Endeavor
Science Teaching Certificate Project

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.

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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.

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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.

2. Nature of Science Assignment **Due Date: February 22nd**

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 21st**

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 February 15th and Final Observations and Write-up due March 28th**

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: April 11th**

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.**

Due Date	Topic	Assignments due
Jan 25	STEM Education Overview	
Feb 1	Scientific Literacy and STEM for the 21st Century	Science for all Americans (SFAA) Introduction (Angier, 2010; President's Council of Advisors on Science and Technology, 2010)
Feb 8	Science as Inquiry	(K. L. Anderson, Martin, & Faszewski, 2006; R. D. Anderson, 2002; Everett & Moyer, 2007); NSES Chapter 2
Feb 15	The Nature of Science, STS Approaches, and Socioscientific Issues Science and Technology	Science for all Americans (SFAA) Chapter 1; National Science Education Standards (NSES) Chapters 1 & 3; (Lederman & Lederman, 2004; Schwartz, 2007) (Aikenhead, n.d.; Sadler, 2004) Also read the blog post in the Lesson. **Science Project Topic Due**
Feb 22	Constructivist Science & Conceptual Change	NSES Chapter 6, pp. 102-105; SFAA Chapter 13; (Colburn, 2000; Driver, Asoko, Leach, Scott, & Mortimer, 1994) **Nature of Science Assignment Due**
Feb 29	Integrating Science Content and Process	(Olson & Loucks-Horsley, 2000; Robertson, 2006; Zubrowski, 2002) *Just Chapter 2 of Olson & Loucks-Horsley

March 7	STEM for all Students	(Carver & Bailey, 2010; Cawley, Hayden, Cade, & Baker-Kroczynski, 2002; Scruggs, Mastropieri, Bakken, & Brigham, 1993)
March 14	Engaging Contexts for Science; Science & Engineering	NSES Chapter 3; (Connolly, Groome, Sheppard, & Stroud, 2006); (Burghardt & Hacker, 2004; Garmire, 2003)
March 21	Assessing Student Learning	NSES Chapter 5 (Peters, 2008; Shepard, 2000; Siegel, Wissehr, & Halverson, 2008; Volkmann & Abell, 2003) (Beckstead, 2008; McNair, 2004; Struble, 2007) **Engaging Contexts Lesson Plan Due**
March 28	Integrating Science and Other Subjects	*(Stoddart, Pinal, Latzke, & Canaday, 2002)* (Rudge & Howe, 2004; Schopf, 2005) (Davison, Miller, & Methy, 1995(Austin, Menasco, & Vanette, 2008; Casteel & Isom, 1994) **Science Projects Due**
April 4	Meaningful Standards-Based Instruction	**Presentations**
April 11	Meaningful Standards-Based Instruction	**Integrated Lesson Plan Due**

Appendix

Readings

Below is the list of readings for the course. You may access these through the course space in the Endeavor Online Learning System.

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-Kroczynski, S. (2002). Including students with disabilities into the general education science classroom. *Exceptional Children, 68*(4), 423-436.

Colburn, A. (2000). Constructvism: 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.

Everett, S., & Moyer, R. (2007). "Inquirize" Your Teaching: A guide to turning favorite activities into inquiry lessons. *Science and Children, 44*(7), 54-57.

Garmire, E. (2003). The Engineering Design Method. *The Technology Teacher, 63*(23-28).

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.

Robertson, B. (2006). Getting Past "Inquiry Versus Content.". [Article]. *Educational Leadership, 64*(4), 67-70.

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.

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.

Volkmann, 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.