PHS 534: Methods of teaching physical science

(sometimes cross-listed with MTE 598: Physical Science with Math Modeling Workshop)

A 3-credit course for Jr. High & 9th grade science and math teachers.

* Need recertification credits?
* Want a standards-based course that integrates science and math content with effective teaching strategies?
* Need a content course to become highly qualified or to get endorsement?

DESCRIPTION:

The Physical Science with Math Modeling Workshop provides teachers of 8th and 9th grade physical sciences and mathematics with education in standards-based content and instructional strategies.

The workshop is an expansion to junior high and 9th grade of the Modeling Instruction Program at ASU. In 2001 the U.S. Department of Education recognized the Modeling Instruction Program as one of 2 EXEMPLARY K-12 science programs in the nation.

Teachers will achieve these goals:

* improve their instructional pedagogy by incorporating the modeling cycle, inquiry methods, critical and creative thinking, cooperative learning, and effective use of classroom technology in instruction),
* master content in topics in the structure of matter, motion, energy, scientific thinking skills, and related skills in each of the Arizona Mathematics Standards,
* strengthen coordination between mathematics and physical science.

Anticipated student outcomes include improved understanding in geometrical and physical properties of matter, motion, force, Newton's laws, energy, graphing, and related mathematics and reasoning skills such as proportional thinking, identification and control of variables, relation between graphs and equations, and measurement.

Participants are introduced to the Modeling Method as a systematic approach to the design of curriculum and instruction. The name Modeling Instruction expresses an emphasis on making and using conceptual models of physical phenomena as central to learning and doing science. Adoption of "models and modeling" as a unifying theme for science and mathematics education is recommended by both NSES and NCTM Standards as well as AAAS Project 2061. However, to our knowledge, no other program has implemented it so thoroughly. Modeling workshops meet or exceed many Arizona professional teaching, science, and math standards.

Thematic strands woven into the course include scientific modeling, structure of matter, energy, force, and use of calculators and computers as scientific tools. Mathematics instruction is integrated seamlessly throughout the entire course by an emphasis on mathematical modeling.

Content of an entire semester course is reorganized around basic models to increase its structural coherence. Participants are supplied with a complete set of course materials (resources) and work through the activities alternately in the roles of student or teacher. Course materials are appropriate for grades 8 and 9.

Student activities are organized into modeling cycles, which engage students systematically in all aspects of modeling. (Specifics of the modeling cycle are at <http://modeling.asu.edu>.) The teacher guides students unobtrusively through each modeling cycle, with an eye to improving the quality of student discourse by insisting on accurate use of scientific terms, on clarity and cogency of expressed ideas and arguments. After a few cycles, students know how to proceed with an investigation without prompting from the teacher. The main job of the teacher is then to supply them with more powerful modeling tools. Lecturing is restricted to scaffolding new concepts and principles on a need basis.

The course includes these models and modeling activities:

1. Modeling geometric properties of matter: length, area and volume
2. Modeling physical properties of matter: mass and density
3. Model of a point particle with constant velocity, constant acceleration; Newton's laws
4. An atomic model of solids, liquids and gases
5. Energy and the states of matter

What urban Phoenix middle school teachers said about PHS 534:

* "The labs helped me visualize why the equations are valid."

* "It has highlighted how little I understood; and what a difference it can make on your view of a subject once you start to understand it. It cured my phobia!"

* "It has proved to me how so many people hate physics because of how it was taught to them, not because it was too hard."

* "I definitely need to change my method of teaching using the modeling method in order to feel that I'm making a difference!"

* "I will definitely use the process including brainstorming and the whiteboards."

* "I plan to use what I learned immediately, starting with the measurement unit."

(If you'd like a description of how the workshop addresses ADE Professional Teaching Standards, and Arizona mathematics, science, and technology standards, reply to Jane.Jackson@asu.edu.)

For how to apply to ASU & register for the course, visit <http://modeling.asu.edu>, and click on 'ASU grad program for high school teachers of the physical sciences'.

Supplies needed for course:
Bound quad-ruled notebook,
3-ring binder, preferably 1 inch thick,
Calculator

A typical course calendar for the version that is cross-listed with MTE 598 follows.

Mon Day 1	Welcome, introductions, orientation to site, workshop description, goals, distribution of instructional materials. Hestenes: History, Naive Beliefs about Physics and Education Pre-Testing: Math Concepts Inventory Pre-testing: Physical Science Concepts Inventory **Unit 1: Geometric Properties of Matter** **1.1 -** Activities 1 & 2, worksheets 2 & 4 (Introduce white boarding results). Quiz **Reading:** Benezet*: The Teaching of Arithmetic: The Story of an Experiment.* **Reading reflection:** Raloff**, "**Errant Texts, Where's the Book?" *Science News Online* (Note: Reading reflections are typed one-page reactions to the reading assignments.) **Homework:** RemainingUnit 1.1 Worksheets
Tue Day 2	Discuss readings, homework **1.2** Activity 1 (paper, pencil recording of data) & 2 (*Graphical Analysis* software) Representational tools and significant figures Discuss measures of central tendency (mean, median, mode) and graphs of lists of data (e.g., stem-and-leaf, box-and-whisker, scatter plots) AIMS test examples. Worksheet 1, quiz 2, worksheet 3 **Reading reflection:** Mestre, Learning & Instruction in Pre-College Phys Science" **Homework:** Do 1.1-1.2 Test
Wed Day 3	Discuss reading, review test **1.3** Battery-powered vehicle lab **Sim-Calc MathWorlds –Java version** Unit 1**-**Position Graphs: Slope-As-Velocity 1.1.1 (class discussion), Worksheets 1 & 2 (constant velocity) 1.1.2 (student activity), 1.1.3 **Homework:** Go through SimCalc MathWorlds Basics – Java version (on your CD) **Reading reflection**: McDermott, "How We Teach & How Students Learn"
Thu Day 4	Discuss homework & reading AIMS test examples; **Sim-Calc MathWorlds** Unit 2- Making meanings for linear functions & eqns (connection between algebraic & graphical representations), practice Sim-Calc MathWorlds 2.1.1, 2.1.2 **Homework**: Unit 1.3 test, Practice Sim-Calc MathWorlds student activities.
Fri Day 5	**1.4** Measurement of Area Activity 1, Activity 2, more features of *Graphical Analysis* software **Homework: Complete 1.4** Measurement of area (worksheets) Update lab notebook (rubric), reflect on whiteboarding.

Mon Day 6	Discuss reading, how to conduct whiteboarding sessions **Sim-Calc MathWorlds**: review homework 2.1.2, 2.2.2 **1.5** Measurement of volume Activity 1: defining volume, discussion, Activity 2: volume relationships **Turn in Lab notebook** **Homework:** Hake, "Socratic Pedagogy in the Introductory Physics Laboratory,"

Tues Day 7	Discuss reading Worksheet 1 & quiz 1 Activity 3 - volume of irregular solids, discussion. Worksheet 2 Activity 4 - graphing volume relationships, worksheet 3 **Homework:** Finish worksheets
Wed Day 8	NCTM Illuminations: diagrams of 3-D solids. (orthographic, isometric, perspective) **AIMS examples** **Unit 2: Physical Properties of Matter** **2.1** Measurement of mass. *Eureka* video: episode 2: mass Begin conservation of mass labs, use of histograms **Homework:** Unit 1.4 & 1.5 test, finish Sim-Calc activities
Thu Day 9	Mid-course correction **More on Unit 2.1** Physical Properties Finish conservation of mass labs *Ring of Truth* video #2: Change (11 min). Worksheet 1 **Homework**: Wells & Hestenes, "A Modeling Method for High School Physics Instruction" *Am. J. Phys.* Bring questions to discuss.
Fri Day 10	Discuss reading **2.2** Density as a characteristic property of matter Activity 1- mass of unit cubes Activity 2 - density of solids. Worksheet1 **Reading reflection:** Wells & Hestenes, "A Modeling Method for High School Physics Instruction" *Am. J. Phys.* Update lab notebook (rubric)

Mon Day 11	Discuss reading Activity 3 - density of liquids. Worksheet 2 Activity 4 - density of gases **Turn in lab notebook** **Homework:** preview activities. Create a lesson with team member for your courses.
Tue Day 12	**Unit 3: Atomic Model of Matter** **3.1** Activity 1- Thickness of a thin layer Video clips from *Ring of Truth* video #5: Atoms Demo/discussion: Icy Hot Notes on solids, liquids and gases. Worksheet 1 Video - *Eureka* Heat and Temperature- episodes 1 - 3 **Homework**: write reflections on videos
Wed Day 13	**3.2** Energy and the states of matter Demo/discussion: thermal expansion *Eureka* videos: episodes 4 - 6 Expansion, contraction, measuring temperature. Worksheet 1, quiz 1 Activity 2a- melting point of water Activity 2b- freezing point of lauric acid **Homework**: 2-page paper: How I will implement Modeling Instruction

Thu Day 14	Representations of energy storage and transfer Activity 3 –Boiling of liquids. Worksheet 3 Activity 4- Energy transfer in materials Force, acceleration, and Newton's Laws: qualitative lab work **Homework:** FinishWorksheets: Unit 3, Quiz
Fri Day 15	Force, acceleration, and Newton's Laws: qualitative lab work Post-test: Physical Science and Math Concepts Inventories direction of future course materials preliminary agenda for follow-up meetings