

Methods of STEM Education

This course includes elements of theory and practice for teaching, learning and assessing science, technology, engineering and mathematics instruction. Participants study the history of science education reforms and engage in a variety of activities to gain experiences with the content and process of science in unique contexts. Explore connections between particular teaching settings to reform-based and 21st Century recommendations in teaching science as you learn to use technology as a tool for promoting student understanding.

Instructor: Meghan Marrero, Ed.D

Email: mmarrero@us-satellite.net

Phone: 914.921.5920 x202

Course Texts

National Research Council. (1996) *National science education standards*. Washington DC: National Academy Press. (You may also access this online: <http://www.nap.edu/readingroom/books/nses/>)

American Association for the Advancement of Science. (1990). *Science for all Americans*. (You may also access this online: <http://www.project2061.org/publications/sfaa/online/sfaatoc.htm>)

Additional readings available through the course site.

Course Objectives

Students will be able to:

- ✓ Describe, compare, and implement a variety of pedagogical strategies, including assessment strategies that will enable students to learn science, technology, engineering and mathematics.
- ✓ Understand the Nature of Science and its importance in STEM instruction.
- ✓ Identify a variety of resources for effective instruction in STEM education.
- ✓ Conduct long-term scientific observations and draw conclusions from them.
- ✓ Develop science lessons based on reform-based and 21st Century recommendations, i.e., constructivism, inquiry, engineering design and science literacy.
- ✓ Construct a lesson plan that meaningfully integrates science with another essential subject.

Course Requirements

This course is a blended synchronous/asynchronous class. The live class meeting dates are indicated on the course calendar and on the schedule below. During non-synchronous weeks, participants must participate in online discussions with their classmates, responding to questions posed by the instructor.

All readings are to be done prior to participating in the discussion (by midnight local time on the Lesson date) or class meeting (live class sessions only) for the week. Assignments must be handed in before midnight on the date specified. Students will be assessed using rubrics. Presentations, projects, and participation in the synchronous and asynchronous portions of the course will be used as tools of evaluation for this course.

Major course assignments are outlined in this syllabus; more detailed information will be provided in class. *Changes may be made to the syllabus to accommodate your learning.*

Plagiarism/improper citation of resources will result in no points awarded for an assignment, and may result in course failure.

Major Assignments

1. Course Discussions

Due Date: Weekly

An important component of any graduate course is the discourse between participants. Note that your active participation in and preparation for the weekly discussion threads comprises over 1/3 of your grade in this course. You are expected to contribute meaningfully in these discussions by drawing on readings from the course and outside as well as on your personal experiences as a teacher, learner, and citizen. Please pay careful attention to the rubric that will be used to assess your level of participation.

Actively participate in discussions. To do this you should create a substantive post for each of the discussion topics. Each post should demonstrate your achievement of the participation criteria outlined in the rubric. In addition, you should also respond to the posts of at least two of your fellow learners for each discussion question—unless the discussion instructions state otherwise. These responses to other learners should also be substantive posts that contribute to the conversation by asking questions, respectfully debating positions, and presenting supporting information relevant to the topic. Also, respond to any follow-up questions the instructor or your colleagues direct to you in the discussion area.

*You may miss up to two weeks of discussion. These are considered your ‘absences’.

2. Nature of Science Assignment

Due Date: January 24th

Protocol: Visit sites such as the New York Times, the Science News, CNN, or similar and find an article that describes a **scientific study**. Post the link to the article and your analysis of how it meets any/all of the tenets of the NOS discussed in some of the articles you have read:

- Distinction between Observation and Inference
- Distinction between Theory and Law
- Science as a creative, imaginative process
- Science as socially and culturally embedded
- Science as subject to change

3. Science in Engaging Contexts

Due Date: March 28th

An important part of teaching science is to engage students in different ways. We have identified some unique contexts in class; there are certainly others that may interest you.

Protocol: Develop a formal lesson plan that you might use with students in a subject area that you teach or wish to teach.

Include:

- ✓ Grade level, Topic of focus, Standards Addressed, Time needed
- ✓ Description of and link to resource for engaging context
- ✓ Objectives
- ✓ Procedures/Methods/Student Worksheets if applicable

- ✓ Assessment procedures, i.e., grading rubric(s)

You may work with a partner on this assignment if you choose. These lessons will be shared with your classmates through the course site. This collection of lessons will become a resource to you.

4. Long Term Science Project

Due Dates: 1 paragraph Project Plan due January 31st and Final Observations and Write-up due April 11th

True inquiry-based science projects require long term, systematic observation. This is your opportunity to observe natural phenomena *or* to conduct your own scientific experiment. It will take place over a period of at least 30 days. Another alternative is to use observational data collected by satellites, rovers, or other means.

Protocol: Choose a phenomenon or experiment. Suggestions include, but are in no way limited to:

- Moon Phases
- Spring 'Greening Up'
- Tides
- Star Patterns
- Plant Growth
- Ocean Currents
- Cloud Cover
- Sunspots and Solar Flares

Additional information for conducting the project will be provided in class.

5. Integrated Lesson Plan

Due Date: May 2nd

Subjects in school should not be taught in isolation. It is useful to have students use similar skills and content in a variety of subject areas. Therefore, you will create a lesson that weaves together science and another subject area.

Protocol: This project will be discussed extensively in class and specific instructions given.

Grading Scheme

Assignment	Points (100 total)
Class Participation & Preparation	40 points
Nature of Science Assignment	10 points
Engaging Contexts Lesson Plan	15 points
Science Project	20 points
Integrated Lesson Plan	15 points

B: 80-89

A: 90-99

CEU credit minimum = 75 total points

Graduate credit minimum = 80 total points

*NOTE: No credit given for plagiarism. Please refer to the American Psychological Association Style Guide as a source for proper citation and referencing of material.

Course Calendar

*LIVE course session weeks denoted in bold.

<u>Week of</u>	<u>Topic</u>	<u>Assignments due</u>
10-Jan	STEM Education Overview	
17-Jan	Scientific Literacy	Science for all Americans (SFAA) Introduction & Chapter 13; National Science Education Standards (NSES) Chapters 1 & 3;
24-Jan	The Nature of Science; STS Approaches, and Scientific Issues	SFAA Chapters 1 & 8; (Lederman & Lederman, 2004; Schwartz, 2007) (Aikenhead, n.d.; Sadler, 2004) Nature of Science Assignment due
31-Jan	STEM for the 21 st Century	(Angier, 2010; President's Council of Advisors on Science and Technology, 2010) Science Project Topic Due
7-Feb	Constructivist Science & Conceptual Change	NSES Chapter 6, pp. 102-105; (Colburn, 2000; Driver, Asoko, Leach, Scott, & Mortimer, 1994);
14-Feb	Science as Inquiry	NSES Chapter 2 (K. L. Anderson, Martin, & Faszewski, 2006; R. D. Anderson, 2002; Rommel-Esham, 2007)
21-Feb	Integrating Science Content and Process	(Olson & Loucks-Horsley, 2000; Zubrowski, 2002)
28-Feb	Engaging Contexts for Science; Science & Engineering	NSES Chapter 3; (Connolly, Groome, Sheppard, & Stroud, 2006); (Burghardt & Hacker, 2004; Garmire, 2003)
7-Mar	Assessing Student Learning	NSES Chapter 5 (Peters, 2008; Shepard, 2000; Siegel, Wissehr, & Halverson, 2008; Volkmann & Abell, 2003)
14-Mar	Assessing Student Learning	(Beckstead, 2008; McNair, 2004; Struble, 2007)
21-Mar	Science and Technology	Readings TBD
28-Mar	Integrating Science & Other Subjects	(Davison, Miller, & Methy, 1995(Austin, Menasco, & Vanette, 2008; Casteel & Isom, 1994)

		Science in Engaging Contexts Lesson Plan Due
4-Apr	Integrating Science & Other Subjects	(Stoddart, Pinal, Latzke, & Canaday, 2002) (Rudge & Howe, 2004; Schopf, 2005)
11-Apr	Blending Western and Indigenous Science	(Kimmerer, 2002; Lambert, 2003; Snively & Corsiglia, 2001) Science Project Due
18-Apr	STEM for All Students	(Carver & Bailey, 2010; Cawley, Hayden, Cade, & Baker-Kroczyński, 2002; Scruggs, Mastropieri, Bakken, & Brigham, 1993)
25-Apr	Meaningful Standards-based Instruction	Presentations
2-May	Meaningful Standards-based Instruction	Presentations Integrated Lesson Plan Due

Appendix

Readings

Below is the list of readings for the course. You may access these through the course space.

Aikenhead, G. (n.d.). What is STS Science Teaching? Retrieved August 7, 2008, from <http://www.usask.ca/education/people/aikenhead/sts05.htm>

Anderson, K. L., Martin, D. M., & Faszewski, E. E. (2006). Unlocking the Power of Observation. *Science and Children*, 44(1), 32-354.

Anderson, R. D. (2002). Reforming Science Teaching: What Research Says about Inquiry. *Journal of Science Teacher Education*, 13(1), 1-12.

Angier, N. (2010). STEM Education Has Little to Do With Flowers. *The New York Times*. Retrieved from http://www.nytimes.com/2010/10/05/science/05angier.html?_r=1

Austin, B., Menasco, J., & Vanette, T. (2008). The Nature of Science in Popular Nonfiction. *The Science Teacher*, 75(5), 27.

Beckstead, L. (2008). Scientific Journals: A Creative Assessment Tool. *Science and Children*, 46(3), 22-26.

Burghardt, M. D., & Hacker, M. (2004). Informed Design: A Contemporary Approach to Design Pedagogy as the Core Process in Technology. *The Technology Teacher*, 64(1), 6-7.

Carver, A., & Bailey, J. (2010). Unit Pages: Differentiation for 200 Students. *Science Scope*, 33(6), 6.

Casteel, C. P., & Isom, B. A. (1994). Reciprocal processes in science and literacy learning. *The Reading Teacher*, 47(7), 538-545.

- Cawley, J., Hayden, S., Cade, E., & Baker-Kroczyński, S. (2002). Including students with disabilities into the general education science classroom. *Exceptional Children*, 68(4), 423-436.
- Colburn, A. (2000). Constructivism: Science Education's 'Grand Unifying Theory'. *Clearing House*, 74(1), 9-12.
- Connolly, R., Groome, M., Sheppard, K., & Stroud, N. (2006). Tips from the Field. *The Science Teacher*, 73(1), 42-45.
- Driver, R., Asoko, H., Leach, J., Scott, P., & Mortimer, E. (1994). Constructing Scientific Knowledge in the Classroom. *Educational Researcher*, 23(7), 5-12.
- Garmire, E. (2003). The Engineering Design Method. *The Technology Teacher*, 63(23-28).
- Kimmerer, R. W. (2002). Weaving Traditional Ecological Knowledge into Biological Education: A Call to Action. *Bioscience*, 52(5), 433-439.
- Lambert, L. (2003). From 'Savages' to Scientists: Mainstream Science Moves toward Recognizing Traditional Knowledge. *Tribal College Journal*, 15(1), 10-13.
- Lederman, N. J., & Lederman, J. S. (2004). Revising Instruction to Teach Nature of Science. *The Science Teacher*, 71(9), 36-39.
- McNair, S. (2004). "A" is for Assessment. *Science and Children*, 35(1), 24-27.
- Olson, S., & Loucks-Horsley, S. (2000). Inquiry and the National Science Education Standards: A guide for teaching and learning. Washington, DC: National Research Council.
- Peters, E. (2008). Assessing Scientific Inquiry. *Science Scope*, 31(5), 27-33.
- President's Council of Advisors on Science and Technology. (2010). *Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America's Future*. Washington, DC: Executive Office of the President.
- Rommel-Esham, K. (2007). How Much Popcorn Will Our Classroom Hold? *Science and Children*, 45(2), 22-26.
- Rudge, D. W., & Howe, E. M. (2004). Incorporating History into the Science Classroom. *The Science Teacher*, 88(10), 52-57.
- Sadler, T. D. (2004). Informal Reasoning Regarding Socioscientific Issues: A Critical Review of Research. *Journal of Research in Science Teaching*, 41(5), 513-536.
- Schopf, K. (2005). Kekule's Dream & Bunsen's Burner. *The Science Teacher*, 89(8), 30-33.
- Schwartz, R. (2007). What's in a Word? How word choice can develop (mis)conceptions about the nature of science. *Science Scope*, 31(2), 42-47.

- Scruggs, T., Mastropieri, M., Bakken, J., & Brigham, F. (1993). Reading versus doing: The relative effects of textbook-based and inquiry-oriented approaches to science learning in special education classrooms. *The Journal of Special Education, 27*(1), 1.
- Shepard, L. A. (2000). The Role of Assessment in a Learning Culture. *Educational Researcher, 29*(7), 4-14.
- Siegel, M. A., Wissehr, C., & Halverson, K. (2008). Sounds Like Success: A Framework for Equitable Assessment. *The Science Teacher, 75*(3), 43-46.
- Snively, G., & Corsiglia, J. (2001). Discovering Indigenous Science: Implications for Science Education. *Science Education, 85*(1), 6-34.
- Stoddart, T., Pinal, A., Latzke, M., & Canaday, D. (2002). Integrating inquiry science and language development for English language learners. *Journal of Research in Science Teaching, 39*(8), 664-687.
- Struble, J. (2007). Using Graphic Organizers as a Formative Assessment. *Science Scope, 31*(5), 69-70.
- Volkman, M. J., & Abell, S. K. (2003). Seamless Assessment. *Science and Children, 40*(8), 41-45.
- Zubrowski, B. (2002). Integrating science into design technology projects: Using a standard model in the design process. *Journal of Technology Education, 13*(2), 47-65.