



Modeling Teachers International 502

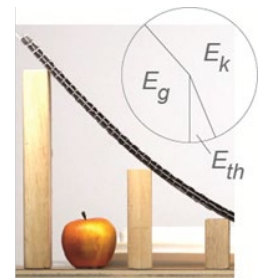
Online Advanced Course in Model Didactics: Examples from Mechanics and Magnetism

Instructor:	Dr. Mark Lattery, Modeling Teachers International President Distinguished Professor of Physics, University of Wisconsin at Oshkosh
Discussion Facilitators:	Cathy Baars, Physics Teacher, Martinus College; Co-Manager, Model Didactics Project; T^3 Instructor Onne Slooten, Physics Teacher, Het Amsterdams Lyceum; Co-Manager, Model Didactics Project
Email:	modelingteachersinternational@gmail.com
Sponsors:	Modeling Teachers International , NVON and BetaPartners
Prerequisites:	Bachelor's degree or equivalent, science teaching certification
Dates:	4 January – 23 April, 2027

Online Advanced Courses in Model Didactics is a science teacher professional development course on modeling theory and practice for the science classroom. The course asks: What is a scientific model? How are scientific models developed and used in science? How can model-centered science instruction improve student understanding of the content and nature of science? Examples are drawn from the topics of mechanics (with a focus on energy concepts) and magnetism.

Course readings

- *Model Didactics Course Materials* (shared on Google Drive)
- [Deep Learning in Introductory Physics](#) (Lattery, Information Age Publishing, 2017)



Required resources

- [American Modeling Teachers Association](#) (instructor access)
- [Pivot Interactives](#) (student access)
- [PhET Interactive Simulations](#)

Additional software

- Microsoft Office
- Adobe PDF Reader

Additional Fees

10 USD (Access to *Pivot Interactives*)

Design considerations

As teaching professionals, finding time for professional development is challenging. Thanks for taking on this challenge! Every attempt has been made to provide great learning opportunities while keeping the course load reasonable. The course consists of labs, reading and writing assignments, discussions, and one final assessment.

Course goals

Professional development courses for physics teachers are in high demand globally. To fill this need, we set three goals for practicing physics teachers:

- strengthen subject-matter content knowledge in physics
- deepen understanding of (1) common student misconceptions and learning difficulties; (2) research-based methods of science teaching and learning; (3) learning theories in science education; and (4) national and state standards
- increase engagement in discussion about the goals and methods of physics teaching through participation in state and national science teaching organizations, local special-interest groups, and classroom action research

Professional development outcomes

By the end of the course, teachers will be able to:

- engage in all aspects of the scientific modeling process, including experimental design, data collection, data analysis, model evaluation, and model revision (Lattery 2017, and references therein)

- apply modern classroom technology and model-centered teaching strategies for the introductory physics classroom
- discuss and critically evaluate problems, concepts, and issues in the physics education literature (e.g., student learning difficulties, alternative student conceptions, and student learning progressions)
- identify and use resources available through local, state, and national physics teaching organizations for ongoing professional development

Course components and grading

1. *Laboratory* (40%). Laboratory assignments include:

- a. Lab worksheets (45%). Contains concepts to review and activities to introduce you to a target physical case. Lab worksheets are completed individually and in a 3-4 member small group. With few exceptions, labs are implemented using Vernier's [Logger Pro](#), [Pivot Interactives](#) and [PhET Simulations](#)
- b. Post-lab worksheets (45%). Contains a summary, additional activities, and quantitative and qualitative problems to solve. Post labs also include worksheets from the [AMTA Modeling Materials](#).
- c. Lab Discussion (10%). Small-group collaboration on data collection and analysis.

2. *Reading and reflective writing (RW)* (40%). Reading and writing assignments include:

- a. Reflective Writing exercises (50%). During the course, you will keep a journal on the textbook reading. For each reading, you will complete a journal entry using the Reflective Writing (RW) technique of El-Helou and Calvin (2018). Journal entries are typically 2 or more pages and can be handwritten. A RW rubric can be found in the Google shared folder.
- b. Teacher reading discussions (50%). Teacher readings include peer-reviewed journal articles in science teaching, science education research, and science technology. These readings bridge the course content with classroom implementation. Following each reading, teachers will participate in a large-group (whole class) discussion. A discussion rubric can be found in the Google shared folder.

3. *Field application* (20%). Participate in a pre-planning and post-reflection discussion (one for each two-week field application period) that integrates the main concepts and themes of the course.

Final grades are determined by the following scale

A (92-100), A- (90-91), B+ (88-89), B (82-87), B- (80-81), C+ (78-79), C (72-77)

Students who earn a grade of "B" or higher will receive a *Modeling Teachers International Certificate of Successful Completion*. Students who earn a grade of "A" will receive a special distinction on the *Certificate*. Grades are recorded and updated in the "scores" doc of your Google private dropbox.

Course policies

1. *Assignment deadlines.* Assignments are due midnight in your time zone for the listed day/date. Assignments are expected to be completed on time unless prior arrangements have been made. Late points are taken off for late assignments. Unfortunately, no credit can be given for contributions to large-group discussions after discussions are listed as “Closed”.
2. *Academic integrity.* Academic cheating, copying, plagiarism, handing in another person’s work, and other examples of academic dishonesty will not be tolerated. All material submitted must be your own work. Any incident of academic or other misconduct will result in dismissal from the program.
3. *Special accommodations.* If you have any condition, such as a physical or learning disability, which will make it difficult for you to carry out the work as outlined, or which will require academic accommodations, please notify the instructor before the *first* day of class.

Course schedule

Week	Date (Mon)	Activity	Week	Date (Mon)	Activity
1	4-Jan	Preparation	9	1-Mar	Field Application
2	11-Jan	Topic 1	10	8-Mar	Topic 3
3	18-Jan	Topic 1	11	15-Mar	Topic 3
4	25-Jan	Topic 2	12	22-Mar	Topic 4
5	1-Feb	Topic 2	13	29-Mar	Topic 4
6	8-Feb	Field Application	14	5-Apr	Field Application
7	15-Feb	Break	15	12-Apr	Field Application
8	22-Feb	Break	16	19-Aprl	Reflection

Bi-Weekly schedule

The course core comprises four (4) topics: 1 topic every two weeks. For a detailed bi-weekly schedule, see the “pin up” on the next page.

Weekdays	Activity	Format
Topic Week 1		
Mon-Tues	No Assignments	
Wed-Fri	Lab Worksheet	Online lab, small group discussion
Weekend	Reflective Writing	Written homework, individual
Topic Week 2		
Mon-Wed	Post-lab Worksheet	Online lab, small group discussion
Thurs-Fri	Teacher Discussion	Large group discussion
Weekend	No Assignments	

Canvas learning management system

Canvas is the *Modeling Teachers International* learning management system. In this course, *Canvas* is used exclusively for small-group and large-group discussions. All file sharing between the instructor and teacher occur using the [course Google shared folder](#).

Course materials

All course materials are contained in the [course Google Drive](#) (*click below*):

dropbox

private (homework assignments deposit) *Google link sent by email.*

[public](#) (supplemental materials introduced through online discussions, etc.)

course materials

[course information](#) (syllabus, student directory, misc)

[readings](#) (general teaching and research articles—from beginning to advanced)

[reflective writing](#) (steps, rubric, articles)

[resources](#) (AMTA materials, PhET sims)

[videos](#) (instructor videos, lab videos)

00 tutorials

01 introduction to modeling

etc. (*see below*)

Artificial Intelligence Policy

Artificial Intelligence (AI) use is encouraged!

We will emphasis AI as a tool to foster conceptual understanding among *real thinkers* – you and your students! Specifically, you will learn the “AI sandwich” method to develop non-AI produced reflective writings.

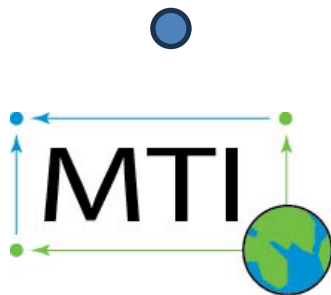


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Bi-Weekly Topic Schedule

Weekday	Day	Activity	Canvas discussion Initial response (you)	Assignments due to dropbox (you)	Instructor materials and grading (me)
Topic Week 1					
Mon					Topic materials distributed
Tuesday					
Wed	1	Lab Worksheet	Lab initial response (11:59 pm)		
Thursday	2	Lab Worksheet			
Friday	3	Lab Worksheet		Lab (11:59 pm)	
Saturday	4	Reflective Writing			Lab graded, Lab KEY posted
Sunday	5	Reflective Writing		RW (11:59 pm)	
Topic Week 2					
Mon	6	Post Lab Worksheet	Post Lab response (11:59 pm)		RW graded
Tuesday	7	Post Lab Worksheet			
Wed	8	Post Lab Worksheet		Post Lab (11:59 pm)	
Thurs	9	Teacher Reading Discussion	TRD initial response (6 pm)		Post Lab graded, Post Lab KEY posted
Friday	10	Teacher Reading Discussion			
Saturday					
Sunday					LD and TD discussion graded

*All due dates/times your time zone.



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Course Topics

Topic	Topic title	Physics teaching and learning	Physics content
Mechanics			
1	Linear spring oscillator	Introduction to the modeling cycle, modeling theory, analogies, pre-concept maps reflective reading and writing (Lattery)	Linear spring oscillator, force and energy relationships, period dependencies
2	Energy transformations	Energy transformations, representations of work-energy processes (Van Heuvelen & Zou 2000)	Energy analysis of spring-launched carts, kinetic energy, grav PE, energy conservation
Magnetism			
3	Ampere's law of magnetism	Research on student learning in magnetism and Ampere's law (Hendrix & Prilliman 2018)	Analysis of wire current and compass data (qualitative and quant), field lines and strength
4	Magnetism force on a current carrying wire	Problems and issues in the teaching of magnetism (Borges et al 1998; Font 2018)	Interaction of current-carrying wire and permanent magnet, RHR-1
Optional			
X	Magnetism force on a charged particle	Classroom activities on Lorentz force, teaching and learning the RHR (Tillotson 2017)	Electron jet and Helmholtz coil, radius-momentum relationship, e/m measurement, RHR-2

About the course

Focus on scientific models and modeling

MTI courses highlight *model-centered methods of science instruction* (Lattery 2017, and references therein). Each new topic begins with a phenomenon and works toward an empirically accountable and explanatory conceptual model. This approach emphasizes collaboration, peer discourse, and the use multiple representations. The goal of a model-centered course is both an understanding of the nature of science, and the subject-matter.

Online discussions

Small-group and large-group discussions are facilitated through the *Canvas* learning management system. Most discussions are *asynchronous*. Small-group discussions occur as you complete lab/post-lab worksheets. Large-group discussions occur after teacher readings. Discussion grades are based on quantity and quality of submissions.

Use of classroom technology

MTI courses employ a mixture of virtual laboratory activities based on [Pivot Interactives](#) and Vernier's [Logger Pro](#), traditional problem-solving activities (based on Halliday, et al., 2018), and worksheets (based on Arizona State University modeling method and [PhET Simulations](#)). Asynchronous small- and large-group discussions are used extensively. Reflective Writing (Kalman, et al. 2019) prepares teachers for large-group discussions of the physics education literature and related problems/issues in classroom implementation. NGMCs are designed to expose teachers to research-based practices in teaching and encourage them to adopt research-based materials (e.g., the ASU modeling instruction) in their own classrooms.

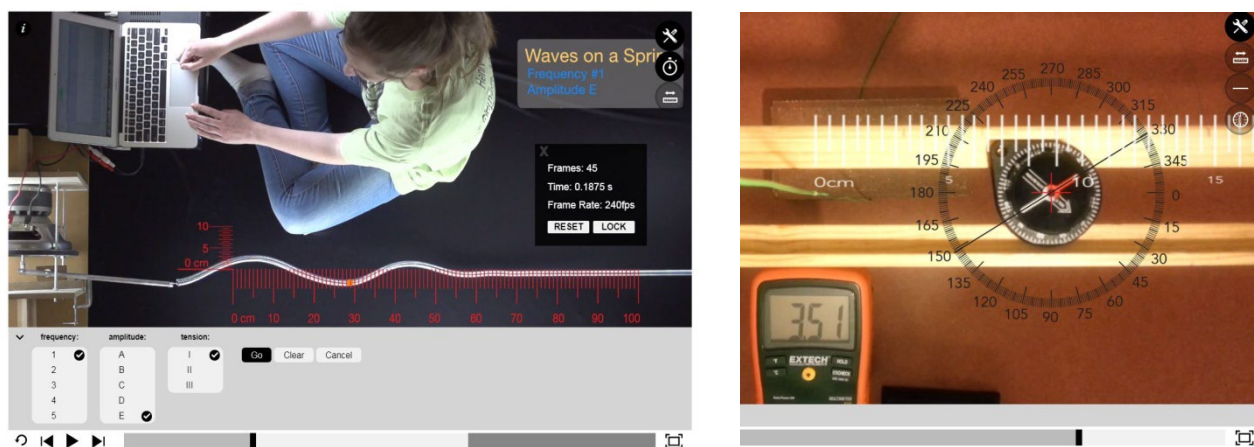


Figure 1. Two examples of Pivot Interactives: (a) waves on a string, and (b) Ampere's law.

Virtual laboratories

Many laboratories are conducted using [Pivot Interactives](#). Pivot Interactives are not simulations, but inductive investigations of real phenomenon using video analysis tools. As an example, consider the lab, *Waves on a Spring* (Figure 1a). In this activity, teachers explore the relationship between the speed of a transverse wave and several

other factors (driving frequency, wave amplitude, and spring tension). The user selects videos for different values of the dependent variables, then measures the wave speed (the dependent variable) with a virtual ruler and stopwatch. A similar example is shown for Ampere's law (Figure 1b). In this case, teachers explore the relationship between the amount of electric current running through a wire (the green wire at the left), the distance of a compass to the wire, the electric current in the wire, and the deviation of a compass needle (a measure of the magnetic field at the compass). Data collection and analyses are conducted in small groups. Individual teachers explore different aspects of the phenomenon, then share and discuss their results using the *Canvas* discussion feature. Many of the same questions that arise in a real lab also arise in a virtual lab, such as how to collect the data to reduce errors. Throughout the process, the non-ideal features of the data challenge teachers to develop explanations and revise their models.

Student and teacher mode

As in most science teacher professional development courses, teachers alternate between "student mode" and "teacher mode". In student mode, teachers experience the course materials as their students would; in teacher mode, teachers explore extensions to the content and discuss practical issues for classroom implementation. For example, a teacher might examine known student alternative conceptions in a content domain, connections to the history of science, and specific research-based strategies to address these conceptions. Learning is reinforced by conventional HW problems and conceptual problems extracted from the physics education literature.

What this course is not...

This course is NOT...

1. *a traditional lecture-lab course.* As an online professional development course for physics teachers, both the style and format of the course will be different than a traditional lecture-lab course.
2. *an independent study course.* This course is highly collaborative. A significant part of the course experience is working together with your colleagues to meet various challenges. For this reason, course activities (laboratories, reflective writings, post laboratories, and teacher reading discussion prompts) will be posted no more than three days in advance. You are, however, welcome to try out any open lab simulations/activities or complete readings ahead of time. Please reserve your questions until we've reached this material together in the course schedule.
3. *a full-length course.* This is a short course, so content goals are narrow. Topics have been carefully chosen to survey major concepts and expose you to instructional materials you can apply and use in your own physics classroom.
4. *a mathematical problem-solving course.* You will solve many, conventional, end-of-the-chapter-style HW problems. However, unlike a traditional full-length physics course, mathematical problem solving will not be the primary focus of the course or course assessment.

Questions?

If you have any questions about the course, please do not hesitate to contact Dr. Lattery by email at modelingteachersinternational@gmail.com

Thanks to
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