Time commitment

The amount of time required to complete the course (including homework, labs, readings, and discussions) is dependent on your subject-matter content background. Most teachers spend between 32-48 hours total for study and review—spread out evenly over the course. (This range does not include direct contact with the instructor and colleagues, and pre-course preparation.) The official total time commitment is governed by UW System Administrative Policy 165. Course activities that count as contact hours include all required small- and large group discussions on homework, laboratory, and teacher readings.

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 be reported to the Dean of Students for further disciplinary action.

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.

Weekly schedule

The course covers 8 topics: 1 topic per week for 8 weeks (during regular school year) or 2 topics per week for 4 weeks (during the summer). Below is a topic schedule for the course during the regular school year.

Weekday	Day	*Activity*	*Format*
Mon	1	Lab Worksheet	Online lab, small group discussion
Tues	2	Reflective Writing	Written homework, individual
Wed	3	Post-lab Worksheet	Online lab, small group discussion
Thurs	4	Teacher Reading	Written homework, individual
Fri	5	Teacher Discussion	Large group discussion
Sat	6	Teacher Discussion	Large group discussion
Sun	7	Open	Open

For the summer course, the first topic is covered Monday through Wednesday and the second topic is covered Thursday through Saturday.

Canvas learning management system

Canvas is the UW Oshkosh learning management system. In this course, *Canvas* is used exclusively for small- and large-group discussions and posting grades. All file sharing between the instructor and teacher occur using the course Google shared folder.

Course content *(tentative)*

Waves and Applications for Teachers is a professional development course with a focus on both physics teaching and learning, and subject-content matter. Example readings and topics given below.

Topic	Topic title	Physics teaching and learning	Physics content
Mechanical oscillations			
1	Simple harmonic motion: An introduction to modeling	Empirical models Inductive vs. conventional labs Modeling theory (Hestenes)	Uniformly rotating platform Spreadsheet/*Excel* physics introduction
2	Linear spring oscillator	Pre-lab concept maps Model making and breaking (Vonk)	Linear spring oscillator Force and energy relationships Euler/Euler-Cromer method
3	Physical pendulum	Modeling paradigm labs Historical-interpretative analysis of student learning (Matthews)	Simple and damped pendulum Force and energy relationships Runge-Kutta method
Wave motion in a medium			
4	Traveling waves on a coil spring	Analogical and literal similarity comparisons, student conceptualizes of wave propagation (Caleon and Subra)	Pulses to waves Wave reflection/interference Transverse/long. vibrations Spreadsheet models of interf.
5	Transverse standing waves on a string	Student conceptions mechanical waves (Wittman) Object coordination class analysis (diSessa and Sherin)	Standing wave formation Waves speed, tension, and linear mass density
6	Longitudinal standing waves of sound	Student mental representations, misconceptions (Wittman), wave representations	Acoustic waves of sound in an air column (c/c, open/closed) Pressure variations/particle movement, Ruben's tube
Applications and extensions			
7	Matter waves, bound particles, and quantum mechanics	Bridging mechanical and quantum phenomenon Positive, negative, neutral analogies (Hesse)	Cd-Te "quantum dot" solutions Infinite/finite square well deBroglie's wave hypothesis Spreadsheet models of SW
8	Resonance and frequency analysis	Waves diagnostic, research results, and classroom implications (Wittman & Redish)	Harmonic analysis/FFT. Applications to classical and quantum (wave) mechanics

Topics 1-6 are based on the ASU Modeling Method of Instruction (MMI) materials on mechanical waves, kinematics, and dynamics. Lesson activities consist of inductive modeling labs and follow-up activities. Each topic ends with a discussion of classroom implementation based on the MMI Instructor Unit Notes.

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 (research articles and diagnostics—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

NGMCs 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- 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

NGMCs 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.

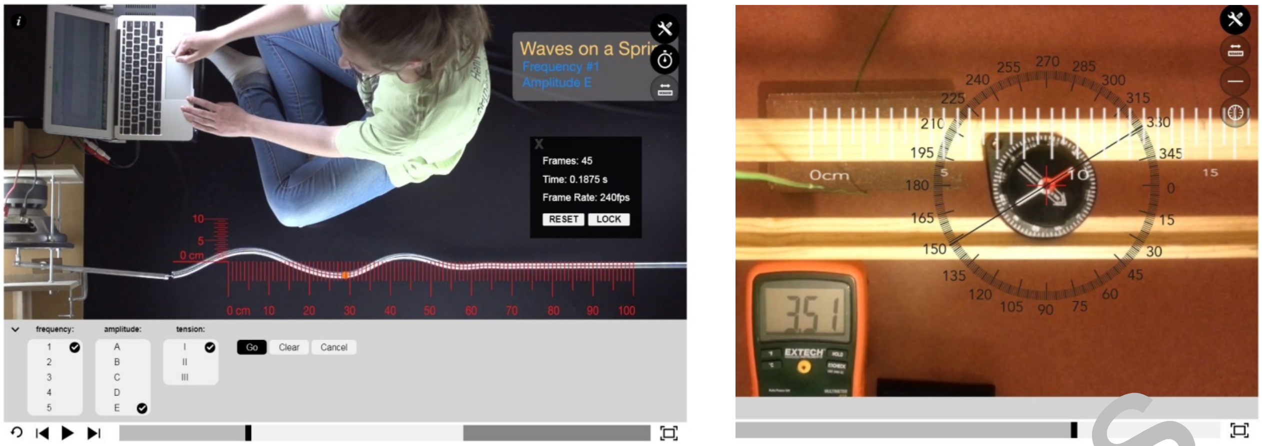

Figure 1. Two examples of Pivot Interactives: (a) waves on a string, and (b) Ampere's law.

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 lattery@uwosh.edu.

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