Science, permeates all aspects of our lives, even before we are born, yet science and science education continue to be controversial issues across all levels of our society. Climate change, Autism, Evolution, Diet, and determining whether our drinking water is safe are but a few of the scientific topics that we wrestle with every day. Do we really understand these issues? Where does our scientific knowledge come from, and now do we acquire this knowledge? Is there something special about science and scientific thinking? How do children acquire scientific concepts? What happens when our scientific concepts are wrong? What is the difference in understanding of scientific concepts different ages? How should science be taught? The goal of this course is to address these questions. We will probe the educational, cognitive, social, and cultural factors that underlie our use of scientific concepts and reasoning. Other goals of the course are to answer questions such as: What is science? Is there such a thing as the scientific method, and what you need to know about the nature of science as a student? How do scientists make discoveries? Are there differences between women and men scientists and students and are they important? How is science learned and taught? Is the human mind/brain wired for science? What is the media’s role in science and science education? How do science, politics and culture interact? Can science be trusted? We will explore these topics by probing contemporary science, education, development, and culture in a lively and up-to-date fashion.

Course objectives. EDHD 414 students will demonstrate:
1. An understanding of the lifespan approach to the learning science. The focus will be on strategies that infants, children, and students use to acquire and use scientific concepts. This includes an understanding of both the history of science and how this relates to theories of both cognitive and social development;
2. Knowledge of the ways that students learn about science and the ways that scientists think and reason while they create science: Analogy, Categorization, Causal reasoning, Induction & Deduction;
3. Understanding key topics in science education such as the nature of conceptual change, gender and science, minorities and science;
4. Understanding why there are public misconceptions about science and why these misconceptions persist; Autism, Climate Change, and Evolution as key examples.
5. How the very forces that lead to successful science can also lead to mistakes, errors and distortions in science. We discuss confirmation bias, fabrication of results and the ethical conduct of science.

Course Structure: Two classes per week incorporating lectures, student discussions quizzes and presentations. Class starts promptly at 9:30. Be on time. Attendance is mandatory.
Pop Quiz on the readings: These will be given at the beginning of Thursday’s class and must be completed at the beginning of the class (9:35-9:40). These questions will be based on the readings for the week (The best 10 out of 12 will be used with all 12 getting at least a C-). Pop quiz’s completion is worth 10% of the final grade. The questions will be very general.

Evaluation:
(1) Midterm Short answers (20%)
(2) Final examination consisting of short essay type questions (25%).
(3) Group Presentations (25%).
(4) In class discussion of readings and participation (10%)
(5) Pop quiz completion and answers (15%). Attendance is mandatory You will sign in.

Readings: All the readings for the course will be available on Canvas. All readings should be read before the class. This is really, really, really important. You must come to class having read the readings. The readings are from journal articles and book chapters that deal with the specific issue being covered that week. A full list of the readings is in the last few pages of this syllabus. Each Thursday class will have 2 assigned group leaders who will lead a discussion of the readings for that week.

The Final essay: The final essay will be about a key topic in scientific thinking or science education that has been covered in the course and, or, is relevant to the course. Essays must be handed in at the beginning of the last class. All the details of the essay will be covered after the midterm. The essay should be on a topic that you find interesting and is related to the course. The topic needs to be approved by the instructor (Prof Dunbar) before you start it. If you have trouble finding a topic I will help you find one.

CLASS POLICIES
Please see the University's website for undergraduate course-related policies at http://www.ugst.umd.edu/courserelatedpolicies.html.

Academic integrity: The University of Maryland, College Park has a student-administered Honor Code and Honor Pledge. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. The code prohibits students from cheating, fabrication, facilitating academic dishonesty, and plagiarism. Instances of this include submitting someone else’s work as your own, submitting your own work completed for another class without permission, or failing to properly cite information other than your own (found in journals, books, online, or otherwise). Any form of academic dishonesty will not be tolerated, and any sign of academic dishonesty will be reported to the appropriate University officials.

Special needs: If you have a registered disability that will require accommodation, please see the instructor so necessary arrangements can be made. If you have a disability and have not yet registered with the University, please contact Disability Support Services in the Shoemaker Building (301.314.7682, or 301.405.7683 TTD) as soon as possible.

Religious observances: The University of Maryland policy on religious observances states that students not be penalized in any way for participation in religious observances. Students shall be allowed, whenever possible, to make up academic assignments that are missed due to such absences. However, the must contact the instructor before the absence with a written notification of the projected absence, and arrangements will be made for make-up work or examinations.
Course evaluations: As a member of our academic community, students have a number of important responsibilities. One of these responsibilities is to submit course evaluations each term through CourseEvalUM in order to help faculty and administrators improve teaching and learning at Maryland. All information submitted to CourseEvalUM is confidential. Campus will notify you when CourseEvalUM is open for you to complete your evaluations for fall semester courses. Please go directly to the website (www.courseevalum.umd.edu) to complete your evaluations. By completing all of your evaluations each semester, you will have the privilege of accessing online, at Testudo, the evaluation reports for the thousands of courses for which 70% or more students submitted their evaluations.

Missed single class due to illness: Once during a semester, a student’s self-authored note will be accepted as an excuse for missing a minor scheduled grading event in a single class session if the note documents the date of the illness, acknowledgement from the student that information provided in the note is correct, and a statement that the student understands that providing false information is a violation of the Code of Student Conduct. Students are expected to attempt to inform the instructor of the illness prior to the date of the missed class.*

Major scheduled grading events: Major Scheduled Grading Events (MSGE) are indicated on the syllabus. The conditions for accepting a self-signed note do not apply to these events. Written, signed documentation by a health care professional, or other professional in the case of non-medical reasons (see below) of a University-approved excuse for the student’s absence must be supplied. This documentation must include verification of treatment dates and the time period for which the student was unable to meet course requirements. Providers should not include diagnostic information. Without this documentation, opportunities to make up missed assignments or assessments will not be provided.

Non-consecutive, medically necessitated absences from multiple class sessions: Students who throughout the semester miss multiple, non-consecutive class sessions due to medical problems must provide written documentation from a health care professional that their attendance on those days was prohibited for medical reasons.

Non-medical excused absences: According to University policy, non-medical excused absences for missed assignments or assessments may include illness of a dependent, religious observance, involvement in University activities at the request of University officials, or circumstances that are beyond the control of the student. Students asking for excused absence for any of those reasons must also supply appropriate written documentation of the cause and make every attempt to inform the instructor prior to the date of the missed class.

DETAILED COURSE SCHEDULE
EDHD 414 fall 2016

Weeks 1 & 2: Overview of the Course & the Nature of Science? (August 30 & September 1, 6 & 8)
We will first look at what YOU think science is. The answer is not so simple. How do you think science should be taught? How have you been taught? What science should everyone know to survive in our science infused world. What do scientists actually do? I will give an overview of the main issues, assumptions, and controversies in understanding science, science education, and the way that the scientific mind works. What is the scientific Mind? How does the scientific mind develop? Is Science in the US falling behind that of other countries. Taking Climate Change as a starting off point we will consider the different aspects of science that have been considered over the past century and how the different views have or have not dealt with the changing developmental needs across the lifespan. We will see a shift in the understanding of science from a set of facts to be understood, to the methods of science, and the thinking processes involved in science and the social nature of science. We will see that politics and science are also intermingled.
Weeks 3 & 4: Science Across the Lifespan: What children know about science and how they learn and construct scientific concepts. September 13, 15, 20, 22

Why do human beings appear to be the only species that has science? Are we born this way? How would we know? What does research tell us? Here we will look at what we know about infants, young children & adolescents. Can they propose a theory? Can children Design an experiment? What do researchers say about the development of the scientific mind and how have changes in our understanding of development changed the ways that science education works? What is an experiment? Do you need a hypothesis to conduct an experiment? Given the potentially infinite number of experiments that scientists could conduct, how do they decide to conduct an experiment in a particular way? We will look at designing experiments as a form of problem solving. We will look at the teaching of the use of controls and control conditions. We will also look at when and whether children can design and interpret an experiment. Are adults and scientists any better at designing experiments than children? Surprisingly the answer to this question is not easy. Recent research has revealed that even young infants appear to have a rudimentary knowledge of cause and effect, yet scientists sometimes fail to see the link between a cause and an effect. How does this happen? Here we will look at infants, children’s and scientist’s use of causal reasoning. Many science educators, psychologists, historians of science, and physicists have argued that the key goal of science and the key goal of learning science are large-scale changes in concepts or conceptual change. Two areas of science where conceptual change has proved very difficult are physics and chemistry. Many educators have argued that both adults and children possess many basic concepts that must be overcome in the classroom and in the laboratory. In Chemistry, the nature of molecules and atoms is extremely difficult for students to learn. We will look at ways that educators have used to overcome these so-called “Naïve” theories and whether they have succeeded or not.

Weeks 5 & 6: The underlying Processes of Science Sept 27, 29, October 4, 6 (midterm Oct 6)

Two common answers to this question are induction and deduction. This week we will unravel the mechanics of induction and deduction and see how they are used when we reason scientifically. One form of induction that is common in science is to generalize from a set of specific examples. Is induction in science different from induction that people use in their everyday lives? We will take a look at some of the problems that both non-scientists and scientists have with using induction and see that deduction also has similar problems and how science education attempts to incorporate these ways of thinking into the science curriculum across the lifespan.

Week 7 Analogies, Deduction and Causality: October 11 & 13

Analogies are used at all levels of science from children understanding the world to Nobel Prize winning scientists developing radical new theories. We all use analogy to help us understand scientific issues and problems. How is it used? When do analogies really help educate and when do analogies get in the way? In particular, we will look at the computer metaphor for the human mind and the solar system analogy for understanding the atom in science education. We will also explore the use of analogy generation and how the use of many analogs can help both scientists and students understand complex scientific phenomena.

Weeks 8 & 9, Minorities, Gender & Science: October 18, 20, 25, 27

Women and minorities continue to be under-represented in many sciences, particularly in senior positions. What are the reasons for this and what is the role of education in issues of minorities & gender in science? In these two weeks we will examine the historical background of these important problems for our society. First, we will examine where women stand in science today, some recent examinations of women in science and some of the issues regarding the idea that women conduct science in a different way from men. Then we will investigate the underrepresentation of African Americans and Latinos in science and what is being done to redress these under representations.
Weeks 10 & 11: (November 1, 3, 8 & 10) Informal Science at home, in the playground and in the museum.
Science and learning about science is a lifelong experience: We learn much of our knowledge about science outside the classroom in informal contexts, ranging from the playground, the world-wide web, movies, museums and apps. Much of this learning is goal directed and is non-hierarchical knowledge. Can we have a coherent understanding of science when we gain our knowledge in such diverse ways? How does informal science work? We will look at children and families at science museums, on the internet, and across different age ranges. We will also consider the citizen science movement and how non scientists are changing science and making scientific discoveries.

Much of our knowledge of science is acquired from unreliable sources, and conspiracy theories of virtually every aspect of science are abundant. Mistruths about science are frequently alluded to in decisions that we make about everything from the food we eat, medicines we take, and the weather that we experience. How does this happen and why does misinformation and misconceptions of science abound? We will explore the underlying reasons for these problems using these controversies.

Weeks 14 & 15: When Scientists go wrong: Ethics, Ghostwriting, Fabrication of results & Replication (November 29, December 1, 6 & 8)
Some scientists have made spectacular claims only later to find out that they were wrong. Why? One of the most important ways the scientists make errors is by "confirmation bias:" Scientists often unwittingly seek evidence that is consistent with their viewpoint, and ignore evidence that is inconsistent with it. Other aspects of science gone astray are ghostwriting -- when drug companies write a paper and the scientist puts their name on the paper. Finally, there are situations where scientists have invented data that is consistent with their theories. This week we will explore when and why this happens. Finally, societal concerns can also shape the way that science is conducted. Most recently the reproducibility project has demonstrated that over 40% of experimental results in psychology do not replicate. The same group are now investigating medical research.

READINGS FOR EDHD 414 Fall 2016
The Development of the Scientific Mind
Across the Lifespan

Weeks 1 & 2: Overview of the Course & the nature of Science

Weeks 3 & 4: Are we born little scientists? The Development of the scientific Mind (September 13, 15, 20, 22)

Weeks 5 & 6: The underlying Processes of Science- Beyond “the Scientific Method.” Sept 27, 29, October 4, 6 (midterm Oct 6)

Week 7: Understanding and creating science by Analogy, Deduction and Causality

Weeks 8 & 9: Gender, minorities & Science

Weeks 10 & 11: (November 1, 3, 8 & 10) Informal Science at home, in the playground and in the museum
Role of Science Learning Outside of School Grows: Learning opportunities are plentiful, from after-school programs to computer simulations to zoo visits. April 1, 2011 - Education Week http://www.edweek.org/ew/articles/2011/04/06/27is-informaloverview.h30.html

Week 13: Public misunderstanding of science: Vaccines Autism, Climate Change, Evolution & Conspiracy Theories in Science November 15, 17, & 22
Egan, Pj., & Mullin, M. (2016). Recent improvement and projected worsening of weather in the United

**Weeks 14 & 15: When Scientists go wrong: Ethics, Ghostwriting, Fabrication of results & Replication**

