Revitalizing Introductory Physics at Community Colleges and More....

Curtis Hieggelke (hay-gull-key)

Emeritus Physics Professor (retired from teaching but not from working)

Joliet Junior College, was established in 1901 and is considered to be the **first community college** in the nation. Physics was a required course at the start of the college and was linked the Universities of Chicago and Illinois (UC).

The term "two-year college" or TYC will be used to include all two-year institutions commonly known as community, technical, branch, and junior colleges.

First, thanks to

- the **American Physical Society** for the recognition of our accomplishments with this **very historic** *Excellence in Physics Education Award*
- the **APS Forum on Education** for their respect for and awareness of our work
- NSF's **Division of Undergraduate Education**, the **workshop leaders, participants, local hosts and workers** for their efforts and support
- **our institutions and colleagues**, and all the **physics teachers from our past who helped shaped us (**Concordia College-Moorhead, MN & U of Neb-Lincoln**)** and finally,
- our supportive **spouses (**Estelle**)** and **children (**Brian, Brent, Jason, and Justin**)**

Our group is

an **informal coalition** of

- Joliet Junior College (Joliet, Illinois) noted as JJC
- Lee College (Baytown, Texas) noted as LC and
- Indiana University-Purdue University Fort Wayne (Fort Wayne, Indiana) noted as IPFW

a **real collaboration and partnership** between TYC and university faculty

Recent expansions and **current grant work now include**

- **Steve Kanim** at New Mexico State University (Las Cruces, New Mexico) and
- **Dwain Desbien** at Estrella Mountain Community College (Avondale, Arizona)

Special Thanks to our Current and Past Project Workshop Staff

at Joliet Junior College




Geoff White Jan Coleman Natalie Ward Christi Wren

at Lee College

Regina Barrera Kathy O'Kuma


Some aspects of our efforts

- **1st,** developed and implemented **new MBL lab materials in rotation, work-energy, sound, and magnetism** along with setting up **model TYC physics programs** at Joliet Junior College and Lee College
- Supported by grants from the National Science Foundation's Division of Undergraduate Education, including
  - Instrumentation and Laboratory Improvement (ILI) Lab Leadership program (1 grant to LC)
  - Instrumentation and Laboratory Improvement program (1 grant to LC and 2 grants to JJC) plus
  - Acquisition of additional computer equipment supported by one grant from Apple Computer, Inc. (to JJC)

2nd aspect, the CSEM (Conceptual Survey on Electricity and Magnetism)

- Developed **with Alan Van Heuvelen** the *Conceptual Survey on Electricity and Magnetism* (CSEM), *Conceptual Survey on Electricity* (CSE), and *Conceptual Survey on Magnetism* (CSM).
- Work **first described in our invited 1996 talk** "The Impact of Physics Education Research on the Teaching of Scientists and Engineers at Two Year Colleges" at international The Changing Role of Physics Departments in Modern Universities Conference
- **Published the CSEM with detailed student data** in "Surveying students' conceptual knowledge of electricity and magnetism," AJP, **69**, S12-S23 (2001)
- **Contact David Maloney for copies suitable** for student use (maloney@ipfw.edu)

3rd aspect, the TIPERs (*T*asks *I*nspired by *P*hysics *E*ducation *R*esearch)

- Developed, promoted, and published educational materials employing **T**asks **I**nspired by **P**hysics **E**ducation **R**esearch (TIPERs) which uses **alternative types of formats**.
- These include **Ranking Tasks**; **Working Backwards Tasks;** What, if anything, is Wrong Tasks; Conflicting Contentions Tasks; Changing Representations Tasks,…

- **Work in magnetism and electrostatics** was published in *E&M TIPERs: Electricity & Magnetism Tasks* (Prentice Hall now Addison-Wesley, 2006)
- Current work in **mechanics is called nTIPERs** (Newtonian TIPERs) with perhaps **future work** may be in thermal, circuits, or optics
- Supported by 3 grants to JJC from the NSF's Division of Undergraduate Education **CCLI** (Course, Curriculum, and Laboratory Improvement) program and the Physics Workshops Project grants as well as JJC, LC, IPFW, NMSU and **Prentice Hall.**

4th, the Physics Workshop Project (PWP)

- Organized and held **multi-day physics workshops** at various community colleges for TYC and high school (HS) teaching participants
- Workshops were supported by JJC, LC, and host sites and seven grants to JJC from the National Science Foundation's Division of Undergraduate Education, including
  - Course and Curriculum Development (CCD) Program (1 grant)
  - Undergraduate Faculty Enhancement (UFE) Program (4 grants)
  - Advanced Technological Education (ATE) Program (2 grants)

Why did we target TYCs?

- There has been an **increasing recognition of the national importance and role** of TYCs starting in 1990s
- We feel strongly that the **task of updating science education programs at TYCs is important for the nation and for science because of the large number of students (particularly women and minorities) who attend TYCs and need to be exposed to, and gain experience with, current technology, and need effective encounters with physics education.**
- "Over five-million credit students, including 55% of first-time college students, 42% of black students, 54% of Hispanic students, 43% Asian students and over 50% of all women collegiate students are attending two-year colleges."
  Report on the National Science Foundation Workshop on Science, Engineering, and Mathematics Education in Two-Year Colleges, June 1989, National Science Foundation

1989 Topical Conference on Critical Issues in Two-Year College Physics and Astronomy

- This conference was held November 3-5, 1989, in Washington, DC and sponsored by the American Physical Society (**APS**), the American Association of Physics Teachers (**AAPT**) and supported by the National Science Foundation (**NSF**)
- Centered on the **problems and issues that TYC physics educators face**
- Featured was the need for the **implementation of new**
  - **technologies** and
  - **teaching practices** in physics
- One of the **recommendations** was made for setting up and using **regional workshops designed for TYC physics faculty**

Survey of TYCs physics faculty (J Tavel)

- Formidable **teaching loads** (15-20+ contact hours for 2-4 courses plus lab setup)
- Amount of **time** it takes **to revise** courses
- **Attitudes** of physics faculty surveyed at TYCs showed they often felt
  - challenged (94%),

- unappreciated (93%),
- exhausted (92%),
- exhilarated (73%), and
- overwhelmed (68%).

- Many faculty are **willing to implement new approaches** if
  - they are **aware** of them and
  - there is **evidence** for improving student learning
  - **without a significant increase** in demand on instructor's time.

Some more important events

- Attended **David Maloney's workshop** on "Developing Research-based **Conceptual Exercises**," held on January 21, 1990 at the 1990 Joint Winter Meeting of the APS and AAPT, Atlanta, Georgia.
- Agreed to accept a request to **write a NSF grant proposal for regional workshops** TYC physics teachers at a **follow-up meeting** at the January 1990 Atlanta AAPT meeting.
- Attended an **MBL workshop lead by Ronald Thornton, David Sokoloff, and Priscilla Laws** on June 29, 1990 at the AAPT Summer Meeting at the Univ. of Minnesota.

Physics courses offered at TYCs

- TYCs teach the **traditional transfer introductory physics** courses:
  - calculus-based physics,
  - algebra-trig based physics, and
  - general education or science literacy conceptual physics for non-science majors
- Most also offer **technical physics**

Physics at TYCs around 1990

- **Small physics departments** (1 to 3 full-time teachers about 87% from the AIP survey) **and classes** (10-30 students)
- **Courses and programs modeled after state universities** in order to serve transfer students.
- Some **issues** dealing with **part-time** or adjunct **physics teaching faculty**
- **Lectures** (3-4 hours per week) **packed with information**
  - Theory, derivations and example problems-the **general to specific** approach
  - **Passive**, not much interaction
- Demonstrations and homework featured **solving problems**
- **Exams** designed and graded by instructor mainly **based on problems**
- **Labs** (2-3 hours per week)
  - students worked in small groups of 2-3
  - many **cookbook style labs but not all**
  - equipment and labs designed back in 1940-50s with some in 1970s-80s
  - typically designed to **verify some known aspect** or law
- **Computer** (perhaps one that was shared for demonstrations)

Typical Physics Lab Equipment (1990)

Behr Free Fall apparatus (floor)
Ballistic Pendulum apparatus (bench)
Calorimeters (cabinet) & Steam generators (cabinet)
HP Dual Trace Oscilloscope
HP Function Generator

Cost per lab group setup-about $500

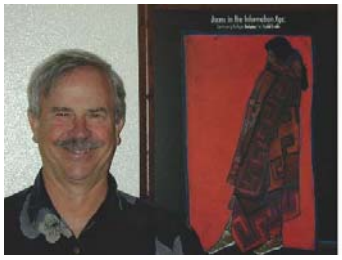
Important physics education developments around 1990 were

- low-cost **microcomputers** were becoming available,
- curriculum materials and strategies using the results of Physics Education Research (**PER**) were emerging, and
- powerful, easy-to-use computer **software** and physics lab **hardware** were being developed for educational use

The topics and leaders for the proposed regional workshop grant for TYC faculty were

Microcomputer Based Lab technology (MBL) to be led by

Priscilla Laws (Dickinson College) & **Ron Thornton** (Tufts University)



and the **Conceptual Exercises/Overview Case** (CE/OCS) strategy to be led by

David Maloney and **Alan Van Heuvelen** (New Mexico State University) &

CE/OCS or Conceptual Exercises/Overview Case Study

- **Conceptual Exercises** are designed to **address the natural ideas**, identified by **PER**, that **students bring** to the study of physics
  - get students to think about the ideas in **multiple ways** and promote **active engagement**.
  - was the origin of the TIPERs (Tasks Inspired by Physics Education Research).
- The **Overview Case Study** (OCS) strategy developed by Alan Van Heuvelen is based in **PER** and designed to facilitate **active engagement**.
  - uses a **spiral approach**,
  - works to build a **hierarchical knowledge base** and
  - produces more **expert-like problem solving** skills.
  - integral to this approach is a variety of conceptual tasks (**ALPS**) such as
    - Motion diagrams
    - Free-body diagrams
    - Energy bar charts
    - Multiple-representations

1991 MBL Hardware - Vernier Software & Technology

- Ultrasonic Motion Detector
- Hall-effect Force Probe
- Universal Lab Interface (ULI)

Major MBL Mechanics Sensors (1991 vintage)

- **Motion Detector**
  - **Ultrasonic pulses** are emitted by the detector, reflected from a target, and then detected by the device.
  - The **time** it takes for the reflected pulses to return is used to calculate position, velocity, and acceleration.
  - The closest target possible was around 30 cm.
- **Force Probe**
  - The probe uses a **Hall-effect** transducer that produces a voltage that is approximately linear with the magnetic field.
  - A small magnet is mounted on a deformable plate.
  - The force applied to the hook on the plate moves the magnet away or toward the transducer causing a change in the voltage.
  - The probe had a **problem of drifting** over time requiring repeated recalibration.

Workshop computer software (around 1991)

- Software developed first for Apple Macintosh computers and then moved over to MS DOS computers
- ***Data Logger*** was the fundamental data-collection software for the ULI
  - analog and digital data from **multiple sensors** at the "same time"
  - **collect data and display** as a "real-time" graphs
  - produce **statistics and curve fits** (linear, power, log, exponential, polynomial), calculated data-dependent variables, and included numerical integration
  - **software set up** of data collection parameters such as data rate, length of experiment, or time units plus calibration of sensors & probes

Breakthrough MBL Software & Hardware

It allowed students to easily

- measure "simultaneously" and **graph immediately** several physical quantities such as
  - **position**, velocity, acceleration, **force**, and **time**,
  - also temperature, light intensity, sound, radiation counts, magnetic field, angular rotation, electric current and potential difference
- deal with **thousands of data points** rather than 10-50 points
- repeat or test **different variations and compare** with previous trial
- provide immediate feedback that could be quickly understood
- **real learning in the lab** since it was easy to discuss and answer questions because of the easy data collection and display
- acquire a competence in the **use and interpretation of graphs** as well as a better understanding of the physical relationships, principles, and concepts which underlie their experiences

Specialized MBL Software (1991-94)

Based on ***Data Logger*** that was designed and developed by Ron Thornton and Steve Beardslee at Tufts with input from David Vernier, Priscilla Laws and David Sokoloff

- ***MacMotion/Motion*** for use with a Motion Detector and/or force sensors
  - used to plot distance, velocity, acceleration, and force graphs in real-time.
- ***MacSound/Sound*** for use with a Microphone
- ***MacTemp/Temperature*** for use with temperature probes
  - support for heat pulse input control
- ***Event Counter*** for use with radiation counters
- ***Electricity*** for use with a Current & Voltage Probes
- ***Rotary Motion*** for use with a Rotary Motion sensor
  - view graphs and monitor analog input with angular displacement
    - display light intensity for the transmission of light through polarizing material as a function of angle

Critical MBL Curriculum based on PER in 1990s

Featured

- **series of guided investigations** using graphs in a predict-and-test cycle
- **assessment** tools
- extensively **student-tested** and revised lab materials
- shown to **improve** students' conceptual understanding

Published curriculum materials

- ***Tools for Scientific Thinking*** (TST) by David Sokoloff and Ronald Thornton (Vernier Software &

Technology)
  - *Motion and Force* laboratory guide (five units)
  - *Heat and Temperature* laboratory guide (four units)
- ***Workshop Physics*** by Priscilla Laws (Wiley Publishing)
  - included non-MBL activities in an activity-based MBL approach
  - two-semester, calculus-based, introductory physics course

1991-2005 Physics Workshop Project (PWP)

- A **project**, **collaboration**, and **informal coalition** of
  - Joliet Junior College (IL) and Lee College (TX) with
  - Support from the National Science Foundation and many others
- Co-Project Directors
  - Curtis Hieggelke (at Joliet Junior College, IL) and Tom O'Kuma (at Lee College, TX)
- The project goal was to
  - **help TYC (and HS) students develop a stronger understanding of physics by updating and equipping their physics teachers with the tools** needed for them to incorporate new and better ideas
- Web site established in 1996 at
  - **http://tycphysics.org/___**

Challenges in improving TYC physics education in the 1990s-

- **many rapidly occurring changes in technology** and
- **the emergence and recognition of the importance of the results of PER** in teaching and student learning,
- the **traditional educational experiences** of most teachers,
- the **isolation of many physics teachers**, and
- the **heavy and complex workload** of physics teachers

Our solution-

- a series of **short, intensive, three-day faculty development workshops** for TYC physics faculty [and HS faculty (added in 2002 in the 7th grant)]
- workshop **topics** that were
  - **effective, suitable,** and **being used** at TYCs and HSs and
  - focused on the developments and results of **PER** and **computer technology**
- **experiences** and **materials** that would make it **easier for participants to implement** the workshop ideas in their classrooms
- an opportunity to **interact directly with** the **leaders and developers in physics education**
- **post-workshop support and incentives** using a **newsletter** called *CaFD*, email, a **web site** (added in 1996), and post-workshop major and mini-**projects** for participants

PWP Workshop participants received

- a **knowledge** of, and **hands-on experiences** with, recent major advances in the applications of
  - **microcomputers**,
  - **research in teaching and learning**, and
  - **curriculum developments based on PER** and
- a **means** to
  - identify the **appropriateness** and

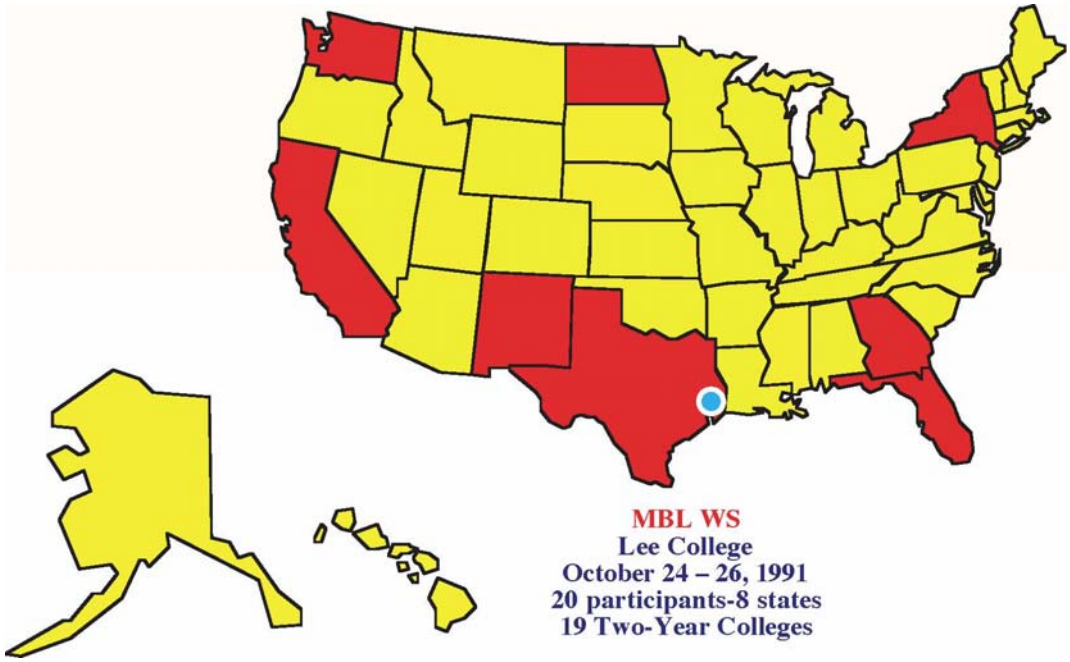
- the **role of** these workshop **ideas in meeting the needs of students** and
- to see **models** of how it has been done at other places and TYCs; and

- an **opportunity** to
  - **adapt,**
  - **incorporate** and
  - **develop new teaching models and materials** into physics courses at TYCs and HSs

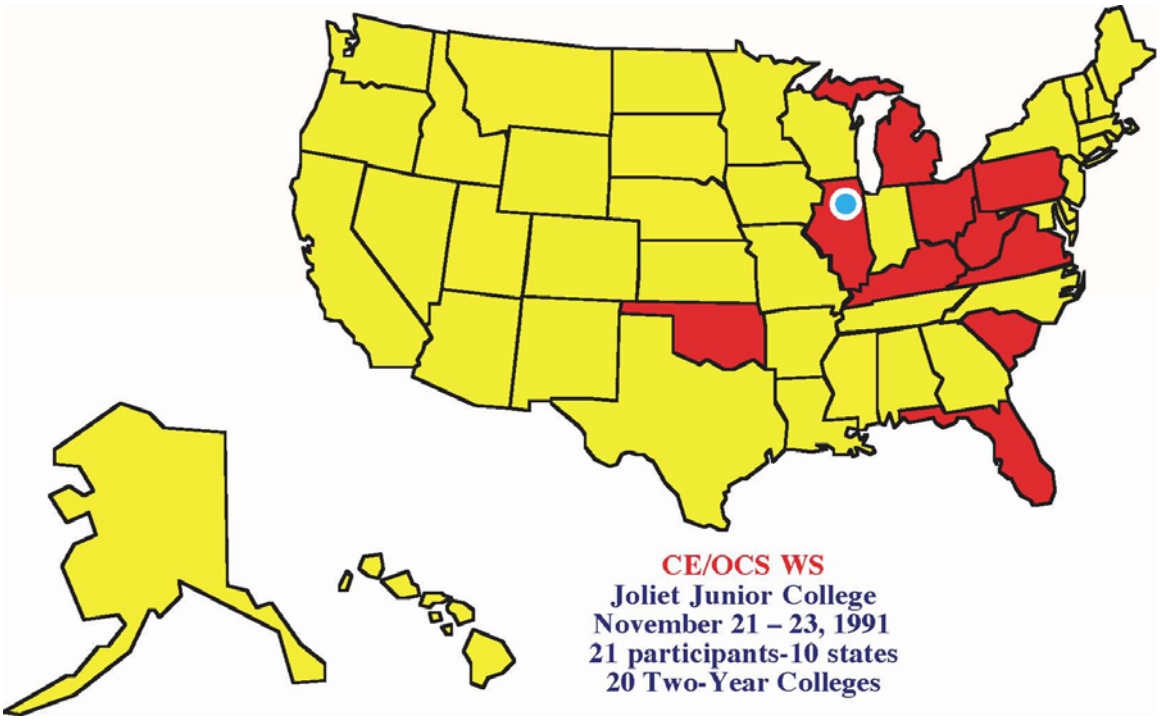
Pilot CC Curriculum Development Workshop Project (July 1991 - December 1993): Startup Phase with Grant #1

- NSF Course and Curriculum Development Program
- 4 "**Regional**" Workshops at **our TYCs**
  - Microcomputer-Based Laboratory Workshops - twice
  - Conceptual Exercise/Overview Case Study Workshops - twice
- Workshop Sites
  - Lee College (TX) - twice
  - Joliet Junior College (IL) - twice
- Workshop Leaders
  - Priscilla Laws & Ron Thornton
  - Alan Van Heuvelen & David Maloney
- 83 TYC Participants from 24 States
  - 20 Females - **24.1%**
  - 63 Males - 75.9%

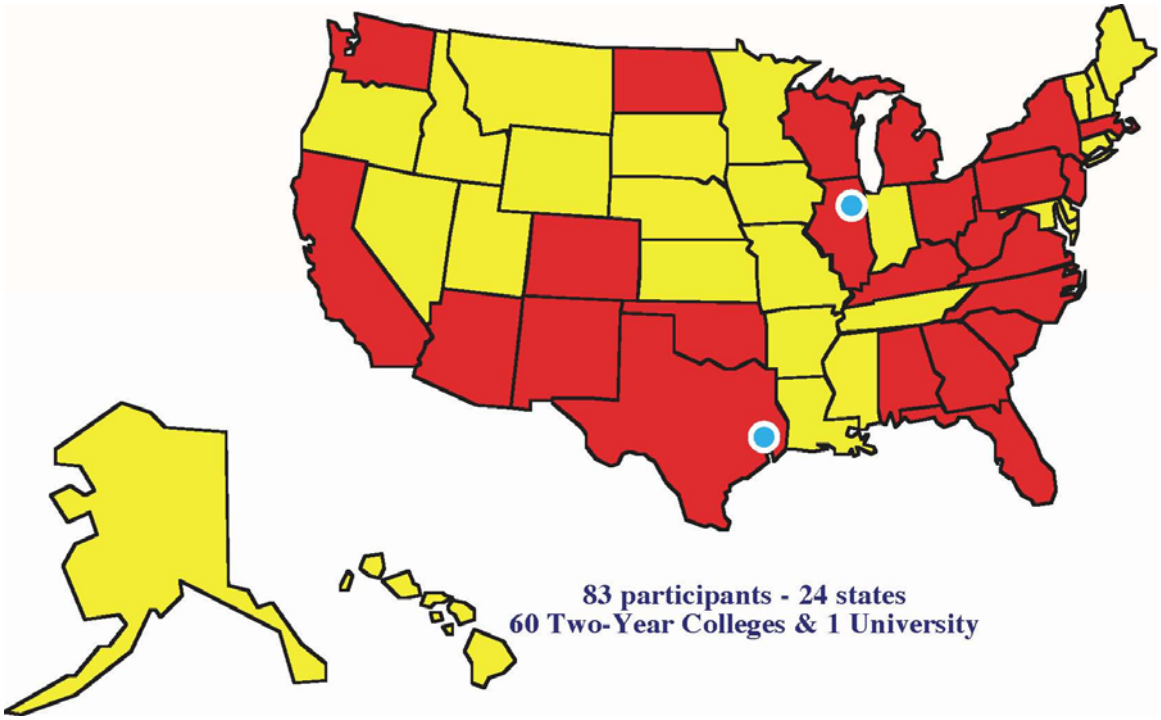
MBL Workshop Participant States at the 1st Workshop October 24 - 26, 1991 at Lee College (Texas)



CE/OCS Workshop Participant States at the 2nd Workshop November 21 - 23, 1991 at Joliet Junior College (Illinois)



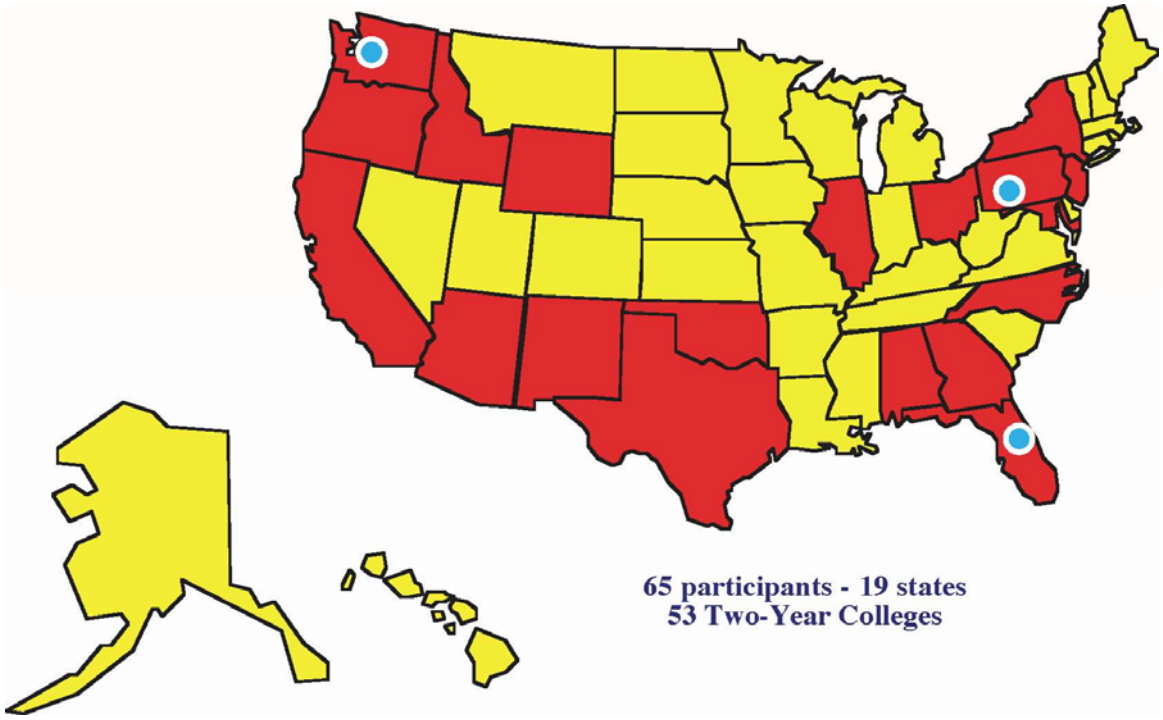
Pilot CC Curriculum Development Workshop Project (1991 - 1993): Participant States Map for 1st four workshop held at JJC and LC



Community College Physics Pilot Workshop Project (November 1991 - November 1993): Expansion Phase 2

- NSF Undergraduate Faculty Enhancement Program
- 3 Workshops held at three **other TYCs**
  - 2 Microcomputer-Based Laboratory Workshops
  - 1 Conceptual Exercise/Overview Case Study Workshops
- Workshop Sites
  - Green River Community College (WA)
  - Westmoreland County Community College (PA)
  - Seminole Community College (FL)
- Workshop Leaders
  - Priscilla Laws & Ron Thornton
  - Alan Van Heuvelen & David Maloney
- 65 TYC Participants from 19 States
  - 5 Females - **7.7%**
  - 60 Males - 92.3%

Community College Physics Pilot Workshop Project (Nov. 1991 - 1993): Phase 2 Participant States Map for 3 workshops

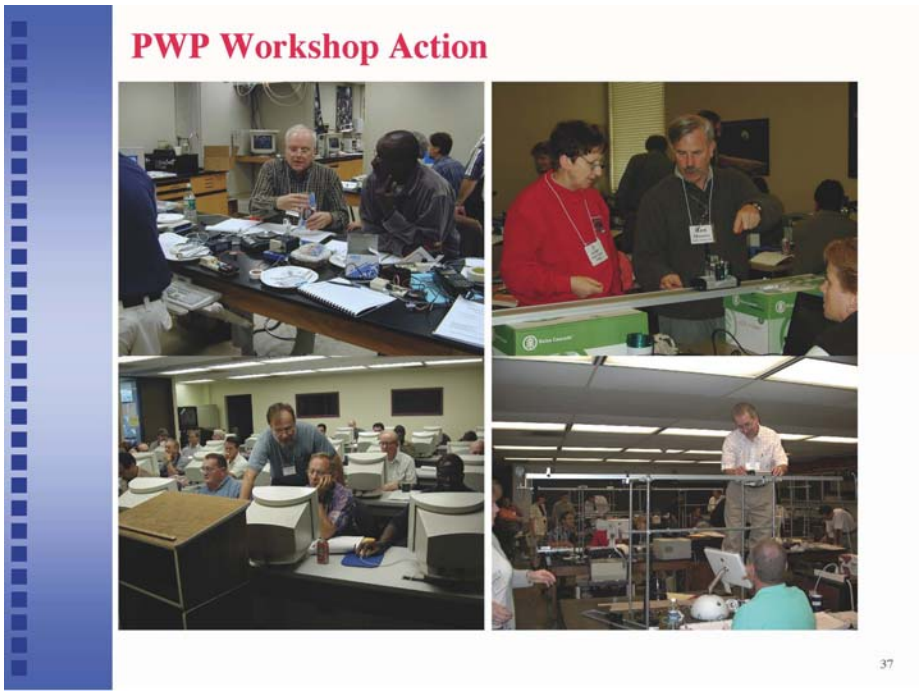


Community College Physics Workshop Project (1993 - 1995): Expansion Phase 3

- NSF Undergraduate Faculty Enhancement Program
- 5 Workshops including **Follow-ups**
  - 2 Microcomputer-Based Laboratory Workshops
  - 1 MBL Follow-up Workshop
  - 1 Conceptual Exercise/Overview Case Study Workshops
  - 1 CE/OCS Follow-up Workshop
- 5 Workshop Sites
  - Lenoir Community College (NC)
  - Lee College (TX)
  - San Jose City College (CA)
  - Joliet Junior College (IL)
  - Green River Community College (WA)
- 13 Workshop Leaders
- 106 TYC participants from 24 States and 1 US Territory
  - 26 Females - **24.5%**
  - 80 Males - 75.5%

Community College Physics Faculty Development Project January 1994 - June 1996: Final Expansion Phase 4

- NSF Undergraduate Faculty Enhancement Program
- 10 Workshops with 13 Workshop Leaders
  - 3 MBL & 2 MBL Follow-up Workshops
  - 2 CE/OCS & 1 CE/OCS Follow-up Workshops
  - 1 Working **Conference** on Introductory Physics: **CSEM**
  - 1 **Physics Simulations Workshop**
- 7 Workshop Sites
  - Seminole Community College (FL) - twice
  - Joliet Junior College (IL) - twice
  - Pikes Peak Community College (CO)
  - Chaffey Community College (CA)
  - Lee College (TX) - twice
  - Los Angeles Valley College (CA)
  - Westmoreland County Community College (PA)
- 202 Participants from 32 States and 1 US Territory
  - 27 Females - **13.4%**
  - 175 Males - 86.6%



Two-Year College Physics Workshop Project
February 1996 - July 1999: Full Operational Phase 5

- NSF Undergraduate Faculty Enhancement Program
- 16 Workshops involving 23 Workshop Leaders held at 10 TYC sites in GA, NC, WA, NY (3), IL (4), TX (3), MO, CA, and AZ
  - 3 Microcomputer-Based Laboratory I Workshops
  - 3 MBL II Workshops
  - 2 Conceptual Exercise/Overview Case Study Workshops
  - 1 Conceptual Exercise/Active Learning Problem Sheets Workshop
  - 3 Physics Simulations Workshops
  - 4 Introductory Physics Conferences
- 351 participants from 171 different TYCs, 2 Universities and 6 HSs located in 37 States and 2 US Territories
  - 66 Females - **18.8%**
  - 285 Males - 81.2%

Introductory Physics Conferences (4-5 days)

- 1st Introductory Physics Conference (**Thermodynamics**) on June 11-15,1996 at Joliet Junior College in Joliet, Illinois (27 participants);
- 2nd Introductory Physics Conference (**Electricity** & **Magnetism**) on June 17-21, 1997 at Lee College in Baytown, Texas (26 participants);
- 3rd Introductory Physics Conference (**Waves**) on June 16-20, 1998 at Joliet Junior College in Joliet, Illinois (27 participants);
- 4th Introductory Physics Conference (**Internet** & **Web Connected Physics**) on June 21-24, 1999 at Joliet Junior College in Joliet, Illinois (25 participants).

Alan Van Heuvelen and Lillian McDermott at JJC at the IPC 3 on Waves in June 1998

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TYC Physics Workshop Project for the 21st Century
May 1999 - April 2002: ATE Expansion Phase 6

- NSF **Advanced Technological Education** Program
- 7 Workshops featuring 23 Workshop Leaders held at 4 sites in IL (3), TX (2), FL, and OH
  - Microcomputer-Based Laboratory Workshop
  - Activity-Based Physics & Digital Video Analysis Workshop
  - Introductory College Physics in the 21st Century Workshop
  - Internet and Web-Connected Physics Workshop
  - Physics in Context Workshop
  - Physics Simulation and Physics Education Research Workshop
  - HTML and Physlets Workshop
- 149 Participants from 24 states
  - 22 Females - 14.8%

A few pictures of the ATE aspect of the workshops

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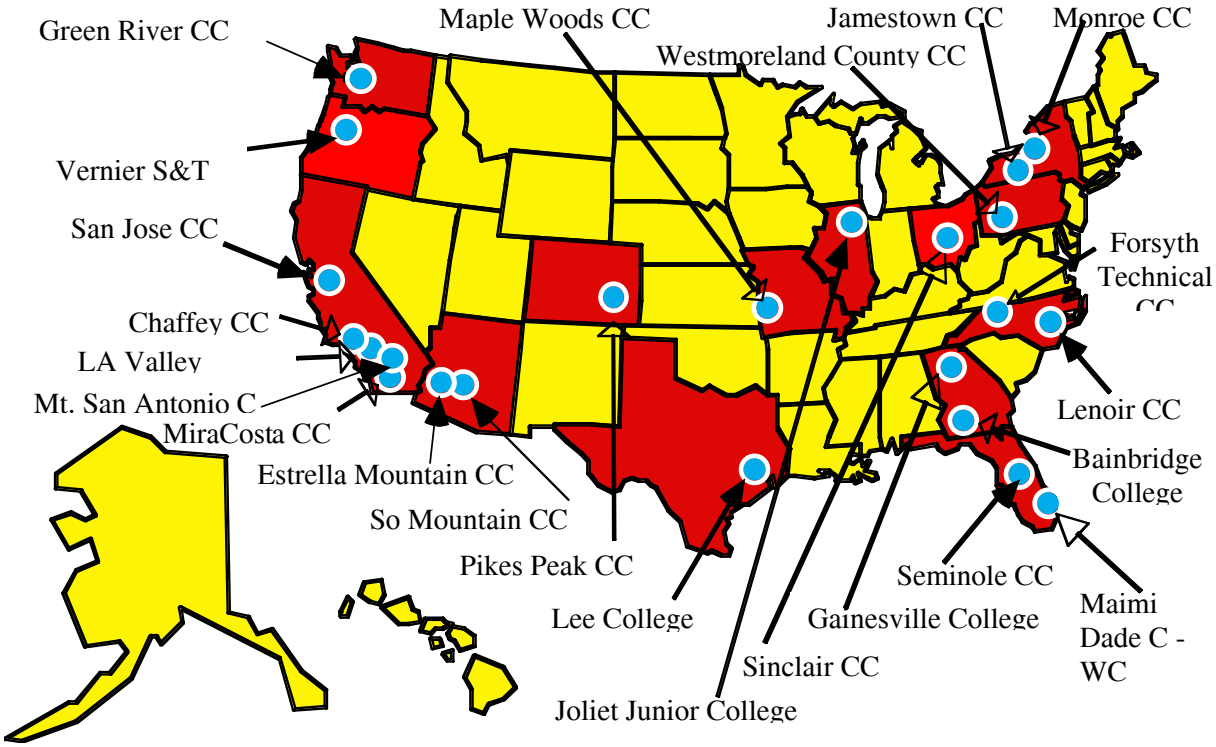
Physics Workshops for the 21st Century
May 2001 - April 2006: Full Operational ATE Phase 7

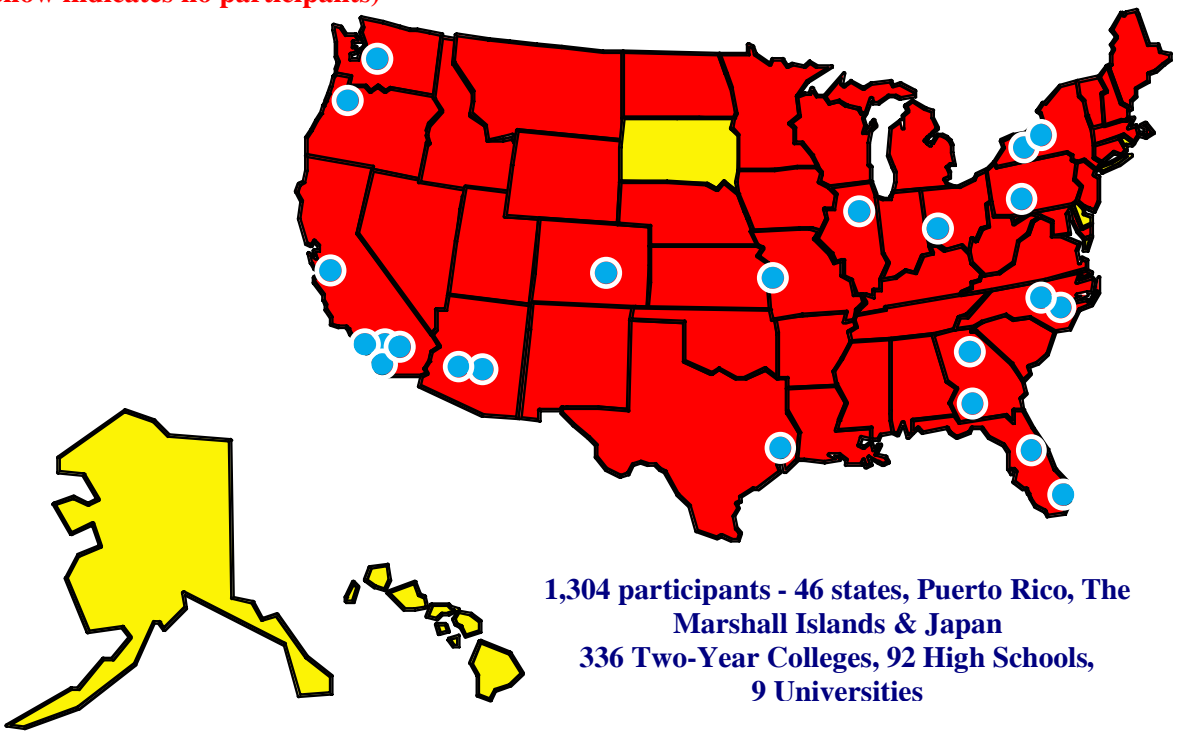
- NSF Advanced Technological Education Program (**support including travel for HS** faculty)
- 16 Workshops with 29 Workshop Leaders held in AZ, GA, IL (3), TX (3), FL (3), CA (3), NY, OR
  - 2 Microcomputer-Based Laboratory Workshops
  - 3 Physlet and TIPERs Workshops
  - 2 Introductory College Physics in the 21st Century Workshop
  - 2 Modeling and PER/Research Based Problem Solving Workshops
  - 3 LabVIEW & LabPro Workshops
  - 1 TIPERs & JiTT Workshop
  - 1 Digital Video Analysis Workshop
  - 1 Project Based Physics Workshop
  - 1 ISLE & TIPERs Workshop
- 348 Participants (168 TYC, 175 HS, 5 University) from 38 states
  - **93 Females - 26.7%**
  - 255 Males - 73.3%

Now looking at the entire series of 61 workshops

Map of the 23 PWP Workshop Sites (1991-2005)



Map of the 46 PWP Participant States and 23 Workshop Sites (1991-2005) for the 61 workshops (yellow indicates no participants)



1,304 participants - 46 states, Puerto Rico, The Marshall Islands & Japan
336 Two-Year Colleges, 92 High Schools, 9 Universities

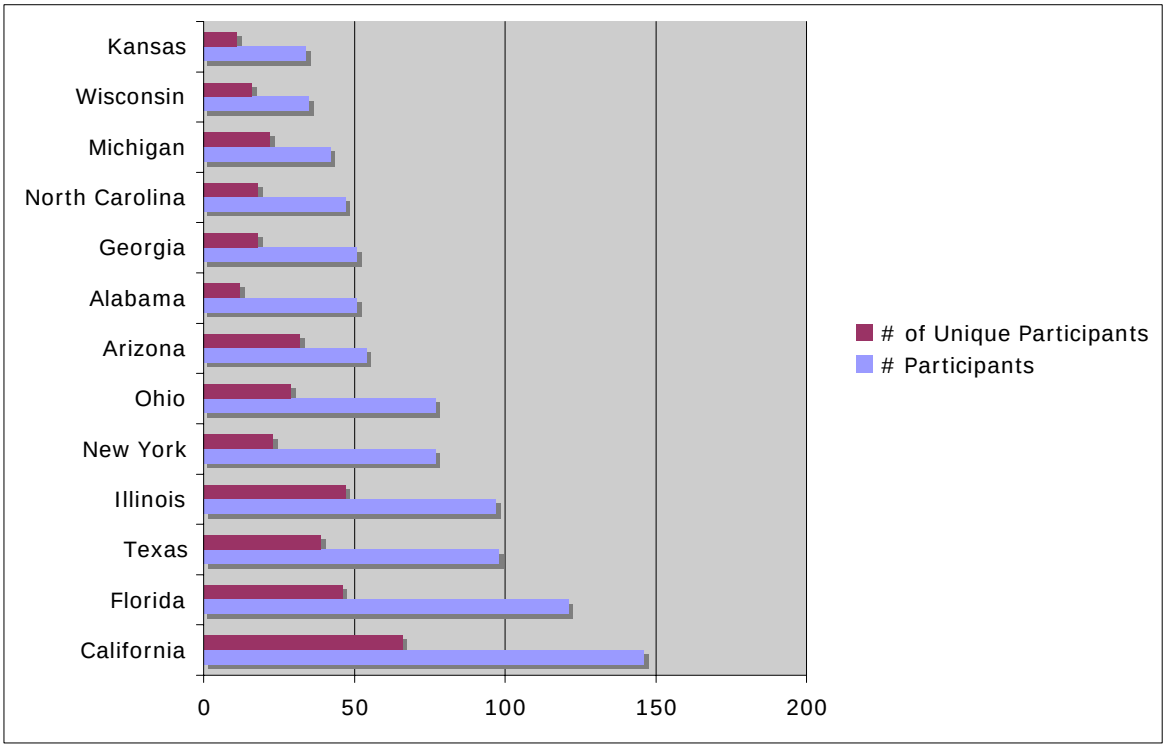
PWP Workshop Data for 1991-2005

- **61 workshops** with **52 workshop leaders** held at **23 sites (22 TYCs)** in **14 states**
- **1,304 participants** came from **46 states** plus Puerto Rico, Marshall Islands & Japan (missing are South Dakota, Rhode Island, Hawaii, and Alaska)
- **Gender** information
  - 259 Females - 19.9%
  - 1,045 Males - 80.1%
- **461 different TYC** faculty members attended from **336 different TYCs** represented **1,113 workshop participants**
- **103 HS faculty** attended from **92 HSs** represented **181 workshop participants**
- 10 people attended from **9 Universities** represented 11 workshop participants
- 279 participants **attended more** than one workshop

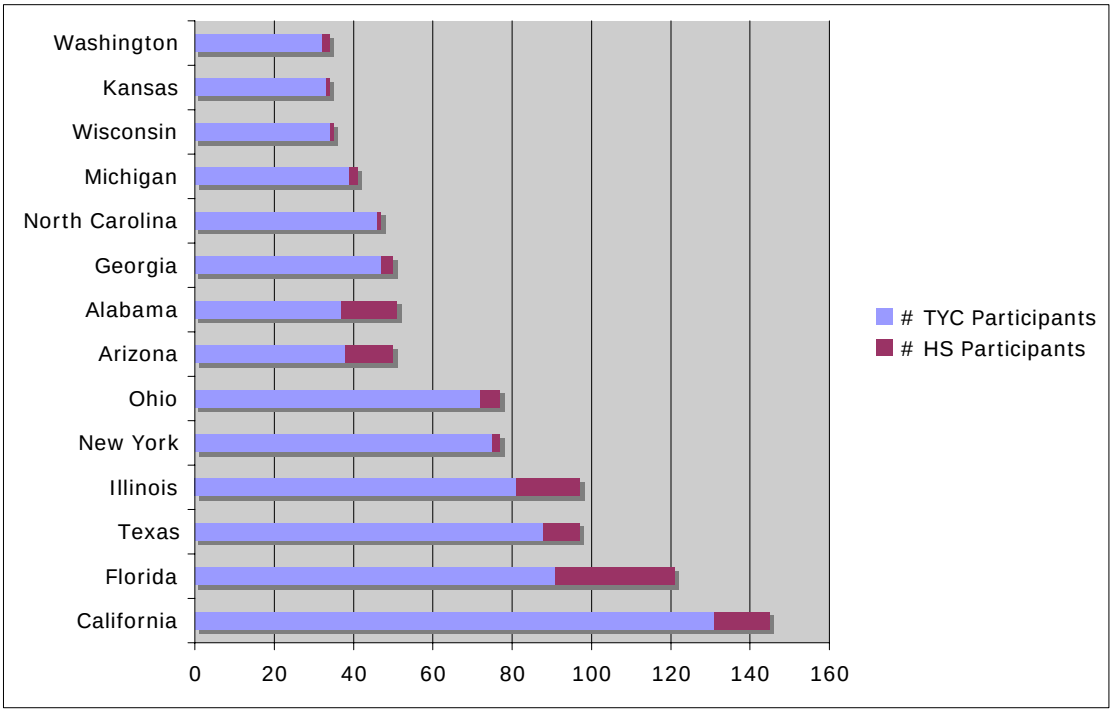
Workshop Group Pictures (last 4 workshops)




Participants Distribution by Largest Participants States (1991-2005)



Participant Distribution Chart by State and Institution Type (1991-2005)

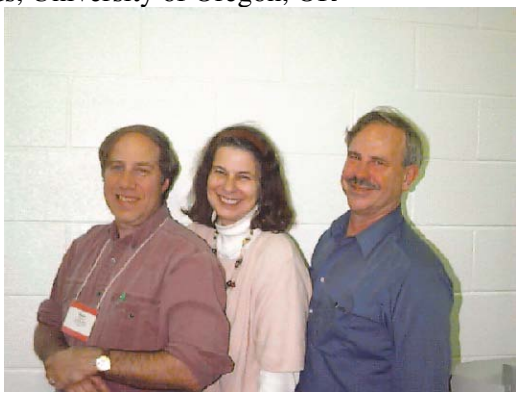


Topics for the 61 PWP workshops (1991-2005)

- **21 MBL Workshops (34%):** 15 MBL + 6 MBL Follow-up Workshops
- **11 CE/OCS Workshops (18%):** 8 CE/OCS + 3 CE/OCS Follow-up Workshops
- 5 Introductory Physics Conferences
- 4 HTML, Physlets & TIPERs Workshops
- 1 Internet and Web-Connected Physics Workshop
- 1 JiTT and TIPER Workshop
- 4 Physics Simulations Workshop
- 1 Physics Simulation and Physics Education Research Workshop
- 3 LabVIEW & LabPro Workshops
- 3 Introductory College Physics in the 21st Century Workshops
- 2 Modeling and PER/Research Based Problem Solving Workshops
- 1 Physics in Context Workshop
- 1 Project Based Physics Workshop
- 1 Activity-Based Physics and Digital Video Analysis Workshop
- 1 Digital Video and Digital Video Analysis Workshop
- 1 ISLE and TIPER Workshop

Microcomputer Based Labs (MBL) Developers and Workshop Leaders

- Ron Thornton, Tufts University, MA
- Priscilla Laws, Dickinson College, PA
- David Sokoloff, Emeritus, University of Oregon, OR



- David Vernier, Vernier Software & Technology, OR

Physics Education Research (PER) Developers and Workshop Leaders

- Steve Kanim, New Mexico State University, NM
- Alan Van Heuvelen, Emeritus, Rutgers, NJ
- Eugenia Etkina, Rutgers, NJ



- Lillian McDermott, University of Washington, WA
- Paula Heron, University of Washington, WA


Physlett and Just in Time Teaching (JiTT) Developers and Workshop Leaders

- Mario Belloni, Davidson College, NC
- Anne Cox, Eckerd College, FL
- Wolfgang Christian, Davidson College, NC



- Gregor Novak, Indiana University - Purdue University at Indianapolis, IN
- Evelyn Patterson, United States Air Force Academy, CO


TYC Participants, Implementators, Local Hosts, Developers, and Leaders I

- Alex Dickison and Sherry Savrda, Seminole Community College, FL
- Dwain Desbien, Estrella Mountain Community College, AZ



- Paul D'Alessandris, Monroe Community College, NY
- Fred Thomas, Sinclair Community College, OH
- David Weaver, Chandler-Gilbert Community College, AZ



TYC Participants, Implementators, Local Hosts, Developers, and Leaders II

- Guillermina Damas, Miami Dade College, FL
- William Hogan, Joliet Junior College, IL
- Marie Plumb, Jamestown Community College, NY



- Marv Nelson, Green River Community College, WA
- Martin Mason, Mt. San Antonio College, CA


Non-academic workshop supporters (selected)

- **Vernier Software & Technology** for MBL lab equipment, interfaces sensors, software, lab books, and post workshop refreshments
- **National Instruments** for LabVIEW software
- **PASCO scientific** for MBL lab equipment, interfaces sensors, & software
- Prentice Hall (*Ranking Task Exercises in Physics*, *emTIPERs*, *Physlets*, & *JiTT* books)
- John Wiley & Sons (*RealTime Physics* and *Workshop Physics* books)
- Addison Wesley (*ActivPhysics* and *ISLE* materials)
- Physics Academic Software, NC (workshop software)
- Working Knowledge Division of MSC Software Corporation (*Interactive Physics*)
- American Association of Physics Teachers (AAPT)
- American Institute of Physics (materials)

Aspects of PWP Workshops I

- **Workshop Schedule**
  - Workshops consisted of approximately **35 scheduled hours** of activities **over three days**, of which 25 hours were in **two or three-hour sessions**.
  - Workshop sessions met from **Thursday morning** (8:30 AM) through **Saturday afternoon** (4:00 PM) with sessions scheduled for **Thursday and Friday evenings** until 9:30 PM.
- **Workshop Meals and Lodging**
  - Non-local participants were provided a **room (shared** with one other participant) for Wednesday, Thursday, Friday, and Saturday evenings at a nearby **motel**.
  - **Meals and snacks were provided** from Thursday morning through Saturday evening.
- **Travel/Transportation Costs**
  - Travel **costs to the workshop** site were provided **by participants' colleges**.
  - Grant paid **limited amount** ($200-300) **for travel by HS** participants.
  - The **host college provided local transportation** to and from the nearest airport in addition to between the motel and the workshop site on campus.
- **Stipends**
  - There were **no stipends for just attending** the workshops.
  - **$150 stipend** for almost any **post-workshop** related activity.
  - A limited number of $5000 **Major Project stipends** available but participants needed pre-approval.

Aspects of PWP Workshops II

- **Workshop Materials**
  - Participants received all **instructional materials** for each workshop including some **pre-workshop materials** prior to the workshops.
  - Participants received coffee cups, cloth TYC PWP logo carrying bag, **CDs** (and **DVDs)** with workshop information
  - **Newsletters** were provided to aid in the update and exchange of ideas and materials related to the workshops.
- **Sessions dealing with**
  - **Implementation** Issues,
  - **Assessment,** and

- **Sharing and networking** during lunch and supper

- **Optional items**
  - Each evening, a **hospitality room** supported by Vernier S & T was available for participants from 10:15 to 11:30 pm.
  - Participants were encouraged to **contact US Congressman**, **Senators** and the NSF **Program Officers** about the workshops. A sample letter was provided and identified various NSF contacts.
  - Provided customized **press releases** for participants before the workshops to send to local media.
  - **Thank-you letters** that included requests for support for implementation were sent **to administrators** from the workshop office.

More Aspects III

- Targeted and funded **workshop size** was 20 participants.
- Participants worked in **groups that changed** at least daily.
- Many participants were **not familiar with HTML**, so sessions were offered to help them learn the basics of it.
- During the early part of the project, very little **email** was available so the grant **provided participants** with AIP **PINET email** and BBS service at JJC.
- **MBL participants** were often **alpha testing MBL software and hardware** that often were updated several times during the workshops.
- In the **CE/OCS workshops**, participants **constructed new exercises** and presented them to the other participants
- **Group projects** at various workshops and conferences allowed participants time to explore and start to develop new materials as well as provide some **networking**.
- **Grant writing** "nuts and bolts" sessions helped participants develop and write grants and get funding.
- **Workshops evolved** or were modified **as new materials or technology** were made available, e.g. Physlets, JiTT, or digital video analysis.

Workshops were different because they

- were **not sponsored by the developers** grant
- were **offered mainly during the academic year** not just summer and **participants stayed in motels** not dorms
- were **offered at TYCs** and **hosted by TYC physics teachers**
- helped **new TYC developers and workshop leaders emerge**
- had been **tested and used at TYCs**
- participants **often received permission to use or copy materials or software** for local use that were not generally available
- **no full-time** staff
- held **more workshops than planned** in grant proposal
- **unusual national impact** since TYCs are normally **locally focused**

Some featured PWP Participant Major Projects

- *Development of **LabVIEW** Controllers for Physics Laboratory Exercises* by Kent Reinhard from Southeast Community College in Lincoln, Nebraska

- *Using **Just-in-Time-Teaching** Techniques in an Algebra-based Physics Class* by James E. Heath, Jr. from Austin Community College in Austin, Texas
- *Using **GPS** to Analyze Real Life Motion in Introductory Mechanics* by J.B. Sharma from Gainesville College in Gainesville, Georgia
- *Waves and Sound using **LabVIEW and LabPro*** by Martin S. Mason from Mt. San Antonio College in Walnut, California
- *Can You Explain This? - **Conceptual Exercises** for Physics Students* by Christopher Wozny from Waycross College in Waycross, Georgia
- ***Very Large Contexts** (VLC) in Physics* by David Weaver from Chandler-Gilbert Community College, Mesa, AZ

Sample articles from the *CaFD* Newsletter (Spring 2007)

- "Experience-Based **Tips and Advice** for Curriculum Development" - Alex Dickison (FL)
- "Implementing Interactive Lecture Demonstrations (**ILDs**) with a **Classroom Response System**" - Paul Williams (TX)
- "Use of **Wireless Polling Devices** in Physics" - J.B. Sharma (GA)
- "Virtual **TIPERs**" - Karim Diff (FL)
- "**SPIRALPhysics** Active Learning" - Paul D'Alessandris (NY)
- "E & M **Ranking Tasks Implementation**" - Eugenia Peterson (IL)
- "**LabVIEW/LabPro** Implementation - Jon Anderson (MN)

Participants spent workshop time

- **listening** to the developers, the TYC Project Directors, and Local Host,
- **asking** questions of the leaders and other participants,
- **doing and discussing** the activities or labs with 2-3 other participants,
- **constructing** or developing modifications with 2-3 other participants,
- **presenting and sharing** ideas or work with the whole workshop group as well as answering questions and
- **becoming** more **aware** of new, real-world **applications of physics**

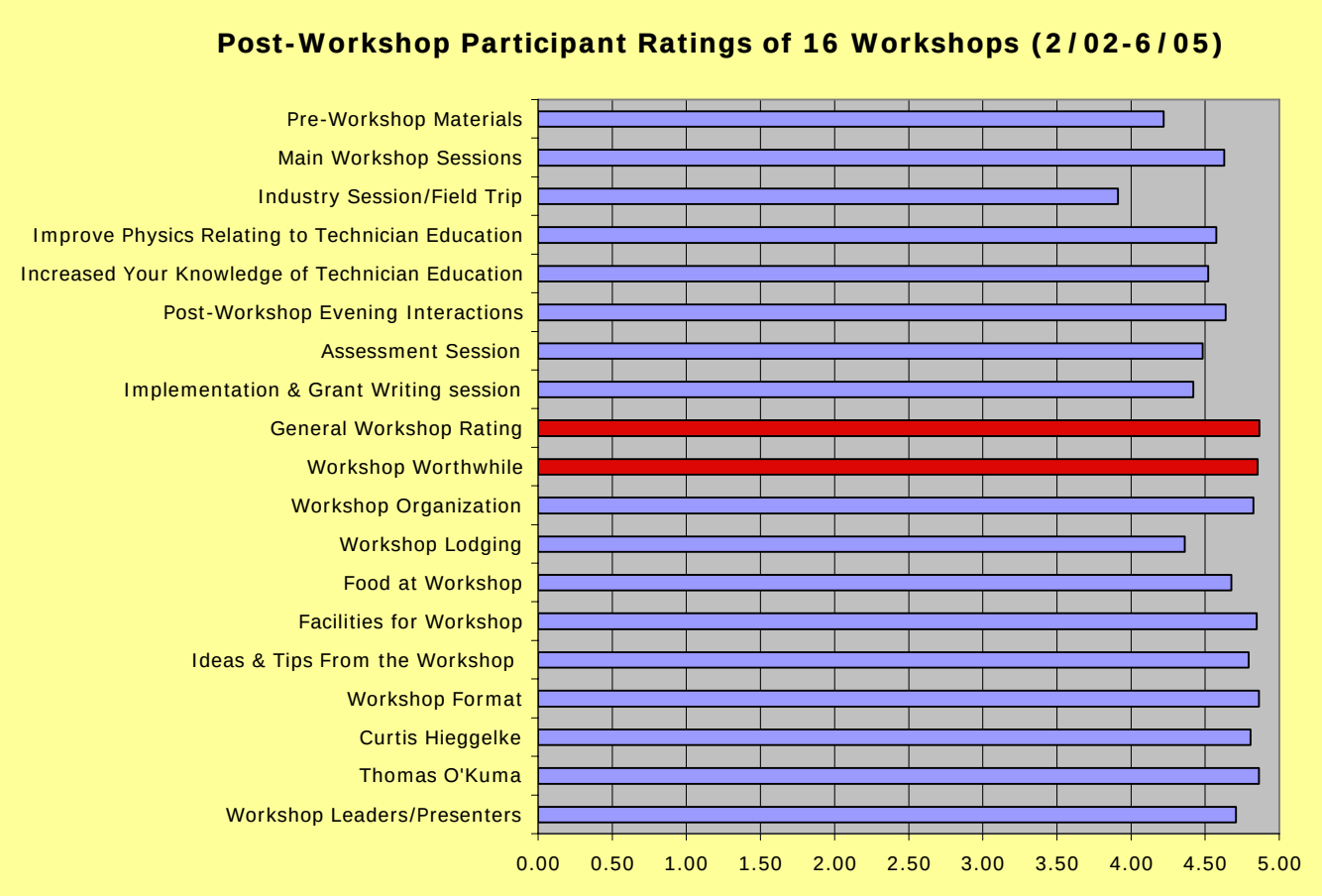
Impact I: Samples of participant comments
Pikes Peak CC (July 94) MBL Workshop

- "Best conference in 30 years of teaching."
- "I will look back on this workshop as a turning point in my professional life. I have been rejuvenated with hope that the chronic disappointments and frustrations of teaching physics can be overcome."
- "One of the best things I've ever attended. Good work guys!"
- "This has been one of the best I have attended."
- "As Pogo once said, "I'm faced with insurmountable opportunity." There's so much to do and so little time to do it. Thanks for continuing to make my life delightfully difficult."
- "Exhaustive - but outstanding! My first experience and a truly memorable one."

Impact II: Samples of participant comments
Pikes Peak CC (July 94) MBL Workshop

- "This was an excellent workshop. I am very excited to try these new lab/lecture approaches and implement them as much as possible. I look forward to the follow-up workshop, though I will likely wait a year so I will have had the opportunity to test these ideas."
- "Extremely valuable for me to see how a computer can enhance learning. I fully intend to begin implementing some of these ideas."
- "Doing the actual labs were increasingly helpful."
- "The workshop was extremely informative, helpful and inspirational though tiring. The materials and services provided will be incredibly helpful in implementing that which was presented in a practical way."

Excellent post-workshop participant evaluations



Changing physics at TYCs

- It was **easier** than at universities since only 1 or 2 faculty are involved
- Student **learning** was (and still is) the overwhelming #1 priority at TYCs
- TYCs were **supportive** and willing to try new approaches and curriculum if there was some evidence of effectiveness
- The main issues at TYC were **time and costs**.

Successful since our timing was right-

- the leading **physics education developers were aware and recognized** the impact of **TYCs** plus **were willing to work and share** with the TYC community.
- **PER** was emerging and being recognized as
  - very **useful and helpful** in teaching
  - making curriculum **more effective**
- **Assessment tools were being developed** that helped make student learning better and stronger
  - *Force Concept Inventory* **(FCI)**
  - *Force and Motion Conceptual Evaluation* **(FMCE)**
  - *Conceptual Survey on Electricity & Magnetism* **(CSEM)**
- Available were new **low cost and reliable**
  - **microcomputers** with graphical user interface (GUI) system
  - lab **interfaces and sensors**
  - student-tested **software** using a GUI system
- Many **other pieces of new PER** curriculum and strategies used in the workshops conferences were becoming available and used

In summary, the Physics Workshop Project

- transformed and influenced substantially the extensive and widespread implementation at TYCs of
  - microcomputer-based laboratories,
  - assessments,
  - computer and internet technology,
  - conceptual exercises, and
  - active engagement PER-connected curriculums.

Thanks

to the **APS Forum on Education** for this opportunity to share our story

as well as to **Dave and Tom** for all they have done to make our efforts successful

It should be noted that the **workshops** are still being **continued under** the leadership of **Tom O'Kuma** (Lee College, TX) and **Dwain Desbien**, (Estrella Mountain Community College, AZ) with support and funding from the Advanced Technological Education Program plus

the *nTIPERs* book may be published in 2010 or so.

Any questions or comments may also be sent to curth@comcast.net or curth@jjc.edu