

**Illinois State University  
Department of Chemistry  
CHE 402.01**

**Advanced Chemistry Demonstrations: Teaching Chemistry as an Experimental Science  
3 credit hours**

**Catalog Description**

Topical analysis of current best practices in teaching chemistry as an experimental science as it can be achieved in secondary school classrooms. A particular emphasis will be to connect content knowledge to modern demonstrations, experiments, and teaching activities.

**Instructor Contact Information**

**Instructor:** TBD

**Required Materials**

**Required:** Access to the ReggieNet Course Website

**Required:** Teaching Chemistry as an Experimental Science Videos  
(<https://www.flinnsci.com/teaching-experimental-science/che402.01>)

**Accommodations**

Any student needing to arrange a reasonable accommodation for a documented disability and/or medical/mental health condition should contact Student Access and Accommodation Services at 350 Fell Hall, (309) 438-5853, or visit the website: StudentAccess.IllinoisState.edu.

**Course Structure, Overview, and Objectives**

This course constitutes a survey course of ways in which we can understand and teach chemistry as an experimental science. A particular emphasis will be to connect content knowledge to modern demonstrations, experiments and teaching activities. Students will improve their chemistry content knowledge from the resource materials, as well as be expected to search local and internet-based resources for current best practices. Students will be introduced to demonstrations, experiments and teaching activities which engage them in a detailed examination of the ways in which current chemistry teachers use experimentation as a central part of their teaching. Students will be exposed to and expected to master the demonstration activities taught in the course.

This course is a structured, self-paced course available online for 8 (*summer*) or 16 weeks (*fall/spring*) according to ISU's semester schedules. Assignments are available from the start of the course to be completed at the student's pace, though deadlines for assignments exist.

This course is structured into six learning modules according to topic:

**1) Introduction to Chemistry as an Experimental Science** - This module reminds you of some basic learning theory, pedagogy, and how it applies to teaching chemistry.

**2) Misconceptions and Discrepant Events in Chemistry** - In this section of the course, we will look at issues surrounding students' misconceptions and the use of discrepant events or other methods to confront those misconceptions.

**3) Science Process Skills and the Nature of Science** - During this section, we will look at ways of incorporating science process skills and nature of science learning into the chemistry classroom.

**4) Inquiry in Chemistry** - In this section of the course, we will look at ways to incorporate inquiry and inquiry learning in the chemistry classroom.

**5) Teaching Strategies for the Chemistry Classroom** - During this section of the course, we will examine some different teaching strategies that might be used when teaching chemistry including the use of toys in the classroom, momentary diversions, silent demonstrations, analogies, and concept maps.

**6) Expanding our Definition of Laboratory Assignments** - In this final section of the course, we will look at some different ways that we have not mentioned yet to challenge students in the chemistry classroom and lab.

This course seeks to provide some answers to the following questions:

1. What is our current best understanding of the traditional and modern scientific method?
2. What are the safety considerations and risks associated with teaching chemistry demonstrations and experiments? How may chemistry be taught safely in schools?
3. What is the role of the National Standards and State Standards in determining what scientific and chemistry process skills are taught in schools?
4. What pedagogical techniques are appropriate for teaching students to conduct experiments in secondary schools?
5. What are the challenges associated with teaching the experimental nature of chemistry and science?

### **Learning Modules: Checklist of Assigned Articles and Videos**

Module 1 Quiz: Introduction to Chemistry as an Experimental Science

- Article: Constructivism: A Theory of Knowledge
- Article: Expanding the 5E Model
- Article: All Students are Not Created Equal: Learning Styles in the Chemistry Classroom
- Article: Straw Men and False Dichotomies: Overcoming Philosophical Confusion in Chemical Education
- Video Package: Scientific Method / Critical Thinking and Problem Solving
  - o Playing With Words

## Module 2 Quiz: Misconceptions and Discrepant Events in Chemistry

- Article: Teaching to Achieve Conceptual Change
- Article: An Inventory for Alternate Conceptions among First-Semester General Chemistry Students
- Video Package: Teaching Strategies / Discrepant Event—Physical Properties
  - The Disappearing Beaker
  - Surface Tension Demonstration
  - Indicator Sponge
  - On the Level
  - Ice Melting Blocks
- Video Package: Teaching Strategies / Discrepant Event—Classroom Lessons
  - Mass vs. Density
  - Discrepant Balloons
  - Preparation of Discrepant Balloons
  - Needle in a Balloon

## Module 3 Quiz: Science Process Skills and the Nature of Science

- Article: *Ten myths of science: Reexamining what we think we know...*
- Article: Science for All Americans, Chapter 1
- Article: The Big Freeze: Water and the Scientific Process
- Article: The Use of Approximations in a High School Chemistry Course
- Video Package: Scientific Method / Observation Skills
  - Foiled Again
  - The Potato Candle
  - Goldenrod Messages and Name Tags
  - Flask and Tubing Observation Activity
- Video Package: Scientific Method / Scientific Method Demonstrations
  - Paraffin Paradox
  - Think Tube
- Video Package: There's Magic in Chemistry
  - Accuracy and Precision Card Trick
  - Ropes and Isotopes
  - Intermolecular Forces Magic Trick
  - The Mellow-Yellow Reaction
  - Magic of Teaching

## Module 4 Quiz: Inquiry in Chemistry

- Article: Inquiry Learning: What Is It? How Do You Do It?
- Article: Preparing Students To Benefit from Inquiry-Based Activities in the Chemistry Laboratory: Guidelines and Suggestions
- Video Package: Scientific Method / Scientific Method Demonstrations
  - Reaction in a Bag
- Video Package: Inquiry Labs / Using Demonstrations to Promote Inquiry
  - Electrochemical Clock
  - Iodine Clock Challenge
  - Rolling Spheres Down an Inclined Plane
- Video Package: Inquiry Labs / Inquiry Lab Activities

- Flinking - Neither Floating nor Sinking?
- Mystery Solutions Lab
- Average or Apparent Mass of an Element
- Analysis of Unknown Solids

#### Module 5 Quiz: Teaching Strategies for the Chemistry Classroom

- Article: The Effect of Using Concept Maps as Study Tools on Achievement in Chemistry
- Article: The role of student-generated analogies in promoting conceptual understanding for undergraduate chemistry students
- Video Package: Scientific Method / Critical Thinking and Problem Solving
  - Lota Bowl
- Video Package: Teaching Strategies / Silent Demonstrations
  - Silent Lecture
  - Penney's Quick Silent Demos
- Video Package: Teaching Strategies / Teaching With Toys
  - Hand Blasters
  - Ralphie, the Drinking Bird
  - Circle of Hand
- Video Package: Teaching Strategies / Momentary Diversions
  - Equilibrium Arrow
  - Bunsen's Birthday
  - Mirror Glass

#### Module 6 Quiz: Expanding our Definition of Laboratory Assignments

- Article: Pedagogies of Enactment in Science
- Video Package: Inquiry Labs / Bob Becker Target Labs
  - Target Lab Discussion
  - Target Density Lab
  - Target Stoichiometry Lab
  - Target Mole Lab
  - Target Gas Law Lab
- Video Package: Inquiry Labs / Jeff Bracken Challenge Labs
  - Measurement Challenge
  - Test Tube Challenge
  - MSDS Challenge Inquiry Lab
  - Production of Sodium Carbonate Lab

## Description of Assignments

- 1) Module Quizzes – Each module quiz covers the articles and videos assigned for that module. Quizzes consist of content specific and pedagogical questions. The lowest order (Knowledge and Comprehension) of the questions are designed to ensure that students watch the video. The medium-order (Analysis and Application) and higher-order (Synthesis and Evaluation) questions may require the use of outside resources to generate correct answers or to consider the use of activity in their own classroom to determine the correct answer. Late quizzes are not accepted.
- 2) Discussion Posts – Modules 1, 3, 5, and 6 contain a prompt for groups of 5-6 students to discuss. Posts are generally 100-200 words in length, and should use supporting information drawn from the articles and videos in that module. Students are also required to post at least three responses to their group members' posts that are thoughtful and constructive of the original post. Responses can be shorter and are generally 50-100 words in length. The module discussion grade includes both initial post and responses. For grading purposes, the discussion board is considered closed when discussion responses are due, although the board will continue to remain active for dialogue to continue.
- 3) Peer Review Assignments – Modules 2 and 4 contain a writing assignment which will be peer reviewed within a student's group of 2-3 others. The writing assignment focuses on using what students have learned over the course of a module to modify an existing activity or lesson. A rubric for each assignment is available within the learning module and is the one that group members use during their peer reviews. Peer reviewing is built into the overall grade and must include constructive comments to earn full credit. Details on how to peer review are included in the learning module assignment. No late peer reviews will be accepted.
- 4) Final Project – Teaching Methods Paper and Peer Review  
Students will be asked to write essay (approximately 1,000 words) about three teaching methods learned throughout the course.

1. *Implementation of method:* A definition/description of the best possible implementation of each method.

2. *Example of method:* At least 1 example from the semester (videos or articles) for each teaching method; it does not have to be the "best implementation" of the method, but you should explain how the example matches or does not match the "best implementation".

3. *Learning theory:* A description of how well each teaching method agrees with our understanding of how students learn. The description is supported with readings/videos from the course or other sources.

A rubric will be provided in the assignment details that group members will use to peer review the essay.

## Course Deadlines – Summer 2018

*Please note that all assignments are due 11:59 PM CST on the date shown. If you are in a different time zone, please plan accordingly.*

	<b>Due Date</b>	<b>Assignment Due</b>	<b>Points</b>
<b>Semester Starts</b>			
Week 2		Module 1 Quiz	30
Week 3		Module 1 Discussion Post	40
		Module 1 Discussion Response	
Week 4		Module 2 Quiz	50
		Module 2 Writing Assignment	70
Week 5		Module 2 Peer Reviews	
Week 6		Module 3 Quiz	50
Week 7		Module 3 Discussion Post	40
		Module 3 Discussion Response	
Week 8		Module 4 Quiz	50
<b>Week 9</b>		<b>Spring Break</b>	
Week 10		Module 4 Writing Assignment	70
Week 11		Module 4 Peer Reviews	
Week 12		Module 5 Quiz	50
Week 13		Module 5 Discussion Post	40
		Module 5 Discussion Response	
Week 14		Module 6 Quiz	50
Week 15		Module 6 Discussion Post	40
		Module 6 Discussion Response	
Week 16		Final Project Writing Assignment	170
Finals Week		Final Project Peer Reviews	
<b>Semester Ends</b>			<b>750</b>

*Note: Each discussion post/response pair is combined for a total of 40 points. Each module writing assignment/peer review pair is combined for a total of 70 points. The final project writing assignment/peer review pair is combined for a total of 170 points.*

### Grading Scale

Grades in the course are based upon timely completion of each assessment/assignment.

- A = 100% – 90%
- B = 89% – 80%
- C = 79% – 70%
- D = 69% – 60%
- F = 59% – 0%