Modeling Teachers International 502 (Spring 2026)

Modeling Method of Instruction (Model Didactics): Theory and Practice with Examples from Magnetism

Pre-requisites:	Bachelor's degree in science, science education, or equivalent; certification to teach secondary school science
Instructor:	Dr. Mark Lattery, Modeling Teachers International President Distinguished Professor of Physics, University of Wisconsin at Oshkosh
Co-Facilitators:	Onne Slooten, Cathy Baars
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Sponsors:	Modeling Teachers International, NVON and BetaPartners

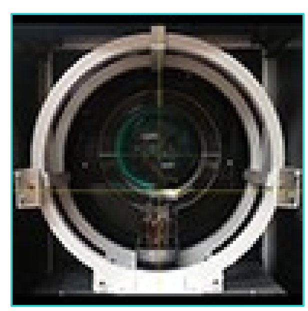
Modeling Method of Instruction (Model Didactics) is a science teacher professional development course on modeling theory and practice for the science classroom. The course asks: What is a scientific model? How are scientific models developed and used in science? How can model-centered science instruction improve student understanding of the content and nature of science? Examples are drawn from magnetism: Ampere's law, the Lorentz force and applications, and Faraday's law.

Course readings

- *Model Didactics Course Materials* (shared on Google Drive)
- *Deep Learning in Introductory Physics* (Lattery, Information Age Publishing, 2017)
- (*Optional*) Cummings, K. et al. (2004). *Understanding Physics* (8th Ed) NY: Wiley.

Course resources

- Pivot Interactives (student access)
- PhET Interactive Simulations
- (*Strongly recommended*) AMTA membership (instructor access)



Additional software

- Microsoft Office 2007 or higher (Word and Excel)
- Google Chrome browser (version 63 or later)
- Windows Media Player
- Adobe PDF Reader

Required additional fees (not covered in the registration fee)

10 USD (Access to *Pivot Interactive*s)

Design considerations

As teaching professionals, finding time for professional development is challenging. Congrats 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 classroom implementation tasks.

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:

- deepen understanding of (1) common student misconceptions and learning difficulties; (2) research-based methods of science teaching and learning; and (3) learning theories in science education

- increase engagement in discussion about the goals and methods of physics teaching

- strengthen subject-matter content knowledge in physics

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 started individually and then discussed in 3-4 member small groups. With few exceptions, labs are implemented using Pivot Interactives and PhET Simulations

   b. Post-lab worksheets (45%). Contains a summary, additional activities, and quantitative and qualitative problems to solve. Post labs may 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 (e.g., selected chapters from Cummings, et al. 2004.) 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 course 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 course folder.

3. *Classroom applications* (20%). Completion of short tasks to apply course knowledge to the classroom.

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)

Course participants who earn a grade of "B" or higher will receive a *Modeling Teachers International Certificate of Successful Completion*. Course participants 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. incident of academic or other misconduct will result in dismissal from the course. The use of AI to aid in the understanding and articulation of course concepts is encouraged.

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.

Topic schedule overview

The course consists of four (4) topics. Each topic is covered over a period of two (2) weeks. Topics 1, 3, and 4 are covered in *consecutive* weeks, whereas Topic 2 is covered in two weeks separated by a break. A general two-week schedule for each topic is given below.

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

Specific due dates associated with this schedule are given below.

Classroom practice tasks

During the course, teachers will implement what they are learning through classroom-practice tasks. Task details will depend on (1) your experience with modeling pedagogy, and (2) your current classroom needs and resources. Each task will accompany a short-written reflection (which may be shared with the rest of the class). Example tasks include, for several lessons:

- modeling lab sub-activities (example: pre-lab concept mapping)
- specific whiteboarding strategies (examples: whiteboard in-the-round, planting, mistake game)
- analogical comparisons

Results can be shared in many forms, including photo, discussion points, tips, and questions resulting from experiences.

***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 course participant occur using the course Google shared folder.

(*The following pages contains topic descriptions, weekly schedule, and course schedule that you can print and "pin up".*)

Modeling Teachers International 502 (Spring 2026)
Modeling Method of Instruction (Model Didactics)

Course Schedule

Week	Week of	Activity
1	Mar 2	Topic 1
2	Mar 9	Topic 1
3	Mar 16	Practice
4	Mar 23	Practice
5	Mar 30	Practice
6	Apr 6	Practice
7	Apr 13	Topic 2
8	Apr 20	*break*
9	Apr 27	*break*

Week	Week of	Activity
10	May 4	Topic 2
11	May 11	Practice
12	May 18	Practice
13	May 25	Practice
14	May 1	Practice
15	Jun 8	Topic 3
16	Jun 16	Topic 3
17	Jun 22	Topic 4
18	Jun 29	Topic 4

Topic Description

Topic	Topic title	Science teaching and learning	Subject-matter content
What are scientific models?			
1	Introduction to scientific modeling	Inductive vs. conventional labs, student learning in magnetism (Hendrix & Prilliman 2018)	Ampere's law of magnetism
2	Magnetism I: Force on a current carrying wire	Whiteboard discussions, problems and issues in the teaching of magnetism (Borges et al 1998; Font 2018)	Interaction of current-carrying wire and permanent magnet, Right-Hand-Rule 1
What does a model-centered classroom look like?			
3	Magnetism II: Force on a charged particle	Physical analogies, classroom activities on Lorentz force, teaching and learning the RHR (Tillotson 2017)	Helmholtz coil, radius-momentum relationship, e/m measurement, RHR 2
4	Faraday's law of induction	TEAM diagram, problems and issues in the teaching of Faraday's and Lenz's law (Galili 2006)	Analysis of electro-magnetic induction, interaction loop and field, induced *emf*

Topic Schedule (Two-Week Block)

Weekday	Day	Activity	*Canvas* discussion Initial response (you)	Assignments due to dropbox (*you*)	Instructor materials and grading (*me*)
First Week					
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)	
Second Week					
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

*Note: Due dates/times your time zone. Topics 1, 3, and 4 are covered in *consecutive* weeks. Topic 2 is covered in two *break-separated* weeks.

Course materials

All course materials are contained in the Google Drive folder model didactics (spring 2026). Access to this link will be given at the start of the course. Key subfolder links are given below.

dropbox
private (homework assignments deposit) *Google link sent by email.*
public (supplemental materials introduced through online discussions, etc.)

course materials
_course information (syllabus, course participant 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*)

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 and reflective writing

MTI courses employ a mixture of virtual laboratory activities based on Pivot Interactives, traditional problem-solving activities (based on Halliday, et al., 2018), and worksheet exercises (based on 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.

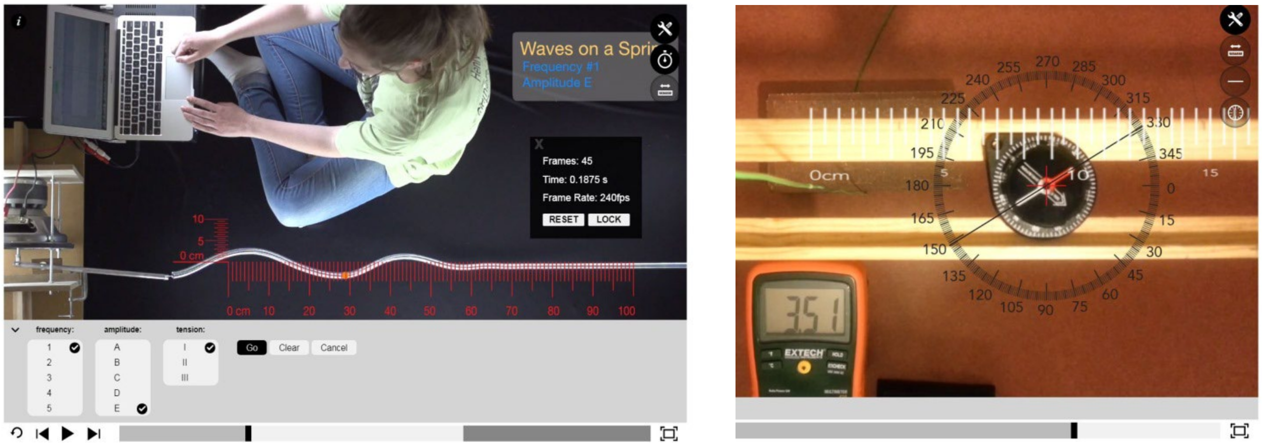


Figure 1. Two examples of Pivot Interactives: (a) waves on a string, and (b) Ampere's law.

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 individually and 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.

Time commitment

The amount of time required to complete the course (including labs, homework, readings, and discussions) is dependent on your subject-matter content background and learning patterns. With this caveat, *expect to spend approximately 50 hours total for study and review*—spread out evenly over the course. This estimate does not include direct contact with the instructor and colleagues, and pre-course preparation.

Note: For longer teaching and research journal articles and/or book excerpts, no expectation exists to read and analyze the entire work.

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