UNIVERSITY OF MARYLAND
College of Education

Instructor: Dr. Diane Jass Ketelhut and Ms. Ashley Coon
Course: EDCI411 Knowledge, Reasoning, and Learning in Science
Course Location: EDU2212b Course Time: T and TH 2-3:15
Office: 2226L Benjamin Office Hours: Tuesday and Thursday 1:30-2 or by appointment
Contact Info: djk@umd.edu 301-405-3324 (email is by far preferable and more assured of reaching us) acoon@umd.edu

COURSE DESCRIPTION:
This is the first of a three course sequence designed for prospective secondary science teachers as well as part of the sequence for prospective middle school math/science teachers. This course will focus on students and models of learning/teaching science to them. Towards that end, we will investigate what students know via interviews, how they come to know that using the literature, and how best to help students learn including the use of educational technology. While focusing on students, we will also think about what students should be learning—content and/or scientific inquiry? Students will apply, evaluate, and reflect upon science teaching methods through class activities and field experience assignments that address the nature of science.

The assignments for the course will use the foundation fostered in the course readings and discussion to (a) examine science content, (b) student conceptions, (c) the meeting of theory and practice, and (d) lesson planning. Students will have opportunities to examine and evaluate various curricula as application of their evolving understanding of how students learn and of what they should be learning.

COURSE GOALS*:
Through course readings, active participation in class discussions, field experiences, and assignments, students will develop knowledge, skills and attitudes relating to:

1. How secondary students learn science (NSTA: 3, 4, 6; InTASC: 1, 2, 5, 7; COECF: EC1, EC2, subject matter, pedagogy, learners)
2. The nature of science (NSTA: 2, 3; InTASC: 4; COECF: EC7, subject matter)
3. The history and goals of science education (NSTA: 2, 3, 4; COECF: EC7, subject matter, pedagogy)
4. Current research on science teaching and learning (NSTA: 5; InTASC: 1, 2, 3, 5, 6, 7; COECF: EC1, EC2, EC7, subject matter, pedagogy, learners, curriculum, social and cultural contexts)
5. The Next Generation Science Standards

COURSE MATERIALS:
1. You must purchase field experience module of live text for the field experience portion of this course. Additional information will be given on this in class.
2. Reading will be assigned throughout the course that will be available as handouts or through the library.
3. Optional: I strongly urge you to join the National Science Teachers Association. There is a sharply reduced price for full time students. The Science Teacher is the journal aimed at high school teachers. Science Scope is for middle school teachers.
4. In addition, you must:
   a. Be sure that you regularly check your UMD email account in order to get all important messages as I will send updates between classes.

COURSE EXPECTATIONS:
1. Attendance Policy:
The interactive nature of this course requires regular attendance to ensure your learning and that of your classmates. One absence is allowed. Additional absences will cause your attendance/participation grade to be reduced by one increment for each absence. In the event of illness or if an emergency occurs preventing

* Parentheses list association standards applicable to goal (also see assignments). Acronyms are as follows: NSTA—National Science Teachers Association; InTASC—Interstate New Teachers Assessment and Support Consortium Standards; COECF: Conceptual Framework of the College of Education)
you from attending class, please contact me privately through email or phone in advance if at all possible. On return to class, please bring a note identifying the dates and reason for the absence and acknowledge the veracity of the note. Please bring a note from a medical professional for absences of more than 1 day.

The University System of Maryland policy provides that students shall be given an opportunity, whenever feasible, to make up within a reasonable time any academic assignment that is missed due to individual participation in religious observances. We are a diverse community and enroll students of many religions; therefore, students' requests for excused absences and make-up test requests due to reasons of religious observances will be honored where at all possible. It is the student's responsibility to inform the instructor of any intended absences for religious observances in advance.

2. Classroom Expectations and Code of Conduct:

a. General Responsibilities:
For me to help you gain content knowledge and practices, and foster a productive and safe science learning community, you will be expected to assume many roles and interact in a variety of situations. I realize that some of these situations may be outside your cultural and social comfort zones. For instance, it is often difficult for some people to continue to question scientifically when they have not received “the right answer.” However, to help foster your learning and those around you, it will be your responsibility during each of these moments and interactions to:
- communicate your understandings, feelings, and perspectives
- work to understand other's perspectives
- take risks
- make your own discoveries, gather new information, and develop your own explanations.

b. Collaboration and feedback:
Collaboration and communication are keys to working within a science community. Therefore, for all of our intellectual development (as students and as teachers) I expect that you will be honest and thoughtful with your reflections of others and be willing to accept feedback. Please remember that we can disagree and challenge one another’s ideas without getting personal.

Many of our projects will be group projects. For some of you, this will be uncomfortable at best. Despite this, please do your best to work together collaboratively. Education, like most careers today, require joint planning and learning. Therefore, we will start this process in this class. If your group has difficulty, please work it out together honestly and cordially. At all times, remember that your students will also be required to work in groups from time to time, so reflect on your own benefits and difficulties to learn how best to support your future students in a similar situation. You will have an opportunity to assess your partners’ participation and collaboration at the end of the course.

c. Cell phone policy:
Please turn your cell phone and other personal communication devices off before entering the classroom. Students who do not observe this policy will be asked to leave the class for the day, resulting in an unexcused absence. Please notify me ahead of time if there are extenuating situations, which will require you to be reachable to others.

3. Policy on Turning in Work:

a. Assignments:
- Students will be expected to adhere to due dates listed on the calendar or negotiated in class.
- An assignment is considered late if it is not handed in by the due date/time listed.
- Points will be deducted for work that is not proof read. Teachers are often judged by the appearance of their communications; it is essential that attention to this becomes a habit.

b. Academic integrity:
- The University has a nationally recognized Honor Code, administered by the Student Honor Council. The Student Honor Council proposed and the University Senate approved an Honor Pledge. The University of Maryland Honor Pledge reads:
I pledge on my honor that I have not given or received any unauthorized assistance on this assignment/examination.

Unless you are specifically advised to the contrary, the Pledge statement should be handwritten and signed on the front cover of all hardcopy papers, projects, or other academic assignments submitted for evaluation in this course. Students who fail to write and sign the Pledge will be asked to confer with me. Since most of our assignments will be electronic, putting your name on a digital paper will stand in lieu of a handwritten pledge/signature.

– I encourage collaboration, as it is a wonderful way to gain perspective on situations and enhance learning. When collaborating on any individual assignment, you must state the names of your partners. Otherwise I will assume that any similarities between individuals is due to one of you copying from the other and will at the very least award zero points for the assignment.

– Please give credit where credit is due. It is plagiarism if you have used science concepts, someone else’s ideas, works and words without citation. Websites must be cited if they are used as a source of information and quoted if directly copied. Please note that academic dishonesty can result in a zero for the assignment (worse for your overall average than a failing grade!) and/or referral to the Student Honor Council.

4. Disability Policy:
Students with documented disabilities and/or who think they may have a disability that entitles them to time extensions for in-class assignments, testing modifications and/or alternative assignments, etc must make an appointment to speak with me privately and consult the Office of Disability Support Services to get written documentation.

5. Bad weather policy:
The course will adhere to the University emergency closing schedule. However, in some cases with an afternoon class, we might fall in the crack between a cancelled evening classes and open day classes. In those cases I will sometimes cancel class ahead of the official ruling. On bad weather days, please check your email and the announcement page on blackboard for information on whether class is being held or not.

6. Learning Assistance Service:
If you are experiencing difficulties in keeping up with the academic demands of this course, contact the Learning Assistance Service, 2202 Shoemaker Building, 301-314-7693. Their educational counselors can help with time management, reading, math learning skills, note-taking and exam preparation skills. All their services are free to UMD students.

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COURSE ASSIGNMENTS:
Note: Additional information for each assignment will be provided in class and posted on Canvas. ‘Your topic’ refers to the one you chose for your microteaching the first week of class. All written assignments must be written with 1 inch margins, double-spaced and font that is similar in size to times new roman size 12.

1. Microteaching Reflections-(50 pts) (NSTA 1, 5, 10; InTASC 4, 7, 9; COECF: EC7, subject matter)
Our very first assignment is to choose a topic to teach to the class. Now that you have completed that, you will need to reflect on how you did this. Please write a 1 page essay that addresses the following questions:
Why did you choose that topic? What sources of information helped you plan your lesson (e.g., prior teaching experience, how it was taught to you, etc)? What aspects were you comfortable with? What aspects were you not comfortable with? What have you learned about yourself as a learner and future teacher?

2. Field experience in Schools (100 points)
You are required to spend 20 hours over the course of at least 7 visits in an assigned school placement. Students already in a full-time or half time internship will not need to add in extra hours and only do ‘e’ below. While you can visit the school more often, it is crucial to understanding what happens in schools that you visit on at least 7 different days. Children (and teachers!) change in response to weather, events at home, illness, etc. These can result in very different experiences in a class.

Your grade for this assignment results from the following:
   a. An attendance record signed by your host teacher and submitted at the end of the course.
   b. Participation in the ‘in your lives’ section of class. Every student MUST contribute at least once about what they are seeing in the schools and connecting that to what we are learning in class.
   c. Engagement with students beyond just ‘observing.’ Please do the following and record this on your attendance record before you ask the teacher to sign for that day.
      i. Work with one student or a small group of students in a focused way for at least 10 minutes to provide support on an assignment the student(s) is working on
      ii. Be responsible for two or more classroom routines for one class period (handing out papers, collecting homework, etc)
      iii. Circulate among the whole class for 10 or more minutes and offer support to various students while they are working independently
   d. Schedule a time to talk with your teacher about her/his pedagogical approaches. During the class, develop a list of 3 specific questions to ask the teacher in order to get insight into the teacher’s decision-making. Submit a 1 page reflection (hard copy) when this is completed.
   e. For interns only: Do ‘d’ above with the following modifications: make your questions directed to reflecting on how theory is driving practice. In your paper, critically reflect on both what you are seeing and what the teacher is saying.

Please note that your host teacher will complete a foundational competencies form for you at the end of the semester which will be part of your admissions application should you decide to apply to the teacher education program.

3. Interviews-100 points each (total 200 points) (NSTA: 5, 7, 10; InTASC 1, 2, 5, 8; COECF: EC1, EC2, learners, social and cultural contexts)
   a. Interview a teacher regarding what strategies they utilize to teach to a heterogeneous class as well as for some “stories” regarding particularly challenging students (either disciplinary, motivational, gifted, emotionally, etc.) You may choose a teacher from the field experience site or one you know. For interns only: please interview a teacher in your school who is NOT your placement teacher—such as a special ed teacher. Be prepared to include these thoughts and anecdotes in a class discussion and on an online discussion forum.
   b. Interview two students, using the following 4 steps with your content partner:
      i. Design a set of questions to interview a student about what they understand about your topic. The purpose of this interview is to learn more about children’s prior knowledge of and experiences with the concept, as well as to identify possible areas of difficulty with respect to learning. Therefore, you may use questions, demonstrations, drawings and/or experiments to elicit this information in the ‘interview.’
      ii. You will practice this interview in class with your content partner by interviewing another classmate.
      iii. After revising your interview based on the above practice, you and your content partner will each interview 1 student separately.
      iv. In a 2-page memo, you and your content partner will synthesize your findings on what you have found about the understanding, pre-conceptions and non-scientific conceptions your students hold about this topic. What did you find out about the children’s
knowledge? How did their understanding differ from what you thought before the interview? Did they show any indication of non-scientific preconceptions? What does this mean (specifically) in terms of teaching and learning? How did their understanding fit (or not fit) your learning progression. Explain how this experience (and specifically the concepts the child understands/does not understand, how the child’s understanding differs/is similar to yours, etc) will have an effect on your planning and instruction. Please be specific and support your claims with evidence from the interview.

4. Learning progression of content and issues-100 points (NSTA: 5, 6, InTASC: 1, 4, 5; COECF: EC1, EC2, subject matter, learners)
   In order to understand how best to teach a topic to your students, you need to understand how the topic is developed and where students run into difficulties with the content. For this assignment, using the next gen science standards, you and your content partner need to find/create a K-12 mapping of how your topic is developed—what is foundational knowledge for your topic and what does understanding your topic help prepare students for in later studies. This can be done in a graphical form or in text.

   Once you have the mapping figured out, you will need to research where students have difficulties with this topic. What preconceptions, misconceptions, non-scientific conceptions related to your topic and foundational topics do students typically have? By understanding what students know about this topic and what possible barriers exist to learning your topic, you will be better prepared to help them develop a strong scientific understanding of it. Questions to consider include but are not limited to: What areas do you think students will have difficulty with and what prior non-scientific or misconceptions might students hold? How will you overcome those issues? How might you interest students in your topic?

   You will synthesize your findings in a 3 page, double-spaced memo. Start with a couple of sentences that describe your topic and the grade where it will be taught. This assignment could be done with graphics, bullets as well as sentences.

5. Curriculum analysis-150 points (NSTA: 6; InTASC: 1, 2, 3, 4, 5, 6; COECF: EC4, EC5, EC7, subject matter, pedagogy, curriculum, learners)
   This assignment asks you to apply what you have been learning about science and science education to analyzing a curricular unit of your choice. You should choose a unit of approximately 2 weeks in length, although longer is acceptable. Possible sources of curriculum are the district in which you are doing your field experiences, your own high school, online curricula. Preferably, this curriculum will cover your topic but this is not required. You will have to get your curriculum approved at least 2 weeks in advance. Please address the following 4 areas with connections to what we have been learning, the literature we have been reading etc. Be sure that you have supporting evidence for your points. The final paper should be no longer than 5 pages double-spaced.
   a. Development of understanding:
      i. What are the curriculum goals? Are they reasonable and coherent? Is the focus conceptual or factual?
      ii. Does this match with NGSS? How? To what degree?
      iii. Do the lessons build to a greater conceptual understanding?
      iv. Is the science accurate and appropriate? Are ‘big ideas’ addressed?
   b. Epistemology related to
      i. The nature of science: what views of science and nature of science will this curriculum promote development of in students? How does this fit with what we have studied?
      ii. How students learn: what are the assumptions of how students learn science that underlie this curricular unit?
   c. Scientific inquiry:
      i. In particular, how is scientific inquiry portrayed in this unit? Does it support learning of the content?
      ii. How regular are these opportunities? Are there areas where it is missing but could have added to conceptual development?
iii. How does this fit with what we have studied?

d. Sociocultural aspects
   i. Are there connections to the local sociocultural context? Are they appropriate? Describe.
   ii. Are there places where connections to students’ lives should be made and are not?

6. **Teaching your topic:** (NSTA: 1, 5; InTASC: 1, 2, 3, 4, 5, 7; COECF: EC1, EC2, EC5, EC7, subject matter, pedagogy, learners)

   The culminating activity in this course is taking what you have learned about your topic and its place in K-12 along with understanding your learners and learning theory to create a short engaging introductory lesson. This will take place in two parts.

   a. **Design a lesson plan—50 points**

   For this part, you and your content partner will design a lesson plan on your topic, using the 5E’s outline. Details of what must be included in this design are below. The purpose of this lesson is to both engage students and introduce the topic in a way to inspire curiosity. Further, this lesson should help you understand a bit about what your students know about the topic. It is expected that scientific inquiry will be prominent in this lesson. Your grade will be based on whether you follow the plan below and whether your lesson includes elements that we have discussed this semester as important, such as scientific inquiry, learner-centered approaches, etc.

   **Your Name, Lesson Title, Target grade**

   **Part 1:** This should NOT be more than ½ page, double-spaced.

   **Lesson Concepts/Big Ideas:** What do you want the students to understand about the topic? The focus here is on conceptual knowledge. Why is it important for students to know this? What will be difficult for students about these concepts? How will you address those difficulties?

   **Lesson Objectives:** What do you want the students to be able to do by the end of the lesson? The focus here is on skills.

   **Standards:** What NGSS standards are being addressed?

   **Accommodations:** How does this lesson address the needs of a diverse group of students?

   **Important Prerequisites:** List 2-3 important content prerequisites for this lesson.

   **Part 2:** This part is the meat of your lesson plan…the recipe of what you would do in the classroom. The length of this section is open-ended, but should be succinct.

   1. **Engage:** Engage the students in preliminary thinking related to the coming activity. Help the students understand the problem setting, the mathematical or scientific context, and the challenge. **This is the time to capture their interest** for the upcoming lesson, review old concepts, and connect the new problem to past experiences of the students.

      Things to consider:
      a. How will students be organized (individually, pairs, or whole group)? What cooperative learning strategy will be used?
      b. What prior knowledge might need activation?
      c. Is there an everyday experience, visual aid, or other device that will spark students' interest or curiosity? How can I make the situation personal to them? List or describe what you will do.
      d. How can I keep from giving away ideas I want students to generate?

   2. **Explore:** Have students explore the problem or activity. Students should actively interact with the topic during this phase. Observe, listen closely, and ask questions that promote learning. Students should plan for/gather/organize data, share ideas, look for patterns, make conjectures, and develop strategies.

      Include in your lesson plan explicit questions to be posed to students that will probe students’ method and understanding, foster further understanding, encourage student discourse, provoke discussion, and/or
challenge apparent misconceptions. Make sure to include expected student responses (especially incorrect ones) and how you will respond to support the students’ thinking.

3. **Explain**: In this phase of instruction students analyze their explorations, discuss their solutions as well as the strategies they used to approach the problem. Have individuals or pairs share their learning. Use the lesson’s Big Ideas and Objectives to identify key ideas you want highlighted. Based on those, prepare questions to help students develop/consolidate these new ideas. List questions in the lesson plan.

   **Things to consider:**
   a. What are the key science concepts, representations, and processes that need to be highlighted?
   b. How can I orchestrate the summary so students draw big ideas from the exploration or activity?
   c. How can I help students integrate new learning with previous learning?
   d. How can I help students extend or generalize their understanding?
   e. What ideas do not need closure at this time? Why not?

4. **Elaborate/extend**: Expand/solidify student understanding, practice new skills, apply learning to a real world situation.

5. **Evaluate**: Assessment of student learning can take many avenues: formal/informal, formative/summative, student/teacher centered.

   **b. Microteaching in class-50 points**
   You and your content partner will take a piece of your designed lesson that can be taught in 15 minutes and teach it to our class together. Please be sure to choose a piece that shows how you will engage your students. This should encompass the “engage” and/or “explore” sections. *Your grade on this assignment will be based on how your plan illustrates what we have been learning to date, how engaging it was, and your professionalism.*

   **c. Reflection on your microteaching-100 points**
   This assignment has two parts. The first part is a reflection on how your microteaching went. You will think about what went well and what could have been improved, using the questions below as a guide. The second part is to reflect on your first microteaching at the start of the course and compare it to this one. That second piece should be written in one page.

   Reflection is a hallmark of good teachers but VERY difficult to learn. Consider the following questions to help you reflect on your lesson. This part of your assignment should be no more than 2 pages, double-spaced:
   • What worked, what failed? For whom?
   • Did you have the attention of the class? If not, where/when did you lose it?
   • Was a question asked that stumped you or that you feel you didn’t answer well?
   • Did you feel comfortable that your background research into learning progressions and student understanding had prepared you sufficiently for this experience?
   • Did you achieve your objectives? If not, why not do you think?
   • What theories of learning did you use to guide your design?
   • What would you do the same and what would you do differently next time? Why?

7. **Participation and attendance-100 points** *(InTASC 10; )*
   A course such as this depends on participation and attendance for all of us to grow and learn. This ‘grade’ reflects that importance. Sharing in the “in your lives” section is important to this grade.

8. **Final exam-100 points** *(NSTA: 10; InTASC: 9; COECF: EC4, pedagogy )*
   Throughout this course, we will be creating a series of wikipages on major ideas that cut across the various readings and discussions and field experiences we will be engaging in. Each person as individuals and as members of small groups will participate in co-creating the final knowledge set of this course in these
wikipages and they will constitute the final exam grade. More information will be disseminated in class.

**EDCI 411: Class Schedule and Assignments Calendar**

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<tr>
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<tbody>
<tr>
<td><strong>Sept</strong></td>
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<tr>
<td>2</td>
<td>Introduction</td>
</tr>
<tr>
<td>3</td>
<td>Microteaching</td>
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<tr>
<td>9</td>
<td>Finish microteaching</td>
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**Part 1: Science and Science Education**

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<tr>
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<td>Course info&lt;br&gt;Ms. Johnson&lt;br&gt;Peer microteaching feedback</td>
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<td>16</td>
<td>What is science&lt;br&gt;Nature of science&lt;br&gt;Admissions talk</td>
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<td>Historical perspectives on science &amp; science teaching</td>
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**Part 2: Learners**

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<td>Debrief teacher interview</td>
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<td>30</td>
<td>Adolescent learners</td>
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<tr>
<td><strong>Oct</strong></td>
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<tr>
<td>7</td>
<td>Ms. Bancroft - Ms. Hayes&lt;br&gt;Small group work on student interview</td>
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<td>Do Student Interview</td>
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<td>14</td>
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<td>16</td>
<td>Begin naïve conceptions</td>
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### Part 3: Teaching science

<table>
<thead>
<tr>
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<th>Activity</th>
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| 23   | Curriculum Design  
      | What is teaching science?  |
| 28   | Standards  
      | Curriculum analysis  
      | assignment  
      | Curriculum examples  |
| 30   | How to teach science?  
      | Lesson Planning Models  |
| Nov 4 | Wikipages synthesis of  
       | learning: bring laptop  |
| 6    | Small group meetings about  
      | wiki  |
| 11   | Wikipages -presentation  |
| 13   | PCK  
      | Questioning: Inquiry as  
      | pedagogy  |
| 18   | Assessment  |
| 20   | Peer feedback of lesson plan  
      | draft  |
| 25   | NO CLASS - -  
      | Curriculum analysis (CA) due by Friday noon  |
| 27   | THANKSGIVING  
      | HOLIDAY  |
| Dec 2 | Microteaching  |
| 4    | Microteaching  |
| 9    | Microteaching  |
| 11   | Discussion of CA  |

13. NARST papers on NGSS:  
   [http://www.narst.org/NGSSpapers/index.cfm](http://www.narst.org/NGSSpapers/index.cfm)  
   All students will read the intro, then everyone will be assigned one more to read and share in class

   read chapter 1-3, pages 1-38

15. inquiry versus direct instruction

16. [http://sites.nationalacademies.org/dbasse/bose/dbasse_071087](http://sites.nationalacademies.org/dbasse/bose/dbasse_071087) scroll to Phillip Bell paper

17. TBD on PCK


19. assessing hands-on learning

20. [http://sites.nationalacademies.org/dbasse/bose/dbasse_071087](http://sites.nationalacademies.org/dbasse/bose/dbasse_071087) scroll to Minstrell, Anderson and Li paper

Field experience due  
Bring draft of lesson plan to class

Final lesson plan due

Finish wikipages

Reflection on microteaching due Dec 5, 7 and 12