MODELING INSTRUCTION in HIGH SCHOOL PHYSICS
Southern Methodist University, 2015

The Modeling Workshop in mechanics is an intensive 3-week course with these goals:
1. educate teachers in use of a model-centered, guided inquiry method of teaching high school physics.
2. help participants integrate computer courseware effectively into the physics curriculum.
3. help teachers make better use of national resources for physics education.
4. establish electronic network support and a learning community among participants.
5. strengthen local institutional support for participants as school leaders in disseminating standards-based reform in science education.

Evaluation:
Lab Journals
Meaningful Participation

Week 1: Intro, Kinematics

Mon Day 1	• Introductions. FCI Overview and Pre-Test. **Unit I: Scientific Thinking in Experimental Settings** • Bouncing ball lab – pre-lab, data collection, analysis, whiteboard discussion, model development and summary. • Deployment exercise and discussion. • Pull-back lab: pre-lab, data collection and analysis. Teaching on linearization. Re-analysis and discussion. • Ranking Task deployment **Readings:** • Hestenes, "Force Concept Inventory," (on website); • McDermott, "Guest Comment: How we teach…"
Tue Day 2	• Overview of Unit 1. • Discussion of readings **Unit II: Particle with Constant Velocity.** • Buggy Lab: Motion Terminology and Pre-Lab Discussion. How long is an instant? Data Collection. Graphing, modeling, whiteboards. Full model development. Concept Map. • Motion map reading; work WS1 deployment **Readings:** • Adams, "Quick before it dries…" (handout); • Arons, ch 1 (special attn: sections 8, 9, 11, 12)
Wed Day 3	• Whiteboard WS1. Sonic ranger graph matching. • Work and whiteboard WS2. Demonstrate how seeding of new ideas is done in discussion context. Look at other worksheets. • Discuss readings. • Lab Practicum. • Bonus: TIPERs **Readings:** • Mestre, "Learning and Instruction in Pre-College...", • Arons 2.1-2.6

Thu Day 4	**Unit III: Uniformly Accelerating Particle Model** • Inclined-track motion: pre-lab & data collection (photogates), analysis incl. linearization, and board meeting. Instantaneous velocity seeded or introduced. Re-analysis, discussion, model building. Seed motion maps. • Discuss reading. • Cart-ramp demo/discussion with predictions and graph matching. • Bonus: interactive lecture demonstrations **Readings:** • Arons 2.7-12.
Fri Day 5	• Deployment exercise: graphical problem solving. Discussion. Derivation of equations, completion of model. Discussion: can you justify the model from our data. • Work selected worksheet problems – deployment. Board meeting, focus of justifying work based on model. Students play teacher – questioning strategies. • Discuss Reading. • Free-fall lab deployment and discussion. • Seminar: Relative Motion. **Turn in Journals for evaluation.**
Sat-Sun	**Optional Readings** • Redish, Chapter 2 from "The Physics Suite" on cognition and instruction in Physics • Meltzer & Thornton, ALIP Resource Letter, "Active Learning Instruction in Physics", browse sections I through V, omitting section II, to learn about the development of the field of Physics Education Research (PER) and find citations for many important PER papers • Work through the TUG-K2

Week 2: Dynamics, Projectiles

Mon Day 6	**Unit IV: Free Particle Model-inertia & interactions** • Interaction discussion. Force-motion activities; Model Development. • Gravitational Force. Contact forces. Balanced forces. Evidence-based reasoning. • A look at free body diagrams and WS1. Whiteboards and discussion – WS1. Discussion of vector components. • Introduce spring scales. Force Vector equilibrium lab and discussion. Gravitational Force lab **Reading:** • Minstrell, "Explaining the 'at rest' condition…" • 3 Readings on whiteboarding and Socratic Dialog
Tues Day 7	• More deployment exercises. Participants practice questioning skills. • Deployment / prediction with discussion and testing – Newton's 3rd Law. • Discuss Reading. • Friction lab. **Reading:** • Introduction & chapter 1, Preconceptions in Mechanics, Camp/Clement; • Jackson, Dukerich, Hestenes, "Modeling Instruction…"
Wed Day 8	• Friction lab discussion, modeling. **Unit V: CDP Model-force and acceleration** • Newton's 2nd Law lab – pre-lab, data collection, analysis, discussion, model creation, deployment example • Deployment problems and sharing. • Reading discussion. • Graphical organizer of "the story so far" **Reading:** • Arons 3.1-4, 3.6-13
Thu Day 9	• More deployment and sharing including Physlet Problem 5.6 (Newton's 2nd and 3rd laws, kinematics and dynamics). Introduce physlets. • Lab practical exam (possibly accelerating friction block?) • Discussion of Reading **Unit VI: Particle Models in Two Dimensions** • Free fall worksheet (WS 1) and whiteboarding (review) **Reading:** • Hestenes, Wells: "A Modeling Method For High School...
Fri Day 10	• Projectile Lab – pre-lab discussion including role of movie analysis and Cartesian coordinates. Predictions, lab, discussion and model statements. Introduction to video analysis. • Bonus: Direct measurement videos, livephoto physics. • Deployment exercises. Lab practicum. Week 2 wrap-up. • Discuss readings. • Seminar: Periodic Motion. **Reading:** • Megowan, Excerpts from her dissertation, parts 1-3.

Week 3: Energy, Circular, Momentum

Mon Day 11	• Conceptual intro to energy, development of concept. Introduce pie charts and practice representing situations (WS1). Storage and transfer model. • Introduce work through hill lab. Quantitative energy definition. Quantitative "test" lab and discussion. • Deployment. • Bonus: simulations and videos. **Reading:** • "Making Work Work," by Gregg Swackhamer (on website)
Tue Day 12	• More deployment and discussion. Lab practicum • Discussion of readings **Unit VIII: Central Force Model** • Introduction to uniform circular motion – vector discussion using motion diagram. Testing lab using pendulum – pre-lab and set-up. **Reading:** • Van Heuveln, Zou: "Multiple Representations of Work-Energy Processes" • Megowan-Romanowicz, Excerpts from her dissertation, parts 4-6.
Wed Day 13	• Carry out and discuss "model testing lab" • Discussion of reading. • Deployment. Discussion: assessment methods. Discuss ways to include gravitational (and/or electric) force laws here. **Reading:** • Megowan-Romanowicz, Excerpts from her dissertation, parts 7-8.
Thu Day 14	**Unit IX: Impulsive Force Model** • Model-development lab: inelastic collisions. Develop model, hypothesize extension to elastic collisions, test. Lab and discussion. • Discussion of reading. • Demonstration-lab: Impulse-Momentum Theorem. Completion of model, with representational tools. • Deployment practice and questioning.
Fri Day 15	• More deployment practice. Practicum. FCI post-test. De-brief. • Seminar: Rotational Motion.