Final Report for Period: 06/2009 - 05/2010
Submitted on: 08/30/2010
Principal Investigator: Nelson, James H.
Award ID: 0138617
Organization: Amer Assoc of Phys Tchrs
Submitted By:
Nelson, James - Principal Investigator
Title:
Rural PTRA

Project Participants

Senior Personnel

Name: Nelson, James
Worked for more than 160 Hours: Yes
Contribution to Project:
Nelson Responsibilities

James 'Jim' Nelson, principal investigator of AAPT/PTRA Rural Project, provides primary leadership for the project. This includes coordinating the efforts of the AAPT staff and the national and rural sites, establishing project calendar and goals, overseeing production and revision of workshop leader?s handbook, designing summer institutes, working with summer institute workshop leaders during national and regional training, coordinating with vendors that are supporting the project with cost-sharing, consulting with Horizon Research, Inc. and EAT, Inc. on evaluation of project, approving expenditures, selecting regional centers, and arranging for PTRA presenters at all the regional centers. He is responsible to see that both the PTRA Professional Development Provider and Participant workshops have an appropriate blend of scientific content, instructional strategies based on Physics Education Research, and use of technology. Nelson is also responsible for development of project evaluation instruments and surveys. Nelson is presently developing an online survey, which all past participants will be requested to complete to compare and evaluate the impact of the PTRA series of projects.

Name: Amann, George
Worked for more than 160 Hours: Yes
Contribution to Project:
George Amann serves as co-PI on the Rural AAPT/PTRA Project and is the National Contact for AAPT/PTRA Rural Regional Sites in the northeastern quadrant of the United States. He plays an organizational and leadership role during the National AAPT/PTRA Summer Leadership Institutes. He attends all AAPT/PTRA Summer Leadership Institutes and AAPT/PTRA Advisory Board meetings. He is responsible for the development and review of AAPT/PTRA Teacher Resource Books and has written three. The first is titled 'Exploring Physics in the Classroom' that is published by AAPT. The second is titled ?Homemade Physics? that is published by AAPT. The third is titled 'Teaching about Gravit" which is under review for AAPT publication by the AAPT book editor. He has carried out a variety of duties assigned to him (e.g., scheduling participants during AAPT/PTRA Summer Leadership Institutes, organizing AAPT/PTRA PASCO Institutes, Approves AAPT Summer Leadership Institutes travel vouchers, arranging for equipment needed during Summer Leadership Institutes, et cetera).

Name: Mader, Jan
Worked for more than 160 Hours: Yes
Contribution to Project:
Jan Mader serves as co-PI on the Rural AAPT/PTRA Project and is the National Contact for AAPT/PTRA Rural Regional Sites in the northwestern quadrant of the United States. She plays a leadership role during the National AAPT/PTRA Summer Leadership Institutes. She attends all AAPT/PTRA Summer Leadership Institutes and AAPT/PTRA Advisory Board meetings. In addition she evaluates the second tier participants' work for graduate credit awarded by the University of Dallas. Jan Mader has served a lead PTRA for several regions and is the lead of a spin-off Mathematics and Science Partnership grant for Idaho. Jan Mader is the co-author of the AAPT/PTRA Teacher Resource Book titled 'Teaching Physics for the First Time.'

Name: Matsler, Karen
Worked for more than 160 Hours: Yes
Contribution to Project:
Karen Jo Matsler serves as co-PI on the Rural AAPT/PTRA Program and is the National Contact for AAPT/PTRA Rural Regional Sites in the southwestern quadrant of the United States. She plays a leadership role during the National AAPT/PTRA Summer

Leadership Institutes. She attends all AAPT/PTRA Summer Leadership Institutes and AAPT/PTRA Advisory Board meetings. In addition she serves as the project's internal assessment director. In this role she evaluates teacher pre, post, and formative assessments, develops and coordinates on-line questionnaires which are used to obtain information pertaining to the background of teachers, student demographics, and teacher confidence in content and pedagogy. The surveys also have been instrumental in realigning the focus of the project's goals and objectives based on feedback from the participants. This research is used to gauge the impact of the AAPT/PTRA Program on participants and their students. The teacher assessments focus on teachers' content knowledge and confidence in their answers. She reviews and documents patterns in the second tier participants' and their students' assessment results when possible. Karen Jo Matsler has also organizes the AAPT/PTRA Project outreach efforts to the National Science Teachers Association, and is the PI of a spin-off Mathematics and Science Partnership grant for Texas.

Name: Hein, Warren

Worked for more than 160 Hours: No

Contribution to Project:

Dr. Warren W. Hein is the executive officer of AAPT and thus is a co-PI on the AAPT/PTRA Program. As such, he is the Authorized Organizational Representative. Dr. Hein attends all AAPT/PTRA Summer Leadership Institutes and AAPT/PTRA Advisory Board meetings. He represents AAPT and has the responsibility for Program financial records.

Name: Clark, Robert

Worked for more than 160 Hours: No

Contribution to Project:

Although Robert Beck Clark is not financially supported by the grant, he serves as academic content monitor for the AAPT/PTRA Project with particular responsibility for liaison with the professional physics community. As a Ph.D. university physicist, it is one of Robert Beck Clark's primary responsibilities to assure the integrity of the workshop physics content. Clark reviews and edits the workshop proposals and manuals. Robert Beck Clark also provided consultation based on his experience organizing and directing programs for rural and education-limited teachers in Texas.

Post-doc

Graduate Student

Undergraduate Student

Technician, Programmer

Name: Lane, Janet

Worked for more than 160 Hours: Yes

Contribution to Project:

Janet Lane, an employee at AAPT, maintained the records and files for the PTRA Program. This included processing payment of stipends to first and second tier PTRAs, reimbursement of PTRAs for material used in workshops, maintaining PTRA financial records, and process all expenditures and receipts. She maintains the AAPT/PTRA participant database and financial records. She attends the AAPT/PTRA Summer Leadership Institute and manages the AAPT/PTRA office during these institutes.

Other Participant

Name: Managers, Lab

Worked for more than 160 Hours: No

Contribution to Project:

Other Professionals: Site Laboratory Managers at national and at rural regional training sites. The laboratory managers receive, set-up, maintain, take down and return equipment and computers used during AAPT/PTRA national and regional summer institutes.

Research Experience for Undergraduates

Organizational Partners

PASCO Scientific

PASCO Scientific provides equipment on loan to support AAPT/PTRA Workshops and Rural Summer Institutes throughout the year. In addition PASCO provides discounts to participants for motion and electricity equipment.

Seven PTRAs spent three days, June 28-30, 2004, at the PASCO headquarters in Roseville, California developing an AAPT/PTRA workshop manual. The PTRAs were George Amann, Jane Nelson, Jim Nelson, Jan Mader, Peggy Schweiger, and Tom Senior. PASCO provided travel, lodging, meals, facilities, equipment, and technical personnel for this effort.

This summer training was repeated in 2005, 2006 and 2007.

Each year PASCO, Scientific has provided up to $8,000 cost sharing for a total of $29,500 over the life of the rural project.

Vernier Software

Vernier Software and Technology provides equipment and instructional materials to support AAPT/PTRA Workshops and Rural Summer Institutes throughout the year.

In July 2004 five PTRAs spent three days at the Vernier headquarters in Portland, Oregon developing AAPT/PTRA workshop manuals. The PTRAs were Richard Borst, Roy McCullough, Jodi McCullough, Karen Jo Matsler, and David Taylor. Vernier provided travel, lodging, meals, facilities, equipment, and technical personnel for this effort.

This event was repeated in 2005, 2006, and 2007.

Each year Vernier Software and Technology has provided up to $8,000 cost sharing for a total of $25,850 over the life of the Rural Project.

Vernier Software and Technology provide at no cost to PTRA project copies of the Teaching with Video Analysis for National PTRA leaders and participants at PTRA workshops. Also provide GO-temp probe and software for National PTRA leaders and participants at PTRA workshops.

Texas Instruments Inc

Texas Instrument has loaned equipment for AAPT/PTRA Workshops and Rural Summer Institutes through their Teachers Teaching with Technology program.

TI supported the attendance of two teachers (Glen Malin and Michael Thompson) to attend the 2004 AAPT/PTRA Summer Leadership Institute in Sacramento, California. Glen and Michael are teachers of the two top scoring schools on the AAPT 2004 Physics Bowl.

Ti support two additional teachers to attend the 2005 AAPT/PTRA Summer Leadership Institute in Salt Lake City.

James Madison University

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2002, 2003, 2004 and 2005. James Madison University provided laboratory space, equipment and staff support for the institutes.

Beginning in 2008 through 2010 James Madison University received a grant from Toyota to fund additional PTRA Summer Institutes.

Illinois State University

Illinois State University was a prototype site in 2001 funded by American Physical Society funds.

AAPT/PTRA Summer Institutes and follow-up sessions were held on the Illinois State University campus during the summers of 2001, 2002, 2003 and 2004. Illinois State University provided laboratory space, equipment and staff support for the institutes.

Texas Tech University

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2003, 2004, and 2005. Texas Tech provided laboratory space, equipment and staff support for the institutes.

Montana State University

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2003, 2004, and 2005. Montana State University provided laboratory space, equipment and staff support for the institutes.

Texas A & M University

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2003, 2004, and 2005. Texas A&M University provided laboratory space, equipment and staff support for the institutes.

Brigham Young University

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2003, 2004, and 2005. University provided laboratory space, equipment and staff support for the institutes.

College Misericordia

A Rural PTRA Institute was held on the campus of College Misericordia in the summer of 2003. The university provided laboratory space, equipment and staff support for the institute.

Emporia State University

Rural PTRA institutes were held on the campus of Emporia State University in the summer of 2003, 2004, and 2005. The university provided laboratory space, equipment and staff support for the institutes.

In 2008 Emporia State University hosted a summer institute on Waves and Optics

Prentice Hall

Prentice Hall (Now Addison Wesley) provides copies of 'Physlet Physics' and 'Physlets: Teaching Physics with Interactive Curricular Material' free to all participants attending AAPT/PTRA National Leadership Institute on Physlets Workshops, and to all participants at rural regional sites.

In addition Prentice Hall provides copies of 'Ranking Tasks' and TIPERS free to all participants attending AAPT/PTRA National Leadership Institute, and to all participants at rural regional sites.

Colby College

AAPT/PTRA Summer Institutes were held on the campus of Colby College during the summers of 2004, 2005, and 2006. Colby College provided laboratory space, equipment and staff support for the institutes.

Colgate University

AAPT/PTRA Summer Institutes were held on the campus of Colgate University during the summers of 2004, 2005, 2006, and 2007. University provided laboratory space, equipment and staff support for the institutes.

Colorado School of Mines

AAPT/PTRA Summer Institutes were held on the campus of Colorado School of Mines during the summers of 2004, 2005, 2006 and 2007. Colorado School of Mines provided laboratory space, equipment and staff support for the institute.

Colorado School of Mines hosted a fee for service institute during summer 2009. Also hosted a workshop on waves during the 2008 school year.

Frostburg State University

AAPT/PTRA Summer Institutes were held on the campus of Frostburg State University during the summers of 2004, 2005, and 2006. Frostburg State University provided laboratory space, equipment and staff support for the institute.

Frostburg State University applied for and received a Maryland Commission of High Education Improving Teacher Quality grant to support AAPT/PTRA summer institutes in 2007, 2008, 2009 and 2010.

Georgia College & State University

AAPT/PTRA Summer Institutes were held on the campus of Georgia College & State University during the summers of 2004, 2005, and 2006. University provided laboratory space, equipment and staff support for the institute.

In 2008 Georgia College & State University hosted a PTRA summer institute on Waves and Optics.

Gonzaga University

AAPT/PTRA Summer Institutes were held on the campus of Gonzaga University during the summers of 2004, 2005, and 2006. Gonzaga University provided laboratory space, equipment and staff support for the institutes.

Idaho State University

AAPT/PTRA Summer Institutes were held on the campus of Idaho State University during the summers of 2004, 2005, 2006 and 2007. Idaho State University provided laboratory space, equipment and staff support for the institutes.

Idaho State University also received a MSP grant to provide PTRA institutes during summers of 2008, 2009 and 2010.

Lee College

AAPT/PTRA Summer Institutes and follow-up sessions were held on the campus during the summers of 2004, 2005, and 2006. Lee Community College provided laboratory space, equipment and staff support for the institutes.

In 2008 Lee College hosted a PTRA workshop on Physics Education Research.

In 2008, 2009 and 2010 Lee College hosted PTRA MSP institutes.

Perimeter Institute

Perimeter Institute has provide workshops during the 2008, 2009, and 2010 AAPT/PTRA Summer Leadership Institutes as well as provide copies of the Mystery of Dark Matter and Quantum Conundrum for all PTRA Leaders and participants at PTRA workshops.

University of Pittsburgh at Bradford

AAPT/PTRA Summer Institutes were held on the campus of University of Pittsburgh @ Bradford during the summers of 2004, 2005, and 2006. University provided laboratory space, equipment and staff support for the institutes.

Saginaw Valley State University

institutes were held on the campus of Saginaw Valley State University during the summers of 2004, 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institutes.

State University of New York at Fedonia

institutes were held on the campus of the State University of New York at Fredonia during the summers of 2004, 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institutes.

University of Wisconsin-River Falls

institutes were held on the campus of the University of Wisconsin-River Falls during the summers of 2004, 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institutes.

Youngstown State University

institutes were held on the campus of Youngstown State University during the summers of 2004, 2005, 2006. University provided laboratory space, equipment and staff support for the institutes.

Santa Fe Community College

AAPT/PTRA Summer Institutes were held on the campus of Santa Fe College during the summers of 2005, 2006, and 2007. During 2006, two summer institutes were held. Santa Fe College provided laboratory space, equipment and staff support for the institutes. In 2008 a summer institute on Waves, Optics and Sound was conducted.

Bismarck State College

institutes were held on the campus of Bismarck State College during the summers of 2005, 2006, 2007 and 2008. College provided laboratory space, equipment and staff support for the institutes.

Auburn University

AAPT/PTRA Summer Institutes were held on the campus of Auburn University during the summers of 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institutes.

Juniata College

AAPT/PTRA Summer Institute was held on the campus of Juniata College during the summer of 2005. College provided laboratory space, equipment and staff support for the institute.

Dickinson College

AAPT/PTRA Summer Institutes were held on the campus of Dickinson College during the summers of 2004,and 2076. College provided laboratory space, equipment and staff support for the institute.

Maxine Willis of Dickinson provided national training on use of Video Analysis in the Classroom during 2008 and 2009 AAPT/PTRA Summer Institutes.

Coastal Carolina University

Coastal Carolina University was a prototype site in 2001 funded by American Physical Society.

AAPT/PTRA Summer Institutes were held on the campus of Coastal Carolina University during the summers of 2002, 2003 and 2004. University provided laboratory space, equipment and staff support for the institutes.

South Dakota State University

South Dakota State University was a prototype site in 2001 funded by American Physical Society.

AAPT/PTRA Summer Institutes were held on the campus of South Dakota State University during the summers of 2002, 2003 and 2004. University provided laboratory space, equipment and staff support for the institutes.

Eastern Kentucky University

AAPT/PTRA Summer Institutes were held on the campus of Easter Kentucky University during the summers of 2004, 2005, and 2006. University provided laboratory space, equipment and staff support for the institutes.

California State Polytechnic University-Pomona

AAPT/PTRA Summer Institutes were held on the campus of California State University during the summers of 2005, 2006, and 2007. University provided laboratory space, equipment and staff support for the institutes.

These were organized under Higher Education Consortium of Central California.

Mississippi State University

APT/PTRA Summer Institutes were held on the campus of Mississippi State University during the summers of 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institutes.

Ohio State University

APT/PTRA Summer Institutes were held on the campus of Ohio State University during the summers of 2003, 2004 and 2005. University provided laboratory space, equipment and staff support for the institutes.

University of Dallas

APT/PTRA Summer Institutes were held on the campus of University of Callas during the summers of 2005, 2006 and 2007. University provided laboratory space, equipment and staff support for the institute.

University of Dallas hosted summer institute in 2006, 2007 and 2008 funded by MSP grant in Texas.

University of Dallas also provide graduate credit to PTRA participants at nominal cost. For additional information see APT/PTRA web site.

University of Arkansas

AAPT/PTRA Summer Institutes were held on the campus of University of Arkansas during the summers of 2005, 2006, 2007 and 2008. University provided laboratory space, equipment and staff support for the institutes.

Dr. Gay Stewart of University of Arkansas is also a evaluation specialist who reviews the AAPT/PTRA Pre and Post content assessments.

AAPT/PTRA is a partner in an NSF MSP project awarded to University of Arkansas.

University of North Carolina Greensboro

An AAPT/PTRA Summer Institute was held on the campus of University of North Carolina at Greensboro during the summer 2007. University provided laboratory space, equipment and staff support for the institute.

University of North Carolina at Greensboro received a NC MSP grant to host five AAPT/PTRA summer institutes in 2008 (1 Institute), 2009 (2 Institutes), and 2010 (2 Institutes).

See http://www.uncg.edu/phy/workshops/

Belmont Abbey College

Belmont Abbey College was site for two AAPT/PTRA summer institutes in 2010. These were funded by a NC MSP grant.

See http://www.uncg.edu/phy/workshops/

George Washington University

George Washington University was site for three week AAPT/PTRA summer institutes in 2008. This was funded by a DC MSP grant.

University of North Carolina at Charlotte

University of North Carolina at Charlotte was site for an AAPT/PTRA summer institute in 2009. This were funded by a NC MSP grant.

See http://www.uncg.edu/phy/workshops/

University of North Carolina at Pembroke

University of North Carolina at Pembroke was site for five AAPT/PTRA summer institutes in 2008 (1 Institute), 2009 (2 Institutes) and 2010 (2 institutes). These were funded by a NC MSP grant.

See http://www.uncg.edu/phy/workshops/

University of West Georgia

University of West Georgia was site for AAPT/PTRA summer institutes in 2007, 2008, 2009, and 2010. These were funded by a Georgia MSP grant.

University of West Georgia provided laboratory space, equipment and staff support for the institute.

Other Collaborators or Contacts

The Rural AAPT/PTRA project has an active collaboration with the NSF-funded ComPADRE NSDL project. The collaboration involves developing an online Mentoring capability through the Physics Front as well as providing online materials for new and cross-over teachers through the Physics Front. The Physics Front is a collection of online resources specifically targeting the needs of pre-college physics and physical science teachers.

In addition PTRA has provided workshop for PhysTEC participants, and American Physical Society Teacher Days associated with the March and April American Physical Society meetings.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)
Executive Summary

Activities for AAPT/PTRA Rural Project NSF Award Number 0138617:

1. Developed an on-line survey to compare and contrast the various AAPT/PTRA professional development efforts over time. The comparison included Urban PTRA project; non-NSF funded PTRA projects, and Rural PTRA project. For details and results see findings.

2. Completed an overall evaluation of the PTRA Rural Project. For a complete report see findings section of this report.

3. Developed a description of the basic features of the AAPT/PTRA professional development model. See Appendix #1 in Activities Section of this Report.

4. Developed AAPT/PTRA assessment instruments to document the impact of the project. These include Pre, Post, Formation, and Retention assessments for both teachers and for Students, as well as Institute Correlation For PTRA Leaders and Teacher Assessment Answer & Analysis Sheet. See Appendix #2 in Activities Section of this Report.

5. Developed a comparison chart for the various iterations of the PTRA projects supported by NSF. See Appendix #3 in Activities Section of this Report.

6. During the summer of 2009, conducted 12 non-NSF funded Regional Summer Institutes with follow-up sessions for 42 hours using the AAPT/PTRA Professional Development model. These spin-off projects were funded by Mathematics and Science Partnership (MSP) grants in Arkansas (2 MSP), Georgia (MSP), Idaho (MSP), and North Carolina (4 MSP). Also Maryland (funded by Commission on Higher Education), and Virginia (Funded by Toyota). 80 national PTRA Leaders attended the leadership institute held at University of Michigan in July 2009. See Appendix #4 in Activities Section of this Report.

7. During the summer of 2010, conducted 17 non-NSF funded Regional Summer Institutes with follow-up sessions for 42 hours using the AAPT/PTRA Professional Development model. These spin-off projects were funded by Mathematics and Science Partnership (MSP) grants in Arkansas (2 MSP), Georgia (MSP), Idaho (MSP), and North Carolina (6 MSP). Also Maryland (funded by Commission on Higher Education), Texas (4 Fee for Service), and Virginia (Funded by Toyota) using the AAPT/PTRA Program. Fifty national PTRA Leaders attended the leadership institute held at Portland State University in July 2010. See Appendix #5 in Activities Section of this Report.

8. Using non-NSF funding, developed and published 15 AAPT/PTRA Teacher Resource Guides. See Appendix #6 in Activities Section of this Report.

9. Developed three new workshop topics including Engineering Design, Radioactivity, and Magnets & Magnetism.

10. During the AAPT 2010 summer meeting in Portland the following PTRA activities were completed:

? Plenary Session celebrating the contributions of the AAPT/PTRA Program;
? Invited Session on the AAPT/PTRA Urban Project;
? Invited Session on the AAPT/PTRA Rural Project; and
? AAPT/PTRA booth in the vendor exhibition hall to solicit faculty from Institutions of Higher Education who are interested in developing a PTRA project for teachers in their area.

11. Documentation for cost sharing of over 1.7 million dollars. See Appendix #7 in Activities Section of this Report.

The AAPT Executive Board continues to approve mini-grants (about $2,000 each) for AAPT sections to provide PTRA workshops for new physics teachers. The total number of section mini-grants over the last three years has been 18.

Findings: (See PDF version submitted by PI at the end of the report)
Executive Summary

Findings for AAPT/PTRA Rural Project NSF Award Number 0138617:

A brief listing of the findings follows:

Teachers who participated in the Rural PTRA project showed an increased in their

? knowledge of physics content;
? confidence of their physics content knowledge;
? knowledge of instructional strategies;
? use of active student centered classroom instructional strategies;
? knowledge of instructional technology;
? use of instructional technology; and
? attendance when multiple sites institute sites are available.

Students of teachers who attended AAPT/PTRA professional development increased in their
? knowledge of physics content; and
? confidence of their physics content knowledge.

For examples of data, analysis, and conclusions see findings PDF file.

For description of the AAPT/PTRA Professional Development model see Appendix #1 of the Activities Section of this report.

Training and Development:
PTRA TRAINING ACTIVITIES (2002-2010)

Each year the week before the AAPT summer meeting the PTRA Leadership Institute is held. Participants in this training activity are called National PTRA Professional Development Providers. One of the strengths of the AAPT/PTRA Project is that National PTRA Professional Development Providers have strong physics backgrounds and a great deal of experience teaching physics prior to joining the project. The outreach lead by the National PTRA Professional Development Providers is described in the outreach section of this report. Schedules for the 2009 and 2010 institutes are including in the Activities component of this report.

During the AAPT/PTRA Leadership Institutes National PTRA Professional Development Providers cycle through three types of workshops - some workshops deal with subject specific content (e.g., Kinematics, Energy, Magnetism, etc.), some workshops deal with subject specific teaching strategies (e.g., Guided Inquiry, Understanding by Design, Role of Ranking Tasks, etc.), while other workshops deal with workshop/leadership strategies (e.g., Adult Learner, Physics Education Research, Leadership). Although these are distinct descriptions, the institute workshops integrate these three components in every aspect of the AAPT/PTRA Leadership Institute. For examples of the schedule see AAPT/PTRA 2009 and 2010 National Leadership Institute Schedules attached to the Program Activities section of this report.

According to a 2003 Study of K-12 Mathematics and Science Education in the US done by Horizon Research, Inc. ?High Qualify Professional Development?
1. Focuses on content knowledge
2. Emphasizes active learning (we do that and we are training National PTRA Professional Development Providers in Inquiry)
3. Promotes coherence (we have a road map, etc)
4. Provides a large amount of training sustained over time (+80 hours)
5. Encourages collaboration among teachers (we do that--listserv, etc)

The annual AAPT/PTRA Leadership Institute workshops at the national level emphasize each of these five areas. How the AAPT/PTRA Program provides each of these five components is described below:

1. Focuses on content knowledge: The AAPT/PTRA Program provides Focus on content knowledge by concentrating on a few common topics in physical science and physics. The AAPT/PTRA Teacher Resources that describe the activities used in AAPT/PTRA workshop are developed by PTRAs with reviews by university physicists. Rural Regional Sites that begin in the same summer do the same sequence of workshop topics:

A. First summer and follow-up ? Kinematics & Newton's Second Law.
B. Second summer and follow-up: Energy & Momentum
C. Third summer and follow-up: Electricity (Static & DC Circuits)
D. Fourth summer and follow-up: Waves, Optics & Sound
E. Fifth summer and follow-up: Magnets & Magnetism

AAPT/PTRA Teacher Resources that are used in the workshops support each of these topics. These Teacher Resources are developed by PTRAs and reviewed by content and pedagogy experts. In order for a PTRA Teacher Resource to be published by AAPT, the Teacher Resources first undergo a stringent review by the AAPT Publications Board. Hill and Ball found that content-focused professional development led to improvements in teacher content knowledge. Although this research was for mathematics teachers, this finding is collaborated by AAPT/PTRA internal and external assessments. Hill, H.C., Rowan, B., & Ball, D. (2005). Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement. American Educational Research Journal, 42 (2), 371- 406. Since the Educational Commission of the State?s report (www.ECS.org) indicates that similar research is not available for physical science and physics, the AAPT/PTRA Program has a goal of publishing the results of professional development for physical science and physics teachers at the conclusion of this project.

2. Emphasizes active learning: During the AAPT/PTRA Leadership Institutes National PTRA Professional Development Providers participants are continuously doing, discussing and evaluating PTRA activities. The National PTRA Professional Development Providers institutes uses the AAPT/PTRA Professional Development model that is then used by the National PTRA Professional Development Providers PTRA leaders to provide workshops during summer regional institutes and follow-up sessions.

3. Promotes coherence: Each of the workshops presented by PTRAs is carefully constructed so that the activities follow a story line based on the learning cycle where the wrap-up of one topic leads to the ?engage? of the next activity. For example in the Teaching about Energy workshop, the first activity has students reflect on the design of a roller coaster amusement park ride. This first activity deals with the part of the ride where the car is pulled up to the top of the first drop. The analysis of the data results in a definition of work as force times distance, and the fact that the amount of work done is independent of the angle of the track. This leads to the general equation for gravitational potential energy $PE = mgh$. The second activity deals with the car descending the first hill of the roller coaster. The analysis of the data gathered leads to the concept of kinetic energy and equation for kinetic energy.

4. Provides a large amount of training sustained over time: The development of strong workshop leaders takes time. As a result, the AAPT/PTRA Program commits to support a cadre of about 200 National PTRA Professional Development Providers leaders. About 100 of these leaders attend the annual AAPT/PTRA Leadership Institute each summer. PTRAs typically go through a gradual transition of thinking about themselves as a teacher to thinking of themselves as a professional development leader. The sustained national leadership is essential for this transition to take root and flourish.

5. Encourages collaboration among teachers: The AAPT/PTRA Program provides collaboration by encouraging PTRAs to take on roles of leadership (leading national workshops, writing AAPT/PTRA Teacher Resources, et cetera.) AAPT also provides a ListServ for PTRAs, Lead PTRAs and for Rural Regional Coordinators.

The Program's success depends upon the PTRAs. Thus, providing PTRAs with a vision of effective professional development, as well as the knowledge and skills to implement that vision, is critical.

The AAPT/PTRA Program consists of three parallel levels of vision. The first vision, at the classroom level, is that of effective teaching and learning. The project leadership, the PTRAs, and the outreach participants need to develop a shared understanding of what effective physics/physical science instruction looks like. Without such a vision of teaching and learning, professional development cannot be focused on helping teachers work towards that goal. The set of knowledge and skills needed by teachers to achieve this vision becomes the objectives for professional development (i.e., the Rural Regional institutes). In addition, having a vision of effective teaching and learning provides teachers a standard for reflecting upon their practice.

The second level of vision is at the Rural Regional Institute level. The project leadership and the PTRAs need to have a common vision of effective professional development in addition to a vision of effective classroom practice. This vision of professional development allows the project leadership and the PTRAs to determine what skills, experiences, and knowledge are needed by the PTRAs to help teachers move towards the vision of effective classroom practice. This vision of effective professional development provides the PTRAs with a standard for reflecting upon their practice as professional development providers.

The third level is at the AAPT/PTRA Leadership Institutes. In order to prepare the PTRAs to provide high-quality professional development, the project leadership and the designers and implementers of the AAPT/PTRA Leadership Institutes need to share a vision of how best to prepare the PTRAs for their role as professional development providers. The skills, experiences, and knowledge needed by the PTRAs to provide effective professional development to outreach participants are the focus of the AAPT/PTRA Leadership Institutes.

Developing these three levels of vision is not an easy or quick task, however, it is essential if the project is to maximize its impact on physics/physical science teaching and learning. To help in the process, the project may want to initiate a conversation with the PTRAs about effective classroom practice, perhaps using video of classroom instruction, or role-plays, providing examples and non-examples of effective teaching as a basis for the discussion.

Given that physics, more so than any other subject, has a large body of research about misconceptions and effective teaching practices, the AAPT/PTRA Rural Program is perfectly positioned to help bridge the gap between the physics education research community and the classroom teacher.

END PTRA TRAINING ACTIVITIES (2002-2010)

Outreach Activities:

PTRA OUTREACH ACTIVITIES (2002-2010)

Participants in PTRA outreach activities are practicing teachers. The training of the PTRA Professional Development providers is described below and in the Training and Development section of this report.

As stated in the grant proposal, the primary aim of the AAPT/PTRA Rural Program is to ?serve isolated and neglected rural teachers by building on the experience, expertise, and resources of the existing AAPT/PTRA Program. The Program provides opportunities for these teachers to grow professionally in physics content, in the use of technology for instruction, and in established teaching strategies. To accomplish these goals, the AAPT/PTRA Rural Program has adopted a peer professional development approach. The professional development providers called PTRAs, are typically accomplished physics teachers, meeting during annual weeklong AAPT/PTRA Leadership Institutes, where the PTRAs are provided with instruction on how to present workshops on a wide variety of physics and pedagogical topics. Most AAPT/PTRA Leadership Institute workshops are six or 12-hours in length and focus on familiarizing the PTRA Leaders with the classroom activities in the AAPT/PTRA Teacher Resources, and the most effective methods to present these activities to their participants. The institutes also provide opportunities for the PTRAs to network and share ideas related to the classroom and to workshop leadership. The major goal for the summer institute is to provide the PTRAs with the knowledge, experience, and skills needed to effectively lead outreach institutes for teachers.

PTRA-led Rural Regional Institutes were typically five days long and focused on one or two core physics topics. In addition, the program has two, daylong follow-up workshops. These follow-up sessions are intended to give the outreach participants an opportunity to revisit concepts and skills from the previous summer institute and to share and reflect on their efforts at incorporating what they learned into their classrooms. The meta-cognitive nature of this aspect of the program allows the participants to internalize the material used in their classes.

In order to evaluate the AAPT/PTRA Professional Development Model effectively, most of the Rural Regional Sites that begin in the same summer did the same sequence of workshop topics.

According to a 2003 Study of K-12 Mathematics and Science Education in the US done by Horizon Research, Inc., ?High Qualify Professional Development?
1. Focuses on content knowledge
2. Emphasizes active learning
3. Promotes coherence
4. Provides a large amount of professional development sustained over time
5. Encourages collaboration among teachers

1. Focuses on content knowledge: The AAPT/PTRA Program provides Focus on content knowledge by concentrating on a few fundamental topics in physical science and physics. Rural Regional Sites that begin in the same summer did the same sequence of workshop topics:

First summer and follow-up ? Kinematics and Newton's Second Law
Second summer and follow-up ? Energy and Momentum
Third summer and follow-up ? Electricity (Static and DC Circuits)
Fourth summer and follow-up ? Waves, Optics and Sound
Fifth summer and follow-up ? Magnets and Magnetism

Another strength of the AAPT/PTRA Program is the collection of instructional resources that has been amassed in the creation of the AAPT/PTRA Teacher Resource Guides. These Teacher Resources are the foundation of the outreach workshops, and the outreach participants highly value receiving the activities in them. These activates are typically coupled with appropriate instructional strategies to maximize the impact of the activity.

AAPT/PTRA Teacher Resources that are used in the workshops support each of these topics. These Teacher Resources are developed by PTRAs and reviewed by content and pedagogical experts. Hill and Ball, Hill, H.C., Rowan, B., & Ball, D. (2005), ?Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement, American Educational Research Journal, 42 (2), 371- 406, found that content-focused professional development led to improvements in teacher content knowledge. This finding is collaborated by AAPT/PTRA assessments conducted by EAT, Inc. and described in the Finding section of this report. Since the Educational Commission of the State?s report (www.ECS.org) indicates that similar research is not available for physical science and physics, the AAPT/PTRA Program has a goal of developing the results of professional development for physical science and physics teachers at the conclusion of this Program. See results reported by EAT, Inc. in the Findings section of this report.

2. Emphasizes on active learning: The AAPT/PTRA Model for Professional Development is based on having participants do laboratory activities that encourage active learning. Participants have the opportunity to do and experience the activities so that they will be more confident and thus more likely to use the laboratory activity in their own teaching. PTRA assessment conducted by EAT, Inc. shows that participants are in fact using more active teaching methods. See Findings section of this report.

3. Promotes Coherence: The AAPT/PTRA Professional Development activities are sequenced in a logical and development order. Each activity is linked to the previous and following activity in order to present a story line of understanding. The workshops done using the AAPT/PTRA Professional Development Model for participants is an integration of the subject specific content and the subject specific teaching strategies. The AAPT/PTRA Program has developed ?Roadmaps? for workshop curriculum that give a general outline of the concepts to be covered and listing several activities that can help learners develop that concept.

4. Provides a large amount of professional development sustained over time: Each year participants can attend 36 hours of professional development by attending the rural regional summer institute and at least one of the two follow-up sessions. The 108 hours was selected as the goal because according to research reported by Horizon Research Inc. this in-depth exposure to topics that appear in all middle and high school curricula is needed for maximum impact on the participants. See Education Week, March 8, 2006, article NSF Educator-Training Effort Seen as Helpful.

This article reviews the CAPSTONE study by Horizon Research Inc. that indicated that gains in teaching skills for math and science are typically slow but steady, and require a consistent and extensive experience for teachers.

5. Encourages collaboration among teachers: For many rural teachers attending an AAPT/PTRA Institute is their first opportunity to interact with teachers with similar teaching assignment and conditions. As a result of the AAPT/PTRA Institute many rural participants have become more professionally active by attending and presenting at local and regional science teacher meetings. AAPT provides ListServs for both leaders and participants in order to encourage collaboration.

The rural institutes include a strong technology component, seeking to introduce outreach participants to a number of the tools that can be used to support physics instruction, including graphing calculators and calculator/computer-based laboratory activities. These institutes also give rural teachers, who are often the only science teacher in their school, an opportunity to network with other science teachers. The Program expects to have an impact on rural teachers? understanding of important physics content and use of effective teaching strategies. Further, the Program hypothesizes that these changes will lead to impacts in student learning. For supporting data, see EAT Inc. Report in the Findings sections of this report.

Below is a listing of the PTRA sites for NSF Rural Project.

University Years Participated Number of Participants
Auburn University 2005-2007 12
Bismarck State College 2005-2008 66

Brigham Young University 2003-2005 19
Misericordia (2003), Dickinson (2004),
Juniata (2005). Dickinson (2007) 2003-2005
2007 60
Coastal Carolina University 2001-2004 74
Colby College 2004-2006 23
Colgate University 2004-2007 51
Colorado School of Mines 2004-2007, 2009 50
Eastern Kentucky University 2004-2006 55
Emporia State University 2003-2005, 2008 33
Frostburg State University 2004-2006 23
Georgia College & State University 2004-2006, 2008 47
Gonzaga University 2004-2006 17
Higher Education Consortium of Central California 2005-2007 51
Idaho State University 2004-2007 82
Illinois State University 2001-2004 56
James Madison University 2002-2005 55
Lee College 2004-2006 30
Mississippi State University 2005-2007 17
Montana State University 2003-2005 32
Ohio State University 2003-2005 24
Saginaw Valley State University 2004-2007 44
Santa Fe College 2005-2008 52
South Dakota State University 2001-2004 80
State Univ. of NY 2004-2007 41
Texas A&M 2003-2005 34
Texas Tech University 2003-2005 49
Univ. of Pittsburgh @ Bradford 2004-2006 43
Univ. of Wisconsin-River Falls 2004-2007 36
University of Arkansas 2005-2008 28
University of Dallas 2005-2007 18
University of North Carolina 2007 14
University of the South 2005-2008 31
Youngstown State University 2004-2006 18

The PTRA leadership also received Math ? Science Partnership, Toyota, and Commission on Higher Education grants to support additional institutes listed below:

University, State, (Number of Institute - weeks) Years Participated Number of Participants
Belmont Abby College, NC (2) 2010 35
Frostburg State University, MD (4) 2007-2010 39
George Washington University, DC (3) 2008 15
Idaho State University, ID (3) 2008-2010 45
James Madison University, VA (3) 2008-2010 32
Lee College, TX (3) 2008-2010 45
University of Arkansas AR (4) 2008-2010 30
University of Dallas, TX (2) 2006-2008 44
University of North Carolina @ Charlotte, NC (1) 2009 20
University of North Carolina @ Greensboro, NC (5) 2008-2010 115
University of North Carolina @ Pembroke, NC (4) 2008-2010 65
University of West Georgia, GA (4) 2007-2010 45

In addition to the workshops that were directly related to the Rural AAPT/PTRA Program, a number of PTRAs made presentations using the AAPT/PTRA Professional Development Model at local, regional, state, and national meetings. In addition some of presentations were made to raise awareness of the AAPT/PTRA program and the professional development opportunities that it provides.

Total Number of NSF Support Rural Regional Participants = 1321

Total Number of MSP/Toyota/CHE Supported Participants = 525
Total Number of Fee for Services Supported Participants = 2245

END PTRA OUTREACH ACTIVITIES (2002 - 2010)

Journal Publications

Books or Other One-time Publications

William Franklin, "AAPT/PTRA Teacher Resource Guide: Teaching About Impulse and Momentum", (2004). Book, Published
Editor(s): Jim Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

ISBN 1-931024-06-5

Jane Bray Nelson
James Nelson, "AAPT/PTRA Teacher Resource Guide: Teaching About Kinematics", (2009). Book, Published
Editor(s): Jim Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse

Robert Morse, "AAPT/PTRA Teacher Resource Guide: Teaching About Newton's Second Law", (   ). Book, Submitted
Editor(s): James Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Submitted for review. Will not be published until the fall of 2008.

George Amann, "AAPT/PTRA Teacher Resource Guide: Exploring Physics in the Classroom", (2005). Book, Published
Editor(s): Jim Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

ISBN 1-931024-07-3

Deborah Rice
Rex Rice, "AAPT/PTRA Teacher Resource Guide: Role of Graphical Analysis in Teaching Physics", (   ). Book, Submitted
Editor(s): Jim Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Submitted to the AAPT Publications Committee for Review.

John Roeder, "AAPT/PTRA Teacher Resource Guide: Teaching about Energy", (2008). Book, Published
Editor(s): James Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers

One Physics Ellipse
College Park, MD 20740-3845

ISBN - 1-931024-09-X

Jim Nelson & Jane Nelson, "AAPT/PTRA Teacher Resource Guide: Force Supplement", (2007). Book, Submitted
Editor(s): James Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

Jan Mader and Mary Winn, "AAPT/PTRA Teacher Resource Guide: Teaching Physics for the First Time", (2009). Book, Published
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

ISBN - 978-1-931024-10-5

Jim Nelson & Jane Nelson, "AAPT/PTRA Teacher Resource Guide: Role of Ripple Tank in Teaching Physics", (   ). Book, Submitted
Editor(s): James Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

Jan Mader and Jane Nelson, "AAPT/PTRA Teacher Resource Guide: Teaching about Waves in One Dimension", (   ). Book, Submitted
Editor(s): James Nelson, George Amann, Jan Mader, Karen Jo Matsler and Robert Beck Clark
Collection: AAPT/PTRA Series
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

James & Jane Nelson, "AAPT/PTRA Teacher Resource Guide: Momentum Supplement", (2008). Book, Pre Publication
Editor(s): Jim Nelson
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse
College Park, MD 20740-3845

Jane and Jim Nelson, "AAPT/PTRA Teacher Resource Guide: Teaching about Magnets and Magnetism", (2010). Book, Submitted
Bibliography: Published and Distributed by:
American Association of Physics Teachers
One Physics Ellipse

Web/Internet Site

URL(s):
http://www.aapt.org/PTRA/index.cfm
Description:

This website provides links to all materials and activities that are taking place within the AAPT/PTRA Program. This includes downloadable PTRA Brochure, Upcoming workshops, Workshop Leader Report forms, Mission & Goals of the PTRA Program, Contact Information for Leaders and Participants, Regional Coordinator Expectations, Horizon, Inc. Reports, and list of Nationally Certified PTRAs by State/ZipCode

Other Specific Products

Product Type:

Pre & Post Participant Assessments and Surveys

Product Description:

AAPT/PTRA Assessment Instruments

Topic Teacher Student
Type Assessment Pre Form Post Pre Post

Kinematics & Dynamics X X X X
Energy & Momentum X X X X
Electricity X X X X
Waves & Optics X X X X

Sharing Information:

These assessment instrument have been developed without NSF funds, and at present are being used to evaluate the AAPT/PTRA Professional Development Model. They are available to national certified PTRA Professional Development providers only.

Product Type:

We have developed survey for PTRA Participants Description of AAPT/PTRA PD Model

Product Description:

Description of the essential characteristics of the AAPT/PTRA Professional Development Model

Sharing Information:

Will be placed on the AAPT/PTRA web site

Product Type:

Data or databases

Product Description:

The attached file is a copy of the survey. We will be doing a beta test for a couple of week and then put online for participants to complete.

Sharing Information:

This data will be used in the report and article on the PTRA Professional Development model and experience.

Product Type:

Instruments or equipment developed

Product Description:

We have completed an on-line survey and had beta tested it. The survey will be used to collect imput for evaluation of AAPT/PTRA efforts for the last 10 years

Sharing Information:

Could be used as a model for other interested in collecting data about professional development models development over time.

Product Type:

On-Line Evaluation Survey

Product Description:

This survey is designed to collect data regarding AAPT/PTRA Institutes held around the United States over the past 10 years. The survey is designed to help the AAPT/PTRA Program evaluate the results of NSF over time.

Sharing Information:

We plan to publish an article on PTRA web site and The Physics Teacher journal.

Contributions

Contributions within Discipline:

The main contribution is to the teachers and students who benefited from the professional development provided by the AAPT/PTRA Program. In addition 15 Teacher Resource Books are now published by AAPT and severl more are under review for future publication. See Publication section of this report.

Several assessment instruments have been developed and tested. These will continue to make a contribution in the physics teaching community. See activities section of this report.

Below are links to materials and activities that are taking place within the AAPT/PTRA Program.

Georgia College & State University (2004)
[Georgia] http://physics.gcsu.edu/sciencecenter/ptra.htm

Saginaw Valley State University (2004)
[Michigan] http://www.svsu.edu/mathsci-center/AAPT.htm

Santa Fe Community College (2005)
[Florida] http://www.flaapt.org/Opportunities/current/0504_2006_opportunities_ptra.htm

Univ. of Wisconsin-River Falls (2004)
[Wisconsin] http://www.uwrf.edu/~W1037315/rural.html

Frostburg State University (2004)
[Maryland] http://acsun.frostburg.edu/cgi-bin/lyris.pl?enter=ptra

Univ. of Pittsburgh @ Bradford (2004)
[Pennsylvania] www.upb.pitt.edu/academics/programs/physics/ptra

Colorado School of Mines (2004)
[Colorado] http://www.mines.edu/outreach/cont_ed/aapt2006.htm

Higher Educ Consortium of Cent. CA (2005)
[California] http://listbot.csustan.edu/mm/listinfo/heccc-physics.

North Carolina MSP Institutes http://www.uncg.edu/phy/workshops/

Contributions to Other Disciplines:

The professional development model developed and implemented could be used by other societies for other disciplines.

Contributions to Human Resource Development:

The professional development activities provided for middle and high school teachers through the Rural AAPT/PTRA program is providing better-prepared teachers and improved science education for middle and high school students in rural schools. It has been shown that many students who go on in the STEM fields and choose STEM careers do so because of the teachers they had in middle and high school. Thus, it is expected that the Rural AAPT/PTRA program will have a positive influence on students who might choose a STEM career.

Contributions to Resources for Research and Education:

The project has worked with EAT, Inc our evaluator to develop new pre- and post-workshop assessment instruments and pre and post-workshop surveys that were used to evaluate the extent to which the project is achieving its objectives. Additional instruments have been developed to assess the level of understanding by the students of the project participants. The results of using these instruments are available for review by other researchers. For information about results of research see Finding section of this report.

Contributions Beyond Science and Engineering:

A scientifically literate population is critical for the nation's economic stability, personal health, military security, and the general feeling of citizens that they are a part of the nation?s future. If the physical science and physics teacher shortfall problem is not resolved, our nation runs the risk of increasing the percentage of the population who are scientifically and technologically illiterate.

Conference Proceedings

Categories for which nothing is reported:

Any Journal
Any Conference

AAPT/PTRA 2008/2009 Rural Regional Centers + Others

University (Inaugural Year) [State]	Schedule 2008 (Number)	National PTRA	Regional Coordinator	Lead PTRA and Others
Bismarck State College (2005) [North Dakota]	June 22-26 Waves & Optics (22)	Jan Mader	Frank Koch Frank.Koch@bsc.nodak.edu	Larry Cook, Jan Mader
Edmonton (National Leadership Institute)	July 14-18 (80)	NA	Terry Singleton Terry.Singleton@ualberta.ca	NA
Emporia State University (2003) [Kansas] http://www.emporia.edu/physics/ptra/index.htm	June 30-July 3 Waves & Optics (17)	Jim Nelson	DeWayne Backhus backhusd@emporia.edu Jorge Ballester ballestj@emporia.edu	Danielle Spaete & Valerie Michael & Al Thompson
Frostburg State University (2007 MSP Grant) [Maryland] http://www.frostburg.edu/topps/	July 07-11 Energy & Momentum (24)	Jim Nelson	Francis Tam ftam@frostburg.edu	Jane Nelson & Katya Denisova
George Washington University (2008 MSP Grant) [DC]	July 28 - August 13 Kinematics & Dynamics (18)	Jim Nelson	Cornelius Bennhold bennhold@gwu.edu	Debra Roudebush & Bob Morse, Katya Denisova
Georgia College & State University (2004) [Georgia]	June 1-6 Waves & Optics (17)	Jim Nelson	Rosalie Richards rosalie.richards@gcsu.edu	Ann Robinson, Sharon Kirby, Jane Nelson. Rich Borst cannot make it due to school schedule.
Idaho State University (2004) (2008 MSP Grant) [Idaho]	June 15-20 Kinematics & Dynamics (31)	Jan Mader	Steven Shropshire shropshi@physics.isu.edu	Emma Smith, Lars Johnson
James Madison University (2008 Toyota Grant) [VA]	June 23-27 Kinematics and Newton's Laws (13)	Jim Nelson	Mark Matson mattsome@jmu.edu	Deborah Roudebush & John Roeder
Lee College (2004/3) [Texas]	June 23-27 PER (24)	Karen Jo Matsler	Thomas O'Kuma tokuma@lee.edu	Janie Head, Jill Lewis
Santa Fe Community College (2005) [Florida]	June 23-27 Waves & Optics (14)	Jim Nelson	Karim Diff karim.diff@sfcc.edu	Jane Nelson & Jim Nelson
Texas Regional Collaborative/ESC for Collaborative Directors	July 21-24 Energy & Momentum (40)	Karen Jo Matsler	Karen Matsler kjmatsler@gmail.com	Janie Head, Stacy Gwartney, Jan Mader, Tommi Holsenbeck, Clarence Bakken, Gary Nicholson (PASCO),

AAPT/PTRA 2008/2009 Rural Regional Centers + Others

University (Inaugural Year) [State]	Schedule 2008 (Number)	National PTRA	Regional Coordinator	Lead PTRA and Others
Univ. of Pittsburgh @ Bradford (2004) [Pennsylvania] www.upb.pitt.edu/ptra	June 23-27 Waves & Optics (23)	George Amann	Hashim Yousif yousif@pitt.edu	Dave McCachren & Pat Callahan
University North Carolina Greensboro (2008 MSP Grant) [North Carolina] http://www.uncg.edu/phy/workshops/	July 28-Aug 1 Kinematics & Dynamics (23)	Jim Nelson	Steve Danford danford@uncg.edu	Nina Morley-Daye & Jane Nelson
University North Carolina Pembroke (2008 MSP Grant) [North Carolina] http://www.uncg.edu/phy/workshops/	June 16-20 Kinematics & Dynamics (16)	Jim Nelson	Jose D'Arruda jose.darruda@uncp.edu	Ann Robinson & Sharon Kirby
University of Arkansas (2008 MSP Grant – Few PTRAs also) [Arkansas] http://physics.uark.edu/amsp/	June 16-21 Waves & Optics (25+5)	Jim Nelson	Gay Stewart gstewart@uark.edu	Mark Kinsey (MSP), Nancy Easterly (MSP) & Bill Franklin (PTRA)
University of Dallas, (2007-08 MSP Grant) [Texas]	June 9-13 Energy/Momentum (20)	Karen Jo Matsler	Karen Matsler kjmatsler@gmail.com	Janie Head, Stacy Gwartney
University of the South (2005) [Tennessee]	June 22-27 Waves & Optics (16)	Jim Nelson	Randolph Peterson rpeterso@sewanee.edu	Ann Robinson & Sharon Kirby
University of West Georgia (2007 MSP Grant) [Georgia]	June 9-13 Energy & Momentum (24)	Jim Nelson	Robert Powell bpowell@westga.edu	Sharon Kirby & Ann Robinson
West Texas (2007-08 MSP Grant) [Texas]	June 2-6 Kinematics, Energy/Momentum (15)	Karen Jo Matsler	Karen Matsler kjmatsler@gmail.com	Leslie Richburg, John Myrick

MSP Sites = 11 Sites

PTRA Rural Sites = 7 Sites

Final Report AAPT/PTRA Rural Project

(NSF Award Number 0138617 2002-2010)

Including comparison with AAPT/PTRA Urban Project

(NSF Award Number 9619041)

August 2010

Prepared by

Karen Jo Matsler, Ed.D

Education, Assessment and Training, Inc.

Submitted to:

Warren Hein, AAPT Executive Officer
Jim Nelson, PTRA Director
George Amann, PTRA Co-Director
Jan Mader, PTRA Co-Director

Table of Contents

Introduction and Background

The American Association of Physics Teachers (AAPT) and the Physics Teaching Resource Agents (PTRA) have worked together for 25 years to support physics and physical science teachers across the United States. The AAPT/PTRA model has evolved over the 25 years and has become a nationally recognized provider of physics and physical science professional development. The National Science Foundation (NSF) provided most of the funding for the PTRA program, although other funds have been secured through partnerships with foundations, businesses, and Math Science Partnership (MSP) grants. The objective of this report is to summarize the overall impact of the PTRA program over the years of NSF funding. Documentation of impact is mostly limited to the Rural Initiative since research evaluation requirements were different in the early years of PTRA. In an effort to collect information for all the projects, the AAPT/PTRA leadership and Education Assessment and Training, Inc. (EAT, Inc.) developed a final online survey, which was administered in 2009. A summary of that survey is included in this report.

The Urban PTRA program (2000-2003) targeted teachers in physics and physical science that were teaching in large urban districts. Several improvements were made from the urban project that formed the basis for the Rural PTRA Initiative. A comparison of the urban and rural projects is below:

Comparison of Urban PTRA and Rural PTRA

Urban PTRA (2000-2003)	**Rural PTRA (2003-2008)**
Focus on teachers in large urban school districts	Focus on teachers in small rural school districts
High school physics teachers (9-12)	Secondary physics and physical science teachers (6-12)
Week-end workshops, usually one day in length (6-8 hours)	Week-long institutes in the summer (35-40 hours) with two follow up sessions during academic year
No attendance requirement	Participants asked to commit to 3 summers of institutes
Segmented curriculum (one-day topics) with workshops focused on specific content or make-n-take	Coherent curriculum designed around specific topics and roadmaps modeled on best practices while focusing on content, pedagogy, and instructional technology
No content assessments to determine level of understanding, gains, or areas of need	Teacher content assessments developed for each topic (pre, post, and formative) aligned to institute objectives
No measure of student impact	Limited samples of student assessments

Urban PTRA (2000-2003)	Rural PTRA (2003-2008)
No survey given to determine needs of participants	Online surveys to determine needs
No measure of changes in participant confidence	Assessment of participant confidence level before and after institutes
Contact for workshops was district administration, but workshops led by PTRAs choosing the material.	University faculty hosted institutes on-site led by National PTRAs; curriculum guided by leadership team
Leadership institutes for PTRAs focused on demos, short activities, content -professional development activities for classroom use were often demos or single activities	National leadership institutes focused on instructional strategies based on physics education research (e.g., learning cycles, inquiry, and practicums)

In the summer of 2001, the PTRA program launched three prototype rural institutes with funding from the AAPT Campaign for Physics. The purpose was to provide rural teachers, who were isolated and neglected, proper training opportunities through the use of the existing PTRA program. The project goal was to "impact rural teachers' understanding of physics content and their use of effective teaching strategies, which should lead to an increase in student learning" (Horizon Research, 2003).

In the summer of 2003, the first summer institutes funded by the Rural PTRA program began with 11 universities hosting institutes for one week. Each site had trained PTRA leaders, a cooperating university professor, and a small support staff. The sites were allowed to invite up to 25 rural teachers, although some sites (Texas Tech University, Idaho State University, and Texas A&M University) had more participants due to funding by outside sources. The participants at each site committed to returning for three summers and attending two follow-up sessions during the year. The professional development model included follow-up days to allow participants an opportunity to revisit concepts and skills learned from the summer institute. Follow-up days were also used to reflect on their efforts to implement the teaching skills, technology, and techniques in their classrooms. In accordance with the No Child Left Behind program, the long-term PTRA goal was to provide a minimum of 108 hours of instruction per teacher in order to maximize the impact on professional growth of teachers and student achievement.

The Rural PTRA program was designed to assist teachers in rural settings who have multiple preparations and limited opportunity for professional development in physics. Rural schools represent a major component of the educational system of the United States. According to the National Center for Education Statistics, the number of schools now considered rural is approximately 30% of the total (www.ruraledu.org). In addition, if rural schools are calculated as those based in communities of 25,000 or less, rural communities enroll one-third of the students in the country. More than half of the rural population of the United States lives in 13 states, and rural populations account for a majority of the population in only four states (Lewis, 2003). These rural teachers often teach many different subjects which can lead to frustration, confusion, and lack of preparedness. According to a 1996-97 AIP (American Institute of Physics) teacher survey, only 3% of the 1997 physics teaching corps had taught physics exclusively in their careers. However, 48% of the teachers taught multiple courses with physics being the subject taught more frequently than any other (Neuschatz & McFarling, 2000).

Rural areas are similar to those in economically depressed areas because they both have trouble attracting and retaining well-qualified teachers. Many teachers in these areas teach subjects outside their area of certification and benefit greatly from professional development programs that are designed to enhance teachers' content and pedagogical knowledge (Guskey, 2003). The professional development programs that target content are particularly useful in science, because the content can be difficult to learn from textbooks. In fact, a study done by Hashweh (1987) found that teachers teaching physics or biology outside their expertise tended to treat textbook information mechanically, often missing content errors. This would lead one to believe that they would in turn pass those content errors on to their students.

Method of Assessment and Instruments

Assessment Design

The AAPT/PTRA leadership team developed and implemented content specific assessments designed to focus on the specific content topics being taught in the summer institutes. The original assessments measured understanding and confidence in kinematics/dynamics and energy/momentum and were developed by Horizon, Inc., and the PTRA leadership team. After the first year, Horizon decided to change the assessment from focusing on kinematics/dynamics to also include energy/momentum in hopes of obtaining baseline information for the participant's understanding before they attended the institutes. Unfortunately, the combined assessment was only used for one year (2004) due to the length of the assessment and the inherent complications of administering the assessment at the beginning and end of the institute. In 2005, Horizon administered separate kinematics/dynamics and energy/momentum assessments.[1]

In 2005, Education Assessment and Training, Inc. (EAT, Inc.) took over the administration of assessments, surveys, and evaluation components and supervised the administration of the electricity assessment. Therefore, the majority of this report is from 2005-2008 and focuses on the electricity institutes with the assumption that other institutes had a similar impact. Also, since 2005 was the first year for the electricity institutes, the longitudinal data is most complete for that content area.

All assessments were peer reviewed by national experts. The assessment design was based on targeted levels of Bloom's taxonomy and PTRA institute topics and activities, state, and national objectives. Assessments scored by EAT, Inc. were administered at the beginning (referred to as the pre-assessment) of the institutes and on the last day (post-assessment). Some sites also chose to give a retention assessment either at the follow-up or the following summer. Formative assessments were available for all sites to use during the week of instruction to monitor progress and identify misconceptions that needed to be addressed.

Assessments were specific to the content addressed during the institutes. The assessments were correlated to specific national standards/objectives, as well as Bloom's taxonomic levels. They were evaluated according to the level of math background required to answer the question (i.e., computational or conceptual). The rigor of the assessments was intentionally aimed to the upper levels of Bloom's taxonomy with most of the questions at the application, analysis, and synthesis levels. This allowed room for improvement for the majority of the teachers yet did not overwhelm them with concepts that would not be considered relevant to a basic physics class. On most assessments the majority of the questions were conceptually based with only approximately one-fourth needing mathematical computations.

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[1] Evaluation reports for 2003-2005 were made by Horizon and can be referenced online at aapt.org

The beta versions of each assessment instrument were evaluated according to participant responses to specific distracters. The following table indicates possible initial foil distracters that may have been issues or misconceptions for the participants and then compares participant's initial responses to their final responses. In some cases (6, 9, 14, 25, 28) it appears there was no valid distracter foils since most participants got the responses correct initially and there was no even distribution of alternative responses. Data from the beta assessments was used to finalize the assessments used for the institutes.

2006 Electricity Participant Pre/Post Assessment Item Analysis Comparison

	Initial Distracters	**Post Comparison**	**Comments**
1	A=33%	A=17%	Correct answer increase from 58% to 73%
2	B=12%, C=12%	B=9%, C=12%	Not much change in C distracter
3	B=31%, D=11%	B=17%, D=4%	Correct response increase from 54% to 72%
4	C=30%	C=16%	Correct response increase from 63% to 80%
5	A=22%	A=14%	Correct response increase from 73% to 81%
6			No valid distracters
7	A=13%	A=13%	No change in incorrect answer
8	D=21%	D=15%	Correct response increase from 65% to 75%
9			No valid distracters
10	C=26%, A=27%	C=14%, A=32%	
11	A=32%	A=25%	
12	C=17%	C=14%	
13	B=27%, D=37%	B=19%, D=29%	Only 48% got correct answer on post
14			No valid distracters, no change in %
15	C=25%, D=42%	C=18%, D=36%	Less than half got the answer correct on the post
16	A=13%, D=12%	A=8%, D=12%	No change in incorrect answer of D
17	D=56%	D=52%	Majority got incorrect answer
18	C=18%	C=22%	Increase in incorrect answer
19	C=18%	C=10%	Overall increase from 74% to 83%
20	B=19%,D=21%,A=20%	B=6%, D=20%, A=14%	Only 52 % got answer correct on post
21	B=9%, C=13%	B=6%, C=14%	No change in incorrect answer of C
22	B=12%	B=14%	Increase in incorrect answer; overall decrease in correct percentage from 82% to 78%
23	C=10%	C=8%	Overall decrease of correct answer 84% to 78%

	Initial Distracters	Post Comparison	Comments
24	B=18%	B=16%	No change in incorrect answer of C
25			No valid distracters
26	C=25%, E=16%	C=20%, E=17%	Only half got correct answer on post
27	B=8%	B=13%	Slight increase in incorrect answer
28			No valid distracters
29	C=24%	C=22%	
30	B=30%, D=15%	B=24%, D=17%	Less than 44% answered correct on post

Source: 2006 EAT Report

Sampling

Researchers recommend the testing sample be at least 15 times the number of items, or in this case at least 450 participants for the electricity test. The sample size for the electricity exceeded the minimum sample size factor-analysis requirement for a 30-item instrument by having over 600 samples. The sample sizes for each assessment are reported in the Participant Assessment section of this report.

Ideally institutes address each of the objectives, but this did not always happen due to time constraints, availability of equipment, and adjustments that were made due to different levels of participant knowledge. Therefore, even if all the objectives were not specifically addressed during the institutes, participants were to answer all of the assessment questions. The objectives for the assessments were:

Objectives for kinematics/dynamics assessments

- Space, Time, Speed, and Velocity
- Uniform Circular Motion and Acceleration
- Motion Graphs (Position, Velocity, Acceleration)
- Force and Newton's First Law
- Newton's Second Law

Objectives for energy/momentum assessments

- Work & Power
- Mechanical Energy (PE & KE)
- Thermal Energy
- Impulse

- Momentum
- Conservation of Energy & Momentum

Objectives for the electricity assessments:

- General Electricity/Ohm's law
- Series Circuits
- Parallel Circuits
- Combination Circuits
- Electrostatics/Electric Fields

Objectives for waves/optics assessments

- Properties of Waves in One Dimension
- Properties of Waves in Two Dimensions
- Linear Propagation of Light
- Reflection of Light & Mirrors
- Refraction of Light
- Lenses

The pre-assessment was typically given on the first day of the institute, and the post-assessment was given on the last day before they returned home. Approximate time between the pre and post assessments was 35 hours of instruction. Retention assessments were given during follow-up sessions, which varied from site to site, therefore retention assessment results were not included in this report.

To eliminate bias from recall or memory, all assessments (pre, post, retention) varied slightly in the questions asked, but the overall rigor and objectives were consistent. A summary of the objectives, rigor (Bloom's), and assessment answers for electricity are given in the appendix. The assessments were made available to the site director but are not attached to this report.

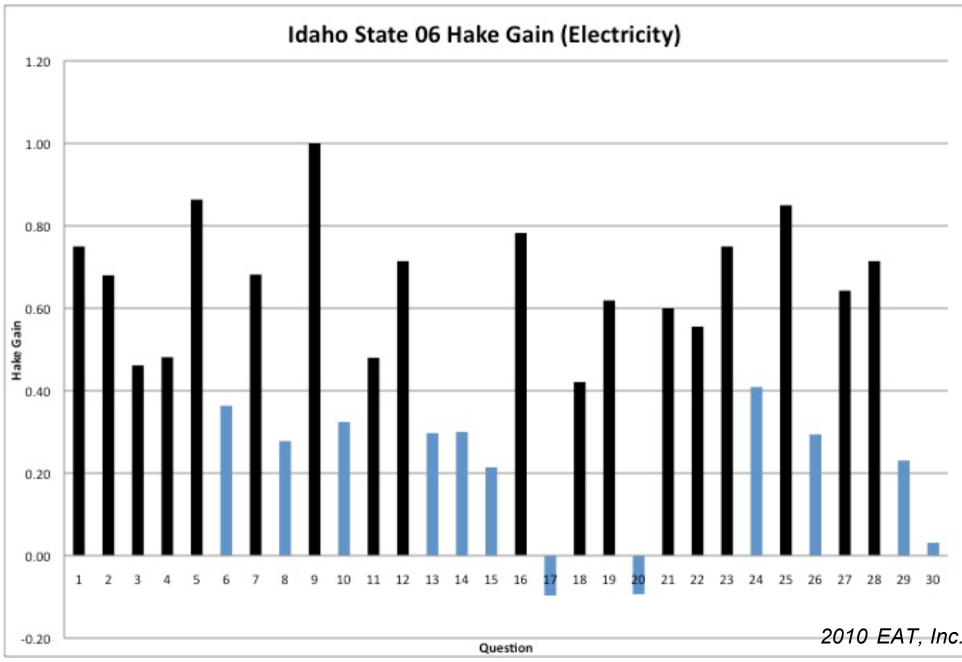
Longitudinal data was weighted according to the number of participants at each site so the results of a site with 35 participants would be justified in the overall average. This allowed the statistical averages to correctly represent the number of participants. The data for each site was then compiled with other sites across the nation teaching the same content in the same year (see appendix). Yearly averages were then recalculated to obtain a longitudinal comparison where possible (i.e., where questions remained the same) for multiple years. The longitudinal data in this report does not compare each question for each site for each year. Individual site reports have that information.

Scores are documented according to the percent gain for each question (which is a weighted average) as well as the Hake Gain. Richard Hake (1998) collected data from over 6000 high schools and colleges across the country in a study designed to determine effectiveness of instructional methods in physics such as lecture vs. activity based learning. Hake measured the effectiveness of instruction by the *gain G* defined as

G = (post-test average% - pre-test average %)/100-pre-test average %
= fraction of the maximum possible gain

where "average" means the class average. Possible gain ranges from 0 (posttest average = pretest average, i.e., no learning) to 1 (posttest average = 100, perfect learning). Hake found that conventional lecture mode instruction had gains on the average of $G = 0.22$ (class average went up only 22% of what was possible). Hake also found that effective instruction which included interactive engagement have $G = 0.52$, which is more than twice the gain of conventional instruction. A Hake Gain of 0.20 is considered typical gain for traditional instruction, 0.30 is considered good, and anything over 0.5 is considered excellent. The graph below indicates Hake Gains for a 2006 site studying electricity. The black bars on the graph indicate questions where Hake Gains exceeded 0.40, (i.e., statistically significant).

Sample Hake Gain Data from 2006 Site



Scaled scores for each assessment were computed as the percent of items correct. Other statistical information for each content assessment is listed in the Participant Assessment section of this report.

Most sites did not have time during the week of the institute to complete the entire curriculum, in any of the content areas. During the electricity institute, there was not enough time to cover electrostatics or magnetism. As expected, questions dealing with those content areas did not have the same gains as other questions.

Surveys

Participant Needs

In 2003 and 2004, information revealing the needs of participants in terms of content, pedagogy, confidence, and technology was collected via paper surveys that were hand entered into spreadsheets. Participant pre and post responses were to be matched according to zip codes since they were in rural sites. However, it was soon discovered that some of the zip codes were the same and the project needed another means of matching pre and post surveys. In 2004 the participants were asked to give the last five digits of their phone number in order to match responses since there was less chance of duplication within a particular site. The problem that surfaced was that the participants could not remember whether they had entered their home or work phone. In 2005, the participants were asked to specifically give their home phone, but this meant the longitudinal comparisons would be impossible to match back to zip code or previous phone numbers given. Unfortunately, even this did not resolve the matching of surveys because by 2006 many of the participants had cell phones and did not have home phones anymore. Therefore, there are no longitudinal cross-site comparisons that are valid for the duration of the project. Individual sites were given information regarding participants at their site.

In 2006, using an online survey, the pre and post needs surveys expanded to collect more information. This enabled the PTRA project to collect information regarding school demographics, teacher background, comments, and other feedback giving insight as to the issues the participants were facing, which helped the project leadership redirect resources and efforts appropriately. In addition to content and confidence, the post survey asked for feedback on specific activities learned in the institutes, perceived difficulty of implementing some of the activities and pedagogy, and time spent on preparing for class. However, even the online surveys presented challenges. The online survey neglected to give them choices for the location of their institute, but instead asked them to give the location as part of a free response question. This resulted in not being able to match many participants because they either did not know what the name of the site was or they put in the name of their hometown or some other name that did not match. By the time the problem was detected, about six institutes had been completed. The survey was changed to have participants select from a predetermined list, but the error hindered compiling longitudinal data for some sites.

Another problem with the online surveys were firewalls within the university systems that prevented participant's responses from being tabulated. Most of the pre survey information was resolved by resubmission if the leaders checked how many responses came through. Post responses were often lower due to these firewalls or the fact that many sites did not have their participants fill out the surveys at the end of the institute, but instead asked them to complete the survey when they got home, which many participants failed to do.

The 2003 pre and post survey questions used in 2003 were designed for dissertation research. However, as funding requirements changed, it was apparent there was a need for more structured evidence documenting the impact of the program on participants and students. Horizon Research, Inc, evaluated the first years of the grant, 2003-2005, and those reports have been submitted to NSF and are also available on the AAPT/PTRA website. Education Assessment and Training, Inc. (EAT, Inc) assumed the role of continuing the evaluation process that began in 2003 and continued to enhance, expand, and develop it to the current state. As the evaluation process evolved, there were changes to the pre and post surveys as well as development of assessments.

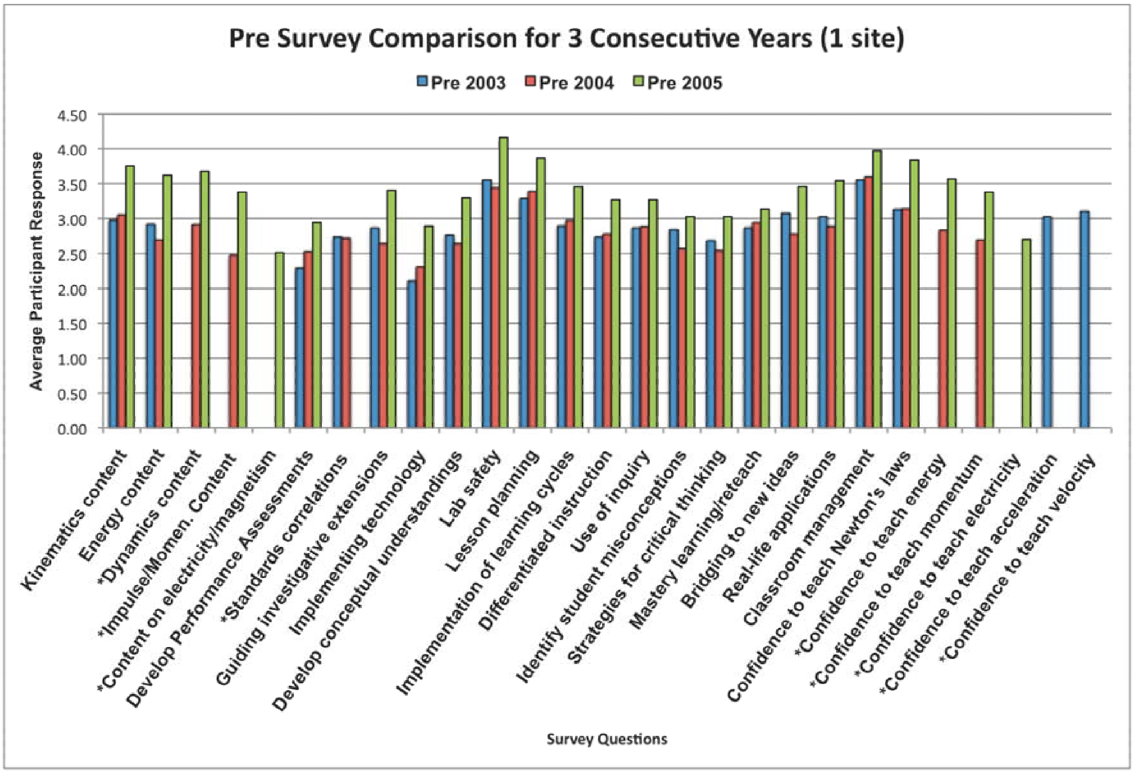
The original pre needs survey changed in order to include institutes added to the project. The table below shows the questions that were changed and the year they were changed. If there is not a year beside the question, it was the same every year.

- Kinematics content
- Energy content
- Dynamics content (added in 2004)
- Impulse/Momentum content (added in (2004)
- Content on electricity (added in 2004)
- Develop Performance Assessments
- Standards correlations (removed in 2005)
- Guiding investigative extensions
- Implementing technology
- Develop conceptual understandings
- Lab safety
- Lesson planning
- Implementation of learning cycles
- Differentiated instruction
- Use of inquiry
- Identify student misconceptions
- Strategies for critical thinking
- Mastery learning/reteach

- Bridging to new ideas
- Real-life applications
- Classroom management
- Confidence to teach Newton's laws
- Confidence to teach energy (added in 2004)
- Confidence to teach momentum (added in 2004)
- Confidence to teach electricity (added in 2005)
- Confidence to teach acceleration (removed in 2004)
- Confidence to teach velocity (removed in 2004)

Although the questions changed slightly as the needs to the project shifted, the data suggests that the participants were generally more concerned with content in their first two years and then began to focus on implementation of different activities, pedagogy, and implementation of technology in their third year. The following graph is an example of the pre needs survey for a first year site, which started in 2003. Following the predetermined sequence of content, the site targeted kinematics/dynamics in 2003, energy/momentum in 2004 and electricity in 2005. The graph clearly shows an equal amount of concern for most areas for years 1 and 2, but in year 3 there is a concern for all of the areas, including more content knowledge. These results are typical.

Sample Pre Survey Results for 3 Consecutive Years at One Site

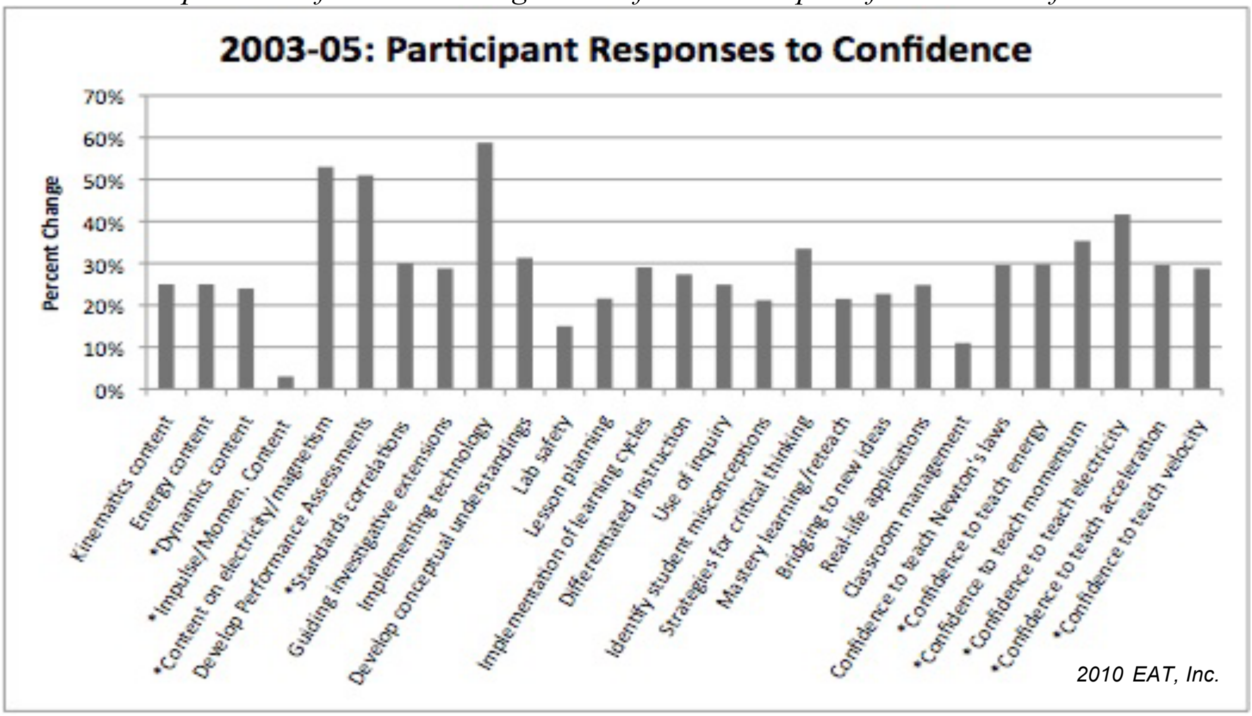


**indicates questions with incomplete longitudinal data*

Participant Confidence

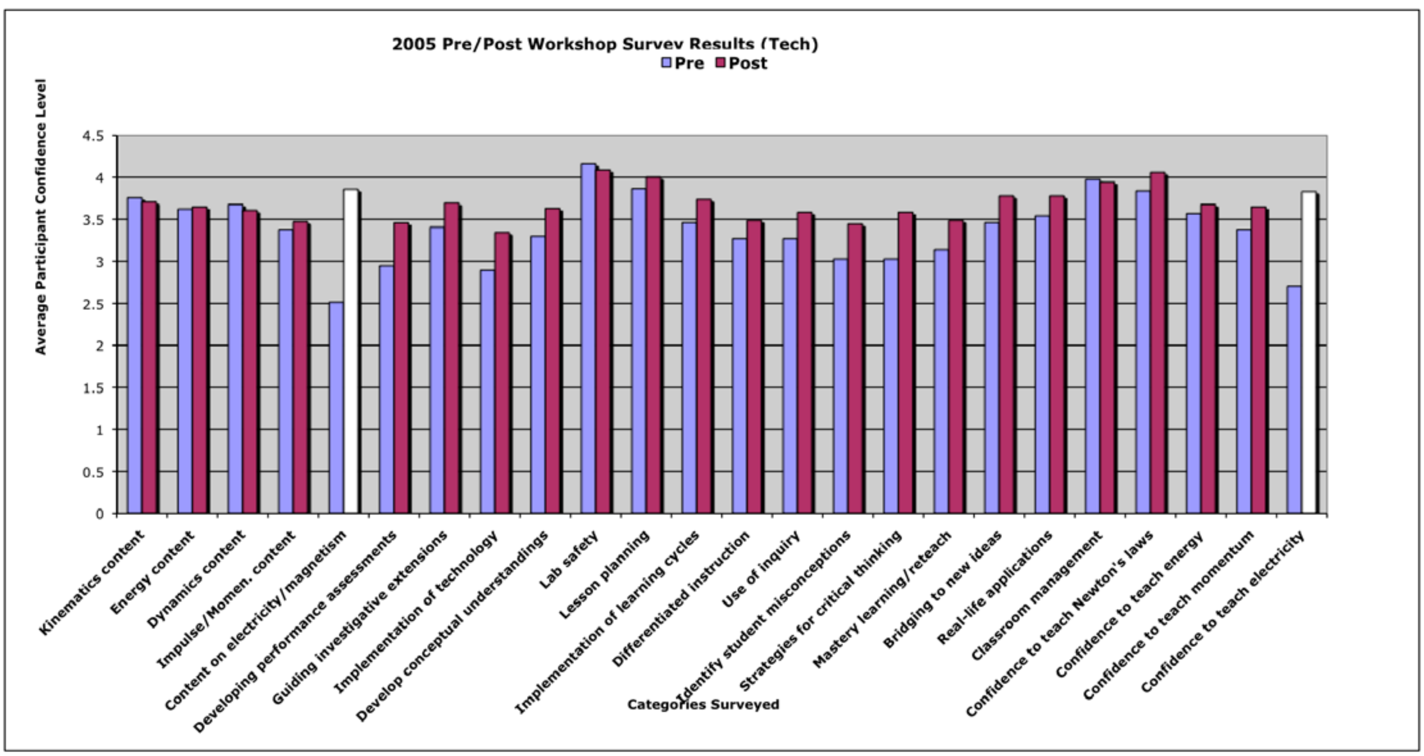
In looking at the total change (gains or loss) in the self-reported surveys over a three-year period, there are trends that become evident such as the gains in confidence to use technology, strategies to help students increase critical thinking skills, and the development of standards based assessments. Likewise, there were some areas of little gain, such as classroom management skills and lab safety, which is to be expected since these were not specifically addressed in the institutes. The percentages below were calculated from the year the first question was asked (ex. 2003) until 2005 or the question was removed (which ever came first). Those that were not calculated from 2003-2005 are marked with an asterisk (*) and coincide to the list given previously as to the changed questions.

Sample Data of Percent Change in Confidence Compiled from 2003-05 for One Site



2010 EAT, Inc.

Sample Data of Average Confidence 2005 for Institute on Electricity



Source: IDisk/Surveys/2005/2005Year3(version1)

Increase in confidence levels was found to correlate to the targeted content topic each year. For example, electricity increased dramatically in the year it was taught at the Tech site in 2005 as shown by the white bars in the previous graph.

All assessments administered by EAT, Inc. had participants and students give responses to confidence in addition to the content. After answering each question, the respondent rated their level of confidence at having answered each question correctly. Respondents were asked to fill in their level of confidence in answering the question according to the following Likert scale:

- A (5) = Absolutely sure of answer
- B (4) = Pretty sure of answer
- C (3) = Probably right, but might be wrong
- D (2) = I have a hunch it is correct
- E (1) = I am guessing

For the individual site reports, each confidence correlation was scored on both the pre and post assessments and given to site leaders in their annual report. In order to condense the vast amount of data taken from the confidence reports, the answers for each site were converted to a score where the greatest confidence had a score of 5 and the guessing translated to a score of 1. The scores were weighted and recalculated by site, year, and content topic. The three highest levels of confidence (i.e., Levels 3,4, and 5) were averaged for the results shown in the table below. Site leaders reviewed the confidence responses for each assessment question to determine misconceptions or content information that needed to be readdressed during the follow-up sessions.

Average Confidence by Year and Content

	2006 Pre	**2006 Post**	**2007 Pre**	**2007 Post**	**2008 Pre**	**2008 Post**	**2009 Pre**	**2009 Post**
Kinematics	4.15	4.52	4.29	4.47	4.05	4.12	4.35	4.48
Energy	4.15	4.27	3.95	4.25	4.16	4.43	4.03	4.29
Electricity	4.11	4.42	3.90	4.19	n/a	n/a	4.01	4.41
Waves	3.85	3.92	4.09	4.34	3.74	4.16	n/a	n/a

Each site received an analyzed confidence report for their pre and post assessments. The sites were then compiled by topic within a year and then longitudinally. A 2006 confidence report for electricity is in the appendix.

In addition to the content assessment confidence, participants were asked to self report their overall confidence in the content, pedagogy, and technology aspects of the institutes. The first three years (2003-2005) were completed on paper and the information was hand entered into a spreadsheet. In 2006, electronic surveys were implemented in the hope of gathering more information and allowing quicker evaluation of the responses. However, there were several unforeseen glitches in setting up the survey. Problems and solutions included the following situations:

- The participants were not asked which site they attended on the post survey, therefore it was difficult to sort the responses by site and compare to pre. Participants had been asked to give the last 5 digits of their home phone to correlate pre and post, but they often did not put the same number.
- The participants were asked for the site they attended on the pre, but they often did not know (or left blank) the site name or gave various responses (i.e., town, state, etc). Several sites had completed their institutes and surveys before the survey was changed asking the participants to select a site that they had attended. This eliminated the random answers and they were forced to choose one of the sites listed.
- There were several sites that had filters set by the universities that would not allow the participants to respond to the surveys. This was later remedied but some data was never regained and a few sites did not have complete pre and post surveys. For example Idaho did not have any post surveys get through the filters.

The tables below were included in the 2006 EAT report to AAPT. The table correlates questions on the electricity assessment to the participant's level of confidence that they answered the question correctly. For example, on the pre assessment question #13, 30% answered correctly and 18% of those who answered correctly were confident of their answer (i.e., rated their confidence as a 4 or 5). On the post assessment, 53% answered correctly and 45% of those answering correctly were very confident of their answer.

Sample: Confidence Electricity (2006)

Comparison of Confidence for Low Pre and Post Responses											
Question Number	**Pre Levels of Confidence (% with correct answer)**						**Post Levels of Confidence (% with correct answer)**				
	5	**4**	**3**	**2**	**1**		**5**	**4**	**3**	**2**	**1**
13	8	10	7	3	2		27	18	7	1	0
20	21	12	2	3	4		34	12	3	2	2
30	9	6	5	5	14		15	8	6	8	10

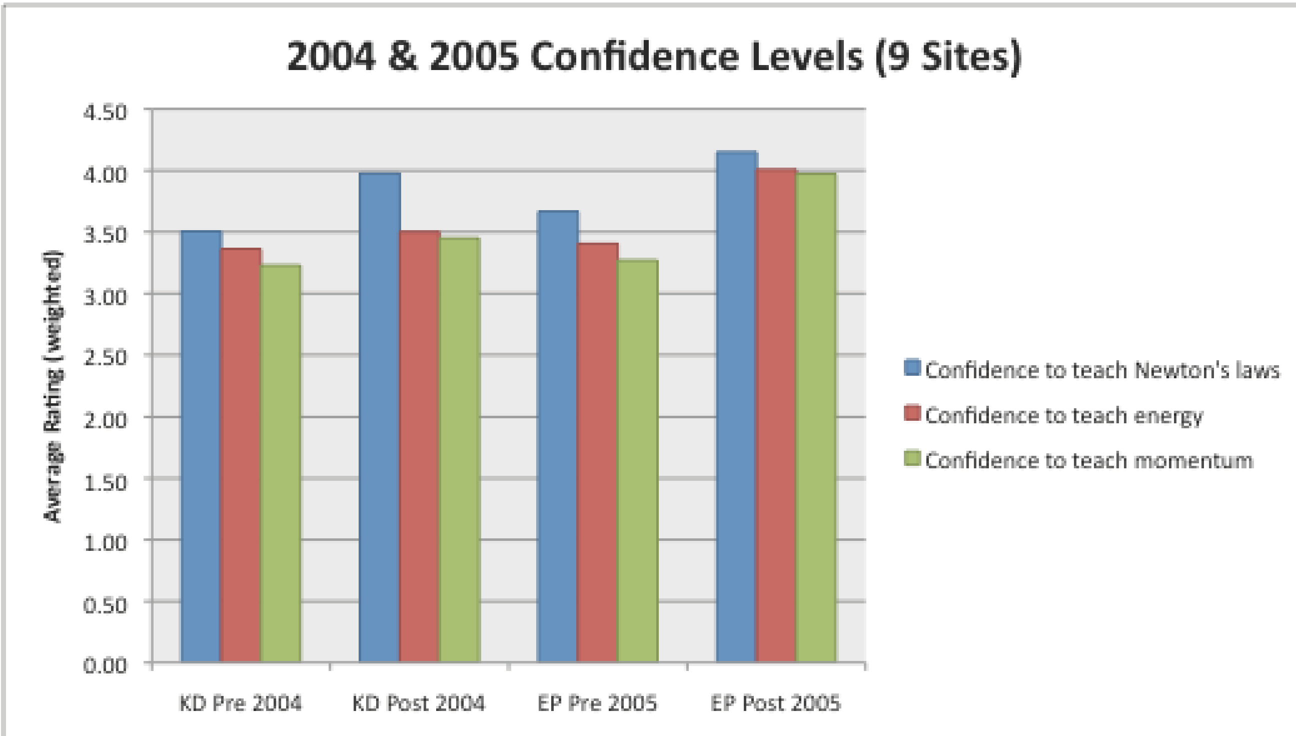
Source: 2006 EAT Report

The table below is a comparison of confidence levels and changes for different assessments.

	Question	**Level 5 Confidence (Very Confident)**		**Reference Data Table (Compared to Content Increase)**		
		Pre	**Post**	**Greatest Gain**	**Least Gain**	**Low Pre/Post**
Electricity	1	12	45	X		
	10	8	34	X		
	14	32	46		X	
	9	28	60		X	
	17	6	15			X
	13	8	27			X
Energy/Momentum	1	27	58	X		
	6	6	19	X		
	15	35	51		X	
	24	13	25		X	
	21	2	38			X
	30	13	30			X
Kinematics/Dynamics	29	2	18	X		
	10	5	35		X	
	25	34	57		X	
	28	11	31			X

Source: 2006 EAT Report

Due to problems mentioned earlier (re: collection of longitudinal information), confidence for all sites could not be combined. The following graph is a comparison of two years (2004, 2005) for nine sites that were compiled and correlated for 2004 and 2005. There is little change between the pre and post confidence on energy and momentum in 2004 (when kinematics was taught), but there is a change in 2005 when impulse, momentum, and energy were taught. Also, note the post confidence in Newton's laws (taught in 2004) dipped slightly on the pre in 2005, but ended at a higher level approximately the same as the energy and momentum by the post of 2005.



Participant Profile

The urban PTRA project targeted teachers in major urban areas whereas the rural PTRA project targeted teachers in rural areas as defined by the National Center for Educational Statistics website (http://www.nces.ed.gov/surveys/sdds/c2000.asp). Teachers in the rural areas were mostly generalists and taught multiple content areas for their school and/or district. Often they were the only science teacher in the high school and sometimes the only science teacher for both the middle and high school. Although the number of years of experience for the rural teachers was between 7 and 25 years, less than one-fifth (only 18%) had more than 24 hours of undergraduate physics and 9% had no undergraduate hours in physics.

How many years experience do you have as a classroom teacher?		
Answer Options	**Response Percent**	**Response Count**
0-3	6.8%	19
4-6	5.0%	14
7-10	15.8%	44
11-15	18.6%	52
16-20	16.1%	45
21-25	13.3%	37
26-30	7.5%	21
more than 30	16.8%	47
	answered question	**279**
	skipped question	**51**

Source: 2009-2010 Final PTRA Survey

How many undergraduate physics credits have you received?		
Answer Options	**Response Percent**	**Response Count**
0	8.9%	25
3	7.9%	22
4	3.9%	11
6	5.0%	14
8	11.4%	32
9	4.3%	12
12	12.5%	35
15	6.4%	18
16	3.2%	9
18	6.8%	19
20	5.0%	14
21	2.5%	7
24	4.3%	12
more than 24	17.9%	50
Other (please specify)		33
	answered question	**280**
	skipped question	**50**

Source: 2009-2010 Final PTRA Survey

The lack of undergraduate preparation in physics was one of the main reasons cited by participants wanting to attend the PTRA professional development institutes. Many felt they were not certified or qualified to teach physics, even if they had proper certification. There is a strong consensus that adequate subject knowledge is necessary for teachers to be successful, but what the term "adequate" means is not clear.[2] Over 170 teachers received graduate credit from 2003-2008 through a cooperative agreement between AAPT and the University of Dallas. It is unknown how many of the graduate credits on the final survey were from the University of Dallas, but 43% still did not have any physics graduate credits at the time of the final survey.

How many graduate physics credits have you received?		
Answer Options	**Response Percent**	**Response Count**
0	43.0%	114
3	9.1%	24
4	1.9%	5
6	5.3%	14
8	1.9%	5
9	3.8%	10
12	9.8%	26
15	3.8%	10
16	2.3%	6
18	1.5%	4
20	4.5%	12
21	0.8%	2
24	1.9%	5
more than 24	10.6%	28
Other (please specify)		28
	answered question	**265**
	skipped question	**65**

Source: 2009-2010 Final PTRA Survey

According to comments given by teachers in post surveys, participation in the Rural PTRA institutes impacted their decision to remain in teaching (i.e., their retention). In addition, the final survey indicated over 94.7% of the teachers were still in the classroom and 87.7% indicated they were in the same position as they were when they began their first AAPT/PTRA institute.

Are you currently teaching?		
Answer Options	**Response Percent**	**Response Count**
Yes	94.7%	305
No	5.3%	17
	answered question	**322**
	skipped question	**8**

Source: 2009-2010 Final PTRA Survey

[2] Allen, Michael, 2003. Education Commission of the States, *Executive Summary, Eight Questions on Teacher Preparation: What Does the Research Say? www.acs.org/tpreport*

Are you currently in the same position as when you took the AAPT/PTRA institute or workshop?		
Answer Options	**Response Percent**	**Response Count**
Yes	87.7%	284
No	12.3%	40
answered question		**324**
skipped question		**6**

Source: 2009-2010 Final PTRA Survey

What was your position at the time you took the AAPT/PTRA institute or workshop?		
Answer Options	**Response Percent**	**Response Count**
Elementary Classroom Teacher	1.0%	3
Middle School Classroom Teacher	19.2%	60
High School Classroom Teacher	78.8%	246
Science Consultant/Specialist	1.3%	4
University Professor	2.6%	8
2 year College Instructor	1.6%	5
Retired	0.3%	1
Other (please specify)		12
answered question		**312**
skipped question		**18**

Source: 2009-2010 Final PTRA Survey

What is your current position? Please check all that apply		
Answer Options	**Response Percent**	**Response Count**
Elementary Classroom Teacher	0.9%	3
Middle School Classroom Teacher	18.9%	60
High School Classroom Teacher	76.7%	244
Science Consultant/Specialist	1.3%	4
University Professor	2.8%	9
2-year College Instructor	2.5%	8
Retired	4.1%	13
Other (please specify)		24
answered question		**318**
skipped question		**12**

Source: 2009-2010 Final Survey

Responses indicated that anyone who had moved out of the classroom had moved to an administrative position or employed in an education related profession (i.e., none had left education). The responses included: two were currently enrolled in doctoral programs, one was on maternity leave, one was a NASA educator ambassador, one was an Einstein Fellow, and one was a forensic scientist.

Grade level/subject you taught in 2008-09. Check all that apply		
Answer Options	**Response Percent**	**Response Count**
12th Grade AP/IB Physics	14.3%	46
11th Grade AP/IB Physics	8.1%	26
12th grade Honors or Pre AP Physics	14.0%	45
12th grade Regular Physics	38.8%	125
11th grade Honors or Pre AP Physics	13.0%	42
11th grade Regular Physics	26.7%	86
10th grade Honors Physics	2.5%	8
10th grade Regular Physics	5.6%	18
IPC/Physical Science	21.1%	68
9th Grade Physics	12.4%	40
Non-teaching science teacher coach	0.6%	2
Grade 8 Science	13.0%	42
Grade 7 Science	9.9%	32
Grade 6 Science	5.6%	18
Grade 5 Science	1.2%	4
K-2 Science	0.9%	3
3-4 Science	0.6%	2
Gifted and Talented	3.1%	10
Other (please specify)	35.4%	114
	answered question	**322**
	skipped question	**8**

Between two-thirds and three-fourths of the participants were high school physics teachers and the others were middle school or upper elementary. Approximately one-fifth of the middle school participants were also the high school teachers. Those responding to the “other” commentary listed classes they taught, not specific grade levels. Classes included principles of technology, biology, IB classes, and chemistry.

As expected, most of the participants were employed by public schools. Private and charter schools were represented indicating their participation was recommended and encouraged.

What type of school are you affiliated with?		
Answer Options	**Response Percent**	**Response Count**
Private	5.6%	18
Charter	0.9%	3
Public	93.5%	301
	answered question	**322**
	skipped question	**8**

Source: 2009-2010 Final Survey

The average school size for the 322 respondents was a little over 1300 students. The average number of students per teacher was 113. Using the average number of students per teacher (113) and multiplying the average number of students by all the teachers that attended the Rural PTRA institutes (1019), the potential impact would be over 150,000 students per year.

Curriculum

In an effort to provide valid comparisons for evaluation and a replicable professional development model, the Rural PTRA program developed templates (called roadmaps) for each institute as well as content teacher resources. National PTRAs (institute leaders) and the university professors (site coordinators) were expected to follow the blue print or roadmap for the institutes as closely as possible. Allowances were made for the leaders to use other materials if necessary to address misconceptions or provide more content than provided by the teacher resources. As a result of the proven consistency of the content provided during the institutes, the University of Dallas was able to offer graduate credit to the Rural PTRA participants in the three main content topics (kinematics/dynamics, electricity, energy/momentum). In order to receive the graduate credit, participants attended the summer session and follow-up and submitted lesson plans designed around the activities they learned in the institute. Approximately 170 teachers received graduate credit from 2003-2008 for completing the requirements as outlined by the University of Dallas, thus increasing the number of teachers who would be considered highly qualified.

Attendance/Retention

The collaborative partnership between the host universities, AAPT, school districts, and PTRA leaders coupled with solid content provided during the institutes, modeling of effective pedagogy, and mentoring provided components important for teacher retention.[3] In fact, over 94% of the participants were currently teaching in the classroom at the time of the final survey. All of the participants were teaching at the time they entered and participated in the PTRA professional development, but by the end some had moved to administrative positions or retired.

The total number of hours that participants completed while attending Rural PTRA and Urban PTRA institutes can be analyzed differently according to the number of hours required by the grants (urban and rural). Therefore, since one of the project leadership's goals of Rural PTRA was to increase the number of hours of professional development in comparison to the urban project, the following comparison can be made:

Comparison of Urban PTRA and Rural PTRA Hours

Hours Completed	**1-29**	**30-59**	**60-89**	**90-119**	**120+**
Urban	83%	13%	3%	1%	0%
Rural	4%	38%	18%	16%	24%

Even though the hourly breakdown for the urban and the rural institutes was different according to the terms of the respective grants, the hours completed by those attending the urban sites is much less than those attending the rural institutes. Over 83% of those attending the urban institutes had less than 30 hours compared to 34% of the rural participants having less than 36 hours. Slightly over 1% had 90 or more hours for the urban and over 44% had over 73 hours in the Rural Project.

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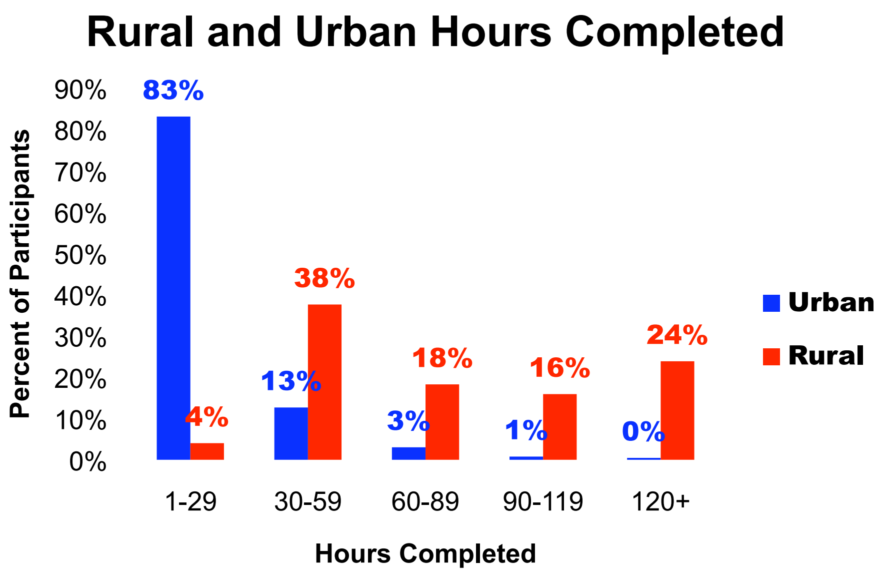
[3] Allen, Michael, 2003. Education Commission of the States, *Executive Summary, Eight Questions on Teacher Preparation: What Does the Research Say? www.acs.org/tpreport*



In an effort to increase retention, Texas offered multiple sites and topic rotations over a 5- year period allowing teachers entering the program in year 2 to complete the professional development from year 1 by attending another site. As a result the Texas sites had a higher number of teachers complete over 90 hours of training.

The sites in Texas rotated according to the following schedule. Those indicated with Rural PTRA were part of the Rural PTRA program and those with MSP were funded from state funding sources due in part to the success of the Rural PTRA program. This allowed the professional development to continue in different topics and reach more teachers with non-NSF funds.

2003: Texas Tech and TAMU =Kinematics/Dynamics (Rural PTRA)

2004: Texas Tech, Lee, and TAMU = Energy/Momentum (Rural PTRA)

2005: Texas Tech and TAMU = Electricity (Rural PTRA)

Lee = Electricity (Rural PTRA)

University of Dallas = Electricity (Rural PTRA)

2006: Texas Tech University = Light/Optics (MSP)

Lee = Kinematics/Dynamics (MSP); Light/Optics (MSP)

University of Dallas = Kinematics/Dynamics (Rural PTRA); Light/Optics (MSP)

2007: Lee = Kinematics/Dynamics (MSP); Waves and Light (MSP);

University of Dallas = Energy/Momentum (Rural PTRA); Kinematics/Dynamics (MSP); Waves and Light (MSP)

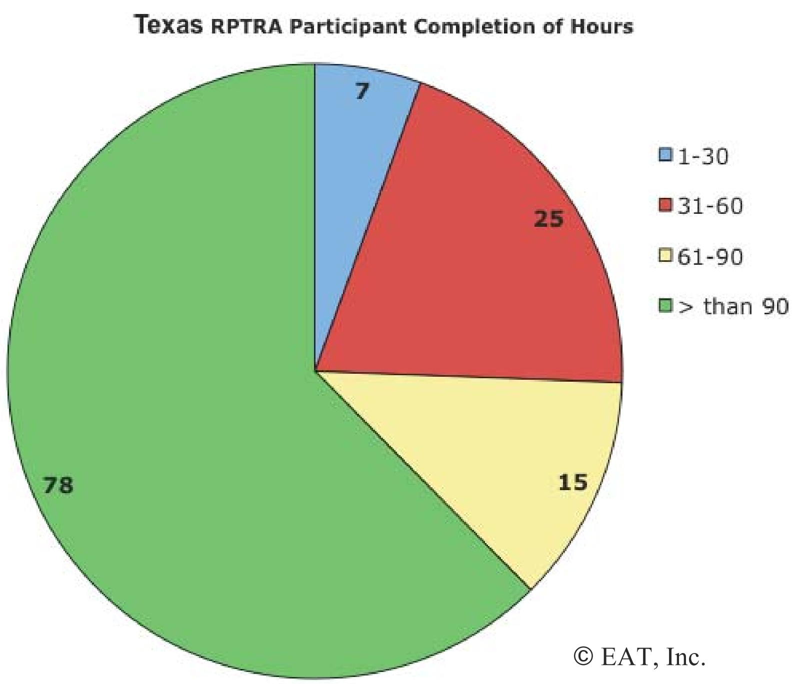
Texas Tech University = Waves (MSP)

2008: Lee = Tools for Intro Physics (Rural PTRA)

University of Dallas = Energy/Momentum (MSP)

2009: University of Dallas = Electricity (MSP)

The graph below summarizes the Texas sites under the Rural PTRA funding (RPTRA). Seventy-eight of the participants completed over 90 hours, 15 completed 61-90 hours, 25 completed 31-60 hours, and only 7 had less than 30 hours (i.e., one week). The tables below the pie chart give the numbers from the other rural sites.



Texas Rural PTRA summary (hours completed by site)

	Total # of Participants	1-30	31-60	61-90	> than 90	Avg. hours
Texas A&M	34	1	4	4	25	107.3
Tech	52	5	8	7	32	91.3
Lee	27	0	9	2	16	103.0
Univ. of Dallas	12	1	4	2	5	79.5
Total	125	7	25	15	78	97.04

Urban Sites Total Participant Hours

REGION	**1-29**	**30-59**	**60-89**	**90-119**	**120+**
Boston	245	78	4	1	0
Brooklyn	114	0	0	0	0
Chicago	65	7	0	0	0
Cleveland	107	26	3	5	2
Dallas	114	6	3	0	0
Denver	15	18	4	0	0
Detroit	7	0	0	0	0
Houston	348	54	21	7	6
Jersey City	34	12	5	0	0
Miami	39	0	0	0	0
New Orleans	147	22	13	2	2
New York	129	6	2	0	0
Oakland	41	0	0	0	0
Orlando	192	14	1	2	0
Philadelphia	274	39	4	0	0
Pittsburgh	54	3	0	0	0
Queens	52	8	0	0	0
Salt Lake City	49	9	5	0	0
San Antonio	18	0	0	0	0
San Francisco	93	31	8	1	0
St Louis	21	5	6	1	0
Washington DC	149	22	7	3	3
Non-Urban	56	0	0	0	0
Total	2363	360	86	22	13
Percent of total	83.09%	12.66%	3.02%	0.77%	0.46%

Source: AAPT Executive Office

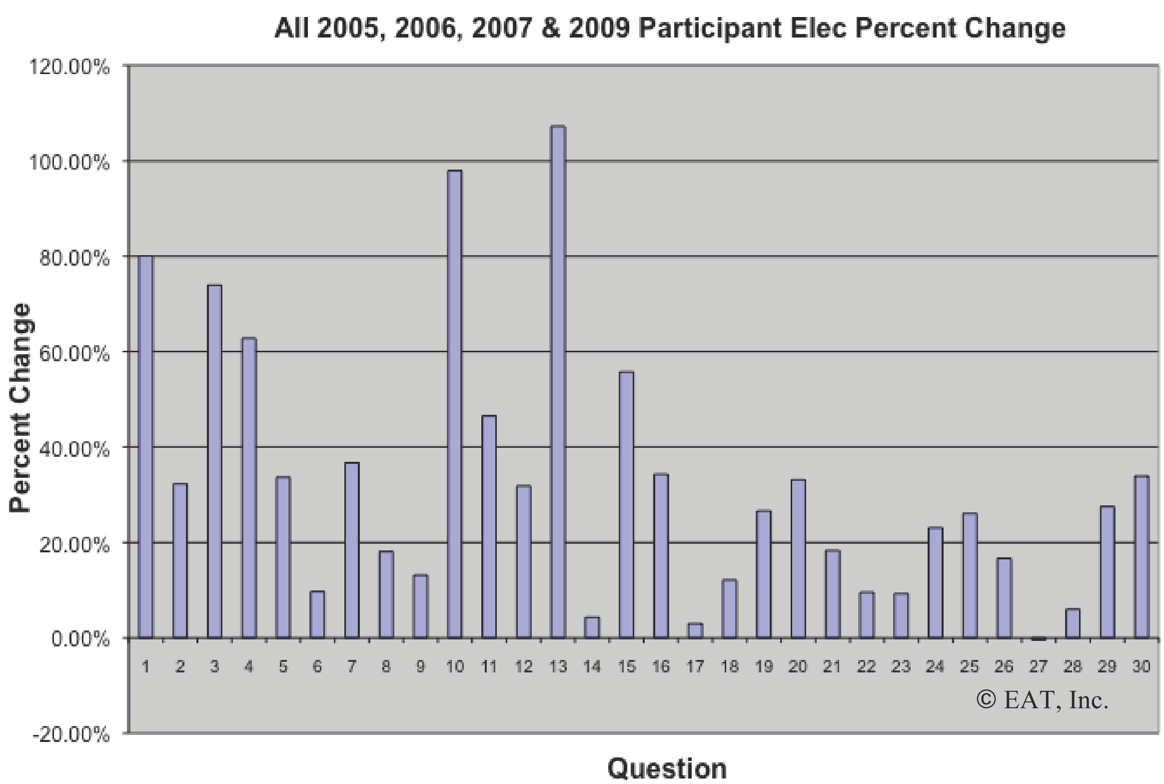
Content Assessments (Participants)

Participants were assessed in their understanding of physics content before the professional development (pre assessment), during the professional development (formative assessment), and after the professional development either at the end of the week (post assessment) or at a follow-up session (retention). Sites typically administered both pre and post assessments, therefore the information given in this report is taken from the pre assessment given on the first day and the post assessment given on the last day. The disadvantage of giving the post assessment on the last day is participants were often more eager to leave and go home than concentrating on the assessment because the results were coded and therefore anonymous, so participants have a reduced incentive to do well. However, most participants did at least attempt to answer as many questions correctly as possible therefore, the post scores are likely to be slightly deflated and would indicate a minimum increase in content understanding.

Electricity

The Electricity assessment was the only assessment that was given consistently throughout the Rural PTRA program (i.e., did not have major changes to the questions) and therefore, is the best indicator of changes in content understanding.

The combined percentage change on the electricity assessment is indicated in the following graph. There were several questions that had a percent change of over 80% and there were several questions that did not see a significant difference. However, it should be noted that if the participants scored high on the pre assessment, there would not be a significant change in the post assessment, therefore a lower percent change. This would be true of questions such as 6, 9, 14, 27, and 28. It should also be noted that none of the percent changes for electricity resulted in a negative percent.



A comparison of statistics for the electricity assessment is shown in the table below. All of the 2009 sites were funded by Math Science Partnership and Higher Education grants; the other years were Rural PTRA sites funded by NSF.

Electricity Pre and Post Assessments
Longitudinal Analysis

	2005	2005	2006	2006	2007	2007	2009	2009
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Number of items scored	30	30	30	30	30	30	30	30
Number of tests scored	154	153	276	264	118	118	116	110
Number of sites	8	8	11	11	6	6	4	4
Mean % Score	52.40	67.41	61.74	75.08	50.00	67.00	48.85	68.21
Std Deviation	5.96	5.84	5.5	4.71	6.25	5.71	5.58	5.52
Mean Score	15.72	20.22	18.52	22.52	15.00	20.12	14.66	20.46
Median Score	15.00	21.00	18.5	23	13.00	20.50	13.5	21.5
Maximum Score	29	30	30	30	28	29	29	30
Minimum Score	5	6	5	7	3	6	5	8
Variance	35.51	34.67	30.26	22.21	39.04	32.56	31.15	30.45
Cronbach	0.84	0.86	0.83	0.81	0.85	0.85	0.81	0.84
Sites	BYU		Bradford		Arkansas		UWGA (MSP)	
	U Dallas		Colby		Auburn		UNCG (MSP)	
	Emporia		Colgate		Bismarck		Frostburg (HEC)	
	Lee		Colorado		HECC		TRC UD (MSP)	
	Montana		Kentucky		Santa Fe			
	Penn		Georgia		South			
	TAMU		Gonzaga					
	TTU		Idaho					
			Saginaw					
			SUNY					
			Wisconsin					

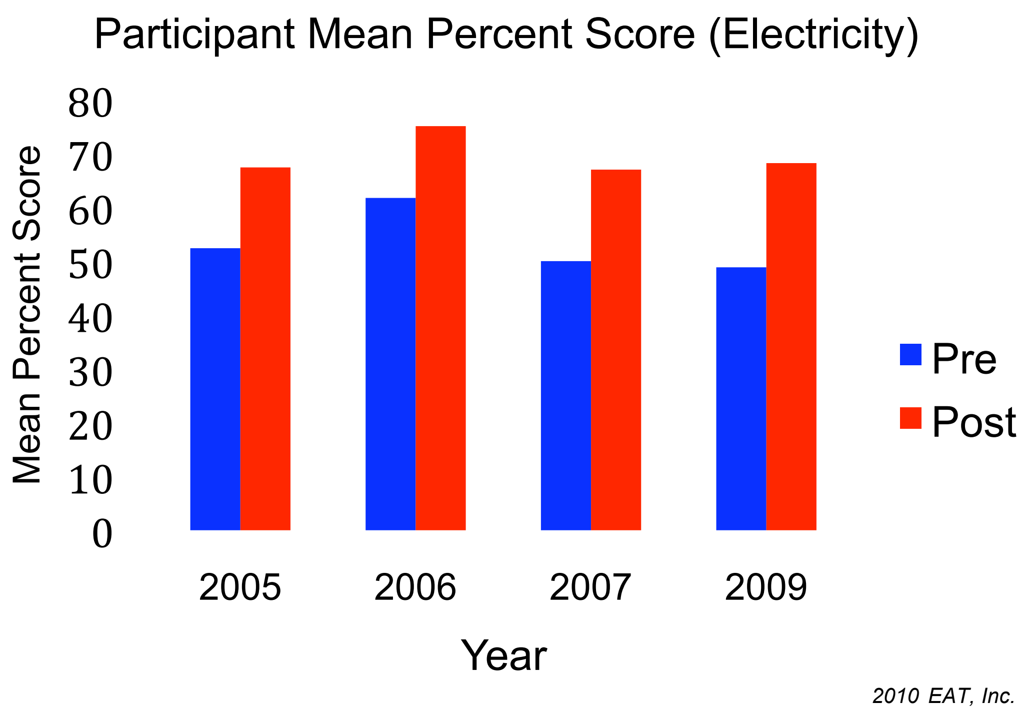
The longitudinal comparison of 2006, 2007, and 2009 (no assessments were given in 2008) electricity assessment included results from 29 sites and over 600 teachers (664 pre and 645 post). Although the post-assessment scores were low, they were consistent in both the percent gains and Hake Gains.

The mean percent score for each year indicates participants always had an overall increase in their understanding of the content for electricity. The assessment measured understanding in the following objectives: general electricity/Ohm's law, series circuits, parallel circuits, combination circuits, and electrostatics/electric fields. Most sites reported that they did not have time to cover all the objectives (particularly electrostatics, electric fields, and limited time on combination circuits), but the participants were asked to answer all the questions and any answers left blank were counted as being incorrect. There were eight questions (out of 30) or about 1/4 of the assessment that specifically addressed the 4th and 5th objectives and the participants would not be expected to see increases in those topics. Although the sites did not indicate a decrease in those objectives, they also did not show an increase. This validates the Rural PTRA professional development since the increase in understanding was directly linked to the objectives taught during the institute.

Summary of Electricity Assessments
Participants 2006-2009

	2005-2009 Combined	**2005-2009 Combined**
	Pre	**Post**
Number of items scored	30	30
Number of tests scored	664	645
Number of sites	29	29
Mean % Score	55.12	69.4
Standard Deviation	5.86	5.37
Mean Score	16.53	20.82
Median Score	16	22
Maximum Score	30	30
Minimum Score	3	6
Variance	34.39	28.84
Cronbach	0.83	0.83

Electricity Mean Percent Scores 2005-2009



A Hake Gain was calculated on all sites, all years, and all content topics and then combined for an average Hake Gain. The table below reveals the average Hake Gain for electricity, which suggests there were significant gains by the participants since the averages are all above 0.30.

Average Hake Gain for Electricity 2005-2009

Year	Avg. Hake Gain
2005	0.32
2006	0.35
2007	0.34
2009	0.38

Kinematics/Dynamics

As discussed previously, Horizon Research, Inc. compiled the data for the first years of the Rural project, which mainly focused on kinematics/dynamics and energy/momentum. The information below was compiled from the pre and post kinematics/dynamics assessments administered by EAT, Inc. between 2006 and 2009. These assessments were administered in the same manner as the electricity assessments. Data was correlated only when the assessments were similar (i.e., 2007-2009).

Participant Mean Percent Score for 2006, 2007, 2008, and 2009 Kinematics/Dynamics

	2006	2006	2007	2007	2008	2008	2009	2009
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Number of items scored	30	30	35	35	35	35	35	35
Number of tests scored	53	51	56	63	81	83	77	75
Number of sites	3	3	3	3	4	4	4	4
Mean % Score	59.94	67.71	54.39	68.03	47.44	57.25	54.06	65.26
Std Deviation	5.76	5.17	7.53	6.67	6.36	6.08	7.61	7.07
Mean Score	17.98	20.31	19.04	23.81	16.6	20.04	18.92	22.84
Median Score	18	20	17	24	16	19	17	21
Maximum Score	30	30	33	34	33	34	35	35
Minimum Score	7	10	6	7	5	9	6	7
Variance	33.13	26.74	56.69	44.48	40.44	36.96	57.94	49.92
Cronbach	0.85	0.82	0.89	0.88	0.84	0.84	0.89	0.89
Sites	Dallas		University of West Georgia (MSP)		UNCP (MSP)		AR (State)	
	Lee		Frostburg (HEC)		UNCG (MSP)		AR (NSF)	
	Santa Fe, FL		UNC (MSP		Idaho (MSP)		Galveston (MSP)	
			Univ of West Georgia (MSP)		GWU (MSP)		UNCC (MSP)	

The low pre assessment results were initially a shock to the leaders of the institutes as well as the site coordinators and leadership team. Pre assessments revealed the amount of content understanding, or lack thereof, by the participants to be approximately 50% of what the leadership team felt the minimal threshold should be (according to the assessment design). Although there were considerable gains in content understanding, most participants still had scores below 70% for the post assessment. There are several possible explanations for the low scores, the most likely being: 1) the rigor of the assessment as designed by content experts, 2) the lack of content background by the participants as evidenced by the limited physics classes they took in college, 3) the limited time available to address all the objectives within each content, and 4) the difficulty of addressing very diverse backgrounds within the constraints of the workshop; low pre scores indicating weak content could not be anticipated prior to the workshop. In fact, many participants felt they were very comfortable with their content knowledge before they came to the institute and that is was only during the course of the institute that they realized how little they really knew or understood. This trend was documented through the feedback of the participants as well as the dip in confidence levels when comparing their pre, formative, and post responses. The minimal amount of professional development necessary to impact the classroom has been documented in research by Horizon, Inc. to be approximately 80 hours.[4]

Average of Kinematics/Dynamics Assessments
Participants 2007-2009

	2007-2009 Combined	**2007-2009 Combined**
	Pre	**Post**
Number of items scored	35	35
Number of tests scored	214	221
Mean % Score	51.64	63.04
Standard Deviation	7.2	6.76
Mean Score	18.07	22.06
Median Score	17	21
Maximum Score	35	35
Minimum Score	5	7
Variance	51.83	45.73
Cronbach	0.88	0.88

Energy/Momentum

Energy and momentum objectives were to be addressed in the second year of the Rural institutes. The initial content understanding, as evidenced by the pre assessment, for the participants was

[4] Horizon Research, Inc. Capstone Report

considerably lower than expected, similar to the kinematics/dynamics. In some instances, the leaders had to revisit the topics of kinematics and dynamics to address misconceptions necessary to understand energy and momentum. Although the intent of the leaders was admirable, it often led to less time for energy and momentum and therefore the gains may not have been as evident. The mean overall (post) score was several points lower than it was for kinematics and dynamics. In hindsight, it may have been useful to administer the post kinematics/dynamics assessment prior to the energy/momentum institute to determine the level of competency before proceeding.

Data for energy and momentum was only correlated when the assessments were similar in content, 2007-2009.

Participant Mean Percent Score for 2006, 2007, 2008, and 2009Energy/Momentum

	2006	**2006**	**2007**	**2007**	**2008**	**2008**	**2009**	**2009**
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Number of items scored	30	30	30	30	30	30	30	30
Number of tests scored	147	143	17	17			68	70
Number of sites	7	7	1	1	4	4	3	3
Mean % Score	53.04	61.70	50.78	60.20	54.11	63.38	43.43	48.81
Std Deviation	6.01	5.79	5.11	5.14	6.05	5.87	5.69	5.57
Mean Score	15.91	18.51	15.24	18.06	16.23	19.01	13.03	14.64
Median Score	15.00	18.00	16.00	18.00	15.00	19	11.5	14
Maximum Score	28	29	26	26	29	29	29	30
Minimum Score	4	6	7	8	3	7	4	4
Variance	36.16	33.53	26.07	26.43	36.60	34.5	32.32	30.99
Cronbach	0.85	0.85	0.79	0.79	0.85	0.85	0.83	0.82
Sites	Arkansas		U Dallas (MSP)		Lubbock (MSP)		Idaho (MSP)	
	Auburn				U Dallas (MSP)		UNC Greensboro (MSP)	
	Bismarck				UWGA (MSP)		UNC Pembroke (MSP)	
	California				Frostburg (HEC)			
	Miss St							
	Santa Fe							
	Univ of South							

Average of Energy/Momentum Assessments
Participants 2007-2009

	2007-2009 Combined Pre	**2007-2009 Combined Post**
Number of items scored	30	30
Number of tests scored	303	301
Number of sites	15	15
Mean % Score	51.03	59.01
Standard Deviation	6.01	5.95
Mean Score	15.31	17.7
Median Score	15	18
Maximum Score	29	30
Minimum Score	3	4
Variance	36.06	35.37
Cronbach	0.85	0.85

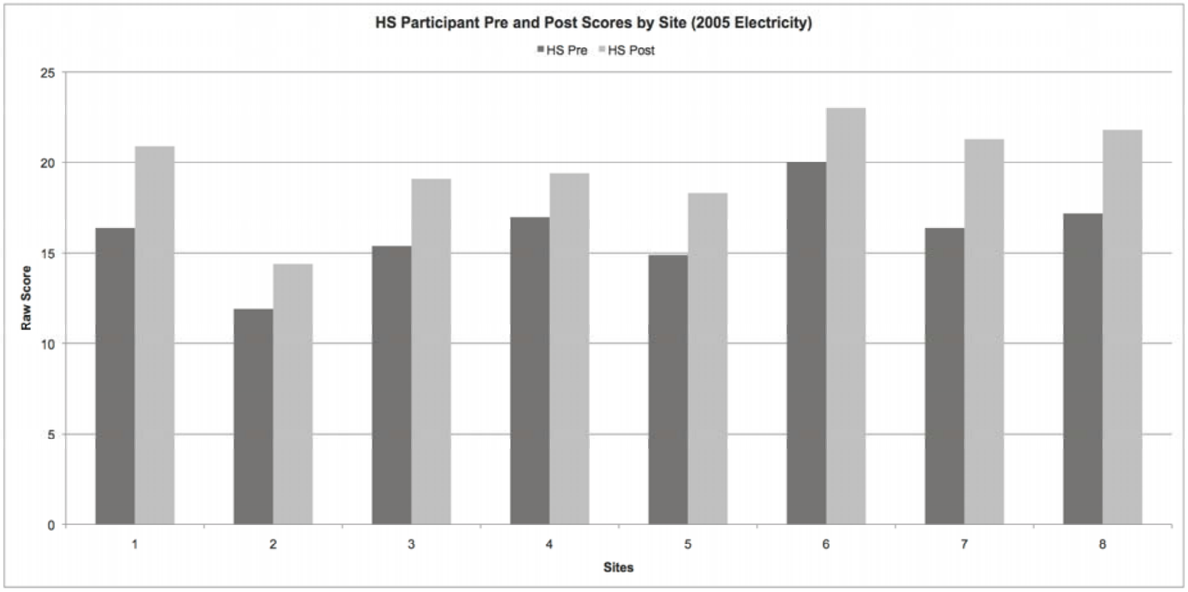
Additional Findings

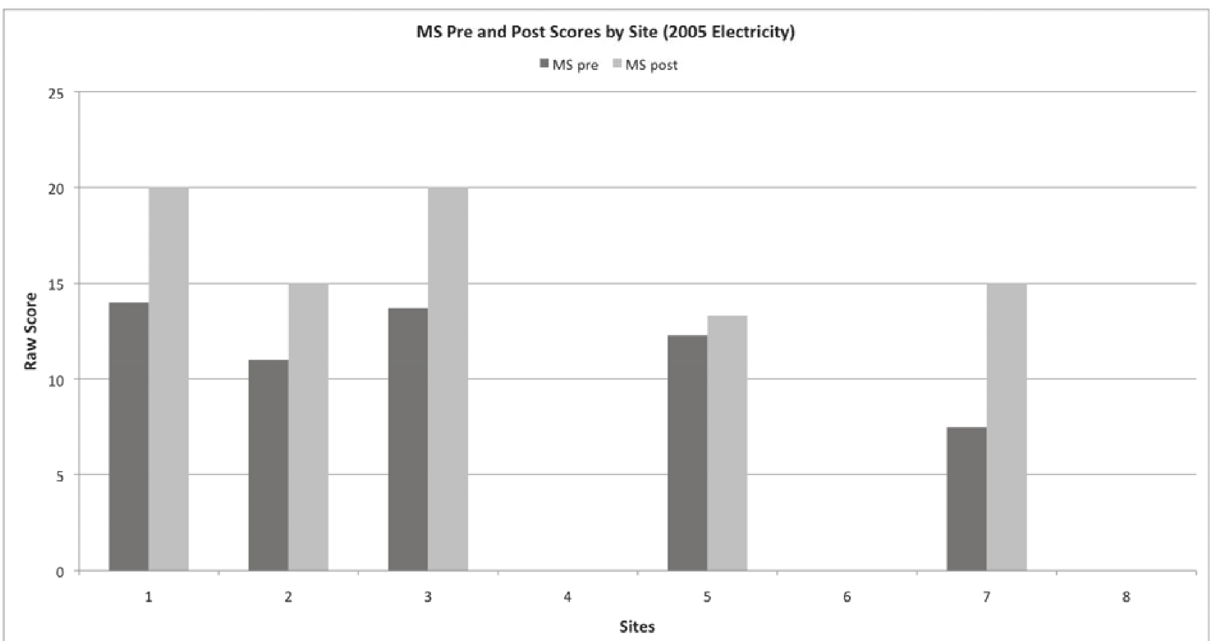
Comparison of Middle and High School Teachers

In 2005, in addition to analyzing general content understandings, EAT, Inc. compared the assessment scores of participants teaching middle school to those teaching high school. The following graphs give the breakdown by site (listed as sites 1-8) for the pre and post high school assessment as well as the pre and post middle school assessment for electricity. Both had gains in content understanding, but the middle school participants had much higher gains.

2005 Comparison of Pre and Post Assessments for HS and MS (Electricity)

Institute	MS pre score (raw)	MS post score (raw)	HS pre score (raw)	HS post score (raw)	MS Percent Gain (%)	HS Percent Gain (%)
1	14	20	16.4	20.9	42.9	27.4
2	11	15	11.9	14.4	36.4	21.0
3	13.7	20	15.4	19.1	46.0	24.0
4			17	19.4		14.1
5	12.3	13.3	14.9	18.3	8.1	22.8
6			20	23		15.0
7	7.5	15	16.4	21.3	100.0	29.9
8			17.2	21.8		26.7





Source: 2006 EAT report

The greatest gains in number of correct responses by middle school teachers were on the energy/momentum assessment, with a gain of 23.6%. However in all three content topics, none of the middle school teachers scored higher than 56% correct on the post assessment.

The table below summarizes the percent change for each of the assessments from 2005.

	Electricity % Change	Energy/Momentum % Change	Kinematics/Dynamics % Change
High School	8.6% (N pre = 220, post = 213)	15.7% (N pre=129, post 123)	12.6 %(N pre = 41, post = 39)
Middle School	13.7% (N pre = 51, post = 44)	23.6% (N pre = 18, post = 18)	20.3% (N pre = 12, N post = 11)

Source: 2006 EAT Report

Gender

Data was summarized for gender percent correct, gains, and Hake Gains for each site as shown in the sample below for the 2005 electricity assessment. Females showed an average gain of 11.9% between the pre and post assessment while males improved 9.75%.

Gender Comparisons for Electricity 2005

Gender	Pre (N)	% Correct		Post (N)
		Pre	Post	
Male	148	36.26	39.80	139
Female	120	31.26	35.03	117
Blank	8	45.0	40.0	8

Source: 2006 EAT Report

Females increased on kinematics/dynamics assessment by 20%, energy/momentum increased 17.8%, and electricity increased 12.1%.[5] Males also improved on all the assessments, but not to the same extent as the females. The males increased the most on the electricity assessment with an increase of 9.75% in comparison to 7.5% on kinematics/dynamics and 5% on energy/momentum.[6]

	Electricity % Change	Energy/Momentum % Change	Kinematics/Dynamics % Change
Males	9.75% (N pre = 148, post = 139)	5.1% (N pre=58, 59 post)	7.5 %(N pre = 21, N post = 19)
Females	11.9% (N pre =120, N post = 117)	17.8% (N pre=89, 84 post)	20.4% (N pre = 32, N post = 31)

[5] 2006, EAT, Inc. Report to AAPT
[6] 2006, EAT, Inc. Report to AAPT

Content (Student)

The main gold standard for evaluating professional development is not to determine the impact on teachers, but the impact on the students they teach. The model developed and used by EAT, Inc. included gathering results from pre and post student assessments by using students of teachers before they were trained in a specific content topic (baseline) and then repeating the process in the year following the treatment of the teachers. The use of this method eliminates some of the variables typically associated with measuring student achievement by allowing the untreated students (prior to teacher participation) to be compared to students the year following the teacher treatment (treated students). This comparison assumes the following: 1) teachers will be teaching students with approximately the same background and understanding in both years, 2) the teachers have not received significant professional development in the content topic being studied outside the AAPT/PTRA institutes, and 3) the teachers implement a large percent of what they learned at the institute into their classroom practice.

There are several limitations and drawbacks to this type of comparison. In the case of the Rural PTRA program, the first topics to be taught at the institutes were kinematics and dynamics, which also happens to be the first topics taught by teachers during the school year. Therefore, gathering baseline data for this content topic has been extremely difficult because the teachers are treated before they really have an opportunity to evaluate their students and collect baseline data. In the Fall of 2006, there were five teachers who gave pre and post assessments to their students, but they had already attended the institute. The teachers did not have a large number of students since they were rural teachers. However, the Cronbach[7] indicates this is a reliable data comparison. It should also be noted there was a mistake on question 27, which was omitted from the scoring process leaving a maximum total of items scored to be 29 instead of 30.

[7] Acceptable Cronbach should be higher than 0.6

Students of Treated Teachers
Kinematics/Dynamics

	2006 Pre	2006 Post
Number of items scored	29	29
Number of tests scored	94	89
Number of sites	5	5
Mean % Score	43.95	56.62
Standard Deviation	4.46	5.38
Mean Score	12.74	17
Median Score	12.5	17
Maximum Score	24	27
Minimum Score	5	5
Variance	19.91	28.91
Cronbach	0.72	0.82

The electricity and waves/optics are toward the end of the PTRA topics sequence and therefore it was possible to gain some baseline information from teachers enrolled in the program to be used to compare students after teachers participated in professional development in these content topics. Through the efforts of teachers involved in the professional development, it was also possible to gather some data on students of teachers that were not involved in the institutes. These teachers were typically at the same school as the participating teachers, so the students would be similar in background and content understanding. However, there are limiting factors such as teacher experience and background knowledge that must be considered and therefore the results should be viewed with discretion.

The advantage of having time (due to the unit being at the end of the topic sequence) to solicit teacher participation for the electricity student assessments is countered with the disadvantage of losing those teachers once they have attended the professional development. It was easier to collect baseline data while they were still in the program, but since electricity was the last summer of the program for most sites it was difficult to collect data on the students after the third year.

Most comparisons for student achievement have been done in Texas in the content topic of electricity and due to supplemental funding from the Texas Regional Collaboratives (TRC). [8]

[8] See additional information in Alternative Funding Section

Although student data is continuing to be collected for both treated and untreated[9] students, the comparisons will be slightly different since project directors who were trained by PTRAs will have trained most of the treated teachers. This model is slightly different from the Rural PTRA model where the teachers (Tier 2) were directly prepared by the PTRAs (Tier 1). The TRC model involves directors (Tier 3) providing the professional development for teachers (Tier 4). The results of the TRC study are not included in this report. There are 14 additional sites (teachers) that have given the student assessment to their students in the spring of 2010 through the TRC study. Those results can be obtained through EAT, Inc.

The Rural PTRA content for electricity is based on the CASTLE (Capacitor Aided System for Teaching and Learning Electricity) curriculum (NSF #MDR-9050189 and Department of Education National Diffusion Network #R073A 40037). The curriculum is self-contained, therefore the level of implementation in the classroom is easily documented. However, even in using the CASTLE curriculum, most teachers indicated they did not have time to complete all of the learning cycles since most districts place this unit at the end of the school year and unfortunately it is rarely allowed over 2-3 weeks to complete. Although the curriculum is self-contained and uses specific language and analogies, the pre and post assessments (for students and teachers) were designed to be representative of any standardized assessment in electricity and magnetism. This eliminated any prejudices towards the curriculum and likely enhanced the overall validity of the instrument due to the fact that students would have to transfer their knowledge to a standardized format in order to do well on the assessment.

Another component of the gold standard for professional development is measuring the implementation of the skills or activities into the classroom. In the case of CASTLE, it was easy to determine if the participants were implementing the curriculum. It is possible both the curriculum and the teacher professional development impacted the student scores, but difficult to determine which factor had the greatest influence. The low post score, in both groups, is attributed to the lack of classroom time spent on electricity regardless of the curriculum used and the fact that most teachers commented that they do not have time to cover all of the objectives in electricity appropriately. However, it is significant that the treated teachers had students that

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[9] Untreated students are students of teachers who have not been trained in a PTRA institute

scored an average of 10 points higher than the students of untreated teachers. Unfortunately, the Cronbach is not reliable in either the treated or untreated data.

The following tables give the statistics compiled from students of untreated teachers between 2006 and 2009. Note most of the students did not have a significant Hake Gain, with the exception of the teacher in 2007. Although the teacher in 2007 did not attend the Rural PTRA professional development in electricity, she did attend the previous two years (kinematics/dynamics and energy/momentum). Therefore, it is not possible to determine if this affected the scores shown.

Student Assessment Results from Un-Treated (Control) Teachers
High School Physics Students
Electricity

	2006 Pre	**2006 Post**	**2007 Pre**	**2007 Post**	**2009 Pre**	**2009 Post**
Number of items scored	30	30	30	30	30	30
Number of tests scored	261	250	38	31	418	403
Number of sites*	10	10	1**	1**	9	9
Mean % Score	32.14	39.84	26.23	40.11	26.08	30.82
Standard Deviation	3.35	4.39	2.79	2.9	2.5	3.29
Mean Score	9.9	11.94	7.87	12.03	7.82	9.25
Median Score	9	11.5	8	12	8	9
Maximum Score	23	27	16	18	21	27
Minimum Score	4	2	1	6	0	3
Variance	11.23	19.31	7.79	8.43	6.25	10.86
Cronbach	0.47	0.69	0.37	0.31	0.11	0.47
Avg. Hake Gain		0.11		0.19		0.06
Avg. Percent Change		23%		83%		16%

**Sites refer to number of teachers administering the assessments*
***Teacher attended 2 Rural PTRA institutes prior to giving this assessment*

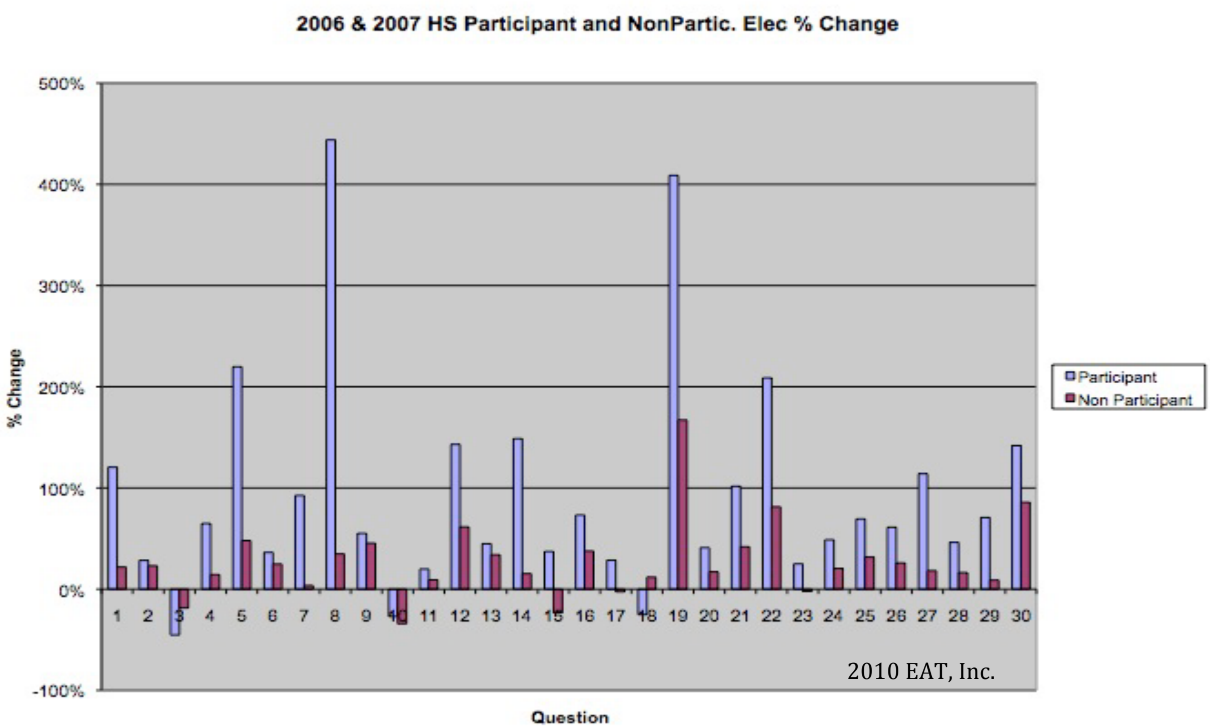
Students in classes taught by teachers who had attended the Rural PTRA professional development (i.e., treated) improved dramatically in their content as seen by percent increases of 80% and 108% and Hake Gains of 0.24 and 0.37 (table below). The untreated classrooms (table above) were much lower with percent increases of 23%, 83% (one teacher), and 16% and Hake Gains that 0.11, 0.22, and 0.06. Both treated and control (untreated) groups have relatively low (25% to 35%) pre mean percent scores.

Student Assessment Results from Treated Teachers
High School Physics Students
Electricity

	2006 Pre	2006 Post	2007 Pre	2007 Post
Number of items scored	30	30	30	30
Number of tests scored	58	57	119	115
Number of sites*	4	4	5	5
Mean % Score	35.46	50.94	30.16	54.93
Standard Deviation	2.59	4.04	3.1	5.1
Mean Score	10.64	15.28	9.18	16.48
Median Score	11	15	9	17
Maximum Score	15	25	21	28
Minimum Score	4	7	4	7
Variance	6.73	16.31	9.59	26.09
Cronbach	0.12	0.62	0.41	0.79
Avg. Hake Gain		0.24		0.37
Avg Percent Change		80%		108%

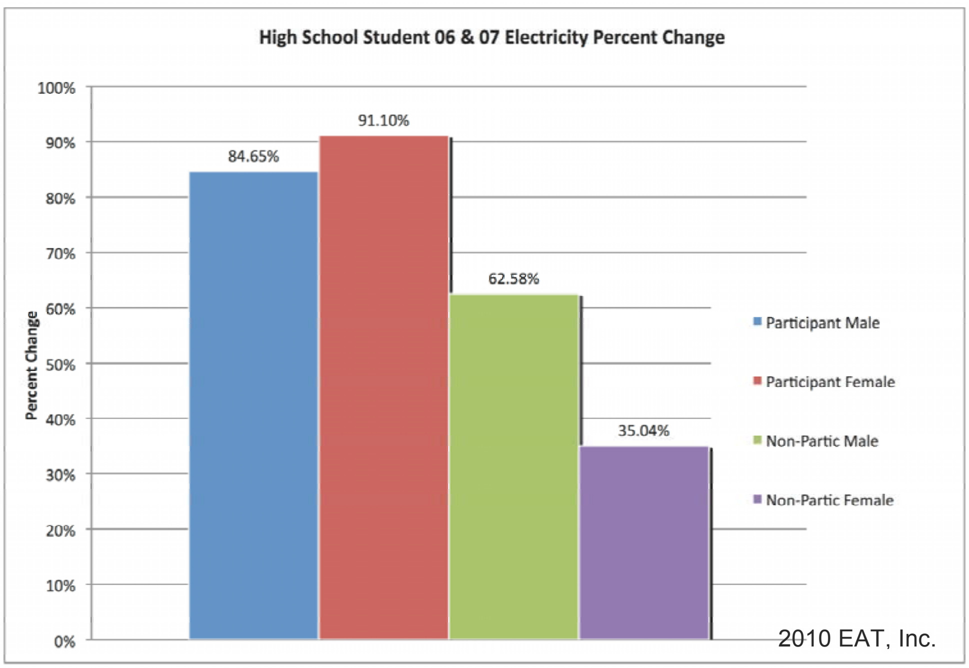
**Sites refer to number of teachers administering the assessments*

Data were compared by breaking down each assessment to individual questions, the pre and post assessment choices, how many students chose each foil of the question, confidence level for each question, and the percent change for each question.



The graph above compares responses for students of participating and nonparticipating teachers for the combined 2006 and 2007 school year. There are three questions indicating negative percent changes for students of participating teachers, but they clearly outscore the students of non-participating teachers on all the other questions.

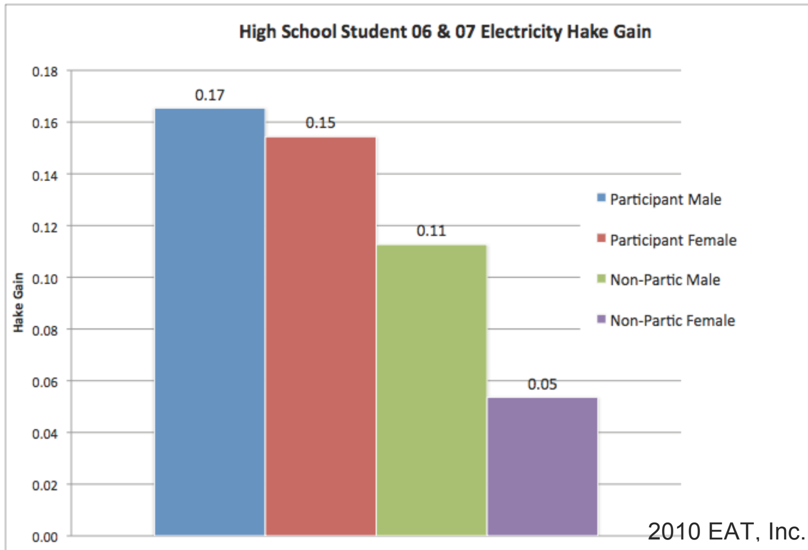
The 2006 and 2007 student electricity assessment was analyzed according to gender and whether they were students of participating teachers (treated) or nonparticipating teachers (untreated). The analysis indicates both females and males in classrooms of teachers attending the professional development understood the content better than those in classrooms of nonparticipants. The females of the participating teachers had the greatest percent change in content understanding while females of the nonparticipating teachers had the lowest percent gains.



The Hake Gains revealed similar differences when comparing gender and participation of teachers to student achievement. Although none of the Hake Gains in this sampling were significantly large, the fact that female students in the classes of nonparticipating females scored 0.05 is significant since they basically had no gains at all, thereby widening the gender gap for nonparticipating students.

N untreated pre = 299; post = 281

N pre treated = 177, post = 172



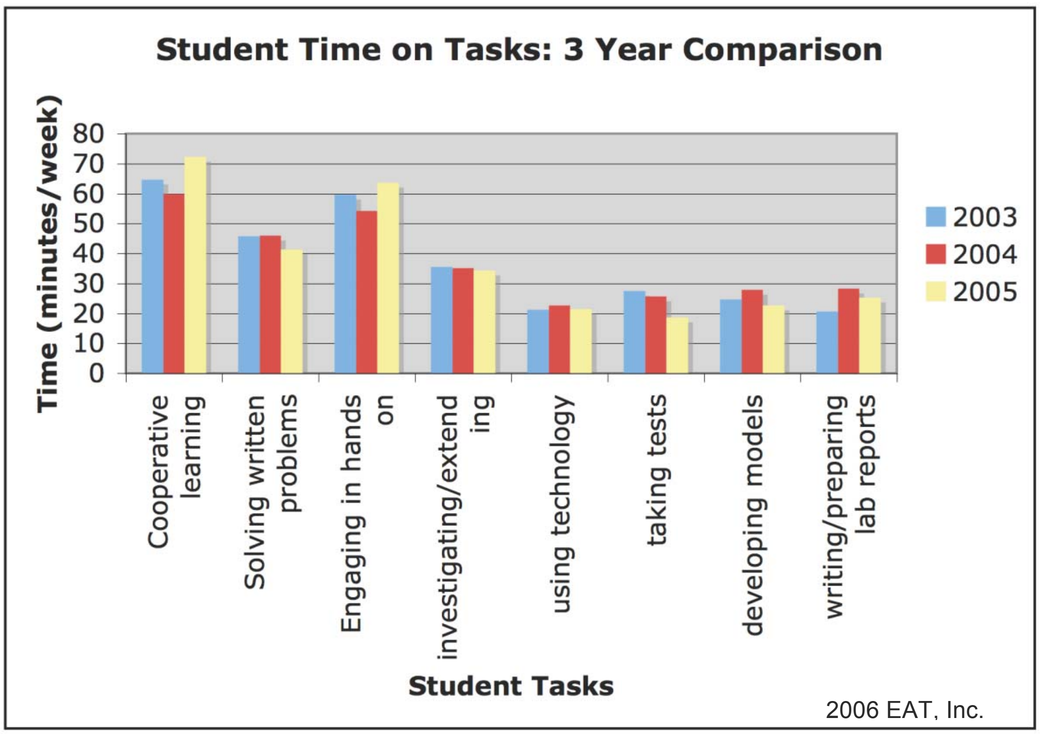
Impact on Classroom Practice

There is substantial evidence that the Rural PTRA model of a week in the summer and follow-up sessions during the school year has impacted teachers and their classrooms. The institute leaders observed that participants who only attended one summer were most focused on the content; those who had been there two weeks tended to focus more on the content and appropriate technology (i.e., felt more comfortable using the technology); those who attended all three summers shifted from a focus of content to appropriate pedagogical strategies and techniques. The actual changes in classroom practice are difficult to document without multiple years of classroom visits, which are extremely expensive and time consuming. Therefore, the Rural PTRA leadership attempted to collect appropriate qualitative evidence to support these shifts through self-reported online surveys after the institutes. Individual site comments and survey results are part of the site reports.

However, one longitudinal study comparing time spent on various classroom tasks for participants was tracked for three years, from 2003-2005 for one of the larger sites that had a high retention rate. Self reported data was only taken for the 38 participants that completed the first three years. Those that completed in 2007 or 2008 were not included.

A follow-up survey was administered during the year to collect information regarding the time students spent on specific classroom activities. The survey asked them to estimate the time based on a weekly average of five hours for one class (i.e., 300 minutes/week). The times given were estimates since teachers were not asked to keep a specific log.

Although the estimates are self-reported, the data for the three-year period clearly indicates that the participants increased classroom time spent on cooperative learning and engaging in hands on activities. They spent less time working homework problems (about 5 minutes) and taking summative assessments. The time spent extending lab activities and using technology remained constant although some commented that they were now more effective in their use of technology. This data would support the assumption that the teachers redirected the time spent working problems and taking tests (total of about 15 minutes) to cooperative learning and more engaging activities (about 12 minutes). Unfortunately, the resources were not available to track all the sites and participants in the same manner due to the problem in longitudinal consistent coding. However, the research would suggest this trend could continue to impact classroom practice and the learning environment by changing it to an interactive situation for students to actively engage in learning the content.



Time is in minutes/week based on one hour a day for 5 days (300 minute week).

Student Task	2003	2004	2005
Cooperative learning	64.62	59.89	72.41
Solving written problems	45.87	45.95	41.38
Engaging in hands on	59.69	54.21	63.72
Investigating/extending	35.52	35.14	34.35
Using technology	21.28	22.71	21.51
Taking tests	27.62	25.81	18.62
Developing models	24.66	27.88	22.76
Writing/preparing lab reports	20.73	28.40	25.24

One of the components of a doctoral study[10] involved evaluating the effectiveness of some of the activities used in the Rural PTRA professional development. Participants were asked to list up to five activities they had used and evaluate their effectiveness in the classroom. The intent was to create a listing of effective instructional activities that future institutes could incorporate into their curriculum. However, there were unforeseen problems in gathering and summarizing these data:

1) Timing of the survey retrieval. The participants were asked to return the survey by mid-October. Very few forms were returned by that date, so the deadline was extended. This meant that several of the participants who turned in an early survey were not allowed the opportunity to evaluate activities that might have been incorporated in their class during November or December.

2) Several indicated they had not taught the topics of kinematics and dynamics by the time the survey was due back.

3) Teachers of IPC (integrated physics and chemistry) did not teach physics at all until the second semester. Therefore, they were not able to give their input on specific activities.

The surveys allowed teachers to give free responses as to specific techniques they implemented in their classroom after the institute. Teachers mentioned their effective use of whiteboards to solicit student responses. Others indicated they found success with use of technology, such as motion detectors and accelerometers. Graphing activities that allowed students to conceptually understand motion were popular as well as the use of

[10] K.J. Matsler, 2004. *Assessing the impact of sustained, comprehensive professional development on rural teachers as implemented by a national science teacher training program*, Argosy University

timer-tape to analyze motion, and simple demonstrations for Newton's Law of Inertia. Other non-specific activities were mentioned including the use of toys in the classroom, visual ways to show vector resolution, and the use of buggy carts to show constant velocity as well as relative motion.

Information documenting the impact on the classrooms was obtained through free response questions in the latter years (not the original surveys) because the shift was not immediately apparent to the leaders of the institutes or the PTRA leadership team. At one of the site's final follow-ups, the conversation evolved into a discussion of changes they had made in their classrooms as a result of attending the institutes for three years. As the participants shared their classroom activities, one of the site leaders (Pat Callahan) recognized that the shift in their concern, behavior, and professional maturity was much more dramatic than we had anticipated. He then asked his participants to write down some of the comments (see appendix) and other sites were asked to do the same. These comments were very insightful and therefore were collected, compiled, categorized, and tallied from the final survey results.

Results of Final Survey Administered in 2009

In an effort to quantify the impact of the AAPT/PTRA program, the leadership team developed an online survey to collect information relevant to the project's success, challenges, and overall impact. In the summer of 2009, all AAPT/PTRA participants that were in the database were sent the link to the survey and asked to complete the survey before January 2010. There were over 370 respondents to the survey, but some had incomplete data and some were duplicates. After the incomplete and duplicate responses were deleted, there were 330 responses tabulated. Some of the information gathered was background information and other components were free responses.

The number of respondents was large enough to be representative of the participants at recent institutes. Unfortunately, most of the respondents had attended the Rural PTRA or MSP institutes, very few (35) indicated they attended the urban institutes. Of the 329 respondents, 171 were male and 158 were female.

Some of the comments from the final survey include:

- I now use discovery and scaffolding type learning.
- I use technology to collect, display and analyze data.
- I understand misconceptions and how to deal with them.
- I understand how to differentiate.
- My labs are inquiry based, not facts and equations.
- I have my students develop equations after they do the labs, we don't use the labs to verify equations.
- I do less lecture and more active learning.
- I look at the big idea or conceptual idea they need to know, not the equation.

Participants were asked to respond to several open ended responses regarding the benefits of the institutes. For example, they were asked, "What component of the workshop or institute did you feel was most beneficial to your effectiveness in the classroom? Explain." The analysis of this question was difficult due to the lack of pre-specified choices, but the design was deliberate in that the evaluator did not want to guide the participants to a specific response. The intent was to have the participants reflect on their experience and self report the highlights of the professional development and how it impacted their effectiveness in the classroom. There were several comments that were mentioned significantly more often than others. Participants most often mentioned the opportunity to increase their content knowledge in physics, networking/collaboration with peers (face to face), learning effective strategies for the classroom, and new ideas and labs. One participant commented: "These workshops saved me. The knowledge that I learned from the institute gave me the background to be a highly qualified teacher."

The increase in self-efficacy or confidence is reflected in the open responses as well as the increase in answering questions on the assessments, which is later in this report. The overall increase in confidence is also the main response when asked, "How do you think the three changes listed above impacted student achievement in your classroom?"

Tally of Open Ended Responses:
"What component of the workshop or institute did you feel was most beneficial to your effectiveness in the classroom?"

Open Ended Response (N=310)	Number of responses	Percent of responses
Concepts/knowledge	90	29.03%
Collaboration/networking	75	24.19%
New ideas for the classroom	51	16.45%
Better teacher/effective strategies	50	16.13%
Self efficacy/confidence/leadership	43	13.87%
Pedagogy/methods/PLC	36	11.61%
Higher level of teaching/applications	18	5.81%
Student Centered learning	18	5.81%
Resource awareness	17	5.48%
Motivation to teach/enthusiasm	15	4.84%
How to use technology	13	4.19%
Awareness/addressing student misconceptions	12	3.87%
Inquiry methodology	9	2.90%
Modeled effective teaching	7	2.26%
New materials/equipment to use	7	2.26%
Adult learner/cognitive dissonance	7	2.26%
Certification/endorsement	7	2.26%

Data collected through surveys, conversations, and interviews throughout the Rural PTRA project indicated the participants did make significant changes in their classroom practice as a result of attending the institutes. Although the data was self-reported, the quantity and consistency of responses is sufficient to document that the teachers did implement the strategies modeled and discussed at the institutes. The final survey responses were consistent with the yearly surveys and clearly substantiate the impact on students. Participants were asked on the final survey to list three things they now do differently in the classroom as a result of the institute. Since they could list three things, the total percent does not add up to 100, but it is important to note that over half of the participants stated they now have students being more active in their learning through the use of inquiry and discovery labs. Several teacher comments clearly identified how the institutes have helped them in the classroom and the impact on students. One teacher's comments were particularly revealing:

> "I have had students actually talk about pursuing a college degree in physics because they enjoy my class so much. I did not have that before when I was just teaching from a

textbook. I don't even use a textbook on a regular basis. I use all my AAPT/PTRA materials. The students that take my physics class are the honors/GT group and the way I teach physics now really stretches their brains. I have learned so many new methods of assessment and they normally require them to think in a way they are not used to. It is so rewarding when they get the right answer. They are so proud and so am I. I owe all of this to these workshops I attended."

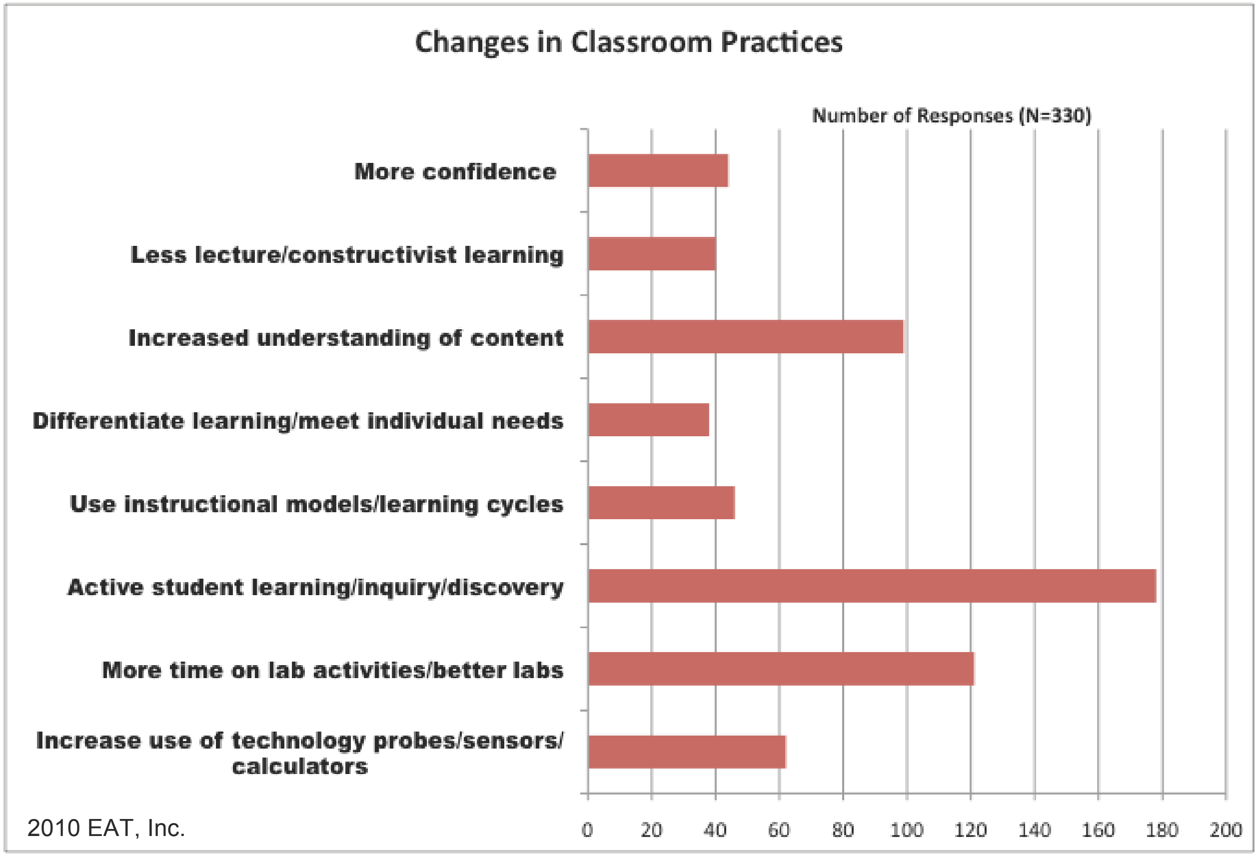
Some responses were unique and therefore would not be tallied with the others. A few unique responses include:

- I've incorporated the physics concepts into my math classes to explain the "why?" behind the math. Specifically, I've used a spring lab, a density lab, projectile motion lab, and distance vs. time lab.
- I never could use my photogates and get good data. Now I know HOW to use it.

Tally of Open Ended Responses:

Question: "*If you could list 3 things that you do differently in the classroom now than before the institute or workshop, what would they be?*"

Open Ended Response (N=330)	**Number of Responses**	**Percent of responses**
More Confidence	44	13.33%
Less lecture/constructivist learning	40	12.12%
Increased understanding of content	99	30.00%
Differentiate learning/meet individual needs	38	11.52%
Use instructional models/learning cycles	46	13.94%
Active student learning/inquiry/discovery	178	53.94%
More time on lab activities/better labs	12	3.64%
Increase use of technology probes/sensors/calculators	62	18.79%



The participants were also asked to respond as to whether they felt the changes listed above impacted student achievement in the classroom (since it could not be measured directly). Again, although the data is self-reported, the similarity in responses and the number of responses supports the claim that the institutes did impact student learning, attitudes, and achievement. The responses below are indicative of the hundreds of responses that have been submitted through surveys. These responses are important because they were submitted on the final survey, which is at least 2 years after most had finished the professional development institute and therefore are reflective of how they have changed and how students have benefitted. The responses below are direct quotes.

- Better organizational skills - fewer lost papers and data, much more interest in topics due to hands-on activities.
- Better attitude toward science in general
- The students have taken ownership of knowledge and are able to move forward with a solid foundation, which they can add to as they encounter new information.

- Tremendously... even the administration has noticed an improvement!
- Student evaluation was higher than before
- More permanent acceptance of corrected misconceptions
- Improved science FCAT
- I have better state test results and more students sign up to take Physics.
- They now see physics as a way of explaining nature more than just solving problems and memorizing information.
- My students have become more proficient in their understanding of physics concepts
- Students spend more time doing meaningful learning. They use technology to extend their depth of knowledge.
- Improved performance on state tests.
- There is an improvement in depth of understanding.
- They take ownership of the learning process
- It improves their quality of education because i am not as lost as they are
- They are more involved, remember more as they draw from experience in the classroom, they learn the process of learning.
- There is some immediate recognition of it through assessment but I believe the real value will be in the years ahead when the students are in post secondary settings and beyond.
- They are better prepared for college Physics in terms of experimentation and using data to support text concepts than those I worked with prior to my attendance.
- The inquiry-based instruction improved their conceptual understanding in the waves and optics units in my AP and college prep physics class
- Enrollment increased, more students pursue engineering and physics in college, greater student satisfaction
- Better retention, students able to shift their understanding under own power, better rapport with students.
- Student test scores (MEAP) have increased each of the past four years
- I have seen students deepen their understanding and discuss the concepts in the labs, where before they didn't as much
- I haven't taught physics since 2002-2003, but my students at that time went on to complete college, many with science degrees. They have told me they understood college

science courses, and some who weren't science majors actually tutored those who were. I think my students were more successful than they might have been had I not taken the AAPT/PTRA workshops.

- We replaced 3 months of graph papers and one experiment with many experiments and the corresponding analysis.
- Students became better at experimental design and graphing
- Students are eager to get home to find things to try and replicate the activity for that day. Having parents to say that their child enjoyed a particular experiment conducted in class.
- The greatest impact is the level of engagement and interest students have has increased therefore it increases learning.
- Improved engagement, better test scores
- From my previous 17 years of teaching experience, I can assure you that my students are now more engaged and have increased their level of scientific comprehension.
- Scores on tested that are normed for the AP class have been higher

Other Responses from the Final Survey

Some of the responses were disaggregated according to the type of professional development they attended (rural, urban, or MSP). Survey respondents were asked to give the years they attended the institutes/workshops, but most could not correctly identify the year or the program (rural vs. urban). When possible, information was triangulated (by using the location and topic) to properly identify the year and proper project. However, there were still many responses that were incorrect because they said they were part of the urban project in 2003, 2004, or 2005 and there was no urban project going at that time. Therefore, some results are not listed as individual projects, just as an overall summary. The following tables and charts were collected from the final survey given in 2009.

Gender

	Rural PTRA	**Urban PTRA**	**MSP/Other**
Male	132	16	36
Female	122	16	36

Ethnic Background

	Rural PTRA	Urban PTRA	MSP/Other
American Indian or Alaskan Native	1	1	4
Asian or Pacific Islander	4	0	4
Black, non Hispanic	10	1	4
Hispanic	1	0	2
White, non Hispanic	234	32	54
Other	3	1	1

Position (Employment)

	Rural PTRA		Urban PTRA		MSP/Other	
	Current	**Previous**	**Current**	**Previous**	**Current**	**Previous**
Elementary Classroom Teacher	3	3	0	0	0	0
Middle School classroom Teacher	45	45	1	1	17	17
High School Classroom teacher	192	193	21	25	49	47
Science Consultant/Specialist	4	3	1	2	0	1
University Professor	6	6	5	3	1	1
2 Year College Instructor	7	3	6	3	1	1
Retired	9	1	8	1	0	0
Other	19	6	2	1	4	3

Previous refers to position at time participant took the institute

How much total time have you actually spent in AAPT/PTRA workshops or institutes?		
Answer Options	**Response Percent**	**Response Count**
Less than one day	0.9%	3
1 day	3.5%	11
1-3 days	6.0%	19
5 days (one week)	12.6%	40
5-8 days (one week and follow-up)	20.8%	66
10 days (two weeks)	6.6%	21
10-13 days (two weeks and follow-up)	9.7%	31
15 days (three weeks)	5.7%	18
15-18 days (three weeks and follow-up)	10.1%	32
More than 18 days (please specify below)	24.2%	77
Other (please specify)		54
	answered question	**318**
	skipped question	**12**

Source: 2009 Final PTRA Survey

Follow-up sessions

The rural teachers had to drive long distances, often over five hours one-way, in order to attend the institutes since they were held at the campus of universities and two year colleges. Therefore, funding was provided to supplement travel and they were often housed in the university dorms. Due to the long distances required to attend, multiple follow-up sessions were often combined as one long weekend that typically would start on Friday around noon, go until 9 PM Friday night, and end on Saturday in time to allow them time to travel back home. Having the follow-up sessions begin on Friday meant the participants would have to miss school on Friday, often having to pay for their own substitute expenses, in order to have time to drive the long distances to the institutes. They would then turn around and drive back late Saturday afternoon; many times they were driving longer than they were at the institute. Although combining the follow-up hours into one session was advantageous to those attending the sessions, the disadvantage was that a single follow-up session prohibited someone from obtaining the targeted number of hours if they could not attend. If they did not come to the follow-up they lost 12-15 hours per year for a total of 36-45 hours over the course of the grant, which is equivalent to one week of the summer institutes. The majority of the participants did attend follow-up sessions, but when asked why they did not, 73% said the follow-up session conflicted with other responsibilities and 19.4% indicated the travel distance was too great. Only

4 of the 330 participants who responded to the final online survey indicated the follow-up sessions were of no value to them and a few indicated that financial restrictions prohibited their attendance, likely due to only partial reimbursement of travel expenses.

Did you attend at least one week-long summer institute?		
Answer Options	**Response Percent**	**Response Count**
Yes	91.5%	268
No	8.5%	25
	answered question	**293**
	skipped question	**37**

Source: 2009-2010 Final PTRA Survey

Did you attend any of the follow up sessions?		
Answer Options	**Response Percent**	**Response Count**
Yes	74.3%	214
No	25.7%	74
	answered question	**288**
	skipped question	**42**

Source: 2009-2010 Final PTRA Survey

If you did not attend the follow up session(s), what was the main reason?		
Answer Options	**Response Percent**	**Response Count**
Follow-up sessions were not of value to me	6.0%	4
Date of follow-up sessions conflicted with other responsibility	73.1%	49
Distance to follow-up sessions was too far to travel	19.4%	13
Teaching assignment changed	7.5%	5
Financial restrictions	6.0%	4
Other (please specify)		43
	answered question	**67**
	skipped question	**263**

Source: 2009-2010 Final PTRA Survey

Of those responding to the open ended question (above), most replied that they entered into the program in the last year and therefore did not have a chance to complete the cycle. To avoid this problem in Texas, the cycle was rotated through different sites so if they came in late, they still had a chance to complete all three summers. This significantly increased the completion rate in Texas as mentioned earlier.

The “other” category included (in order or most responses): chemistry, biology, earth science, and math.

Please rank the following tasks according to the approximate time the STUDENTS spend each week (based on 5 hours of classroom instruction).					
Answer Options	**Never**	**Less than 1 hour**	**1-2 hours**	**2-3 hours**	**More than 3 hours**
Working in small groups (cooperative learning)	4	57	128	67	43
Working problems (homework and in class)	3	93	122	53	28
Engaging in hands-on activities/labs	2	44	153	66	34
Investigating/extending an activity that was initiated in class	34	157	72	24	12
Using technology/probes to gather data in lab	57	140	72	25	5
Taking tests (summative assessments)	6	247	41	3	2
Developing scientific models based on class experiences	46	146	84	20	3
Writing/Preparing lab reports	31	185	71	9	3
Taking notes relating to content (teacher directed)	13	119	130	29	8

Source: 2009-2010 Final PTRA Survey

Institute Evaluation

Question: *'To what extent, if any, do you feel that you experienced each of the following types of learning as a result of your participation in the AAPT/PTRA institutes or workshops?"*

There were 291 responses. The rating average is the average of the four choices where "not at all" is a 1 and "great extent" is a 4. The lowest rating was the exposure to professional magazines and journals although several mentioned in the comments that they had joined AAPT or subscribed to a physics journal as a result of the workshop.

	Not at all or n/a	**Small extent**	**Moderate extent**	**Great extent**	**Rating Average**
I gained greater understanding of the applications of science or technology in everyday life	8	50	129	104	3.13
I acquired greater understanding of fundamental concepts in science	5	44	108	134	3.27
I became familiar with new materials and equipment that I can use in my teaching	1	11	64	214	3.69
I learned about innovative ways to use standard materials and equipment in physics	0	18	94	177	3.55
I gained a greater appreciation of the difficulties some students encounter when learning science	6	72	106	107	3.08
I better understand how collaborative inquiry can be done successfully	6	46	133	105	3.16
I expanded my knowledge of how to use computers and technology in my teaching	17	60	117	95	3.00
I learned about magazines, professional journals, and/or professional organizations that are relevant to my classroom teaching	39	119	87	44	2.47

Source: 2009-2010 Final PTRA Survey

Question: *"How would you rate the AAPT/PTRA Institute(s) you attended?"*

To obtain the rating average, the 291 responses were ranked and scored with strongly disagree being a 1 and strongly agree being a 4. The responses indicate the participants knew the objectives of the institute and they felt they were reasonable and fulfilled.

	Strongly Disagree	**Disagree**	**Agree**	**Strongly Agree**	**Rating Average**
Goals/learning objectives of workshops were clear	0	5	99	187	3.63
Organized for optimal learning	0	12	117	159	3.51
Provided useful information I can use in the classroom	1	3	83	204	3.68
Provided specific strategies and skills	0	4	97	190	3.64
Improved my knowledge of student learning	1	21	147	121	3.34
Provided ample training in use of technology for the classroom	2	22	155	112	3.30
Included ideas and strategies for implementation	0	7	123	161	3.53
Provided adequate opportunities for peer collaboration	2	4	110	173	3.57
Provided appropriate resources for implementation	0	12	134	141	3.45
Increased my content skills	2	20	116	150	3.44
Increased my confidence in teaching	2	15	114	157	3.48
Allowed ample time to incorporate new skills and activities into lesson plans to expedite implementation	1	52	139	95	3.14
Increased my awareness of appropriate pedagogy	2	35	155	94	3.19
Provided appropriate bridging from existing knowledge to new concepts	3	25	138	119	3.31

Source: 2009-2010 Final PTRA Survey

Question: *"In comparison to other professional development opportunities, how would you rate the AAPT/PTRA experience and the overall usefulness to your professional growth?"*

Answer Options	Response Percent	Response Count
Not useful at all	0.0%	0
Less useful than most professional development I have attended	3.9%	11
More useful than most professional development I have attended	51.6%	147
Most useful professional development I ever attended	44.6%	127
Other (please specify)		16
	answered question	**285**
	skipped question	**45**

Source: 2009-2010 Final PTRA Survey

Many participants gave an open response to the question above. Some of the responses included:

- "There is nothing out there that comes close to what we did each summer at Lee College. The crew really worked hard and our students and we benefitted. I am really missing getting together."
- "The classes were taught by my colleagues, not by someone unfamiliar with the high school classroom."
- 'The only professional development that rates higher are the ones that are 3 - 5 weeks long. One week is a tall order to cover a Physics topic."

Question: *"To what extent do you agree or disagree with each of the following statements according to the impact of the AAPT/PTRA program on you professionally?"*

	Strongly disagree	Disagree	Agree	Strongly Agree	N/A	Rating Average
It increased by confidence in myself as a teacher	3	12	118	153	5	3.47
It elevated my enthusiasm for teaching	2	9	112	160	4	3.52
It increased my interest in research and the ways that science and technology can be applied	4	30	145	100	11	3.22
It stimulated me to think about ways I can improve my teaching	1	2	88	195	5	3.67
I believe it made me a more effective teacher.	2	10	103	167	8	3.54
It provided a community of learners and allowed me to network with other teachers	2	15	109	149	16	3.47

	Strongly disagree	Disagree	Agree	Strongly Agree	N/A	Rating Average
It increased my commitment to life long learning	1	21	124	132	13	3.39
It increased my desire to seek new ideas and incorporate them into my classroom	1	7	104	170	9	3.57
It increased my understanding of learning cycles and appropriate pedagogical approaches	6	37	162	76	10	3.10
It increased my ability to use inquiry-based instructional materials	4	14	127	134	11	3.40
It increased my awareness of student misconceptions and how to address them appropriately	3	16	145	117	9	3.34
It increased by ability to develop appropriate and authentic assessment tools	8	40	154	76	11	3.07
It increased my confidence in my ability to mentor other teachers or pre service teachers	4	31	129	108	18	3.25

Source: 2009-2010 Final PTRA Survey

Question: *"Please rate the leadership team in each of the following areas. Note: some workshops may have had multiple leaders, please give an overall rating. Individual comments may be placed in the comment box."*

	Poor	Satisfactory	Good	Excellent	N/A	Rating Average
Prior preparation for your arrival (location information, directions, etc)	0	8	49	232	2	3.78
Knowledge and support of the workshop goals	1	9	37	245	0	3.80
Adherence to a planned and sequenced curriculum	0	13	61	216	1	3.70
Modeled effective instructional practices	2	13	61	216	0	3.68
Paced the activities and learning experiences appropriately	2	19	75	194	0	3.59
Knowledge of the challenges and responsibilities of the participants	6	13	72	199	1	3.60
Commitment to provide opportunities to you to learn and gain expertise	3	12	49	228	0	3.72

	Poor	Satisfactory	Good	Excellent	N/A	Rating Average
Respectful of participants, hosts, and each other	2	7	36	247	0	3.81
Able to communicate content information clearly	1	16	47	226	0	3.72
Provided professional collaboration and community after the institute	3	20	64	192	9	3.59

Source: 2009-2010 Final PTRA Survey

Comments on this question included:

- "I do not believe you could put together a better team."
- "The best organized and presented workshops I've ever attended."
- "The instructors were some of the best I have met in my 25+ years of teaching science."
- "Outstanding team!"

Professional and Personal Growth

Question: *"How would you rate each of the factors listed below in preventing you from implementing the things you learned in the workshops or institutes?"*

	Impossible	Significant problem	Moderate problem	Very few problems	Not a problem	Rating Average
Administrative support	3	25	45	77	137	4.11
Use of technology (probes, etc)	8	76	79	61	60	3.31
Money for activities/labs	16	110	85	54	22	2.85
Time to plan, prepare activities/labs	2	79	106	63	37	3.19
Classroom size (floor space/student)	3	41	75	91	77	3.69
Student/teacher ratio	7	37	74	79	90	3.72
Mandated district curriculum	3	35	65	78	102	3.85
Mandated state curriculum	3	46	58	85	93	3.77
Need for differentiated instruction (ESL, 504, etc)	6	32	74	95	77	3.72
Appropriate resources (equipment, texts)	12	76	80	78	40	3.20
Difficulty of subject matter	3	11	82	104	85	3.90
Student resistance to subject matter	3	25	86	104	67	3.73

Source: 2009-2010 Final PTRA Survey

Did your participation in the institute or workshop influence your role in other professional activities or organizations? If so, which ones?		
Answer Options	**Response Percent**	**Response Count**
Yes	33.2%	91
No	66.8%	183
If so, please list (e.g. NSTA, AAPT)		86

Source: 2009-2010 Final PTRA Survey

Of the above responding to the open response, 53 mentioned AAPT and 30 mentioned NSTA.

Did you ever present what you learned at the institute or workshop with your peers?		
Answer Options	**Response Percent**	**Response Count**
Yes	46.2%	127
No	53.8%	148
If yes, please list places and type of presentations		114
	answered question	**275**
	skipped question	**55**

Source: 2009-2010 Final PTRA Survey

If so, did you present at local, regional or national conferences?		
Answer Options	**Response Percent**	**Response Count**
Local	69.1%	65
Regional	22.3%	21
National	8.5%	8
If yes, please list places and type of presentations		54
	answered question	**94**
	skipped question	**236**

Source: 2009-2010 Final PTRA Survey

Length of workshop or professional development

There is considerable controversy and conflicting evidence as to the most appropriate use of time for summer workshops or institutes. The current Math Science Partnership programs require a minimum of two weeks in the summer and are therefore referred to as institutes. Horizon Research, Inc. recommended a minimum of 80 hours of professional development in order to change classroom practice in the Capstone Report. Although both recommendations are admirable, reality is that most teachers cannot afford to be in two weeks of professional development in addition to their other responsibilities either during the year or in the summer. This is particularly true of the rural teachers who teach multiple subjects and grade levels. It is not reasonable to assume they would be willing to attend two weeks of professional development for every subject they teach. The final survey asked the participants what was a reasonable length of time to have professional development and nearly 85% chose between three and five days and 65% preferred days of 5 to 7 hours. Several of the PTRA leaders commented that their participants preferred to stay four days and work longer hours than to spread the time over a five-day period. However, only 13% on the survey requested days longer than 7 hours. Home responsibilities, professional development required by districts and/or states, AP professional development, and financial constraints were all mentioned as reasons for only being allowed to attend for one week at a time.   There were several comments regarding the fact that if you go for much longer than 4-5 days you have too much information and you do not have time to assimilate it and therefore the rest of the time is not used effectively. Many commented that they preferred a week plus some follow-up sessions during the year (see 3rd table below).

How long should a summer institute of professional development last in order to maximize time and productivity?		
Answer Options	**Response Percent**	**Response Count**
Less than three days	0.8%	2
Between 3 and 5 days	84.9%	220
At least 2 weeks	11.6%	30
At least 3 weeks	2.3%	6
At least 4 weeks	0.4%	1
Other (please specify)		26
	answered question	**259**
	skipped question	**71**

Source: 2009-2010 Final PTRA Survey

Based on your experience, how long should a day of professional development last?		
Answer Options	**Response Percent**	**Response Count**
Less than three hours	0.4%	1
Between 3 and 5 hours (with appropriate breaks)	20.8%	56
Between 5 and 7 hours (with appropriate breaks)	65.4%	176
More than 7 hours (with appropriate breaks)	13.4%	36
Other (please specify)		12
	answered question	**269**
	skipped question	**61**

Source: 2009-2010 Final PTRA Survey

Which of the following is your preferred method of attending professional development? You may select more than one, but please limit selections to no more than 2.		
Answer Options	**Response Percent**	**Response Count**
During school hours.	7.0%	19
During school year and after school hours.	5.1%	14
Week ends	16.1%	44
Summer institutes (One week)	59.0%	161
Summer institutes (One week) and 1 or 2 days of follow-up sessions during the school year	48.7%	133
Summer institutes (Multiple weeks)	16.5%	45
Other (please specify)		5
	answered question	**273**
	skipped question	**57**

Note: Participants could select more than one response, so the total was over 100

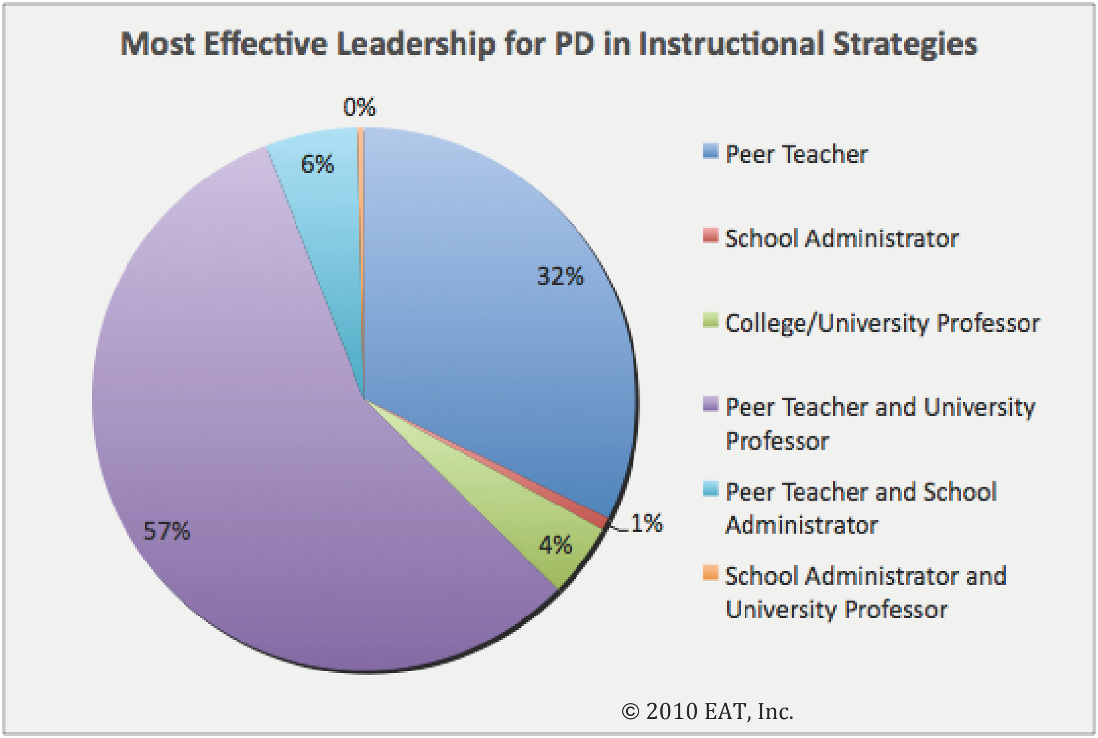
Professional Development Suggestions

Participants were asked to consider the various types of professional development they have attended, including the AAPT/PTRA models, and determine which type of leadership combination is best for the overall success of the institute and the continuing support. As indicated in the following table, the overwhelming majority felt the leadership should consist of peer teachers and university administrators for both instructional strategies and content knowledge. The comments revealed that they prefer professors who are also good at relating to students and/or teachers. The two questions were:

1) The most effective person to lead professional development on instructional strategies is.......

2) The most effective person to lead professional development on physics content is.......

Question	Peer Teacher	School Administrator	College/University Professor	Peer Teacher and University Professor	Peer Teacher and School Administrator	School Administrator and University Professor
1	88	2	12	155	15	1
2	41	0	22	208	1	1


Most Effective Leadership for PD in Instructional Strategies
0%
6%
32%
1%
4%
57%
Peer Teacher
School Administrator
College/University Professor
Peer Teacher and University Professor
Peer Teacher and School Administrator
School Administrator and University Professor
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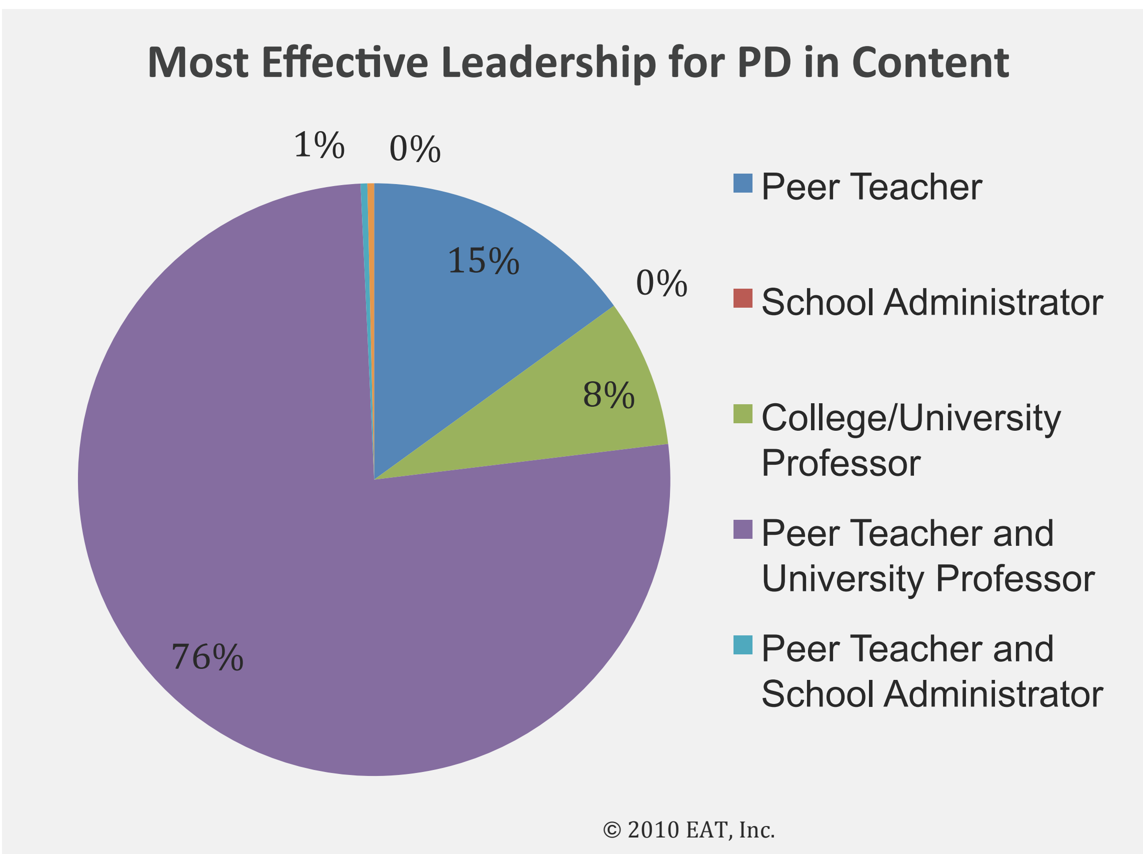
Most Effective Leadership for PD in Content
1%
0%
15%
0%
8%
76%
Peer Teacher
School Administrator
College/University Professor
Peer Teacher and University Professor
Peer Teacher and School Administrator
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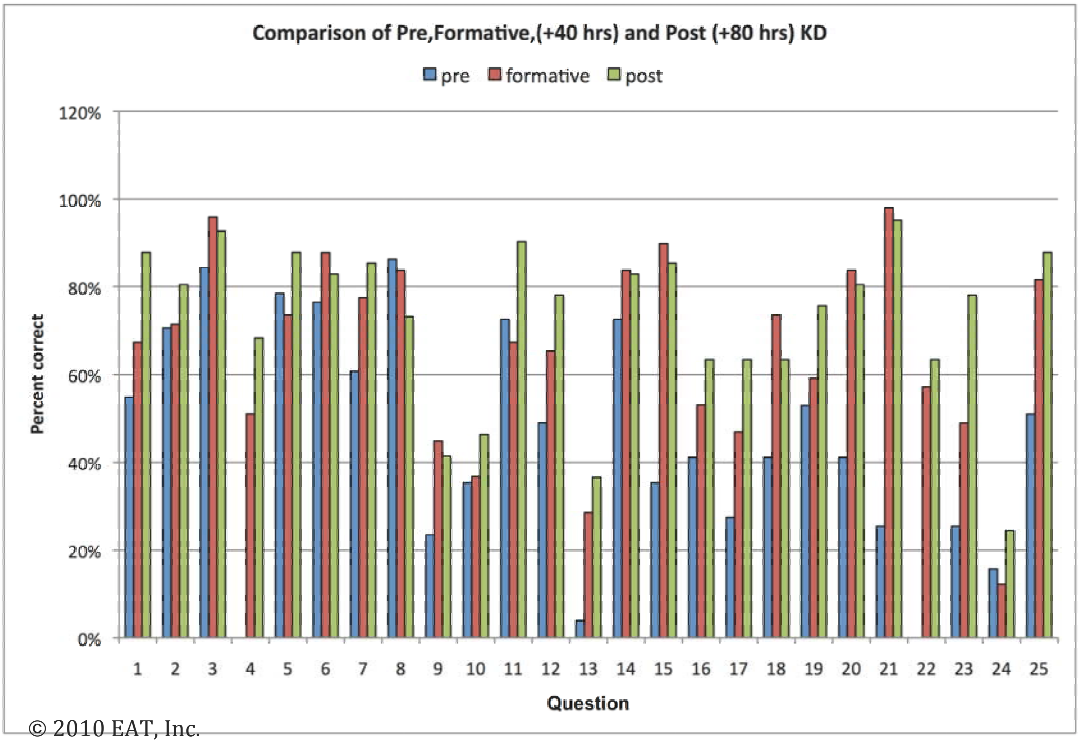
Alternative Funding

The AAPT/PTRA professional development model was successful in establishing additional sites with alternative funding from Math Science Partnership (MSP), Higher Education Commission (HEC), and Toyota grants. Since 2005, alternative funds totaling over 6 million dollars, have supported PTRA professional development institutes in Arkansas, Georgia, Idaho, Texas, North Carolina, and Washington DC. These institutes, initially started in Texas, were funded as a result of successful collaborative partnerships between AAPT, PTRA, universities, and districts.

The initial groundwork for soliciting and receiving alternative funding was in Texas. The Texas institutes were supported by funds through the Texas Regional Collaboratives (TRC), an extension of the University of Texas designed to provide professional development for teachers in science and math. The partnership with TRC provided over 4 million dollars in professional development funding from 2006-2009 and was the beginning of the transformation of the Rural PTRA national model to one that focused on state initiatives and funds.

The partnership between the TRC and the documentation that participants needed more time to master the content provided an opportunity to acquire additional data. The TRC model required participants to receive over 100 hours of professional development. Although implementation of 100+ hours was difficult, it did provide some additional research opportunities to compare the gains made by teachers in the Rural program who had been to approximately 35 hours of professional development in a content topic to those that had received more hours of instruction. A more detailed report on the comparisons and results can be obtained through EAT, Inc., but the graph below summarizes the results revealing that the longer the participants were trained, the greater the increase in content understanding. The formative assessment was given after 40 hours of instruction (similar to the post assessment for the Rural program) and the post assessment was given after 80+ hours. All professional development was in the same content topic, kinematics and dynamics.



N pre= 51, N formative = 49, N post = 41

Results/Conclusions

- Although the content understanding was not significantly higher in all topics for all sites, the mean percent score for each year indicates participants always had an overall increase in their understanding. The low percent change in gains may be due to: 1) the rigor of the assessment since it was designed by content experts, 2) the lack of content background by the participants as evidenced by the limited physics classes they took in college, 3) the limited time available to address all the objectives within each content, and 4) the difficulty of addressing very diverse backgrounds within the constraints of the workshop since their low pre scores indicating their weak content could not be anticipated prior to the workshop. The results of the assessments using the Hake Gain show the teachers did increase in their content understanding in the time allocated.
- It can be substantiated that the institutes significantly increased the confidence level for the teachers attending. Teacher confidence in content and pedagogy has been documented (Ramsey-Gassert, Shroyer, & Staver, 1996; Shrigley, 1977; referenced in Levy, Pasquale, & Marco, 2008) to correspond with student success, therefore the data suggest that teachers who gained in confidence as a result of the PTRA institutes will positively

impact their student's achievement. The estimated number of students impacted by the Rural PTRA program is over 150,000 per year. Comparison of the student assessments and confidence scores for the assessments administered to students of teachers attending the institutes to those who had teachers that were not participants, suggests the impact on these students is substantial since there were over 1000 teachers who received professional development during the course of the grant.

- Targeted content topics (i.e., those addressed during the institute) had higher average confidence scores after the institute. There was not an increase in all the content topics each year, indicating reliable self reported data and reducing the chance of bias or inflated scores. For example, there was little change between the pre and post confidence on energy and momentum in 2004 (when kinematics was taught), but there was a significant change in 2005 when impulse, momentum, and energy were taught. The increase in content confidence is sufficient to impact classroom teaching practice since the confidence levels were measurable.
- The Rural PTRA model was effective in soliciting participation and maintaining/retaining the teachers in the institutes. One of the goals of the project was to have participants complete over 100 hours of instruction during the 3-year period. Nearly half (40%) of the original participants completed over 90 hours of instruction. Over 83% of those attending the urban institutes had less than 30 hours compared to 34% of the rural participants having less than 36 hours. Slightly over 1% had 90 or more hours for the urban and over 44% had over 73 hours in the Rural project. Having multiple sites within a state (or area) offer the same workshops during different times in the summer or different years increased the retention rate significantly. The rotation of sites in Texas increased the retention so that 78 out of 125 teachers complete over 90 hours of instruction and only 7 had less than 30 hours.
- Teachers involved in the Rural PTRA project indicated the program was instrumental in their professional growth and helped them become better teachers. Many indicated they would have left teaching if it had not been for the mentoring and support system provided by AAPT/PTRA. The final survey indicated over 95% of the teachers were still in the classroom and 88.6% indicated they were in the same position as they were when they

took the AAPT/PTRA institute. Those that were not in the same initial position, had transitioned to another science education career or were in administration.

- Self-reported surveys collected over a three-year period, indicated shifts in pedagogical priorities in addition to content. In the first institutes, the participants were mostly concerned with their lack of equipment and confidence in their content. Funds from the grant allowed some equipment purchases to be made which reduced the anxiety on implementation, but more importantly the conversations changed from the content to how it could be best implemented, or best practices. It became obvious that once they felt in a safe environment to ask questions among their peers, they began to grow professionally and were more willing to try to implement new classroom strategies. By the end of year 3, their conversations were focused on classroom practices and pedagogy, as well as deeper content and understanding.
- Over the course of the grant, there were documented changes in classroom practice. Although these were self-reported, they involved incorporation of technology, implementing strategies to help students increase critical thinking skills, and changing from a teacher centered classroom to one where the students were actively engaged in the learning process. Teachers reported that over a three-year period they increased the time students spent in cooperative learning and engaging in hands on labs. They decreased the time to take tests and solving written problems.
- Success of the Rural PTRA model can be partially attributable to the consistency and the cohesive structure of the AAPT/PTRA program. The summer institutes for the leaders (Tier 1) allowed curriculum and pedagogy to be addressed and regulated to ensure that the goals were implemented at all institutes and the evaluation components were valid and consistent. In addition, the support and infrastructure of AAPT gave the PTRA program the opportunity to focus on the project, not the administrative responsibilities which can often be distracting to the project leadership.
- The consistency and duplicity for the 33 sites of the Rural PTRA program allowed over 170 teachers to receive some type of graduate physics credit through the University of Dallas. Through the use of roadmaps, rigorous assessments, site visits, and the Tier 1 professional development, the curriculum was structured in such a way as to meet accreditation guidelines.

- The Rural PTRA model has already shown that it can be effectively replicated or modified. This has been accomplished by securing funding through various Math Science Partnership Grants and Higher Education Grants in several states including Arkansas, Idaho, Georgia, Texas, Maryland, and North Carolina. The key components of the model include: 1) annual professional development of Tier 1 teachers/leaders, 2) cohesive and comprehensive curriculum embedded with appropriate technology, inquiry, and pedagogy, 3) providing a safe environment for teachers to be able to learn, discuss, and try new ideas, 4) providing fundamental equipment appropriate for the content being addressed, 5) partnering with universities and colleges to provide a stable environment and resource for professional development, 6) allowing teachers to be taught by master teachers who are their peers and are considered experts in both content and pedagogy, and 7) development of appropriate evaluation that is consistent and comprehensive allowing for longitudinal studies and comparisons as well as modifications when necessary.
- The perceptions of pedagogical preparedness composite asked participants how well prepared they feel to use various strategies in their classroom, including developing students' conceptual understanding, engaging students in inquiry-oriented activities, and using informal questioning to assess student understanding. Scores on this composite were significantly and positively related to participation in AAPT/PTRA professional development, with an effect size of 0.28 standard deviations. Regardless of the amount of professional development, elementary/middle school teachers had higher perceptions of pedagogical preparedness than high school teachers (an effect size of 0.31 standard deviations). There was no significant difference on this composite between female and male participants. It is worth noting that the relationship between scores on this composite and extent of participation in AAPT/PTRA professional development varied significantly across the different rural centers, indicating that some centers had a greater impact on this outcome than other centers.
- The female students of the participating teachers had the greatest percent change in content understanding for electricity while females of the nonparticipating teachers had the lowest percent gains. It is not known if this was due to the topic or the curriculum. However, it is important to note that there is a significant difference in the gains made by

female students in classes with teachers who participated in PTRA institutes as compared to those who were not (i.e., untreated students).

- Participants felt the leadership at the institutes should consist of peer teachers and university administrators for both instructional strategies and content knowledge. The comments revealed that they prefer professors who are also good at relating to students and/or teachers

Summary

The AAPT/PTRA urban and rural programs have been evolving and adapting for over a decade. Over the years, there are many successes, challenges, and failures that helped contribute to the model that is currently in place. In an attempt to summarize the enormous amount of data that has accumulated, both quantitative and qualitative, it seems the following components of the AAPT/PTRA model are responsible for the successes of the professional development model currently in effect:

- Partnerships between AAPT, university/college professors and PTRAs.
- Workshops were led by PTRAs on university/college campuses
- Offering multiple opportunities to attend professional development (rotate years, sites, and topics)
- Predetermined and consistent curriculum (quality control)
- National PTRAs (Tier 1) trained annually in content, pedagogy, and adult learning methods.
- Assessments correlated to objectives
- Cross-site comparisons allowing the leadership to strengthen, support, and focus on sites needing additional help (see sample in appendix). This evaluation component also allowed collaboration among the site leaders and the opportunity to share strategies, successes, and support.
- Emphasis on active learning

Procedures and strategies that were not successful and therefore were revised, modified, or discarded as the project progressed:

- Smorgasboard curriculum (spray and pray)

- Inconsistency in hours or professional development; no expectations of participants as to number of hours to be completed
- Inconsistency in curriculum taught, length of the professional development, and evaluation
- Lack of a storyline; discontinuity of professional development
- Isolated lecture
- Demonstrations and activities without applicable content
- Free equipment without context or training in appropriate use
- Providing professional development for teachers on equipment they do not have and hope they obtain the equipment later.

Comparison to Other Research Efforts

In April 2010, findings from a federal study (Middle School Mathematics Professional Development Impact Study) of 77 middle schools suggested that intensive, state-of-the-art efforts to boost teachers' skills may not lead to significant gains in student achievement right away.[11] The study, conducted by the U.S. Department of Education's Institute of Education Sciences, found that high-quality professional development failed to translate into dramatic improvements in student learning. The participating teachers received training in both academic subject matter and pedagogical content over a period of several months including summer institutes, follow-up seminars, and even classroom coaching. Teachers in the experimental group averaged 55 more hours of professional development than their counterparts in the control group and they did know slightly more overall than the control group, but the effect was not statistically significant. In fact, the most notable improvements were on a test of pedagogical-content knowledge and there were changes in teaching practice. However, the changes did not translate into gains for student-learning. Eric Hanushek, senior fellow at the Hoover Institution, said the study showed that you cannot change teacher effectiveness with the tools we have. However, Hilda Borko, professor at Stanford, stated that it takes awhile for teacher to take ownership of change and incorporate change into their instruction.[12]

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[11] Viadero, D., 2010, *Intensive Teacher Training in Math Fails to Lift Exam Scores, Study Says*, Education Week, Vol. 29, No. 29, p. 1

[12] Viadero, D., 2010, *Intensive Teacher Training in Math Fails to Lift Exam Scores, Study Says*, Education Week, Vol. 29, No. 29, p. 16

The researchers tested possible explanations as to why the training had failed to affect student achievement and ruled out that the tests were too hard or too easy, but believe the professional development was not properly aligned with what the teacher's evaluation. There is also an independent study being conducted to measure the quality of the instruction the teachers were getting. Preliminary results from a second year suggest the need for more sustained professional development. [13]

There are several comparisons that can be made between the Mathematics study and the AAPT/PTRA study:

1) The AAPT/PTRA professional development model outlined in this report as well as the findings from Horizon Research, Inc., support the Middle School Mathematics findings suggesting professional development must be sustained for periods longer than 40-50 hours in order to impact classroom practice. There is evidence that the minimum number of hours should be between 80 and 100 hours and the focus of the professional development institute should be narrow in order to ensure that participants have time to address their own misconceptions and misunderstandings. Feedback from the AAPT/PTRA project also suggests that the hours of professional development can be focused for several days (4-5), but then should be spread out over the course of several months or even years to allow time for teachers to implement new strategies, modify what did not work, and restructure their classroom practice. The teachers involved in professional development must feel confident in their content before they can implement the skills learned to their classroom. Teachers stated it was easiest to implement when the content and teaching skills were modeled in the institutes and when they were engaged in the learning process, similar to what their students would be in the classroom. The cognitive dissonance experienced by the participants was a necessary component for their transition to the classroom.

2) The professional development objectives must be aligned to what is being evaluated or measured (i.e., the assessment). Often there are requirements by state or federal agencies to use a national assessment in order to make comparisons among multiple groups. However, if that

[13] Viadero, D., 2010, *Intensive Teacher Training in Math Fails to Lift Exam Scores, Study Says*, Education Week, Vol. 29, No. 29, p. 16

assessment is not aligned to the institute objectives, then the findings will not be representative of what the participants, or students, actually learned. In addition, from a statistical standpoint it is extremely difficult to administer a test that covers multiple objectives within one content area (refer to the section on Assessment Design in this report).

3) The quality of instruction teachers receive during the institute is a critical component of the professional development institutes. The AAPT/PTRA project monitored the quality of the institutes in several ways including:

- Site visits by the leadership team to the institutes, particularly in the first year or two.
- Summer institutes for the National PTRAs, which focused on content as well as instructional strategies for both students and adult learners.
- Formative assessments administered during the week to determine misconceptions or areas that needed to be addressed during the institute.
- Follow-up sessions during the school year, which did not focus on content, but rather on problems participants encountered and analyzing student data for activities implemented.
- Pre and post surveys allowing participants to freely express their concerns and give feedback as to what they still needed or wanted to learn.
- An internal evaluation process that normally allowed feedback and assessment results to be returned to the leaders before the follow up sessions, which expedited changes where necessary.

Broader Impacts of the Program

The AAPT/PTRA program has documented evidence of the positive impact on thousands of teachers and countless students. This report is a small glimpse of how the program has helped teachers and students become more confident in their content understanding of physics and physical science, but AAPT/PTRA has also had broader impacts. Some of the broader impacts include:

- Certification and/or graduate physics credit awarded to over 170 teachers
- Impacted on over 500,000 students and 1,000 teachers in less than 5 years
- Development of a replicable model for professional development and evaluation
- Systemic reform at the university level focusing on teacher preparation in content
- Implementation of instructional technology for classrooms

- Change in classroom practice resulting in increased student achievement as well as interest in science and careers related to science
- AAPT/PTRA is now recognized as national provider of professional development in physics and physical science
- Development of a model that can be used to obtain alternative funding sources through businesses, MSP grants, private foundations, district contracts, and higher education commission.

Appendix

2008 Responses from participants attending multiple years

Site Comparison to National Hake Gains

Electricity Answer Analysis Sheet

2006 Compiled Electricity Confidence Report (Participant)

2006 Site Energy Confidence Report (Participant)

2009 Site Item Analysis Report for Electricity (Participant)

The following tables are reflective of changes in classroom practices from participants in some of the 2008 institutes who had attended previous AAPT/PTRA institutes.

Online Survey Open Responses
2008 Participants who attended previous AAPT/PTRA Institutes

What classroom practices did you change as a result of attending previous AAPT/PTRA institutes?	*Lab*	*Inquiry*	*Know*
• *Detailed questioning techniques and more frequent evaluations became a part of my classroom. I was able to demonstrate concepts with better labs than previously used in my classroom.*	1	0	3
• *I believe it gave me some very good hands-on activities to use with my students.*	1	0	0
• *More student inquiry labs*	1	2	0
• *More hands-on labs*	1	0	0
• *It helped me plan a completely new program, that is still improving*	0	0	0
• *Added PASCO probes, added several new hands-on labs and activities, taught vectors more in-depth and in several different ways to help the students fully understand, was able to teach electricity better now that I understand it more*	1	0	3
• *Yes, they have made me better informed which in turn allows me to explain difficult material more clearly.*	0	0	3
• *More and better labs; better quality of explanation of principles*	1	0	3
• *I've updated many labs to inquiry-based lessons*	1	2	0
• *AAPT/PTRA gave me a number of GREAT labs to do in the classroom. They are far better than those in the book.*	1	0	0
• *I used more exploration and application problems with solving in the laboratory*	1	2	0
• *I used the material presented from the sessions.*	0	0	0
• *Where do I begin, everything. More hands-on activities, and an inquiry approach to everything I teach.*	1	2	0
• *Emphasis understanding rather than formulas.*	0	0	3
• *More inquiry and deriving formulas (mentioned multiple times)*	0	2	3
• *More hands on applications and better explanations of concepts*	1	0	3
• *Increased hand-on, use of probe-ware, Physlets, ranking tasks*	1	0	0
• *I incorporated whiteboarding ... Lots of lab practices*	1	0	0
• *Incorporated more hands-on activities in the areas of kinematics and dynamics, energy, and electricity.*	1	0	0
• *I strengthened my drive to push the students to discover the physics on their own through experience and not through my presentation or their reading alone.*	0	2	0
• *Improved low-tech labs and demos*	1	0	0
• *The instruction enhanced my lecture and lab exercises*	1	0	3
• *I am more comfortable with using the formulas.*	0	0	3
• *I was able to use several of the activities with my 8th grade class such as the rocket launchers and the roller coaster activity as well as making the car.*	1	0	0
• *Incorporated some new discovery based laboratory experiences. A more student directed /inquiry based style of learning.*	1	2	0
• *It gave me ideas for hands-on activities in class and advanced my own knowledge*	1	0	3

What classroom practices did you change as a result of attending previous AAPT/PTRA institutes?	*Lab*	*Inquiry*	*Know*
on the subject.			
Totals*:*	19	7	10

Nineteen out of 25 teachers refer to more and/or better Labs, 7 refer specifically to Inquiry, and 10 indicate they increase in their knowledge of physics.

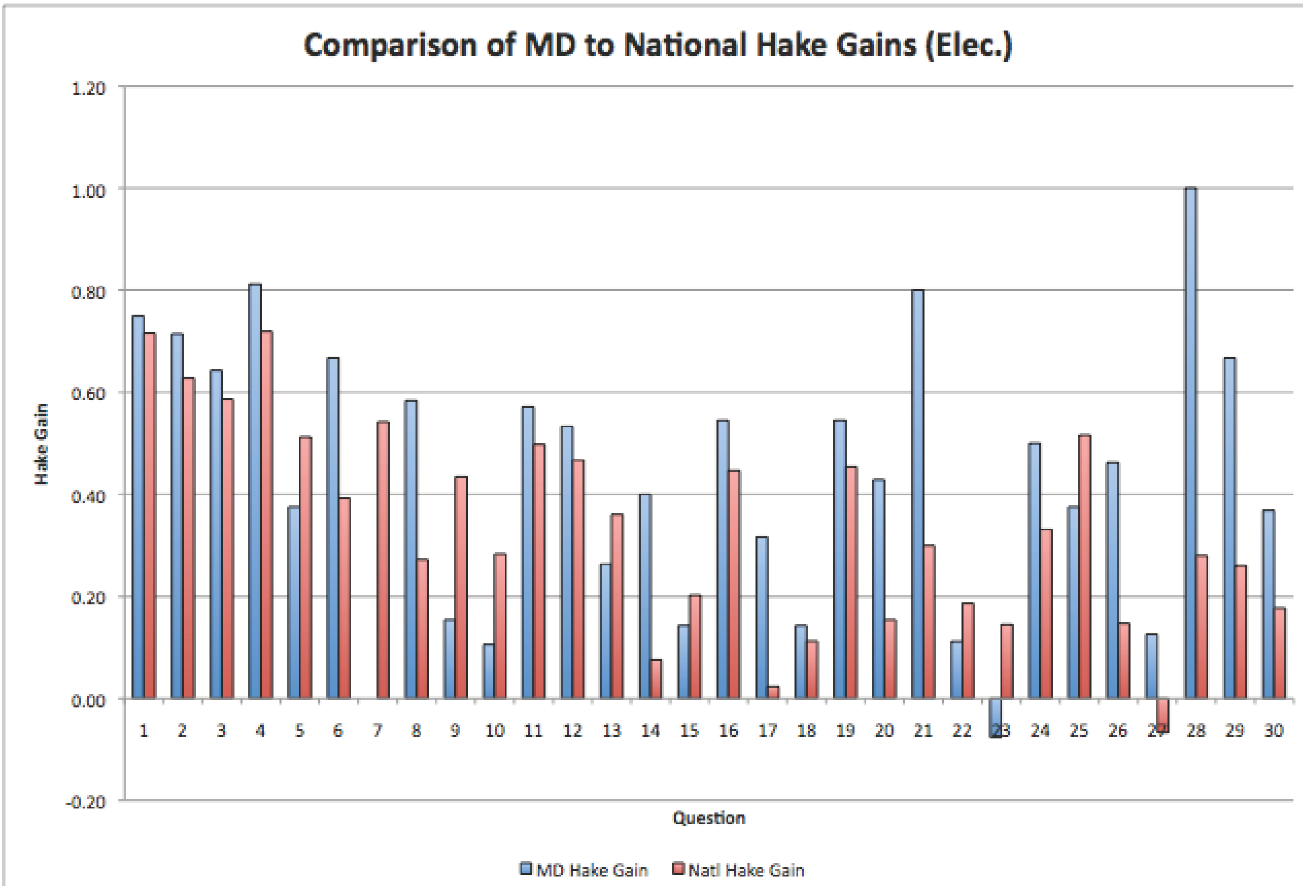
Do you feel the AAPT/PTRA Institutes helped your students become more successful academically? Please explain why or why not.	*Yes*	*Concepts*	*Know*
• *They made me a better teacher, which was passed on to my students.*	1	0	3
• *Yes, because I am now a better informed teacher*	1	0	3
• *Absolutely! The hard evidence is seen in our school's improvement in ACT/SAT scores for physical science. The only factor that has changed has been my attendance in the PTRA Institute and my improved practices in teaching physics. The more subjective evidence is seen in the number of students from our school taking physics in college and being successful.*	1	2	3
• *YES!!! It provides me, the teacher, with activities and information that allows me to successfully get the content knowledge across to the kids and they retain it.*	1	0	3
• *I think that they enjoy my classes more. Perhaps that makes them more successful academically.*	1	0	3
• *Certainly. By improving my understanding and increasing my "repertoire" of demos and labs, I am able to pass this on to the students*	1	2	3
• *Yes. They demonstrated better performance on their assessments.*	1	0	3
• *Yes, I feel my students are more academically successful as a result of me attending AAPT/PTRA Institutes. I have learned so much as a participant in the AAPT/PTRA Institutes and as a result, I am able to clearly and confidently teach physical science topics more effectively.*	1	0	3
• *Yes...These have been awesome, both for new lab ideas for various units, but for new ways to use labs in teaching various things.*	1	0	0
• *Yes, they internalize concepts better and retain info longer, as shown in standardized tests.*	1	2	3
• *No statistical proof, but I believe students outcomes have improved*	1	0	0
• *Yes. They do better on standardized tests*	1	0	3
• *Yes- because I was better prepared in the content area*	1	0	3
• *Yes. They became more involved and understood the formulas better.*	1	0	3
• *Yes. Since I am more confident, they benefit.*	1	0	0
• *Yes. The structure provided along with the hands on activities allows one to transfer the knowledge to the students more effectively.*	1	0	3
• *Yes. I think they were able to grasp general concepts better. Then the equations and math made more sense.*	1	2	3
• *Most definitely. These courses give us such great ideas that allow students to learn as they DO physics.*	1	0	3
• *I was able to teach more information with greater knowledge than before*	0	2	0

Do you feel the AAPT/PTRA Institutes helped your students become more successful academically? Please explain why or why not.	*Yes*	*Concepts*	*Know*
• *Relate concepts to everyday objects by using labs we have learned*	0	2	0
• *Yes, I felt comfortable enough to do more exploration labs with my students.*	1	0	0
• *They have been more successful academically. I believe this because they became more interested in studying, learned new study techniques and developed more inquiring attitudes.*	1	2	0
• *Yes. Reinforces my understanding & confidence as a teacher; provides useful tools and materials*	1	0	0
• *YES! It helps them put ownership to their own education.*	1	0	0
• *Yes I do because if I am more comfortable teaching the material, they will do better in class.*	1	0	3
• *Yes. They demonstrate and idea then they have to explain why.*	1	2	3
• *Yes. Since I've been attending, I've become a better teacher, which helps me teach the students more in-depth and using several different techniques.*	1	2	3
• *I had not taught physics for over 10 years and the new methods of presentation has helped my students and me.*	1	0	0
• *Yes, their understanding of the concepts has greatly increased. They are not just "memorizing" for the tests - they have an understanding of the material, not just the facts of the material.*	1	2	3
• *Yes, my students come back and thank me for a new learning style and way of thinking*	1	2	0
• *I believe the students were more successful because I had a better grasp of the basic concepts. I am a math teacher certified to teach physics, so my concept of physics is weak.*	1	2	0
Totals:	29	12	19

Twenty-nine out of 31 teachers responded yes, 12 refer specifically to Conceptual Understanding, and 19 indicate increase student knowledge of physics.

Cross-Site and National Comparisons

Institutes were compared to each other in order to monitor progress, lend support when necessary, and tap into the resources that helped a site excel in one area or another. Site leaders could request a comparison of their site to another site or to the national average. The individual sites in the cross-site comparisons were not identified



AAPT/PTRA
2010 Electricity
Teacher Assessment, Analysis & Answer Sheet

Topic/Objective:

1	General Electricity/Ohm's law	(6 questions)
2	Series Circuits	(6 questions)
3	Parallel Circuits	(10 questions)
4	Combination Circuits	(5 questions)
5	Electrostatics/Electric Fields	(3 questions)

Bloom's Levels:

1 = Knowledge	(2 questions)
2 = Comprehension	(3 questions)
3 = Application	(11 questions)
4 = Analysis	(10 questions)
5 = Synthesis	(4 questions)
6 = Evaluation	(0 questions)

Breakdown:
CO = Conceptual (no mathematical computations needed) = 6 questions
CA = Calculations involved (computations needed) = 24 questions

NOTE: ANSWERS HAVE BEEN REMOVED FOR SECURITY PURPOSES

Item	Answer	Objective	Blooms	CO or CA
1		1	1	CO
2		1	1	CO
3		2	4	CO
4		1	4	CO
5		3	3	CO
6		1	5	CA
7		2	3	CO
8		3	4	CO
9		3	5	CO
10		3	4	CO
11		3	4	CO
12		3	3	CO
13		4	5	CA
14		2	3	CO
15		2	3	CO
16		1	2	CO
17		2	3	CO
18		3	4	CA
19		3	2	CO

Item	Answer	Objective	Blooms	CO or CA
20		4	4	CO
21		5	5	CO
22		3	3	CO
23		5	4	CO
24		2	3	CO
25		1	4	CO
26		4	4	CA
27		5	3	CO
28		3	2	CO
29		4	3	CA
30		4	3	CA

* indicates correct answer

2006 Electricity/Magnetism
Pre and Post Confidence Report

Confidence Pre 2006
N=276

Question: 1 * Co1

	5	4	3	2	1	Total
A	7%	16%	16%	3%	1%	43%
B	0%	1%				1%
C		0%	1%	0%	0%	2%
D	0%	2%	1%	1%	0%	4%
E*	12%	16%	9%	7%	4%	49%
Total	19%	35%	27%	12%	7%	100%

Question: 2 * co2

	5	4	3	2	1	Total
A*	19%	28%	15%	2%	3%	67%
B	0%	3%	5%	4%	2%	15%
C	0%	5%	4%	2%	3%	15%
D		1%	2%	0%	0%	3%
Total	20%	37%	26%	9%	8%	100%

Question: 3 * Co3

	5	4	3	2	1	Total
A*	19%	16%	11%	2%	1%	50%
B	10%	13%	7%	4%	0%	34%
C	1%	1%	1%	1%	1%	4%
D	0%	3%	3%	3%	2%	12%
Total	30%	33%	23%	9%	4%	100%

Question: 4 * Co4

	5	4	3	2	1	Total
A	0%	1%	0%	0%	1%	3%
B	0%	0%	1%		1%	4%
C	4%	13%	10%	4%	2%	34%
D*	22%	18%	10%	5%	3%	58%
Total	27%	32%	22%	10%	9%	100%

Question: 5 * Co5

	5	4	3	2	1	Total
A	2%	9%	10%	3%	3%	26%
B*	29%	20%	10%	3%	4%	66%
C		0%	1%	1%	2%	5%
D	0%	0%	1%	0%	0%	2%
Total	31%	30%	22%	7%	10%	100%

Question: 6 * Co6

	5	4	3	2	1	Total
A	0%	1%	0%	1%	3%	6%
B		0%	1%		1%	2%
C	0%		0%		2%	2%
D*	49%	17%	8%	6%	9%	89%
Total	50%	18%	10%	7%	14%	100%

Question: 7 * Co7

	5	4	3	2	1	Total
A	0%	3%	5%	4%	5%	16%
B		1%	3%	2%	3%	10%
C*	10%	14%	20%	10%	10%	64%
D	0%	1%	3%	2%	3%	10%
Total	11%	19%	31%	19%	21%	100%

Question: 8 * Co8

	5	4	3	2	1	Total
A		1%	4%	3%	4%	13%
B		0%			1%	1%
C*	12%	22%	15%	10%	5%	64%
D	0%	5%	4%	5%	7%	22%
Total	13%	28%	24%	18%	17%	100%

Confidence Post 2006
N=264

Question: 1 * Co1

	5	4	3	2	1	Total
A	2%	2%	3%			7%
B		1%	0%			2%
C	0%		0%			1%
D	4%	4%	1%	0%		8%
E*	45%	22%	5%	2%	7%	82%
Total	51%	29%	10%	3%	7%	100%

Question: 2 * co2

	5	4	3	2	1	Total
A*	42%	33%	10%	1%		86%
B	1%	2%	0%	0%		4%
C	2%	4%	3%	0%		9%
D	0%		0%			1%
Total	46%	39%	13%	2%		100%

Question: 3 * Co3

	5	4	3	2	1	Total
A*	49%	22%	5%	0%		77%
B	4%	8%	4%	0%		15%
C	4%	1%	0%	0%		6%
D			2%	0%		2%
Total	57%	31%	11%	2%		100%

Question: 4 * Co4

	5	4	3	2	1	Total
A	1%	2%				2%
B	1%					1%
C	3%	6%	3%			12%
D*	59%	20%	5%	1%	0%	85%
Total	63%	28%	7%	1%	0%	100%

Question: 5 * Co5

	5	4	3	2	1	Total
A	2%	5%	4%			10%
B*	62%	20%	5%	1%		88%
C		0%	1%	0%		2%
D						
Total	64%	25%	9%	1%		100%

Question: 6 * Co6

	5	4	3	2	1	Total
A		1%	1%	0%	2%	4%
B			1%			1%
C		0%	0%	0%	1%	2%
D*	62%	18%	8%	2%	2%	93%
Total	62%	19%	11%	3%	5%	100%

Question: 7 * Co7

	5	4	3	2	1	Total
A	2%	3%	3%	1%		9%
B			0%			0%
C*	25%	40%	14%	4%	0%	83%
D	0%	1%	5%	0%		7%
Total	28%	44%	22%	5%	0%	100%

Question: 8 * Co8

	5	4	3	2	1	Total
A	1%	4%	2%	1%		8%
B	0%		0%	1%		2%
C*	31%	27%	13%	4%	1%	76%
D	2%	5%	4%	3%	1%	14%
Total	35%	36%	20%	8%	2%	100%

Question: 9 * Co9

	5	4	3	2	1	Total
A			0%		1%	1%
B*	28%	40%	16%	10%	3%	97%
C		0%	0%	1%	0%	2%
D						
Total	28%	41%	16%	11%	4%	100%

Question: 10 * co10

	5	4	3	2	1	Total
A	9%	8%	3%	2%	1%	22%
B	1%	8%	6%	4%	1%	21%
C	2%	10%	12%	6%	3%	34%
D*	8%	9%	4%	1%	2%	24%
Total	20%	35%	24%	13%	7%	100%

Question: 11 * Co11

	5	4	3	2	1	Total
A	3%	9%	9%	6%	6%	34%
B*	10%	15%	14%	8%	8%	55%
C		1%	1%	0%	3%	6%
D	1%	0%	1%	1%	3%	6%
Total	14%	25%	26%	15%	19%	100%

Question: 12 * Co12

	5	4	3	2	1	Total
A		1%	2%	1%	3%	6%
B*	17%	18%	17%	7%	7%	66%
C	0%	2%	6%	5%	5%	18%
D	0%	1%	2%	1%	6%	9%
Total	18%	21%	26%	14%	21%	100%

Question: 13 * Co13

	5	4	3	2	1	Total
A*	8%	10%	7%	3%	2%	30%
B	1%	10%	11%	6%	4%	31%
C			1%			1%
D	2%	13%	14%	7%	3%	38%
Total	11%	32%	33%	16%	8%	100%

Question: 14 * Co14

	5	4	3	2	1	Total
A	1%	1%	0%		1%	3%
B	0%	3%	1%	1%	3%	9%
C*	32%	25%	15%	5%	7%	85%
D	0%	1%		0%	1%	3%
Total	34%	30%	17%	7%	12%	100%

Question: 15 * Co15

	5	4	3	2	1	Total
A			1%		2%	2%
B*	11%	7%	3%	3%	3%	28%
C	1%	3%	9%	6%	9%	29%
D	3%	9%	9%	8%	12%	41%
Total	15%	20%	22%	16%	27%	100%

Question: 9 * Co9

	5	4	3	2	1	Total
A			0%			0%
B*	60%	29%	9%	2%		99%
C	0%		0%			1%
D						
Total	60%	29%	9%	2%		100%

Question: 10 * co10

	5	4	3	2	1	Total
A	24%	10%	3%			37%
B	2%	2%	2%		0%	6%
C	2%	2%	2%	1%		7%
D*	34%	13%	4%	0%		51%
Total	61%	27%	11%	2%	0%	100%

Question: 11 * Co11

	5	4	3	2	1	Total
A	7%	10%	3%	1%	1%	22%
B*	37%	25%	11%	1%	1%	74%
C	0%	0%	1%	0%	0%	3%
D		0%	1%			1%
Total	44%	36%	16%	3%	2%	100%

Question: 12 * Co12

	5	4	3	2	1	Total
A		1%		0%		1%
B*	38%	33%	11%	1%	1%	84%
C	2%	5%	4%	1%	0%	13%
D		0%	1%	1%		2%
Total	40%	40%	15%	4%	1%	100%

Question: 13 * Co13

	5	4	3	2	1	Total
A*	27%	18%	7%	1%		53%
B	2%	8%	5%	1%	0%	16%
C	1%	1%	2%	0%		4%
D	6%	12%	8%	2%		27%
Total	35%	39%	21%	5%	0%	100%

Question: 14 * Co14

	5	4	3	2	1	Total
A	2%	1%	1%			4%
B	1%	2%	1%	1%		5%
C*	46%	27%	10%	2%	2%	87%
D	0%	0%	0%	2%	2%	4%
Total	50%	30%	12%	4%	4%	100%

Question: 15 * Co15

	5	4	3	2	1	Total
A		0%		0%		1%
B*	25%	16%	5%	1%	0%	47%
C		4%	7%	3%	2%	16%
D	5%	11%	10%	7%	4%	37%
Total	30%	31%	22%	11%	6%	100%

* indicates correct answer

2006 Electricity/Magnetism
Pre and Post Confidence Report

Question: 16 * Co16

	5	4	3	2	1	Total
A	3%	5%	3%	2%	2%	15%
B		0%	3%	2%	2%	6%
C*	13%	22%	15%	8%	6%	64%
D	1%	1%	3%	5%	5%	16%
Total	17%	28%	24%	16%	15%	100%

Question: 17 * Co17

	5	4	3	2	1	Total
A*	6%	7%	10%	6%	4%	33%
B	1%	2%	4%	2%	4%	13%
C					1%	1%
D	13%	19%	12%	4%	4%	52%
Total	21%	28%	25%	12%	13%	100%

Question: 18 * Co18

	5	4	3	2	1	Total
A		0%		0%	4%	4%
B*	20%	23%	12%	6%	8%	70%
C	6%	5%	4%	1%	3%	19%
D	1%	1%	1%	1%	2%	6%
Total	27%	30%	16%	10%	17%	100%

Question: 19 * Co19

	5	4	3	2	1	Total
A	0%	1%	1%		2%	4%
B	1%		2%	0%	2%	6%
C	3%	7%	3%	4%	3%	21%
D*	30%	19%	9%	6%	6%	70%
Total	35%	27%	15%	10%	13%	100%

Question: 20 * Co20

	5	4	3	2	1	Total
A	0%	2%	3%	4%	9%	18%
B	3%	2%	5%	3%	6%	18%
C*	21%	12%	2%	3%	4%	41%
D	2%	5%	4%	4%	8%	22%
Total	25%	20%	14%	13%	28%	100%

Question: 21 * Co21

	5	4	3	2	1	Total
A	0%	0%	0%	1%	2%	4%
B		1%	2%	2%	4%	10%
C	1%	3%	3%	4%	4%	15%
D*	17%	18%	20%	10%	7%	71%
Total	18%	22%	26%	16%	18%	100%

Question: 22 * Co22

	5	4	3	2	1	Total
A		0%	1%	1%	3%	6%
B	0%	4%	2%	2%	4%	13%
C		0%	1%	1%	1%	3%
D*	21%	29%	13%	6%	9%	78%
Total	21%	35%	18%	10%	16%	100%

Question: 16 * Co16

	5	4	3	2	1	Total
A	0%	3%	2%	1%		6%
B			2%			2%
C*	44%	25%	10%	4%	1%	84%
D	0%	2%	5%	0%	0%	8%
Total	44%	30%	18%	6%	2%	100%

Question: 17 * Co17

	5	4	3	2	1	Total
A*	15%	9%	6%	2%	1%	33%
B	1%	2%	4%	1%	1%	9%
C	0%		0%		0%	1%
D	26%	18%	7%	4%	1%	56%
Total	42%	30%	17%	7%	4%	100%

Question: 18 * Co18

	5	4	3	2	1	Total
A			1%	0%	1%	3%
B*	31%	22%	11%	5%	3%	73%
C	8%	8%	2%	0%	1%	20%
D	0%	0%	2%		2%	4%
Total	40%	31%	16%	6%	7%	100%

Question: 19 * Co19

	5	4	3	2	1	Total
A		1%	0%		0%	2%
B	1%	1%	0%			3%
C	1%	3%	2%	1%	1%	8%
D*	52%	21%	10%	3%	2%	88%
Total	54%	27%	13%	4%	3%	100%

Question: 20 * Co20

	5	4	3	2	1	Total
A	2%	3%	5%	2%	4%	15%
B	1%	2%	5%	2%	2%	13%
C*	34%	12%	3%	2%	2%	52%
D	3%	4%	5%	2%	5%	20%
Total	40%	21%	18%	8%	13%	100%

Question: 21 * Co21

	5	4	3	2	1	Total
A	0%	0%	1%	1%	1%	4%
B	0%	1%	3%	1%	0%	5%
C	1%	2%	3%	2%	2%	11%
D*	37%	25%	13%	4%	1%	80%
Total	39%	28%	21%	8%	5%	100%

Question: 22 * Co22

	5	4	3	2	1	Total
A		0%	0%		0%	1%
B	2%	5%	5%	2%		13%
C		1%	1%	0%	1%	3%
D*	39%	31%	9%	2%	1%	82%
Total	41%	38%	15%	4%	2%	100%

Question: 23 * Co23

	5	4	3	2	1	Total
A	0%	2%	1%	2%	3%	8%
B*	19%	30%	18%	8%	5%	80%
C	1%	2%	3%	3%	2%	10%
D			1%		2%	2%
Total	21%	34%	22%	12%	11%	100%

Question: 24 * Co24

	5	4	3	2	1	Total
A*	22%	19%	14%	6%	11%	72%
B	1%	2%	5%	4%	8%	20%
C			0%	1%	3%	5%
D		0%	1%	1%	2%	4%
Total	22%	22%	20%	12%	24%	100%

Question: 25 * Co25

	5	4	3	2	1	Total
A	0%	2%	1%	3%	4%	10%
B		1%	1%	2%	3%	7%
C*	22%	21%	18%	8%	5%	74%
D	0%	1%	1%	3%	4%	9%
Total	22%	25%	22%	15%	15%	100%

Question: 26 * Co26

	5	4	3	2	1	Total
A	0%		2%	2%	2%	6%
B		1%	1%	2%	4%	8%
C	3%	6%	6%	3%	7%	24%
D*	9%	14%	14%	5%	4%	45%
E	3%	4%	5%	3%	2%	17%
Total	14%	25%	27%	14%	20%	100%

Question: 27 * Co27

	5	4	3	2	1	Total
A	0%				0%	1%
B		3%	3%	2%	2%	11%
C		0%	2%	1%	2%	5%
D*	20%	29%	18%	7%	9%	84%
Total	21%	33%	23%	10%	14%	100%

Question: 28 * Co28

	5	4	3	2	1	Total
A*	13%	25%	26%	12%	13%	89%
B			1%		1%	2%
C			0%	0%	3%	3%
D		0%		2%	4%	6%
Total	13%	26%	27%	14%	21%	100%

Question: 29 * Co29

	5	4	3	2	1	Total
A			0%	1%	4%	5%
B		1%	0%	1%	5%	7%
C		2%	5%	6%	13%	25%
D*	30%	10%	8%	3%	12%	63%
Total	30%	13%	13%	11%	33%	100%

Question: 30 * Co30

	5	4	3	2	1	Total
A	0%		4%	2%	7%	14%
B	0%	3%	5%	6%	16%	31%
C*	9%	6%	5%	5%	14%	38%
D	2%	0%	2%	2%	9%	16%
E	0%	0%			1%	2%
Total	12%	10%	16%	16%	47%	100%

Question: 23 * Co23

	5	4	3	2	1	Total
A	2%	2%	2%	1%	1%	7%
B*	34%	31%	13%	3%	2%	84%
C	2%	2%	2%	1%	0%	8%
D		0%	0%		1%	2%
Total	38%	36%	18%	5%	4%	100%

Question: 24 * Co24

	5	4	3	2	1	Total
A*	38%	26%	14%	2%	4%	83%
B	2%	5%	4%	2%	1%	14%
C		0%	0%	1%	0%	2%
D			0%		0%	1%
Total	40%	31%	19%	5%	6%	100%

Question: 25 * Co25

	5	4	3	2	1	Total
A	0%	1%	3%	0%	0%	5%
B	0%	1%	1%			2%
C*	60%	24%	5%	2%		90%
D	1%	1%		0%		2%
Total	61%	26%	9%	3%	0%	100%

Question: 26 * Co26

	5	4	3	2	1	Total
A	0%	1%	2%	0%		4%
B		1%	1%	0%	1%	4%
C	4%	8%	5%	3%	1%	22%
D*	22%	19%	10%	3%	2%	55%
E	7%	5%	2%	0%	0%	15%
Total	34%	35%	20%	7%	4%	100%

Question: 27 * Co27

	5	4	3	2	1	Total
A			0%	0%	0%	1%
B	2%	3%	4%	1%	0%	11%
C		1%	1%	0%	0%	3%
D*	41%	28%	10%	4%	2%	85%
Total	43%	32%	16%	6%	4%	100%

Question: 28 * Co28

	5	4	3	2	1	Total
A*	31%	26%	22%	9%	6%	95%
B			0%	0%	0%	1%
C	0%		1%	0%		2%
D		1%			1%	2%
Total	32%	27%	23%	10%	8%	100%

Question: 29 * Co29

	5	4	3	2	1	Total
A		1%	2%	1%	1%	5%
B	0%		0%	0%	2%	4%
C	2%	2%	6%	5%	6%	21%
D*	43%	9%	8%	5%	6%	70%
Total	46%	12%	16%	11%	16%	100%

Question: 30 * Co30

	5	4	3	2	1	Total
A		1%	1%	3%	3%	7%
B	0%	4%	6%	3%	13%	26%
C*	15%	8%	6%	8%	10%	46%
D	3%	3%	3%	5%	3%	18%
E	1%				2%	3%
Total	20%	15%	16%	18%	30%	100%

2006 Participant Energy
Pre and Post Confidence

Pre Confidence					
Crosstabulation: 1 * Co1					
	5	4	3	2	1
A	1%	1%	6%	1%	1%
B	1%	6%	1%	2%	1%
C	1%	9%	8%	4%	1%
D*	27%	18%	8%	1%	
E					
Total	31%	34%	23%	8%	4%
Crosstabulation: 2 * Co2					
	5	4	3	2	1
A*	17%	17%	15%	5%	4%
B	6%	7%	9%	1%	1%
C		1%	2%	1%	1%
D	1%	5%	6%	1%	1%
E					
Total	23%	30%	32%	7%	8%
Crosstabulation: 3 * Co3					
	5	4	3	2	1
A		1%	1%		1%
B		8%	10%	7%	9%
C*	29%	14%	13%	3%	4%
D		1%	1%		
E					
Total	29%	23%	24%	10%	14%
Crosstabulation: 4 * Co4					
	5	4	3	2	1
A		1%		1%	1%
B		1%	1%		
C*	46%	24%	11%	2%	4%
D	1%	1%	4%	1%	1%
E					
Total	48%	27%	15%	4%	6%
Crosstabulation: 5 * Co5					
	5	4	3	2	1
A	1%	4%	8%	4%	4%
B*	14%	11%	14%	9%	6%
C	1%	4%	4%	4%	1%
D		1%	3%	3%	5%
E					
Total	16%	19%	29%	19%	16%
Crosstabulation: 6 * Co6					
	5	4	3	2	1
A	1%	9%	11%	4%	6%
B*	6%	15%	7%	1%	4%
C	1%	1%	4%	1%	1%
D	2%	8%	6%	5%	7%
E					
Total	11%	33%	27%	11%	18%

Post Confidence					
Crosstabulation: 1*Co1					
	5	4	3	2	1
A		1%	1%		
B	1%	5%	5%		
C		1%	1%		
D*	58%	18%	6%	2%	1%
E					
Total	60%	25%	13%	2%	1%
Crosstabulation: 2 * Co2					
	5	4	3	2	1
A*	32%	25%	13%	1%	1%
B	6%	4%	8%		
C		1%	2%	1%	1%
D		2%	2%	1%	1%
E					
Total	38%	32%	25%	3%	2%
Crosstabulation: 3 * Co3					
	5	4	3	2	1
A	1%	1%		1%	1%
B	3%	7%	6%	4%	1%
C*	40%	19%	9%		3%
D			1%		1%
E					1%
Total	44%	27%	17%	6%	6%
Crosstabulation: 4 * Co4					
	5	4	3	2	1
A					
B					
C*	60%	22%	8%	2%	2%
D	1%	3%	2%		
E					
Total	61%	25%	10%	2%	2%
Crosstabulation: 5 * Co5					
	5	4	3	2	1
A		4%	2%	1%	1%
B*	22%	26%	16%	4%	2%
C	1%	3%	7%	1%	1%
D	1%	2%	4%		2%
E					
Total	23%	35%	29%	6%	6%
Crosstabulation: 6 * Co6					
	5	4	3	2	1
A	5%	4%	7%	1%	1%
B*	19%	16%	11%	4%	1%
C		1%	1%		
D	3%	11%	8%	5%	2%
E					
Total	27%	32%	27%	10%	4%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

2006 Participant Energy
Pre and Post Confidence

Crosstabulation: 7 * Co7							Crosstabulation: 7 * Co7					
	5	4	3	2	1			5	4	3	2	1
A	1%	1%	1%	4%	1%		A	3%	4%	2%	1%	1%
B*	22%	19%	15%	5%	6%		B*	29%	33%	16%	2%	1%
C		2%	4%	2%	3%		C	1%		1%	1%	
D		2%	6%	4%	2%		D		4%	1%		1%
E							E					
Total	23%	24%	26%	15%	12%		Total	33%	41%	20%	4%	3%
Crosstabulation: 8 * Co8							Crosstabulation: 8 * Co8					
	5	4	3	2	1			5	4	3	2	1
A	1%	2%	5%	1%	4%		A	1%	2%	2%	1%	4%
B	1%	2%	1%	1%	9%		B	1%	2%	9%	2%	2%
C	1%	5%	9%	8%	18%		C	5%	8%	17%	6%	7%
D*	11%	4%	1%	4%	13%		D*	9%	14%	2%	2%	2%
E							E				1%	
Total	13%	13%	16%	13%	44%		Total	17%	27%	29%	12%	15%
Crosstabulation: 9 * Co9							Crosstabulation: 9 * Co9					
	5	4	3	2	1			5	4	3	2	1
A		1%	1%	2%	1%		A	1%	3%	1%	1%	
B		1%	1%	2%	1%		B		1%	1%		
C	1%	4%	6%	1%	1%		C	6%	11%	6%	2%	1%
D*	29%	20%	13%	7%	6%		D*	29%	21%	11%	2%	2%
E					1%		E	1%				
Total	30%	27%	20%	13%	11%		Total	38%	35%	19%	6%	3%
Crosstabulation: 10 * Co10							Crosstabulation: 10 * Co10					
	5	4	3	2	1			5	4	3	2	1
A*	35%	25%	11%	8%	3%		A*	54%	21%	6%	4%	2%
B			1%	2%	2%		B	1%		3%	1%	1%
C		1%	1%	3%	4%		C	1%	1%	1%		3%
D		1%	1%	1%	1%		D	1%	1%			1%
E							E					
Total	35%	27%	13%	14%	10%		Total	56%	22%	10%	5%	6%
Crosstabulation: 11 * Co11							Crosstabulation: 11 * Co11					
	5	4	3	2	1			5	4	3	2	1
A	1%	1%	1%	1%			A			2%	2%	1%
B	1%	8%	9%	2%	1%		B	4%	11%	6%	2%	
C*	14%	21%	23%	9%	6%		C*	26%	21%	17%	2%	5%
D			1%		1%		D		1%			
E							E					
Total	16%	29%	35%	12%	8%		Total	30%	33%	25%	6%	6%
Crosstabulation: 12 * Co12							Crosstabulation: 12 * Co12					
	5	4	3	2	1			5	4	3	2	1
A		1%	8%	5%	6%		A	3%	4%	5%	1%	1%
B*	6%	14%	19%	10%	9%		B*	14%	30%	21%	6%	3%
C	1%		2%	4%	4%		C	1%	1%	2%	1%	1%
D	1%	1%	3%	1%	6%		D		1%	1%	2%	1%
E							E					
Total	8%	16%	32%	19%	25%		Total	18%	36%	30%	10%	6%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

2006 Participant Energy
Pre and Post Confidence

Crosstabulation: 13 * Co13							Crosstabulation: 13 * Co13					
	5	4	3	2	1			5	4	3	2	1
A		12%	9%	7%	3%		A	11%	12%	13%	1%	1%
B*	3%	6%	8%	4%	4%		B*	2%	6%	4%	2%	1%
C		1%					C		1%			
D		1%	3%	2%	2%		D		2%	2%	3%	
E	3%	8%	11%	6%	9%		E	3%	12%	15%	5%	4%
Total	6%	27%	30%	19%	18%		Total	16%	33%	35%	11%	5%
Crosstabulation: 14 * Co14							Crosstabulation: 14 * Co14					
	5	4	3	2	1			5	4	3	2	1
A		1%	2%	1%	4%		A		1%	1%	1%	
B		3%	4%	6%	4%		B	1%	4%	3%	1%	1%
C	1%	1%	2%	1%			C	1%	3%			
D*	45%	14%	8%	2%	1%		D*	65%	11%	6%	1%	2%
E							E					
Total	46%	19%	15%	11%	8%		Total	67%	18%	9%	3%	3%
Crosstabulation: 15 * Co15							Crosstabulation: 15 * Co15					
	5	4	3	2	1			5	4	3	2	1
A	1%		2%	3%	1%		A				1%	1%
B*	35%	18%	13%	8%	6%		B*	50%	21%	10%	1%	4%
C		1%		2%	6%		C	1%		3%	1%	1%
D	1%		1%	1%	1%		D	2%	2%	1%	1%	
E							E					
Total	37%	19%	16%	14%	14%		Total	53%	23%	14%	4%	6%
Crosstabulation: 16 * Co16							Crosstabulation: 16 * Co16					
	5	4	3	2	1			5	4	3	2	1
A	1%	1%	1%	1%	1%		A		1%	1%		1%
B	10%	20%	11%	9%	12%		B	21%	21%	11%	4%	3%
C		1%	2%	2%	5%		C		2%	1%	1%	4%
D*	11%	3%	3%	1%	3%		D*	18%	8%	2%		1%
E							E					
Total	23%	25%	18%	13%	21%		Total	39%	32%	16%	4%	9%
Crosstabulation: 17 * Co17							Crosstabulation: 17 * Co17					
	5	4	3	2	1			5	4	3	2	1
A	1%	1%	6%	3%	4%		A		1%	3%		
B	1%	4%	7%	7%	13%		B	1%	4%	9%	4%	9%
C*	14%	5%	6%	2%	7%		C*	21%	16%	9%	2%	8%
D	1%	3%	3%	4%	10%		D	1%	5%	4%	2%	2%
E							E					
Total	16%	13%	21%	15%	35%		Total	23%	26%	24%	8%	19%
Crosstabulation: 18 * Co18							Crosstabulation: 18 * Co18					
	5	4	3	2	1			5	4	3	2	1
A	3%	12%	13%	6%	11%		A	14%	14%	8%	3%	1%
B	6%	6%	7%	4%	5%		B	6%	13%	9%	2%	
C*	10%	8%	4%	1%	5%		C*	14%	11%	4%		1%
D							D					
E							E					
Total	19%	26%	24%	11%	21%		Total	34%	39%	21%	5%	2%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

2006 Participant Energy
Pre and Post Confidence

Crosstabulation: 19 * Co19							Crosstabulation: 19 * Co19					
	5	4	3	2	1			5	4	3	2	1
A	2%	1%	10%	7%	15%		A	4%	6%	8%	4%	4%
B		1%	2%	2%	8%		B		1%	1%	3%	2%
C*	13%	9%	8%	6%	14%		C*	14%	22%	21%	6%	1%
D					1%		D		1%	1%		
E		1%					E					
Total	15%	12%	20%	15%	38%		Total	18%	31%	32%	13%	6%
Crosstabulation: 20 * Co20							Crosstabulation: 20 * Co20					
	5	4	3	2	1			5	4	3	2	1
A	1%		3%	3%	13%		A	1%	1%	7%	5%	6%
B*	11%	4%	6%	4%	20%		B*	13%	12%	7%	7%	10%
C	2%	3%	2%	6%	13%		C	3%	6%	9%	4%	4%
D			1%	2%	6%		D			1%	1%	4%
E							E					
Total	13%	7%	12%	15%	52%		Total	17%	19%	24%	17%	23%
Crosstabulation: 21 * Co21							Crosstabulation: 21 * Co21					
	5	4	3	2	1			5	4	2	3	1
A*	2%	29%	7%	10%	7%		A*	38%	13%	2%	3%	2%
B	1%	3%	4%		5%		B	2%	2%	2%	3%	
C	1%	1%	4%	5%	6%		C	4%	8%	5%	8%	1%
D	1%	1%	2%	1%	2%		D		2%	2%		
E					1%		E				1%	
Total	4%	31%	14%	20%	14%		Total	43%	23%	11%	15%	6%
Crosstabulation: 22 * Co22							Crosstabulation: 22 * Co22					
	5	4	3	2	1			5	4	3	2	1
A	1%		1%	4%	1%		A	2%	3%	5%	3%	1%
B			4%	1%	5%		B		1%	2%	3%	1%
C	1%		4%	1%	4%		C	1%	1%	3%	1%	2%
D*	9%	13%	11%	8%	11%		D*	16%	19%	10%	9%	2%
E		1%	3%	3%	16%		E		4%	4%	3%	5%
Total	10%	14%	23%	16%	36%		Total	20%	28%	23%	18%	11%
Crosstabulation: 23 * Co23							Crosstabulation: 23 * Co23					
	5	4	3	2	1			5	4	3	2	1
A*	20%	17%	7%	4%	6%		A*	34%	22%	10%	2%	2%
B	1%	1%	4%	6%	13%		B	1%	1%	5%	4%	4%
C	1%	1%	2%	1%	8%		C		1%	1%	1%	3%
D			3%	1%	5%		D	1%		3%	2%	3%
E			1%				E					
Total	21%	18%	17%	13%	31%		Total	36%	23%	19%	10%	12%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

2006 Participant Energy
Pre and Post Confidence

Crosstabulation: 24 * Co24							Crosstabulation: 24 * Co24					
	5	4	3	2	1			5	4	3	2	1
A				1%	1%		A			1%		
B		3%	6%	4%	4%		B	1%	3%	6%	3%	
C		1%	4%	2%	5%		C		1%	4%	1%	2%
D*	13%	8%	23%	11%	16%		D*	25%	22%	19%	7%	6%
E							E					
Total	13%	12%	32%	17%	26%		Total	26%	26%	29%	11%	9%
Crosstabulation: 25 * Co25							Crosstabulation: 25 * Co25					
	5	4	3	2	1			5	4	3	2	1
A	2%	5%	7%	5%	4%		A	2%	9%	3%	3%	1%
B*	15%	17%	15%	8%	7%		B*	22%	26%	20%	3%	4%
C			6%	3%	1%		C	1%		2%	1%	1%
D			1%	2%	2%		D			1%		
E							E					
Total	17%	22%	29%	18%	15%		Total	25%	35%	26%	7%	6%
Crosstabulation: 26 * Co26							Crosstabulation: 26 * Co26					
	5	4	3	2	1			5	4	3	2	1
A	1%	1%	2%		5%		A	1%	1%	1%	3%	4%
B	4%	3%	14%	6%	12%		B	3%	10%	11%	6%	1%
C		1%	1%	1%	6%		C	3%	2%	4%	4%	2%
D*	14%	10%	7%	6%	6%		D*	18%	12%	10%	2%	4%
E							E					
Total	19%	15%	24%	13%	29%		Total	24%	26%	26%	14%	11%
Crosstabulation: 27 * Co27							Crosstabulation: 27 * Co27					
	5	4	3	2	1			5	4	3	2	1
A	6%	14%	18%	10%	13%		A	9%	16%	21%	4%	5%
B	2%	3%	4%	1%	3%		B	1%	5%	3%	1%	1%
C		1%	2%	3%	1%		C		1%	1%	4%	
D*	3%	4%	8%	1%	1%		D*	8%	9%	7%	4%	1%
E							E					
Total	11%	23%	32%	15%	19%		Total	18%	30%	32%	13%	7%
Crosstabulation: 28 * Co28							Crosstabulation: 28 * Co28					
	5	4	3	2	1			5	4	3	2	1
A*	14%	11%	5%	8%	10%		A*	28%	16%	12%	4%	2%
B		1%	4%	1%	5%		B		3%	2%	1%	1%
C		1%	2%	3%	11%		C			7%	1%	6%
D	1%	2%	4%	4%	8%		D	1%		1%	1%	2%
E			2%	1%	2%		E		1%	3%	4%	2%
Total	15%	15%	16%	17%	37%		Total	29%	20%	26%	11%	14%
Crosstabulation: 29 * Co29							Crosstabulation: 29 * Co29					
	5	4	3	2	1			5	4	3	2	1
A		1%	1%	2%	1%		A		1%	1%	2%	3%
B		1%	2%	2%	7%		B			1%	1%	1%
C			1%		8%		C			1%	1%	
D	3%	2%	11%	2%	8%		D	9%	12%	11%	6%	4%
E*	8%	7%	13%	6%	13%		E*	16%	12%	11%	4%	4%
Total	11%	11%	28%	13%	37%		Total	26%	25%	25%	13%	11%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

2006 Participant Energy
Pre and Post Confidence

Crosstabulation: 30 * Co30							Crosstabulation: 30 * Co30					
	5	4	3	2	1			5	4	3	2	1
A	3%	6%	5%	6%	4%		A	6%	6%	7%	3%	3%
B	1%		1%	1%	1%		B					
C	1%	1%			1%		C				1%	
D*	13%	15%	11%	4%	6%		D*	30%	15%	9%	1%	1%
E	2%	3%	2%	6%	8%		E	3%	7%	6%	1%	2%
Total	20%	25%	18%	18%	20%		Total	38%	28%	22%	6%	6%

Columns represent confidence levels 5=highest 1=guessing *=correct answer

Item Analysis (Pre)

1			**2**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***E***	13	52.00	D	3	12.00
A	9	36.00	* ***A***	18	72.00
D	3	12.00	B	4	16.00
3			**4**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
B	11	44.00	C	13	52.00
C	3	12.00	* ***D***	9	36.00
* ***A***	11	44.00	A	2	8.00
			B	1	4.00
5			**6**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***B***	17	68.00	A	3	12.00
A	7	28.00	* ***D***	19	76.00
D	1	4.00	C	3	12.00
7			**8**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***C***	18	72.00	* ***C***	13	52.00
D	3	12.00	A	8	32.00
A	4	16.00	E	2	8.00
			D	2	8.00
9			**10**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
B	9	36.00	C	8	32.00
C	4	16.00	A	10	40.00
* ***A***	12	48.00	* ***D***	6	24.00
			B	1	4.00
11			**12**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
D	2	8.00	A	2	8.00
B	11	44.00	* ***B***	10	40.00
* ***C***	11	44.00	D	3	12.00
A	1	4.00	C	10	40.00
13			**14**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
B	9	36.00	A	2	8.00
D	9	36.00	* ***C***	15	60.00
* ***A***	6	24.00	B	7	28.00
C	1	4.00	D	1	4.00

Item Analysis (Post)

1			**2**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***E***	22	88.00	* ***A***	23	92.00
B	1	4.00	B	1	4.00
A	1	4.00	D	1	4.00
D	1	4.00			
3			**4**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***A***	20	80.00	C	2	8.00
B	4	16.00	* ***D***	22	88.00
C	1	4.00	B	1	4.00
5			**6**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
C	2	8.00	A	1	4.00
* ***B***	20	80.00	* ***D***	23	92.00
A	3	12.00	E	1	4.00
7			**8**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***C***	18	72.00	A	2	8.00
D	1	4.00	* ***C***	20	80.00
A	4	16.00	E	3	12.00
B	1	4.00			
9			**10**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
B	10	40.00	C	4	16.00
* ***A***	14	56.00	* ***D***	8	32.00
C	1	4.00	A	13	52.00
11			**12**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***C***	19	76.00	C	4	16.00
A	2	8.00	* ***B***	18	72.00
B	4	16.00	D	1	4.00
			A	2	8.00
13			**14**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
B	9	36.00	* ***C***	19	76.00
* ***A***	11	44.00	A	2	8.00
D	4	16.00	B	3	12.00
C	1	4.00	*	1	4.00

15			16				15			16		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
C	7	28.00	* ***C***	14	56.00		B	9	36.00	B	2	8.00
* ***A***	4	16.00	D	2	8.00		C	8	32.00	* ***C***	20	80.00
D	1	4.00	A	6	24.00		* ***A***	7	28.00	D	1	4.00
B	13	52.00	B	3	12.00		D	1	4.00	A	2	8.00
17			**18**				**17**			**18**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***A***	6	24.00	A	3	12.00		D	7	28.00	E	2	8.00
D	10	40.00	* ***C***	18	72.00		* ***A***	12	48.00	* ***C***	19	76.00
B	8	32.00	D	1	4.00		B	6	24.00	B	3	12.00
C	1	4.00	B	2	8.00					A	1	4.00
			E	1	4.00							
19			**20**				**19**			**20**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
C	7	28.00	D	7	28.00		* ***D***	20	80.00	A	5	20.00
* ***D***	14	56.00	* ***C***	11	44.00		C	3	12.00	* ***C***	17	68.00
B	3	12.00	B	3	12.00		B	2	8.00	D	2	8.00
A	1	4.00	A	4	16.00					B	1	4.00
21			**22**				**21**			**22**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* ***D***	10	40.00	B	5	20.00		* ***D***	22	88.00	B	3	12.00
A	11	44.00	* ***D***	16	64.00		A	3	12.00	* ***D***	17	68.00
B	2	8.00	C	3	12.00					C	4	16.00
E	1	4.00	A	1	4.00					A	1	4.00
C	1	4.00										
23			**24**				**23**			**24**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
E	8	32.00	* ***A***	17	68.00		C	5	20.00	B	3	12.00
C	2	8.00	B	5	20.00		* ***B***	11	44.00	* ***A***	21	84.00
* ***B***	12	48.00	C	3	12.00		E	7	28.00	*	1	4.00
A	3	12.00					D	1	4.00			
							A	1	4.00			
25			**26**				**25**			**26**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**		**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
A	3	12.00	A	2	8.00		* ***C***	20	80.00	C	3	12.00
* ***C***	17	68.00	* ***E***	12	48.00		A	4	16.00	* ***E***	18	72.00
B	5	20.00	C	6	24.00		B	1	4.00	D	3	12.00
			D	4	16.00					B	1	4.00
			B	1	4.00							

27			**28**			**27**			**28**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
A	3	12.00	* A	23	92.00	* D	18	72.00	* A	25	100.00
* D	17	68.00	D	1	4.00	A	5	20.00			
C	2	8.00	C	1	4.00	C	2	8.00			
E	2	8.00									
B	1	4.00									
29			**30**			**29**			**30**		
Response	**Freq**	**Percent**	**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**	**Response**	**Freq**	**Percent**
* D	16	64.00	B	4	16.00	A	1	4.00	B	4	16.00
C	3	12.00	* C	6	24.00	* D	22	88.00	* C	13	52.00
E	2	8.00	D	11	44.00	C	1	4.00	D	7	28.00
B	2	8.00	E	1	4.00	E	1	4.00	*	1	4.00
A	2	8.00	A	3	12.00						

-------------- Activities Executive Summary -----------------

The Project Leadership Team completed the following activities during the current evaluation period to bring this phase of the project to closure. Activities for AAPT/PTRA Rural Project NSF Award Number 0138617 (May 2009 to August 2010):

1. Developed an on-line survey to compare and contrast the various AAPT/PTRA professional development efforts over time. The comparison included Urban PTRA; non-NSF funded PTRA projects, and Rural PTRA participants. For details and results see Final Report AAPT/PTRA Rural Project NSF Award Number 0138617, prepared by EAT, Inc.

2. Completed an overall evaluation of the PTRA Rural Project. A brief listing of the finding of this evaluation follows. For a complete report of the findings see the attached Final Report AAPT/PTRA Rural Project NSF Award Number 0138617 prepared by EAT, Inc. Teachers who participated in the Rural PTRA project showed an increased in their

    - knowledge of physics content;
    - confidence of their physics content knowledge;
    - knowledge of instructional strategies;
    - use of active student centered classroom instructional strategies;
    - knowledge of instructional technology;
    - use of instructional technology; and
    - attendance when multiple sites institute sites are available.

   Students of teachers who attended AAPT/PTRA professional development increased in their

    - knowledge of physics content; and
    - confidence of their physics content knowledge.

3. Developed a description of the basic features of the AAPT/PTRA professional development model. See Appendix #1 below.

4. Developed several AAPT/PTRA assessment instruments to document the impact of the project. These include Pre, Post, Formation, and Retention assessments for both teachers and for Students, as well as Institute Correlation For PTRA Leaders and Teacher Assessment Answer & Analysis Sheet. See Appendix #2 below.

5. Developed a comparison chart for the various iterations of the PTRA projects supported by NSF. See Appendix #3 below.

6. During the summer of 2009, conducted 12 non-NSF funded Regional Summer Institutes with follow-up sessions for 42 hours using the AAPT/PTRA Professional Development model. These spin-off projects were funded by Mathematics and Science Partnership (MSP) grants in Arkansas (2 MSP), Georgia (MSP), Idaho (MSP), and North Carolina (4 MSP). Also Maryland (funded by Commission on Higher Education), and Virginia

(Funded by Toyota). 80 national PTRA Leaders attended the leadership institute held at University of Michigan in July 2009. See Appendix #4 below.

7. During the summer of 2010, conducted 17 non-NSF funded Regional Summer Institutes with follow-up sessions for 42 hours using the AAPT/PTRA Professional Development model. These spin-off projects were funded by Mathematics and Science Partnership (MSP) grants in Arkansas (2 MSP), Georgia (MSP), Idaho (MSP), and North Carolina (6 MSP). Also Maryland (funded by Commission on Higher Education), Texas (4 Fee for Service), and Virginia (Funded by Toyota) using the AAPT/PTRA Program. Fifty national PTRA Leaders attended the leadership institute held at Portland State University in July 2010. See Appendix #5 below.

8. Using non-NSF funding, developed and published 15 AAPT/PTRA Teacher Resource Guides. See Appendix #6 below.

9. Developed three new workshop topics including Engineering Design, Radioactivity, and Magnets & Magnetism.

10. During the AAPT 2010 summer meeting in Portland the following PTRA activities were completed:

    - Plenary Session celebrating the contributions of the AAPT/PTRA Program;
    - Invited Session on the AAPT/PTRA Urban Project;
    - Invited Session on the AAPT/PTRA Rural Project; and
    - AAPT/PTRA booth in the vendor exhibition hall to solicit faculty from Institutions of Higher Education who are interested in developing a PTRA project for teachers in their area.

11. Documentation for cost sharing of over 1.7 million dollars. See Appendix #7 below.

The AAPT Executive Board continues to approve mini-grants (about $2,000 each) for AAPT sections to provide PTRA workshops for new physics teachers. The total number of section mini-grants over the last three years has been 18.

Many individuals have contributed to the success and implementation of this project, and I list here a few who deserve special recognition: George Amann, Robert Beck Clark, Warren Hein, Bernard Khoury, Maria Elena Khoury, Janet Lane, Jan Mader, and Karen Jo Matsler.

Jim Nelson, PI

--------------- **End of Activities Executive Summary** ------------------

--------------- Additional Information provided in Appendices below ------------------

APPENDIX LISTING:

Appendix #1	Description of AAPT/PTRA professional development model.
Appendix #2	Listing of PTRA Assessment Instruments.
Appendix #3	Comparison chart for the various iterations of the PTRA projects.
Appendix #4	University of Michigan Leadership Institute Schedule
Appendix #5	Portland State University Leadership Institute Schedule
Appendix #6	Listing of AAPT/PTRA Teacher Resource Guides
Appendix #7	Documentation of 10% required cost sharing.

Appendix #1

AAPT/PTRA PROFESSIONAL DEVELOPMENT PROGRAM

A MODEL FOR SUCCESSFUL TEACHER PROFESSIONAL DEVELOPMENT

With the help of National Science Foundation (NSF) and the American Physical Society (APS) funding, the American Association of Physics Teachers (AAPT) has developed the Physics Teaching Resource Agent (PTRA) model for successful physical science and physics teacher professional development. This model includes development of peer mentors and professional development leaders, systemic infrastructure, assessment instruments, and a curriculum based on experienced mentors and physics education research.

The AAPT/PTRA curriculum is supported by a series of AAPT/PTRA Teacher Resource Guides. These guides serve not only as a resource for the teacher's professional development, but also are appropriate for teachers' continued use in their grades 7 to 12 classrooms.

NEED FOR "HIGHLY QUALIFIED" TEACHERS

In the United States as a whole, as well as in individual states there is a looming shortfall of highly qualified teachers of physics and physical science. This shortfall is a result of pressure at both ends of the teacher supply and demand continuum.

On the demand side, more and more students are studying physics topics in Environmental Science, Integrated Science, Physical Science, Physics, Principals of Technology, Robotics, et cetera. This is being driven by an increased realization on the part of educators that physics is the fundamental science upon which an understanding of all other sciences and engineering is built. As our national medical, economic and defense systems become increasingly dependent upon an understanding of science and the products of science, more and more students are preparing themselves for the future by studying fundamental sciences, which includes physics topics. This change is sometimes characterized by the phrase "Physics for All." Another factor is the growing movement to teach physics first in the typical high school science curriculum sequence. All this is occurring as states are setting higher expectations for teachers and student achievement.

On the supply side, the "baby boomer" generation of physics teachers are beginning to retire leading to an increased need to find highly qualified teachers as required by the federal "No Child Left Behind Legislation.[1]" With very few students graduating from college with the goal of becoming a professional science teacher, the shortfall is growing. The most likely source of meeting present and future teacher needs is by alternative certification and by recertification of existing teachers. Both of these groups need the opportunity to prepare them to fill their expected role. The AAPT/PTRA Professional Development Program has developed a professional growth model that will help these individuals grow into outstanding teachers.

OUT-OF-FIELD TEACHING IN MIDDLE AND HIGH SCHOOL GRADES

According to U.S. Department of Education, National Center for Education Statistics, "The Condition of Education 2003", NCES 2003-067, Washington, DC, researchers have explored the hypothesis that teachers' knowledge and ability are associated with student learning in the classroom. These studies have found that students learn more from mathematics teachers who majored in mathematics than from teachers who did not (Goldhaber and Brewer, 1997) and more from mathematics and science teachers who studied teaching methods in the subject they teach than from those who did not (Monk 1994; Goldhaber and Brewer, 1997). These findings have prompted further examinations of "out-of-field" teachers (i.e., teachers who lack a major and certification in the subject they teach.)

Students in the middle and high school grades were more likely to have out-of-field teachers in mathematics, foreign language, social science, and physical science classes than in their art, music, and physical education classes.

Overall, out-of-field teachers were more common in physical science than in any other regular subject in both the middle and high school grades. They taught 42 percent of physical science students in the middle grades and 18 percent in high school.

The issue was summarized in the report "Out-of-Field Teaching and the Limits of Teacher Policy**"**, A Research Report co-sponsored by Center for the Study of Teaching and Policy and The Consortium for Policy Research in Education, Center for the Study of Teaching and Policy, September 2003

> The failure to ensure that the nation's classrooms are all staffed with qualified teachers is one of the most important problems in contemporary American education. Over the past decade, many panels, commissions, and studies have focused attention on this problem and, in turn, numerous reforms have been initiated to upgrade the quality and quantity of the teaching force. This report focuses on the problem of under-qualified teachers in the core academic fields at the 7-12th grade level. Using data from the nationally representative Schools and Staffing Survey, conducted by the National Center for Education Statistics, this analysis examined how many classes are not staffed by minimally qualified teachers, and to what extent these levels have changed in recent years. The data show that while almost all teachers hold at least basic qualifications, there are high levels of out-of-field teaching - teachers assigned to teach subjects that do not match their training or education. Moreover, the data show that out-of-field teaching has gotten slightly worse in recent years, despite a plethora of reforms targeted to improving teacher quality.
>
> **--Richard M. Ingersoll,** University of Pennsylvania

[1] http://www.ed.gov/nclb/landing.jhtml

Components of AAPT/PTRA Professional Development Program

According to a 2003 study completed by Horizon, Research, Inc. http://www.horizon-research.com/, on K-12 Mathematics and Science Education in the United States, high qualify teacher professional development must include:

1) Focus on content knowledge,
2) Emphasis active learning,
3) Promote content coherence,
4) Provide a large amount of training sustained over time, and
5) Encourages collaboration among teachers.

As a result of experience and research, the AAPT/PTRA leadership has developed a model for successful teacher professional development. The features included in the AAPT/PTRA Professional Development Model include:

- A consistent and known curriculum for Professional Development consisting of the sequence of Kinematics, Newton's Laws, Energy, Momentum, Electricity (DC Circuits and Electrostatics), Waves, Optics, and Sound. It has been documented that a consistent and logical sequence of professional development events over a period of time, has a much better rate of success than a random collection of events.

  See for example, Hill and Ball (2005).
  http://www-personal.umich.edu/~dball/BallWeb/SelecteJournalArticles.html

  Highly qualified teachers can benefit from a smorgasbord approach to professional development, because they have the personal internal infrastructure into which they can plug the random events they experience; however, the new or developing teacher does not have this infrastructure and cannot incorporate the random events they experience into a consistent infrastructure. Professional development must be more than a collection of activities. Participants must understand how the activities performed during a professional development experience build on one another to tell a story of the science being learned. During an AAPT/PTRA professional development, the learning experience is a gentle slope rather than cliff! During AAPT/PTRA Institutes and Follow-up Workshops the following questions are the focus of the participants experience.

  a. How does an activity help students develop a concept?
  b. How does the lesson/activity help students overcome misconceptions?
  c. How does today's lesson/activity relate to the previous lesson?
  d. How does today's lesson/activity prepare for the next lesson?

  In order to effectively impact classroom practice, participants/teachers need to experience the lesson as if they were students and understand the purpose of the activity in the curricular sequence. As participants/teachers articulate the purpose of the Professional Development, they will begin to internalize its relevance. Changes in beliefs often come after teachers use a new practice and see the benefits (Ball & Cohen, 1999).

- Teacher content knowledge in mathematics and science is closely linked to student performance (Darling-Hammond, 2000); science teachers who improved content knowledge and deepened pedagogical reasoning had greater improvement in student's achievement (Heller, Kaskowitz, Daehler, & Shinohara, 2001). Since AAPT is the world's foremost professional society for physics education, AAPT provides the credibility for the AAPT/PTRA Program, the AAPT/PTRA curriculum, and AAPT/PTRA teacher professional development. Each AAPT/PTRA curriculum Teacher Resource Guide has been developed by experienced and knowledgeable high school physics teacher(s). This assures that the activities and instructional techniques in the Teacher Resource Guide are effective both during the professional learning experience and when teachers use the activities in their classrooms. Each AAPT/PTRA Teacher Resource undergoes rigorous review by the Publication Committee of the AAPT. The review process assures that the content and pedagogy of the AAPT/PTRA Teacher Resource Guides are world class. Consistent curriculum at all sites is based on AAPT/PTRA Teacher Resources Guides and leadership training in order to facilitate system wide AAPT/PTRA evaluation.
- AAPT/PTRA mentors and leaders undergo yearly training in research based pedagogy, including guided inquiry, instructional use of technology, in addition to AAPT/PTRA curriculum and content so they are better prepared as role models for new and crossover science teachers. This approach takes advantage of the old adage, " … teachers teach the way they were taught."
- The AAPT/PTRA leadership selects Regional Sites (RS), usually on a college campus, to host AAPT/PTRA Summer Institutes and follow-up sessions. A college or university professor is selected to be the Regional Coordinator (RC) for this site. Although the AAPT/PTRA professional development model does not use the college or university professor(s) as teachers within the program, the college or university professor is an important component of the collaborative support structure for the program. Each chosen institution serves as a Regional Site providing the support infrastructure for the program. This support includes the use of classrooms, laboratories, technology, and laboratory equipment, as well as a source of housing and meals during the AAPT/PTRA Program summer institutes and follow-up sessions.
- The AAPT/PTRA Program is committed to provide over 100 hours of consistent professional development for participants. Several strategies have been developed to provide incentives for participants to continue for the full 100+ hours. One incentive includes increasing the participant's stipend as they complete more hours of training. In addition, the ability of the participants to purchase equipment at reduced rate from cooperating vendors is only available after completing a topic.
- Consistent curriculum at all sites is based on the AAPT/PTRA Teacher Resource Guides in order to facilitate system wide AAPT/PTRA evaluation.
- The AAPT/PTRA Program has developed formative and summative content assessment instruments for participants. These assessment instruments are

used to gather data for formal assessment of the program. For examples of participant content assessment results see Final Report AAPT/PTRA Rural Project NSF Award Number 0138617, prepared by EAT, Inc.

- Since the key measure of effectiveness of teaching is the growth and development of student skills and knowledge, the AAPT/PTRA Program has developed diagnostic and summative content and skills assessment instruments for use with students taught by participants. For examples of student content assessment results see Final Report AAPT/PTRA Rural Project NSF Award Number 0138617, prepared by EAT, Inc.
- Formative assessments are used during the AAPT/PTRA professional development summer institutes to determine the participants' progress. There are assessments of their conceptually resistant ideas, assessment of areas that need to be re-addressed, etc. For details and results see Final Report AAPT/PTRA Rural Project NSF Award Number 0138617, prepared by EAT, Inc.
- Full commitment for three summers and two follow-up sessions per year is expected of participants who attend AAPT/PTRA Summer Institutes.
- In kind support for the program is provided by cooperating vendors (e.g., PASCO, Prentice Hall, Texas Instruments, Vernier, etc.) Vendors provide up to date equipment for use during PTRA professional development institutes, and reduced purchase prices for participants who have completed a PTRA topic.
- Instructional technology is incorporated into AAPT/PTRA summer institutes and follow-up sessions. Although the technology is used to compliment the science learning of the students, alternative instructional methods are also provided for teachers who do not have the technology available. The AAPT/PTRA Program recognizes that participants should experience the instructional advantages of using appropriate technology in order to be prepared for future technological activities in their school. These activities often make major improvements in student learning.
- AAPT/PTRA summer institutes and follow-up sessions spend time on implementation strategies, overcoming barriers to implementation, and general guidelines to successful instruction based on the needs of participants' students and availability of materials at their school.
- To develop a continuing learning community among participants, the AAPT provides ListServs and websites for continual peer collaboration and communication.
- One experienced AAPT/PTRA is assigned as the Lead PTRA to function as a liaison between the AAPT/PTRA Program, the Regional Coordinator, and the participants at each Regional Site. This partnership brings together the classroom experience and training of the Lead PTRA who will conduct the activities within the academic setting provided by the local institution.
- Peer reviewed criterion-referenced assessments that can be administered to teachers and students are used. These assessments are particularly valuable in determining student success as a result of the AAPT/PTRA Professional

Development for their teachers. For results of Criterion-Referenced Assessment for students and teachers see Final Report AAPT/PTRA Rural Project NSF Award Number 0138617, prepared by EAT, Inc.

- The AAPT/PTRA Program provides continuation education credits via AAPT as well as inexpensive graduate credit through the University of Dallas. This provides an additional incentive to the participants.
- The AAPT/PTRA Program tracks the number of hours each participant has experienced as a member of the program on each of the program topics. Thus the program provides them with proof of meeting their professional development obligations for their districts.
- A website with information about the AAPT/PTRA Program is available. See http://www.aapt.org/PTRA/index.cfm
- The AAPT/PTRA Program provides weeklong summer institutes with 12 hours of follow-up sessions during the school year. The follow-up sessions are based on the previous summer institute topic(s) and provide a support system for the teachers during implementation of the new content, activities and instructional strategies. The five-day format of the summer institute is preferable to a once-a-month or random format during the school year. During extended periods of time such as this, participants can concentrate on the topic being studied. Each AAPT/PTRA topic has a theme as well as a scope and sequence. The institute activities constitute a consistent story with a logical development of concepts. (See PTRA kinematics curriculum example below.) A value added aspect of the weeklong summer institute is the camaraderie that develops among the participants. When a group of teachers are brought together, it takes time and effort to have them coalesce into a group of capable of carrying out collaborative learning experiences that would be expected of their own students. Until the participants spend some informal as well as formal time together they are less likely to be open about dealing with the problems associated with their teaching and their own student's learning.
- Equations of the relationship among variables that represent physical phenomena (i.e., $\Delta PE=mg\Delta h$, $d=v_{(0)} + vt$, $F=ma$, et cetera) are initially developed from laboratory activities rather than from a textbook or teacher lecture. During the laboratory activities data is taken by participants and then logically analyzed to determine the relationships among the variables that they have monitored. Activities are used to introduce concepts rather than verify concepts. This is typically called the constructivism approach.
- Research based appropriate models of instruction are used (e.g., Learning Cycles, Modeling, guided inquiry, self-directed learning, ranking tasks, et cetera) as the foundation for instruction.

AAPT/PTRA - Goals & Activities

The AAPT/PTRA Program goals include providing an opportunity for upper elementary, middle, and high school teachers to experience professional growth in the areas of physics and physical science content (e.g., Kinematics, Energy, Newton's Laws, etc.), use of technology (e.g., electronic measurements, graphic calculators, simulations, etc.), and teaching techniques based on physics education research.

Teachers identified as outstanding in the four areas listed below have been designated, trained and certified by AAPT as AAPT/PTRAs. These teachers were the first to experience this professional growth. These national selected AAPT/PTRAs attend annual AAPT/PTRA professional development sessions on workshop leadership, organization, and delivery of content topics. These teachers continue to be provided with experiences during the annual AAPT/PTRA National Summer Institutes to grow as workshop leaders. The four areas used to critique applicants for AAPT/PTRA status are:

1. Evidence of Content Knowledge
2. Evidence of Creativity in Teaching
3. Evidence of Interest in Personal Professional Growth
4. Evidence of Leadership Potential

A Boston College study,**TIMSS (Third International Mathematics and Science Study) Physics Achievement Comparison Study**, published in April 2000 shows that students of teachers who have attended NSF funded projects, such as AAPT/PTRA Professional Development Program, performed significantly better on the TIMSS physics assessment. See www.timss.org. The USA overall mean is 423 while the mean for students of teachers who have attended NSF sponsored professional development is 475. In addition Horizon Research, Inc has documented the success of the AAPT/PTRA Program. This research indicates that teachers who attend AAPT/PTRA workshops are more confident in their own physics content knowledge and thus are more likely to make a commitment not only to use of technology, but also to use the results of successful and research-based teaching strategies (e.g., modeling, directed guided inquiry, self-directed learning, ranking tasks, etc.)

The AAPT/PTRA Program has established an infrastructure that leads to interaction and sharing by teachers. This is described in the AAPT/PTRA Handbook for Workshop Leaders (2006-2007 Edition), and an article in the AAPT *The Physics Teacher* “Physics Teaching Resource Agent Program” TPT, April 2001.

The AAPT/PTRA workshops are of two types: content specific and teaching strategies specific. Content specific subjects include (e.g., Kinematics, Energy, Geometric Optics, Momentum, Newton’s Laws, and the Electromagnetic Spectrum. etc.). Workshops dealing with teaching strategies include (e.g., Role of the Laboratory, Use of graphing calculators in Teaching Physics, Role of Demonstrations, Guided Inquiry. etc.)

TEACHING ABOUT KINEMATICS/MOTION is a typical content centered workshop. The outline of this workshop covers the basic topics for the study of motion and typically requires 18 hours to complete. Using a constructivist approach, participants develop definitions for position, distance traveled, displacement, time interval, instant in time, frequency, wavelength, speed, velocity and acceleration based on their own observations. In order to develop these definitions, participants have measured fundamental quantities such as position; distances traveled, displacement, wavelength, frequency, and time intervals, as well as calculated instantaneous speed, average speed, linear acceleration, and acceleration in circular motion. This workshop enables teachers to experience novel approaches and activities to the teaching of kinematics.

Participants may do the activities with toy cars and airplanes.

The activities are designed to help students distinguish among:

- Time as an Instant, and Time as an Interval.
- Position, Distance Traveled, and Displacement.
- Instantaneous Speed and Average Speed for Uniform Linear Motion
- Instantaneous Speed and Average Speed for Uniform Circular Motion
- Speed and Velocity for Circular Motion
- Acceleration, Speed and Velocity
- Linear Acceleration and Circular Acceleration
- Verbal, Mathematical and Graphical Representation of Motion
- Sign of Vector Quantities (e.g., Displacement, Velocity, and Acceleration)

Successful laboratory activities rely on the instructional use of the following fundamental measuring instruments: ruler, magnetic compass, computer motion probe, protractor, photogate, stopwatch, and vibration timer.

The approach is unique; the content rigorous, and the classroom strategies are consistent with Physics Education Research and the National Standards. AAPT/PTRA workshops are appropriate for upper middle school (i.e., Grade 7-8) through high school teachers.

OUTLINE OF A TYPICAL AAPT/PTRA WEEKLONG INSTITUTE KINEMATICS/MOTION

Compare/Contrast/Measurement: Time as an Instant, Frequency, Time as an Interval, and Period Using Pendulum and/or Flashing Light.

- Measurement of Time Intervals
- One Second Timer Challenge
- Pendulums on Parade
- Period of a Pendulum using a Photogate
- Frequency versus Period using a Flashing Light

Compare/Contrast/Measurement: Position, Distance Traveled, and Displacement

- Traveling Washer in One Dimension

- Traveling Washer in Two Dimensions
- Where am I?

Compare/Contrast/Measurement: Speed and Velocity

- Toy Car moving with Uniform Linear Motion
- Toy Car moving with Uniform Circular Motion
- Movement of Waves (Wave Equation compared to Speed Equation)
- Instantaneous Speed, Average Speed, Initial Speed and Final Speed Using a Toy Car Coasting Down an Inclined Plane using a Photogate Timer.
- Analysis of Motion Using Graphs Made from a Ticker Tape Timer.

Compare/Contrast/Measurement: Acceleration Using Toy Cars and Toy Airplanes

- Speeding Up
- Speeding (Slowing) Down
- Changing Directions
- Measuring acceleration with a Liquid Level Accelerometer.
- Linear Acceleration and Circular Motion Acceleration

Calculations using basic kinematics definitions, graphs, and equations

- Position versus Time Graphs (Motion Probe)
- Velocity versus Time Graphs (Motion Probe)
- Acceleration versus Time Graphs
- Basic Linear Kinematics Equations
- Freely Falling Objects (Free Fall Timing)
- Basic Uniform Circular Kinematics Equations

All of these topics are develop with inquiry based laboratory activities.

Wingspread Meeting

In 2005 the Education Commission of the States with support of the NSF invited a group of exerts to a Wingspread Conference who identified a variety of areas that policymakers and education leaders should address to improve mathematics and science education.

According to the Education Commission of the States report, **Keeping America Competitive: Five Strategies To Improve Mathematics and Science Education** by Charles Coble and Michael Allen, *July 2005,*[2] the over-reliance on the mathematics and science talent of foreign students represents a major potential weakness in the future competitiveness and vitality of the U.S. economy and workforce. To help address this weakness, policymakers and education leaders must ensure the U.S. education system is successfully preparing its students for careers in science and mathematics.

[2] Charles R Coble; Michael Allen; Education Commission of the States.; National Science Foundation (U.S.); Johnson Foundation (Racine, Wis.)

Five Strategies

The experts, which ECS and NSF gathered at this Wingspread meeting, identified a variety of areas that policymakers and education leaders should address to improve mathematics and science education. Of particular importance are the following essential needs:

1. To effectively assess student learning in mathematics and science
2. To strengthen teacher knowledge and skills in science and mathematics
3. To ensure high-quality mathematics and science teachers are available to all students including the most disadvantaged students
4. To ensure strong leadership from the higher education community, especially from university presidents
5. To promote public awareness of the importance of mathematics and science education to the country's future.

As explained above, the AAPT/PTRA Program is uniquely positioned and prepared to address numbers 1, 2, 3 and 5 on this list. With continued funding, the program hopes to fulfill its stated goal of improving physics education for all students in the United States.

If the physical science teacher shortfall problem is not solved, our nation runs the risk of increasing the percentage of the population that is scientifically and technologically illiterate. A scientifically literate population is critical for the nation's economic, medical health, military security, and the general feeling of citizens that they are a part of the nation's present and future.

Appendix #2
AAPT/PTRA Assessment Instruments
As of August 19, 2010

Content Area	Teacher/Student	Completed	Under Development
Kinematics & Dynamics	Student Pre	X	
Kinematics & Dynamics	Student Post	X	
Kinematics & Dynamics	Teacher Pre	X	
Kinematics & Dynamics	Teacher Formative	X	
Kinematics & Dynamics	Teacher Post	X	
Kinematics & Dynamics	Teacher Retention	X	
Kinematics & Dynamics	Teacher Answer & Analysis Sheet	X	
Kinematics & Dynamics	Correlation to Workshop	X	
Energy & Momentum	Student Pre	X	
Energy & Momentum	Student Post		X
Energy & Momentum	Teacher Pre	X	
Energy & Momentum	Teacher Formative	X	
Energy & Momentum	Teacher Post	X	
Energy & Momentum	Teacher Retention		X
Energy & Momentum	Teacher Answer & Analysis Sheet	X	
Energy & Momentum	Correlation to Workshop	X	
Electricity (Static & DC)	Student Pre	X	
Electricity (Static & DC)	Student Post	X	
Electricity (Static & DC)	Teacher Pre	X	
Electricity (Static & DC)	Teacher Formative	X	
Electricity (Static & DC)	Teacher Post	X	
Electricity (Static & DC)	Teacher Retention		X
Electricity (Static & DC)	Teacher Answer & Analysis Sheet	X	
Electricity (Static & DC)	Correlation to Workshop	X	
Waves & Geometric Optics	Student Pre	X	
Waves & Geometric Optics	Student Post		X
Waves & Geometric Optics	Teacher Pre	X	
Waves & Geometric Optics	Teacher Formative	X	
Waves & Geometric Optics	Teacher Post	X	
Waves & Geometric Optics	Teacher Retention		X
Waves & Geometric Optics	Teacher Answer & Analysis Sheet	X	
Waves & Geometric Optics	Correlation to Workshop	X	
Magnets & Magnetism	Teacher Pre		X
Magnets & Magnetism	Teacher Answer & Analysis Sheet		X
Magnets & Magnetism	Correlation to Workshop		X

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AAPT/PTRA KINEMATICS & DYNAMICS INSTITUTE CORRELATION FOR PTRA LEADERS QUESTIONS IN 2009 AAPT/PTRA TEACHER CONTENT ASSESSMENTS

Main Concepts/Topic/Objective:

Objective 1: Space, Time, Speed, and Velocity – Six Questions
Objective 2: Uniform Circular Motion and Acceleration – Ten Questions
Objective 3: Motion Graphs (Position, Velocity, Acceleration) – Six Questions
Objective 4: Force and Newton's First Law – Four Questions
Objective 5: Newton's Second Law – Nine Questions

#	MAIN CONCEPT/TOPIC	K/D	TOPIC: AAPT/PTRA CURRICULUM OR ACTIVITY
1	1. Space, Time, Speed, and Velocity	K	*DISTINGUISH AMONG POSITION, DISTANCE TRAVELED, AND DISPLACEMENT* *ACTIVITY #5, TRAVELING WASHER IN ONE-DIMENSION & ACTIVITY #6 TRAVELING WASHER IN TWO-DIMENSION*
2	1. Space, Time, Speed, and Velocity	K	*Experimenting to find relationship between period of a pendulum and the length of the pendulum.* *Activity #3 Pendulums on Parade*
3	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Reading a position versus time graph.* *Activity #7 Position vs. Time Graphs Using a Motion Probe*
4	1. Space, Time, Speed, and Velocity (Computational)	K	*Developing and using the equation for average speed* *Activity #9 Measurement of Speed on a Smooth and Level Surface and Activity #23 Position, Velocity & Acceleration vs. Time Graphs Using "Moving Man"*
5	4. Force & Newton's First Law	D	*Section 2-3 Activity #8. What Connects Motion and Force*
6	2. Uniform Circular Motion and Acceleration (Conceptual)	K	*Analysis of ticker tape record of motion.* *Activity #12, Making Graphs of Constant Speed Using Vibrating Timer Tape & Activity #21: Kinematics of a Student - Speed*
7	4. Force & Newton's First Law	D	*Section 2-3 Activity #12 Dueling Fan Units (Demonstration Activity)*
8	4. Force & Newton's First Law	D	*Section 2-4 Activity #18 Sliding to a Halt on a Level Surface (Interactive Demonstration)*
9	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Reading a velocity versus time graph.* *Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #23 Position, Velocity & Acceleration vs. Time Graphs Using "Moving Man", & Activity #33 Finding Acceleration Using a Vibrating Timer Tape*
10	5. Newton's Second Law	D	*Section 2-3 Activity #11. Combinations of Forces and Masses (Demonstration)*
11	5. Newton's Second Law	D	*Section 2-3 Activity #8. What Connects Motion and Force?*
12	4. Force & Newton's First Law	D	*Activity #12 Discussion* *Forces Applied In Different Directions.*

#	MAIN CONCEPT/TOPIC	K/D	TOPIC: AAPT/PTRA CURRICULUM OR ACTIVITY
13	2. Uniform Circular Motion and Acceleration	K	*Fining the speed of an object moving in a circle. Activity #11 Comparing Linear Speed and Circular Speed, Activity #19 Finding Speed & Velocity of a Car Traveling with Uniform Circular Motion, and Activity #39 Using a Liquid Level Accelerometer to Classify Circular Motion*
14	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Calculation of average speed using a graph. Activity #9 Turnpike Story, Activity #10 Comparison of Average Speed and Final Speed, and Activity #28 Straight Line Motion Equations & Graphs.*
15	5. Newton's Second Law	D	*Activity #12 Discussion Forces Applied in Different Directions.*
16	5. Newton's Second Law	D	*Section 2-3 Activity #11. Combinations of Forces and Masses (Demonstration)*
17	5. Newton's Second Law	D	*Section 2-3 Activity #11. Combinations of Forces and Masses (Demonstration)*
18	5. Newton's Second Law	D	*Activity #12 Dueling Fan Units (Demonstration Activity)*
19	5. Newton's Second Law	D	*Section 2-3 Activity #11. Combinations of Forces and Masses (Demonstration)*
20	2. Uniform Circular Motion and Acceleration	K	*Sign of velocity and acceleration. Activity #23 Moving Man, Activity #36 Going Up and Coming Down, and Activity #40 Using a Liquid Level Accelerometer to Classify Simple Harmonic Motion*
21	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Activity #7 Position vs. Time Graphs Using a Motion Probe, Activity #9 Measurement of Speed on a Smooth and Level Surface, and Activity #17 Velocity vs. Time Graphs Using a Motion Probe.*
22	1. Space, Time, Speed, and Velocity (Computational)	K	*Making and using position versus time graphs. Activity #9 Measurement of Speed on a Smooth and Level Surface, Activity #27 The Case of the Slope Shifter, Activity #30 Measurement of Acceleration on an Inclined Plane, and Activity #33 Finding Speed and Acceleration Using Vibrating Timer Tape.*
23	5. Newton's Second Law	D	*Section 2-3 Activity #11. Combinations of Forces and Masses (Demonstration)*
24	2. Uniform Circular Motion and Acceleration	K	*Reading a velocity versus time graph. Activities #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, and Activity #48 Constant Acceleration Problem.*
25	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, and Activity #48 Constant Acceleration Problem.*

#	MAIN CONCEPT/TOPIC	K/D	TOPIC: AAPT/PTRA CURRICULUM OR ACTIVITY
26	2. Uniform Circular Motion and Acceleration	K	*Speed and acceleration for an object moving in a circle. Activity #11 Comparing Linear Speed and Circular Speed, Activity #19 Finding Speed & Velocity of a Car Traveling with Uniform Circular Motion, and Activity #39 Using a Liquid Level Accelerometer to Classify Circular Motion*
27	2. Uniform Circular Motion and Acceleration	K	*Speed and acceleration for an object moving in a circle. Activity #11 Comparing Linear Speed and Circular Speed, Activity #19 Finding Speed & Velocity of a Car Traveling with Uniform Circular Motion, and Activity #39 Using a Liquid Level Accelerometer to Classify Circular Motion.*
28	3. Motion Graphs (Position, Velocity, Acceleration)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, and Activity #48 Constant Acceleration Problem.*
29	2. Uniform Circular Motion and Acceleration (Graph Analysis)	K	*Analysis of data for freely falling object to find relationship between time of Falling and distance fallen. Activities #24, #25, or #26 Freely Falling Object I, II and III, and Activity #35 Acceleration due to Gravitational Force Using a Vibrating Time*
30	5. Newton's Second Law	D	*Activity #11 Discussion Multiple Forces Applied to a Constant Mass*
31	1. Space, Time, Speed, and Velocity (Computational)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, and Activity #48 Constant Acceleration Problem*
32	2. Uniform Circular Motion and Acceleration	K	*Sign of velocity and acceleration. Activity #23 Moving Man, Activity #36 Going Up and Coming Down, and Activity #40 Using a Liquid Level Accelerometer to Classify Simple Harmonic Motion*
33	1. Space, Time, Speed, and Velocity (Computational)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, and Activity #48 Constant Acceleration Problem.*
34	2. Uniform Circular Motion and Acceleration (Computational)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations & Graphs, Activity #34, Graph Hopscotching, and Activity #48 Constant Acceleration Problem*

#	MAIN CONCEPT/TOPIC	K/D	TOPIC: AAPT/PTRA CURRICULUM OR ACTIVITY
35	2. Uniform Circular Motion and Acceleration (Computational)	K	*Reading a velocity versus time graph. Activity #12 Making Graphs of Constant Speed Using Vibrating Timer Tape, Activity #17 Velocity vs. Time Graphs Using a Motion Probe, Activity #28, Worksheet on Straight Line Motion Equations, Activity #34, Graph Hopscotching & Graphs, and Activity #48 Constant Acceleration Problem*

AAPT/PTRA
2009-2010 Kinematics/Dynamics
Teacher Assessment Answer & Analysis Sheet

Topic/Objective:

1. Space, Time, Speed, and Velocity
2. Uniform Circular Motion and Acceleration
3. Motion Graphs (Position, Velocity, Acceleration)
4. Force and Newton's First Law
5. Newton's Second Law

Bloom's Levels:

1. Knowledge (2 Questions)
2. Comprehension (4 Questions)
3. Application (12 Questions)
4. Analysis (11 Questions)
5. Synthesis (6 Questions)
6. Evaluation (0 Questions)

Breakdown:

CO = Conceptual Questions (no mathematical computation needed) = 26
CA = Calculations Involved (some mathematics computation needed) = 9

Topic/Objective:

Objective 1: Space, Time, Speed, and Velocity – Six Questions
Objective 2: Uniform Circular Motion and Acceleration – Ten Questions
Objective 3: Motion Graphs (Position, Velocity, Acceleration) – Six Questions
Objective 4: Force and Newton's First Law – Four Questions
Objective 5: Newton's Second Law – Nine Questions

Question	Answer	Objective	Bloom's	CO or CA
1		1	2	CO
2		1	5	CO
3		3	3	CO
4		1	4	CA
5		4	3	CO
6		2	4	CO
7		4	4	CO
8		4	1	CO
9		3	1	CO
10		5	2	CO
11		5	4	CO
12		4	3	CO
13		2	4	CA
14		3	3	CA
15		5	4	CO
16		5	4	CO

Question	Answer	Objective	Bloom's	CO or CA
17		5	3	CO
18		5	4	CO
19		5	4	CO
20		2	5	CO
21		3	4	CO
22		1	3	CA
23		5	2	CO
24		2	3	CA
25		3	3	CO
26		2	5	CA
27		2	2	CO
28		3	3	CO
29		2	5	CO
30		5	5	CO
31		1	5	CO
32		2	3	CO
33		1	3	CA
34		2	3	CA
35		2	4	CA

NOTE: Answers have been removed for security.

Appendix #3

Urban PTRA (2000-2003)	Rural PTRA (2003-2010)
Focus on physics teachers in large urban school districts	Focus on physics teachers in small rural school districts
High school physics teachers	Middle and High school physical science and physics teachers
Week-end workshops, usually one day in length (6-8 hours) with no requirement for number of workshops to attend	Week-long institutes in the summer (35-40 hours) and participants asked to commit to 3 summers of institutes
Segmented curriculum (One-day topics) with workshops focused on specific content or make-n-take	Coherent curriculum designed around specific topics and modeled on best practices while focusing on content, pedagogy, and technology
No content assessments to determine level of understanding, gains, or areas of need	Developed and administered content assessments for each topic (pre, post, and formative) aligned to workshop objectives
No survey given to determine needs of participants	Developed online surveys to determine needs and level of confidence for participants
Contact for workshops was district administration, but workshops led by PTRAs choosing the material	University faculty hosted workshops on-site led by PTRAs and university faculty following proscribed curriculum
Leadership institutes for PTRAs focused on demos, short activities, content -professional development activities for classroom use were often demos or single activities	Leadership institutes for PTRAs focused on content, role as professional development providers where the professional development started to focus on lesson cycles, inquiry, and Practicums
Focus on supporting the high school classroom teacher	Focus on supporting the secondary classroom teacher

Appendix #4

AAPT/PTRA National Summer Institute
University of Michigan, Ann Arbor
July 18 – July 25, 2009

All workshops will be held in the Physics Department (Randall Lab).
Homeroom will be held in the West Hall, room 340.
Breakfast, lunch and dinner (except for Friday night picnic) will be served in the Hill Dining Center.

DATE	TIME	ROOM #	ACTIVITY
SATURDAY JULY 18	12:00pm - 6:00pm 5:30pm - 6:30pm	Mosher-Jordan Hill Dining Center	PTRAs arrive: Dorm Check-in & registration Dinner
SUNDAY JULY 19	11:00am - 1:00pm 2:00pm - 5:00pm 5:30pm - 6:30pm	Hill Dining Center Randall Lab Room 1261 Room 1224 Room 1209 Hill Dining Center	Brunch Workshops: Vernier Update PASCO Update PTRA Policies and Procedures Dinner
MONDAY JULY 20	7:30am - 8:15am 8:30am - 9:00am 9:15am- 11:15pm 11:30pm-12:30pm 12:45pm - 4:45pm 5:00pm - 6:30pm	Hill Dining Center West Hall - Room 340 Randall Lab Room 1261 Room 1224 Room 1209 West Hall - Room 335 Hill Dining Center Hill Dining Center	Breakfast Homeroom: General announcements--all PTRAs Workshops: Understanding by Design/OP Energy Teaching About Astronomy Make Take & Do Modeling Discourse Management Lunch AM workshops continued Dinner
TUESDAY JULY 21	7:30am - 8:15am 8:30am - 9:00am 9:15am - 11:15pm 11:30pm-12:30pm 12:45pm - 4:45pm 5:00pm - 6:30pm	Hill Dining Center West Hall - Room 340 Randall Lab Room 1261 Room 1224 Room 1209 West Hall - Room 335 Hill Dining Center Hill Dining Center	Breakfast Homeroom: General announcements--all PTRAs Workshops: Understanding by Design/OP Energy Teaching About Astronomy Make Take & Do Modeling Discourse Management Lunch AM workshops continued Dinner

DATE	TIME	ROOM #	ACTIVITY
WEDNESDAY JULY 22	7:30am - 8:15am 8:30am - 9:00am 9:15am- 11:15pm 11:30pm-12:30pm 12:45pm - 4:45pm 5:00pm - 6:30pm	Hill Dining Center West Hall - Room 340 Randall Lab Room 1209 Room 1224 Hill Dining Center Hill Dining Center	Breakfast Homeroom: General announcements--all PTRAs Workshops: Quantum Conundrum LivePhoto Lunch AM workshops continued Dinner
THURSDAY JULY 23	7:30am - 8:15am 8:30am - 9:00am 9:15am - 11:15pm 11:30pm - 12:30pm 12:45pm - 4:45pm 5:00pm - 6:30pm	Hill Dining Center West Hall - Room 340 Randall Lab Room 1209 Room 1261 Hill Dining Center Hill Dining Center	Breakfast Homeroom: General announcements--all PTRAs Workshops: Quantum Conundrum Teaching Physics for the First Time Lunch AM workshops continued Dinner
FRIDAY JULY 24	7:30am - 8:15am 8:30am - 9:00am 9:15am - 11:15pm 11:30pm - 12:30pm 12:45pm - 4:45pm 5:00pm 6:00pm - 8:00pm	Hill Dining Center West Hall - Room 340 West Hall Room 340 Hill Dining Center West Hall – Room 340 Mosher-Jordan Gallup Park	Breakfast Homeroom: General announcements--all PTRAS Workshops: Mystery of Dark Matter Lunch Michigan State Presentation and Participant Sharing Take Bus to go to picnic site Group Picnic Bus will return back to Mosher-Jordan
SATURDAY JULY 25	7:30am - 10:00am	Hill Dining Center	Breakfast Dorm check out **PLEASE RETURN DORM KEY**

Appendix #5

AAPT/PTRA National Summer Institute

Portland State University, Portland

July 10 – July 17, 2010

All workshops will be held in Science Building 2.
Homeroom will be held in the Ondine Residence Hall, Room 218
All meals will be in the Ondine Residence Hall (Victor's at Ondine)

DATE	TIME	ROOM #	ACTIVITY
SATURDAY JULY 10	12:00pm-6:00pm	Ondine Residence Hall	PTRAs arrive: Dorm Check-in & registration
	5:30pm-6:30pm	Victor's at Ondine	Dinner
SUNDAY JULY 11	7:00am-8:30am	Victor's at Ondine	Breakfast
	11:30am-1:00pm	Victor's at Ondine	Lunch
	1:30pm-4:30pm	Science Bldg. 2	Workshops:
		Room 113	Energy Choices
		Room 161	Radioactivity
	5:30pm-6:30pm	Victor's at Ondine	Dinner
MONDAY JULY 12	7:00am-7:30am	Victor's at Ondine	Breakfast
	7:45am-8:15am	Ondine Res. Hall – Rm. 218	Homeroom: General announcements--all PTRAs
	8:30am-11:30pm	Science Bldg. 2	AM Workshops:
		Room 113	Engineering Design
		Room 161	Magnetism I
	12:00pm-1:00pm	Victor's at Ondine	Lunch
	1:30pm-4:30pm	Science Bldg. 2	PM Workshops:
		Room 113	Engineering Design
		Room 161	Vernier
	5:30pm-6:30pm	Victor's at Ondine	Dinner
TUESDAY JULY 13	7:00am-7:30am	Victor's at Ondine	Breakfast
	7:45am-8:15am	Ondine Res. Hall – Rm. 218	Homeroom: General announcements--all PTRAs
	8:30am-11:30pm	Science Bldg. 2	AM Workshops:
		Room 113	Engineering Design
		Room 161	Magnetism I
	12:00pm-1:00pm	Victor's at Ondine	Lunch
	1:30pm-4:30pm	Science Bldg. 2	PM Workshops:
		Room 113	Engineering Design
		Room 161	Vernier
	5:30pm-6:30pm	Victor's at Ondine	Dinner

DATE	TIME	ROOM #	ACTIVITY
WEDNESDAY JULY 14	7:00am-7:30am 7:45am-8:15am 8:30am-11:30pm 12:00pm-1:00pm 1:30pm-4:30pm 5:30pm-6:30pm	Victor's at Ondine Ondine Res. Hall – Rm. 218 Science Bldg. 2 Room 113 Room 161 Victor's at Ondine Science Bldg. 2 Room 113 Room 161 Victor's at Ondine	Breakfast Homeroom: General announcements--all PTRAs AM Workshops: PI Explore & GPS Magnetism II Lunch PM Workshops: E-mentoring Amusement Park Physics Dinner
THURSDAY JULY 15	7:00am-7:30am 7:45am-8:15am 8:30am-11:30pm 12:00pm-1:00pm 1:30pm-4:30pm 5:30pm-6:30pm	Victor's at Ondine Ondine Res. Hall – Rm. 218 Science Bldg. 2 Room 113 Room 161 Victor's at Ondine Science Bldg. 2 Room 113 Room 161 Victor's at Ondine	Breakfast Homeroom: General announcements--all PTRAs AM Workshops: PI Explore & GPS Magnetism II Lunch PM Workshops: E-mentoring Amusement Park Physics Dinner
FRIDAY JULY 16	7:00am-7:30am 7:45am-8:15am 8:30am-11:30pm 12:00pm-1:00pm 1:30pm-4:30pm 5:30pm	Victor's at Ondine Ondine Res. Hall – Rm. 218 Science Bldg. 2 Room 113 Room 161 Victor's at Ondine Ondine Residence Hall Room 218 Vernier Software & Technology	Breakfast Homeroom: General announcements--all PTRAS AM Workshops: Energy Choices Radioactivity Lunch Portland State Presentation and Participant Sharing David Vernier "Physics and Engineering Education - Past, Present, and Future" Take MAX train to Vernier Group Picnic Take MAX train back to campus
SATURDAY JULY 17	7:00am-8:30am	Victor's at Ondine	Breakfast Dorm check out **PLEASE RETURN DORM KEY**

Appendix #6

PUBLISHED AAPT/PTRA TEACHER RESOURCES

Title of AAPT/PTRA Resource	Principal Author	Price
Role of Graphing Calculator TI-83	Cherie Bibo Lehman	$35
Role of the Laboratory	Jane & Jim Nelson	$35
Teaching About Color & Color Vision	Bill Franklin	$35
Teaching About Cosmology	Lawrence Krauss	$35
Teaching About D.C. Electric Circuits	Earl Feltyberger	$35
Teaching About Electrostatics	Bob Morse	$35
Teaching About Energy	John Roeder	$35
Teaching About Kinematics	Jane & Jim Nelson	$35
Teaching About Lightwave Comm.	Mark Davids	$35
Teaching About Magnetism	Bob Reiland	$35
Teaching About Impulse & Momentum	Bill Franklin	$35
Role of Toys in Teaching Physics	Jodi & Roy McCullough	$35
Exploring Physics in the Classroom	George Amann	$35
Teaching Physics for the First Time	Jan Mader & Mary Winn	$35

Other Pre Publication AAPT/PTRA Teacher Resources are available from Jim Nelson.
For more information call 352-395-6686 or email nelsonjh@ix.netcom.com

Appendix #7
Documentation of 10% required cost sharing.

SOURCE	AMOUNT
AAPT Staff Time (Hein, Khoury, etc.)	$244,264
Addison Wesley Contributed Books	$10,000
American Physical Society (Fee for Service)	$4,233
American Physical Society (Participant Travel Support)	$49,423
American Physical Society (PTRA Campaign for Physics including funds for Rural Prototype Institutes)	$386,825
Fee for Service Workshops Lead by PTRAs	$76,503
In Kind Contributions Reported by PTRAs	$329,546
Maryland Higher Ed Improving Teacher Quality Grant	$54,000
MSP Grant Arkansas	$1,766
MSP Grant Georgia	$27,400
MSP Grant Idaho	$26,500
MSP Grant North Carolina	$271,643
MSP & TRC Grants Texas	$73,502
MSP Grant Washington DC	$49,428
National Science Teachers Association	$5,374
PASCO Scientific	$29,500
Perimeter Institute	$53,000
Texas Instruments	$10,000
Toyota Grant JMU, Virginia	$12,020
Vernier Software & Technology	$25,850
Total	$1,740,777

---------------------- END RURAL AAPT/PTRA ACTIVITIES ----------------------