EDUC56:
STEM and Education

COURSE DESCRIPTION
How do we learn, understand, and teach science, technology, engineering, and math (the
STEM disciplines)? In this class, we will explore the nature and development of the
scientific mind; how we formulate theories, design experiments, and understand
scientific, technological, and mathematical concepts; and how we learn and teach related
skills in the classroom, addressing the debate about the effectiveness of direct instruction
and hands-on approaches.
The main goals of this course are to:
- Become proficient at reading empirical research articles in experimental psychology,
  neuroscience, and education focusing on STEM learning
- Become familiar with the major concepts and theoretical models from psychology and
  neuroscience that relate to STEM learning
- Become adept at evaluating the merit of claims from proposed educational
  interventions regarding science and math

COURSE REQUIREMENTS
- All readings will be available on Canvas and you are required to read the assigned
  papers before class.
- In-class discussion of assigned readings is a critical component of this course and will
  be facilitated by bringing the articles to class for your reference.
- Developing the skills of critically reading empirical research articles and writing for a
  scientific audience are central to achieving the course goals.

GRADING OVERVIEW
30% Midterm Exam
30% Final Exam
15% Class Debates and Position Paper
10% Social Impact Practicum Research Paper
10% Quizzes (average of all 6)
3% Class Participation and Attendance
2% Research Participation (or alternative assignment)
ASSIGNMENTS and ASSESSMENTS

Midterm examination – MONDAY, JANUARY 29TH
- Mix of fill-in-the-blank questions (~1-3 word responses) and short answer questions (~1-3 paragraph responses)
- Covers material from lecture slides, class discussions, and assigned readings (the aspects of the readings highlighted in class are the most relevant)

Final examination – SUNDAY, MARCH 11TH @ 8am
- Same question formats as the midterm, more questions
- Cumulative, but greater focus on the material since the midterm

Class Participation & Attendance
- Arrive on time for each class
- Prepare for class discussions (read the assigned materials, stay awake during class, stay off internet, etc.)
- Demonstrate that you are familiar with the assigned readings. Complete understanding of the readings prior to class discussion is not expected – questions about the readings are always encouraged. Hopefully discussion will help elucidate any confusing aspects of the articles. In this way, your comments and questions will help everyone understand the material in greater depth.

Quizzes – Six quizzes throughout the term
- Any material covered to date is fair game, including that day’s assigned readings
- These are intended to be low-stakes opportunities to gauge your understanding of the material.
- Your quiz grade will be the average of your 6 quiz scores

Social Impact Practicum
- We have partnered with two local educational venues, the Vermont Institute of Natural Sciences (VINS) and InspireKids, to design lesson plans for some informative activities into classrooms and outdoor learning environments
- You will work with your group on a specific project (assigned after the midterm) related to, for example, Astronomy, Geology, or pre-engineering skills and write up a brief report on the lesson you design as a group.
- On the last two days of class the groups will share their lessons with the class.
Research Participation
- The goal of this assignment is to provide you with an insightful perspective on research studies. Please complete one of the following options by **Tuesday, March 6th:**

**Option #1:**
*Volunteer to participate in lab research in the Education Department (2 hours total)*

Volunteer to participate in one or more research studies conducted by any research lab in the Education Department, totaling **two hours** of participation (e.g., one two-hour study or two one-hour studies). Specific instructions on how to sign up for a research study are posted on Canvas. To get credit, you must hand in a signed *EDUC16 Participant Confirmation Form* (one signed copy for each study in which you participate) to me in class anytime before **Tuesday, March 6th**. A copy of the form is posted on Canvas.

**Option #2:**
*Write two methods critiques of published research articles (approx. 1 page each)*

If you are unable to participate or uninterested in participating in a research study, you may write an in-depth critique of the methods employed in a published research article. First, locate two empirical articles that were not assigned for this course. Then, for each study, you will write approximately half a page (double-spaced, 12pt font) that explains one aspect of the study procedure that you think the researchers could improve upon without sacrificing the scientific integrity of the study. Be sure to explain why this change is relevant to the authors' conclusions and how the authors expect the results will generalize to other individuals or other situations that were not directly tested. Lastly, on the remainder of the page, briefly describe a research question that builds on the current study but that is not fully addressed by the methods in this article. In other words, given the results of the current study, *what is the next question you would like the researchers to address?* Describe how this research question follows from the results of the current study and briefly outline the new methods that the researchers could use to address this question. Hand in your overview to me in class anytime before **Tuesday, March 6th**. Attach a copy of the first page of the empirical article, including the abstract.

You may also combine these two options. If you choose to do so, each 1-page critique is equivalent to 1 hour of research participation.
GENERAL POLICIES

1. **Read all materials and prepare for class.** You are expected to read the materials posted on Blackboard before each class. Be prepared to discuss that material in class. Everyone is expected to come to every class and to arrive on time. You are also expected to contribute to class discussion. You will learn the material better and others will learn from you. The success of this course depends on everyone coming to class prepared and ready to discuss the material. Both attendance (on-time) and preparation for class will determine a portion of your grade (see “Assignments and Assessments” below).

2. **Before you turn in your papers...** make sure that you use 12-point Times New Roman font, that you double-space the whole document, that your print margins are 1-inch on all sides (not the default in Word), that all your pages are numbered, and that your document is stapled together (if printed). For citations in all papers, you must use APA Style formatting (refer to the APA Style Manual or online guides, such as: [http://owl.english.purdue.edu/owl/resource/560/01/](http://owl.english.purdue.edu/owl/resource/560/01/))

3. **Tell me sooner rather than later.** If you know ahead of time that you will be missing a class, e.g., for sports, please let me know in advance in order to avoid losing participation credit. Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me before the end of the second week of the term to discuss appropriate accommodations.

4. **ASSUME THAT I WILL NOT ACCEPT LATE ASSIGNMENTS.** It’s always better to check with me ahead of time (or as soon as possible) if you think you’ll be turning in something late due to travel, or unexpected illness, etc.

5. **Cell phones are not to be used in class.** If an emergency arises that requires the use of a phone, please quietly excuse yourself from the room to respond.

6. **Accommodations.** Students with learning, physical, or psychiatric disabilities enrolled in this course who may need disability-related classroom accommodations are encouraged to make an office appointment to see me early in the semester (i.e., within the first two weeks). If you have not done so already, students requiring disability-related accommodations should register with the Student Accessibility Services office (301 Collis Student Center). Dartmouth’s policies and resources: [http://www.dartmouth.edu/~accessibility](http://www.dartmouth.edu/~accessibility) Contact info: 646-9900, Student.Accessibility.Services@Dartmouth.edu

7. **Plagiarism is unacceptable.** All work submitted as your own must be written by you and not previously submitted for any other class. It is important to attribute material that is the work of others to the original source. If you are unsure how to properly cite a source, please consult with me prior to handing in an assignment (and see: [http://www.dartmouth.edu/~writing/sources/](http://www.dartmouth.edu/~writing/sources/)). You should be familiar with Dartmouth’s Honor Principle, which applies to all courses at Dartmouth (available here: [www.dartmouth.edu/~uja/honor/](http://www.dartmouth.edu/~uja/honor/)). I do not expect any violations of this code, but if any concerns do arise I will forward all related materials to Dartmouth’s Committee on Standards.
SCHEDULE  
(ASSIGNED READINGS ARE POSTED ON CANVAS)

Wednesdays, January 3
INTRODUCTION and COURSE OVERVIEW

INFORMAL MATH: ESTIMATION AND NUMBER REPRESENTATIONS

Friday, January 5 + Monday, January 8
MAGNITUDE AND THE APPROXIMATE NUMBER SYSTEM (ANS)
Readings:

Wednesday, January 10
NUMBER REPRESENTATIONS AND THE TRIPLE CODE MODEL
Readings:

Friday, January 12
NUMBER LINES: LOG VS. LINEAR REPRESENTATIONS
Readings:
FORMAL MATH: INSTRUCTION AND CALCULATIONS

Monday, January 15 + Wednesday, January 17

MATH INSTRUCTION STRATEGIES; ELEMENTARY MATH
Readings:

Friday, January 19

FRACTIONS AND ADVANCED MATH
Readings:

Monday, January 22

DEBATE #1
MOTION: “Singapore Math’ is a worthwhile investment for US schools.”
Readings:
1) TBD by Debate Group 1
2) TBD by Debate Group 2

Wednesday, January 24 + Friday, January 26

MATH ANXIETY AND STEREOTYPE THREAT
Readings:


Monday, January 29
MIDTERM EXAM

Wednesday, January 31
SIP ASSIGNMENTS and DESIGNING A LESSON PLAN
Readings:
1) See example science lesson plans for Inquiry-based activities: https://www.dartmouth.edu/~academicoutreach/gk12/inquiry.html

Friday, February 2
NAÏVE SCIENCE CONCEPTS
Readings:

Monday, February 5 + Wednesday, February 7
LEARNING TO THINK AS A SCIENTIST: OBSERVING, QUANTIFYING, TESTING
Readings:

Friday, February 9
SOCIAL IMPACT PRACTICUM PROJECT WORK

Monday, February 12
CONCEPTUAL MENTAL MODELS; ANALOGY IN SCIENTIFIC DISCOURSE
Readings:

**Wednesday, February 14 + Friday, February 16**

**LEARNING THE VOCABULARY OF SCIENCE; LEARNING VIA OBSERVATION**

Readings:

**Monday, February 19 + Wednesday, February 21**

**CLASSROOM TECH: ED SOFTWARE, ONLINE INSTRUCTION**

Readings:

**Friday, February 23 - NO CLASS TODAY**

**Monday, February 26**

**DEBATE #2**

**MOTION: “Science labs are worthwhile for US high schools.”**

Readings:
1) TBD by Debate Group 3
2) TBD by Debate Group 4

**Wednesday, February 28 + Friday, March 2**

**CLASS DEMONSTRATIONS OF SIP LESSONS**