Course Syllabus

Title
Teaching Middle School Physical Science

Target Audience
This course is intended for pre-service and in-service teachers of physical science in grades 5-8.

Prerequisites
To successfully participate and complete the assignments in this course, the learner must:
- Be familiar with taking an online course or have completed the PBS "Practice Learning Online with TeacherLine" course.
- Have some experience in grades K-12 classrooms.
- Have an interest in physical sciences.

Course Description
This course focuses on three elements: content knowledge, inquiry and other teaching strategies, and use of multimedia and visualization tools in teaching and learning about physical science. Teaching Middle School Physical Science is designed to help educators gain an understanding of science concepts needed to teach standards-based curricula at the middle school level. This course incorporates methods and metacognitive strategies for learning and teaching, including scientific reasoning, prediction, and abstract and critical thinking, and helps educators optimize their science teaching experiences. Through the readings, videos, discussions, assignments, and other interactive experiences, learners in this course will have multiple opportunities to develop content knowledge about transfer of energy; light, sound, and waves; mechanisms of heat transfer; and solubility and density. The course also develops teachers' understanding of an inquiry learning model and discusses how to create an effective learning environment that enables teachers to assess students' individual learning abilities and needs. Learners will experience a rich multimedia, inquiry-based learning environment as their students ideally would in their own classrooms. The course provides effective teaching methodologies, strategies and tools that can be used when teaching physical science concepts.

Instructor/Facilitator
See instructor/facilitator sheet.

Credits
To be determined by college or university.

Course Goals
As a result of participating in this course learners will*:*
- Develop content knowledge about energy transfer, light and waves, heat transfer, and density and solubility.
- Recognize inquiry-based learning models.
- Explore a range of effective teaching methodologies and strategies for use in teaching science concepts.
- Explore a media-rich learning environment to use with students.
- Review models to illustrate ways to teach beyond the textbook.
- Understand and utilize the scientific process.

Outline of Content and Assignments
Learners in this course are expected to participate in discussions, complete assignments and a final project. Learners are also expected to keep a personal notebook (which is not assessed) to keep notes, complete exercises and record reflections about their learning experiences in this course.

Discussion Activities

- **Essential Question** – Each session includes a discussion about an essential question and to teaching and learning issues related to this question. Learners post responses to questions posed in the course and respond to posts submitted by their colleagues.

- **Final Project Discussion** - There is also an ongoing discussion concerning preparation for the final assignment.

Assignments and Final Course Project - Learners are expected to submit assignments and a final project. Rubrics are provided for assessment of all assignments, and the course content includes assignment samples.

Assignments in this course include:
- **Compare Your Answer –** Learner's written responses to a question are compared to answers written by experts in the field.
- **Writing Assignments –** Short writing assignments (essays) that answer the essential questions for the session are submitted to the facilitator for assessment.
- **Final Course Assignment – A Lesson Based on Motion Lamps**
  Throughout the course learners develop two projects: creating a motion lamp and developing two different concept maps. For the final course assignment learners go back to their pedagogical concept map and their concept map of physical science concepts and add any new information or ideas. Learners then write an essay explaining the physical science concepts that are applied to a liquid motion lamp. Finally, the learners outline a physical science lesson plan.

<u>Required Readings</u>
- Session 1:
  - "Energy, Heat and Temperature"
  - "The Laws of Thermodynamics"
  - "Understanding the Laws of Thermodynamics"
- Session 2:
  - "Pendulums"
  - "Learning Through Inquiry and its Implications for Teaching"
  - "Some Myths About Inquiry-based Learning and Teaching"
- Session 3:
  - "Light Waves and Sound Waves: Similarities and Differences"
  - "How Night Vision Works"
  - "Sea life is troubled by noise"
- Session 4:
  - "Glass That Keeps Its Cool"
  - "Helping Students Ask the Right Questions"
  - "What Is a Good Guiding Question"
  - "Making Predictions: A Way to Expand Learning"
  - "Differentiating Instruction: Finding Manageable Ways to Meet Individual Needs"
- Session 5:
  - "How Thermoses (Vacuum Flasks) Work"
- Session 6:
  - "Teaching Science: Forming Inquiring Minds"
  - "Consider the Possibilities"
  - "Formative Assessment Probes: Uncovering Students' Ideas in Science"
  - "Classroom Assessment for Learning"
  - "A Strategy for Excellent Teaching"

    - “Teaching Standard C” from the National Science Education Standards
    - “Atmospheric Pressure”
- Session 7:
    - “What Causes the Bends?”
    - “How Submarines Work”
    - “Properties and Changes of Properties in Matter”
- Session 8:
    - “Funny Water”
    - “The Engaged Classroom”
    - “Snapshots of Meaning-Making Classrooms”

SESSION 1: TRANSFER OF ENERGY

Objectives - After completing this session, learners will be able to:
- Define what is meant by energy transfer;
- Explain the meaning of the phrase conservation of energy;
- Explain what happens to energy when it is converted from one form to another; and
- Give examples of energy transfer in everyday situations.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What happens when energy transfers from one object to another?***

Activities in this session delve into the online learning environment and the process of thinking like a student again. Participants will examine the process of energy transfer, some of the challenges students may face, and new approaches to teaching and learning.

Assignments in this session require learners to write about an example of energy transfer and how the laws of thermodynamics apply to this example. Learners create a diagram of energy transfer and describe the energy transfer at each step of the diagram.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 2: INQUIRY LEARNING

Objectives - After completing this session, learners will be able to:
- Describe the essential elements of inquiry in the science classroom;
- Explain key findings from research about learning and how they can apply them in the classroom;
- Discuss how an instructional model that sequences learning experiences can help students build a deeper understanding of important physical science concepts; and
- Develop strategies for improving a lesson to increase the level of inquiry and to reflect understandings about how people learn.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can the nature and sequence of learning opportunities improve students’ understanding of physical science?***

Activities in this session delve into the benefits of an inquiry-based approach to teaching.
In this session, participants look at energy transfer in the context of research about how people learn, with a focus on an inquiry-based instructional model.

Assignments in this session require learners to write about their understanding of inquiry and what inquiry looks like in the classroom and to list some concrete ideas for improving the level of inquiry in a chosen lesson plan for improving the learning opportunity for students.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 3: LIGHT AND SOUND WAVES

Objectives - After completing this session, learners will be able to:

- Describe the electromagnetic spectrum;
- Explain that visible light is one part of the electromagnetic spectrum;
- Explain how the terms light and energy are related;
- Give examples of how fundamental principles of light absorption and reflection are applied to beneficial technologies; and
- Compare and contrast visible light waves with other types of waves.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *What are light waves and sound waves, and how do we use them to learn about our world?***

Activities in this session delve into the nature of light and sound waves and their technology applications.

Assignments in this session require learners to summarize how knowledge of the electromagnetic spectrum or of sound waves led scientists to a better understanding of how the phenomenon described in the resource works, or how that knowledge led to a new technology. Learners also write about a current lesson they teach about waves, light, light absorption, or light reflectivity and how that lesson may be modified to make connections between the science and students' everyday experiences.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 4: UNCOVERING WHAT STUDENTS KNOW

Objectives - After completing this session, learners will be able to:

- Improve their ability to use guiding questions to assess student understanding;
- Include strategies for having students make predictions as part of your lesson plans;
- Provide examples of when and how they might use multiple strategies to teach science concepts; and
- Describe examples of ways in which society influences science and vice versa.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can you apply teaching strategies that uncover and build upon what students already know to improve their understanding of science concepts?***

Activities in this session delve into light and waves in the context of how questioning and prediction strategies can help uncover a learner's prior knowledge.

Assignments in this session require learners to write about strategies for modifying a lesson plan to reduce student confusion of science concepts and how they might incorporate making predictions, questioning strategies, or aspects of differentiating instruction in the new lesson plan.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 5: MECHANISMS OF HEAT TRANSFER

Objectives - After completing this session, learners will be able to:
- Define different ways in which energy is transferred between materials as heat;
- Explain how convection and conduction influence density;
- Transfer their knowledge about convection and conduction to real world examples; and
- Connect heat transfer concepts to their classroom practice.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How does energy transfer from one substance to another as heat, and how does this affect these substances?***

Activities in this session delve into the mechanisms of heat transfer, including radiation, convection, and conduction, and explore how heat transfer affects the density of a substance.

Assignments in this session require learners to write about an insulation test, describe convection and conduction occurring in a given scenario, and how heat transfers by convection in a given activity.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 6: FORMATIVE ASSESSMENT

Objectives - After completing this session, learners will be able to:
- Articulate their ideas regarding the effectiveness of various models of teaching;
- Develop strategies to pinpoint students' prior conceptions and misconceptions in science;
- Give examples of formative assessment strategies; and
- Analyze teaching models for their effectiveness in assessing inaccurate prior conceptions.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How does what students already know when they come to class affect what they learn?***

Activities in this session delve into the heat transfer in the context of how to use what students already know to plan instruction that improves student understanding.

Assignments in this session require learners to write a formative assessment script for a scenario and how they may implement the formative assessment strategies and resources from the session with students.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 7: SOLUBILITY AND DENSITY

Objectives - After completing this session, learners will be able to:

- Identify multiple ways to change density;
- Explain how dissolving one substance into another affects mass and volume;
- Apply the effect of solubility on density to explain bubble formation, oil spills, and ocean currents; and
- Describe how they might teach about the effect of solubility on density in the classroom.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How might differences in solubility affect density?***

Activities in this session delve into the changes in density, in particular how solubility of one substance in another affects the density of the resulting mixture.

Assignments in this session require learners to write a definition of density as a macroscopic or microscopic property of a substance, write an explanation of a given story about density and solubility, and to create a lesson idea given a list of materials.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

SESSION 8: THE ENVIRONMENT FOR LEARNING

Objectives - After completing this session, learners will be able to:

- Identify common attributes of effective learning environments;
- Predict the effect that particular aspects of the classroom environment have on student learning; and
- Enhance their ability to change specific aspects of a classroom environment based on evidence from classroom observations.

Using an inquiry-based approach, the session is divided into the following sections: Invitation, Exploration, Explanation, Application and Putting It into Practice. The **Essential Question** for this session is**: *How can the environment of your classroom foster inquiry-based learning?***

Activities in this session delve into solubility and density in the context of how to create a classroom environment that fosters inquiry learning.

Assignments in this session require learners to explain how one non-physical aspect of the learning environment influences learning, how it can be used to further inquiry learning, and how they would approach implementing this aspect. Learners also write about one lesson plan on the properties of matter

and how they will incorporate the ideas and strategies from the course into the lesson. Learners also complete their final assignment essay in this session: A Lesson Based on Motion Lamps.

Discussions in this session focus on finding solutions for the essential question for this session.

Learners will record notes and reflections in their personal notebook about different concepts, methods, activities and ideas presented throughout the session.

Schedule
This course is scheduled to take approximately 45 hours to complete.

Requirements
Learners are expected to:
- Complete all assignments.
- Participate and actively engage in discussions with fellow learners while contributing to the social construction of knowledge.
- Be self-directed and self-motivated.
- Ask for assistance when they need it.

Facilitators are expected to:
- Provide feedback to all learners.
- Participate in discussions to keep them moving forward.
- Provide assistance to learners who need it.

Technical Requirements
- Word Processor
- Internet service provider
- E-mail
- Shockwave and Flash: http://www.macromedia.com/downloads/
- Acrobat Reader: http://www.adobe.com/products/acrobat/readstep.html
- QuickTime: http://www.apple.com/quicktime/download/

Standards of Academic Integrity
As posted on PBS TeacherLine Web site at
http://teacherline.pbs.org/teacherline/help/help_template3.cfm?subID=197

Evaluation
This course is evaluated on a letter grade basis, and graduate credit may be available. See the PBS TeacherLine Web site for details pertaining to specific graduate credit instructions.