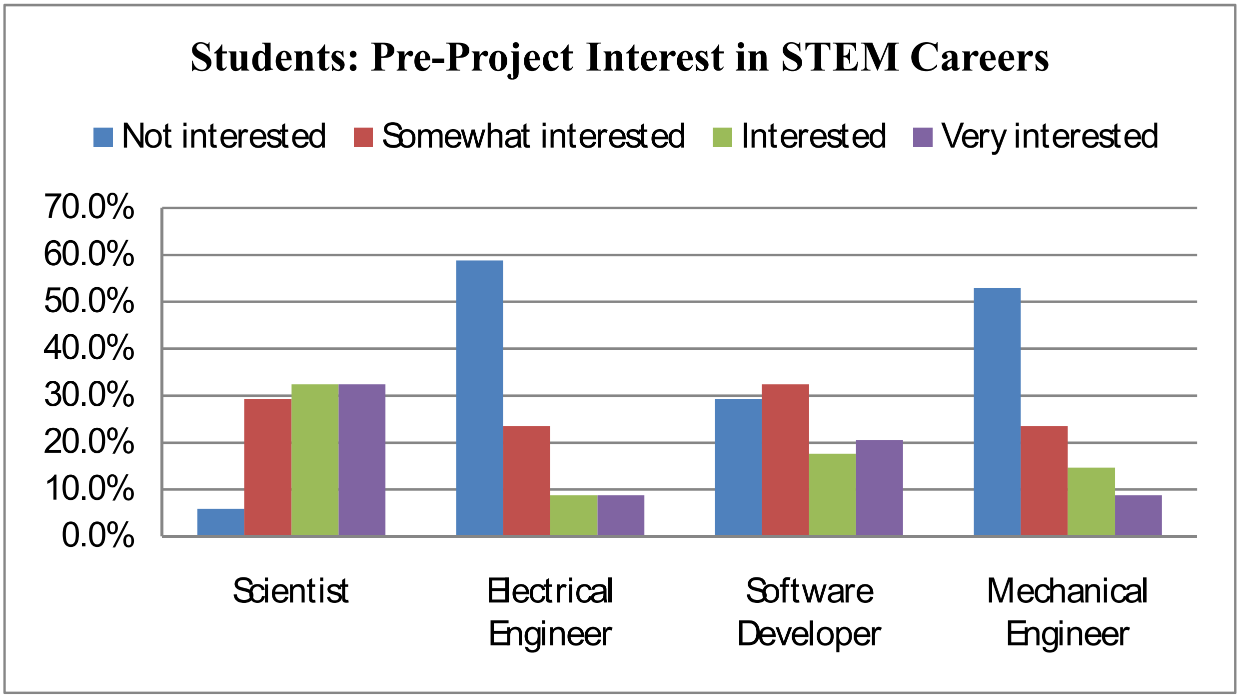
Shaw (9/9/08)

[3] AGREE is represented as "A" and STRONGLY AGREE is represented as SA in this discussion.

E. Participating High School Students' Plans
Summer 2008

The purpose of this reports is to present results pertaining to the project's impact on students' future plans in STEM careers both pre and post project participation. The pre-project information was gathered during the first week the students attended the PSC 2008 Institute.

Students recorded their interest (very interested, interested, somewhat interested and not interested) in future careers. The careers and their interest levels are displayed in the chart and table below.



Job	Not interested	Somewhat interested	Interested	Very interested
Scientist	6%	29%	32%	32%
Electrical Engineer	59%	23%	9%	9%
Software Developer	29%	32%	18%	21%
Mechanical Engineer	53%	23%	15%	9%

Thirty-one (31) of the participating students also recorded the one or two jobs they thought they would do immediately after completing their education. In addition to the job title(s) they also recorded the education required. The job titles listed are displayed on the following page.

Value	Frequency
Aeronautical Design Engineer	1
Aerospace Engineer	2
Allergist	1
Astronomer	1
Astrophysicist	3
Biochemistry	1
Botanist	1
Chemist	2
Chemical engineering	1
Computer scientist	1
Defense lawyer	1
Education	1
Electrical Engineer	2
Fetal Surgeon	1
Freelance Programmer	1
Game Designer	1
Herpetologist	1
Lawyer	1
Mechanical Engineer	2
Mineral Engineering	1
Medical doctor	2
Neonatologist	1
Network administrator	1
Neurologist	1
NICV Nurse	1
Oncologist	1
Pharmaceutical Technician	1
Pharmacy	2
Pharmacy professor	1
Physicist	2
Psychologist	2
Radiologist	1
Research scientist	1
Researcher	1
Scientist	1
Science teacher	1
Spanish professor	1
Specialized medical doctor	1
X-Ray Technician	1

The education required for most of the first job titles recorded was a bachelors (13% of students), masters (30% of students), PhD (30% of students), or medical school (17% of students).

This self-assessment of career plans will be administered at the end of project participation.

Shaw (9/9/08)

F. Site Visit – July 21-23, 2008

The external evaluator arrived at the National Radio Astronomy Observatory in Green Bank, WV in the afternoon of Monday, July 21, 2008 when students were touring the 40 foot telescope. (Students had arrived a few hours earlier.) Both teachers and students were obviously enjoying their time learning about the telescopes. In the evening after a whole group mixer, Dr. McLaughlin gave a research talk during which she introduced pulsar science to the students. The pace of the presentation was appropriate and held students' attention: she introduced pulsars, their properties, black holes, ripples of space-time, and other topics. After the ~60 minute talk snacks were served on the Star Party Patio followed by team meetings and free time.

The institute for students was well organized included the meals which were served in the cafeteria. After breakfast on Tuesday, July 22nd, students and teachers walked to the Jansky Laboratory Auditorium; Sue Ann Heatherly, the ITEST Principal Investigator, distributed project to the students and had students complete an evaluation form. She then gave a talk, *Astronomy Data* that included information on plotting (time/intensity; frequency/ wavelength). It appeared to the External Evaluator that students may not have had the graphing skills that were assumed during the talk. After that students went to the computer laboratory and then on tours; the teachers were led these activities. It was during this time that the External Evaluator visited with the program director of the Brownsville program. The students from Brownsville added demographic variety to the student groups and very quickly the students from Texas were assimilated into the larger student group. That afternoon students were introduced to the Collaboratory participated in *Earth as a Peppercorn* and then they were involved in the two-hour session, *Introduction to Pulsar Observing*.

Students were crowded and interactions among students were prohibited by the room arrangement and space during the *Introduction to Pulsar Observing* session that afternoon. Students would have benefitted from more focused learning; it appeared difficult for students to volunteer anything in such a large group. Small groups instead of a whole group probably would have been more effective. The emphasis on observation versus conclusion interfered with learning. The strategies were too open-ended, instructions were not clear, it was apparent that many of the students would have benefited from more basic information prior to carrying out the designated activities. Students needed more review on graphing and a well implemented investigation requires careful planning and scaffolding. The External Evaluator asked several of the teachers who were not leading this session for ideas on how to improve it. These were some of the ideas:

- Have small groups. Write out a list of observations on one plot and then discuss each section within a group and finally within the entire group.
- Project a plot on a screen that everyone could see and then make observations. Don't make fun of anyone.
- The group is too big; it should be broken into two different smaller groups to foster interest. Kids were more confused than enlightened. Maybe the Lead could focus on key areas to look at; start with some key explanations before just turning them loose on trying to interpret pulsar plots. Begin with explanations of what type of graphs these are and different types of graphs. Explain why the plots are in color.
- Use more structured questioning strategies. Teams should have been given written instructions to the exact goal(s). Verbal commands should have been given with strong inflection.

Using the Horizon Research Classroom Observation Protocol in a structured observation, the External Evaluator noted that adequate time and structure were not provided for "sense-making" and the design of the lesson did not incorporate tasks, roles and interactions consistent with investigative science. Investigative science benefits from careful attention to students' experience and preparedness. The instructor didn't seem to be able to "read" the students' level of understanding in order to adjust instruction. The culture of the session interfered with student learning. Active participation of all was not encouraged and valued; there wasn't always a climate of respect for students' ideas, questions and contributions, interactions did not reflect a collegial atmosphere, and the climate of the session did not encourage students to generate ideas, questions and conjectures. This was ineffective instruction.

There were small group activities, meetings and snacks for the students in the evening after Tuesday dinner in the cafeteria.

On Wednesday morning Dr. Duncan Lorimer presented Properties of Pulsars in the Jansky Laboratory Auditorium. His talk included pulsar essentials (available at http://astro.phys.wvu.edu/essentials.pdf) with wonderful pictures and diagrams. Dr. Lorimer covered many topics which he skillfully connected to phenomena familiar to students (e.g., a prism for visual light). His presentation was exemplary. Later in the morning Dr. Rachel Rosen and Ryan Lynch led a session on analyzing pulsar data. They went back through the graphs from yesterday's *Introduction to Pulsar Observing* but this did not go well because they held up a sheet of paper with the graphs which most people couldn't see (an overhead projector or Power Point presentation would have been better), the room was arranged as it was the day before and this instructional team did not "connect" with the students. This was an ineffective session while the External Evaluator was in the room.

As the External Evaluator left on July 23rd at approximately 11:00 AM several teachers were working hard on planning their sessions and seemed genuinely disappointed that their sessions were not going to be observed. "I wish you could see ours." No doubt the remaining sessions were more expertly implemented.

Shaw (9/10/08)