Course Syllabus

Title
Teaching High School Physical Science

Target Audience
This course is intended for pre-service and in-service teachers of physical science in grades 9-12.

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 High School Physical Science helps educators learn inquiry-based approaches to teaching standards-based science topics, including atomic and molecular structure, chemical reactions, motions and forces, and the electromagnetic spectrum. Learners use multimedia to explore novel learning environments and methodologies that foster student interest, involve them in the research process, advance their critical thinking skills, and develop their conceptual understanding. Through the readings, videos, discussions, assignments, and other interactive experiences, learners in this course will have multiple opportunities to develop content knowledge about energy transfer, light and waves, heat transfer, and density and solubility. 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.
- Introduce inquiry-based learning models.
- Provide a range of effective teaching methodologies and strategies for use in teaching science concepts.
- Introduce a media-rich learning environment to use with students.
- Provide 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 course project preparation.

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:
- **Writing Assignments -** Short writing assignments (essays) are submitted to the facilitator.
- **Final Course Project:**
  As learners work through the eight sessions of the course, they will work on the course project. The project has two parts: construct a motion lamp and develop a graphic organizer to find connections among the teaching strategies and pedagogical issues surrounding teaching physical science.

Required Readings
- Session 1:
  - "Nature of Science (from ENSI)"
  - "The Nature of Science (from Project 2061)"
  - "On Scientific Method"
  - "The Fallacy of Induction in Science Teaching"
  - "View Science Learning From a Constructivist Perspective"
  - "Learning Through Inquiry and Its Implications for Teaching"
- Session 2:
  - "Pendulums"
  - "Some Myths About Inquiry-based Learning and Teaching"
- Session 3:
  - "Teaching for Conceptual Change: Confronting Children's Experience"
  - "Pre-Existing Knowledge"
  - "What Learners Already Know Influences Their Learning"
  - "Helping Students Ask the Right Questions"
  - "What is a Good Guiding Question"
  - "About Nanotubes"
  - "Chemical of the Week: Buckyballs"
  - "Learning and Transfer"
- Session 4:
  - "Experiments on Chemical Reactions"
  - "Formative Assessment Probes: Uncovering Students' Ideas in Science"
  - "Classroom Assessment for Learning"
  - "The Relationship Between Formative and Summative Assessment – In the Classroom and Beyond"
  - "Formative Assessment in Scientific Experimentation"

    - "Student Responses"
    - "Teacher Assessments"
- Session 5:
    - "Pedagogical Content Knowledge: Teacher's Integration of Subject Matter, Pedagogy, Students, and Learning Environments"
    - "Content Knowledge Without Pedagogy Shortchanges Students"
- Session 6:
    - "The Laws of Thermodynamics"
    - "Understanding The Laws of Thermodynamics"
    - "Examples of Potential and Kinetic Energy"
    - "Differentiating Instruction: Finding Manageable Ways to Meet Individual Needs"
    - "Teach Me, Teach My Brain"
    - "Teaching Standard A" from the National Science Education Standards
- Session 7:
    - "Identify Desired Results – Stage 1"
    - "Determine Acceptable Evidence – Stage 2"
    - "Plan Learning Experiences and Instruction – Stage 3"
    - "You Can Teach for Meaning"
- Session 8:
    - "Images of Inquiry in 9-12 Classrooms"
    - "The Engaged Classroom"
    - "Snapshots of Meaning-Making Classrooms"
    - "A Strategy for Excellent Teaching"

SESSION 1: PROCESSES OF SCIENCE

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

- Describe how scientists follow systematic processes of making observations, asking questions, making predictions, taking measurements, collecting data, and making conclusions based on evidence.
- Describe how scientific knowledge can change in light of new evidence or interpretations.
- Identify ways to bring the scientific process into the classroom as a teaching and learning tool.

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 do scientists investigate the natural world, and how can teachers and students apply scientific inquiry to better understand physical science?***

Activities in this session delve into how scientists investigate the natural world, and how teachers and students can apply scientific inquiry to better understand physical science.

Assignments in this session require learners to use resources and concepts to identify how they would improve a lesson on the nature of science and align another lesson to the five essential features of inquiry to improve students' understanding of concepts. Learners also begin working on the course project.

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 IN SCIENCE AND 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 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.
- Develop strategies for improving one of their current lessons 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 how the nature and sequence of learning opportunities improve students' understanding of physical science.

Assignments in this session require learners to explain their understanding of inquiry and describe what inquiry looks like in the classroom. Learners also review and revise a lesson plan to increase the level of inquiry and improve the learning opportunity for students. Learners continue to work on the course project.

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: PRIOR KNOWLEDGE

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

- Assess students' prior knowledge more effectively.
- Help students assess their own prior understanding.
- Identify several types of questions, and describe how to use them effectively in a lesson.
- Refine their ability to ask questions that probe students' understanding.
- Develop strategies to work with students' preconceptions about how bonds between atoms influence a material's properties.

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 do learners' prior experiences and knowledge affect their ability to add new information to their knowledge base?***

Activities in this session delve into the how learners' prior experiences and knowledge effect their ability to add new information to their knowledge base.

Assignments in this session require learners to summarize their understanding about the importance of uncovering a students' prior knowledge and discuss questions and strategies that may be used to help identify students' preconceptions about a topic and to correct misleading preconceptions. Learners continue to work on the course project.

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: ASSESSMENT ON CHEMICAL REACTIONS

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

- Describe the purposes of formative and summative assessments.
- Give examples of formative and summative assessment strategies.
- Analyze teaching models for their effectiveness as formative and summative evaluations.
- Develop strategies for improving formative assessment 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 can specific teaching strategies help you assess what students understand about chemical reactions?***

Activities in this session delve into the how specific teaching strategies can help learners assess what students understand about chemical reactions.

Assignments in this session require learners to write scripts that demonstrate how a students' inaccurate prior conception may be identified and addressed. Learners continue to work on the course project.

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: PEDAGOGICAL CONTENT KNOWLEDGE

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

- Define the term pedagogical content knowledge.
- Explain why pedagogical content knowledge is important for effective teaching.
- Evaluate how their content knowledge and knowledge of pedagogy are reflected in their teaching about motions and forces.
- Develop strategies for improving their pedagogical content knowledge.

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 combine knowledge of content and knowledge of pedagogy to teach about motions and forces more effectively?***

Activities in this session delve into how combining content knowledge and knowledge of pedagogy can lead to more effective teaching of motions and forces.

Assignments in this session require learners to describe how using Pedagogical Content Knowledge (PCK) could help develop an effective approach to teaching a concept related to motion and forces. Learners also identify relationships between the key findings from "How People Learn" and the importance of PCK for effective teaching. Learners continue to work on the course project.

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: MAKING ENERGY UNDERSTANDABLE

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

- Identify key ideas for teaching the concepts of potential and kinetic energy and their relationship to the laws of thermodynamics.
- Identify ways to improve students' understanding about potential and kinetic energy.
- Define differentiated instruction and explain its goals.
- Provide examples of when and how they might use alternative strategies to teach science concepts.

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 modify and shape your teaching strategies to meet the needs of individual learners?***

Activities in this session delve into how learners can modify and shape their teaching strategies to meet the needs of individual learners.

Assignments in this session require learners to describe how they may differentiate their instruction to teach a key idea related to potential and kinetic energy and explore how they may improve the physical science learning experience for each individual student. Learners continue to work on the course project.

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: IMPROVING A LESSON

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

- Identify the big ideas related to waves and the electromagnetic spectrum.
- Explain the purpose and methods of backward design in the development of curriculum.
- Apply some of the principles of backward design to improve the lessons that they teach.

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 principles of effective curriculum design to improve your own lesson planning?***

Activities in this session delve into how learners can apply principles of effective curriculum design to improve their own lesson planning.

Assignments in this session require learners to revise and modify a lesson based on the *Understanding by Design* model and describe how their ideas about lesson planning have changed.

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 effects that particular aspects of the classroom environment have on student learning.
- Enhance your ability to change specific aspects of your 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 how learners' classroom environments can foster inquiry-based learning.

Assignments in this session require learners to discuss how non-physical aspects of the learning environment can influence learning and analyze how their own physical environments help or hinder their students' learning. Learners will finish their course project.

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.