Course Description:
This course is designed to build your knowledge and skills at making science learning more meaningful for students in the middle school classroom. You will gain practical experience in how to plan and deliver instruction that is designed to engage students in three-dimensional learning called for in the Next Generation Science Standards and the NRC Framework for the Next Generation Science Standards (the Framework).

In this course you will work with actual middle school students in a local school. You will gain experience in eliciting and developing student questions and ideas and engaging students in scientific practices to help students figure out important science ideas and explain phenomena. You will learn techniques to help foster meaningful classroom discourse for all students you teach. You will practice using tools designed to help you build and facilitate a dynamic, equitable, and collaborative learning community in the science classroom.

This course is based on current ideas and research about how teachers learn to teach science and how students learn science. The course design is informed by work that went into developing the Next Generation Science Standards.

Four major principles about teaching and learning have been incorporated in the design of this course.

1. Students come into the classroom with valuable prior ideas, experiences, interest, and language about science and phenomena happening in the world around them. These have a profound impact on how they will experience and interpret instructional activities in the classroom. Uncovering these and designing instruction to leverage them, can help teacher craft more relevant and meaningful learning experiences for their students.

2. Three-dimensional learning can help learners make sense of phenomena and design solutions by engaging them in scientific practices to develop and use disciplinary core ideas and crosscutting concepts. Teachers need to develop systematic ways of adapting and designing instructional materials to engage students in three-dimensional learning in every learning activity.

3. Effective instructional planning involves developing coherent and relevant sequences of learning for students. When teachers plan instruction so that it is coherent from the learner’s perspective, they need to take into account a) what ideas are most relevant and useful for students to learn, b) what compelling phenomena these ideas can help to explain, c) what a target explanation/model that answers questions about the related phenomena would look like at the end of the instructional sequence, and d) how each step in the instruction is connected to what students have already figured out and what they will need to and want to investigate next.

4. Accomplished science teachers develop and cultivate classroom norms and compose and orchestrate classroom discourse to a) help individual students share, expand, and clarify their own thoughts, b) help students carefully listen to each other, c) help students deepen their reasoning, and d) help students engage with the reasoning of others. Ongoing practice in using talk moves with adolescents helps develop confidence and capacity in using these tools effectively in varied instructional settings.
Driving Question for the Course:
How can we design, implement, and sustain a classroom culture of figuring out?

Building a classroom culture of figuring out requires developing a learning community in which students are involved in science and engineering practices in a meaningful way. This requires orchestrating instruction in a classroom such that students help manage the trajectory of their knowledge building. Classrooms should be places where students can say:

- We figure out the science ideas.
- We figure out where we are going at each step.
- We figure out how to put the ideas together over time

Creating this classroom culture requires developing answers to five questions, whenever we analyze an instructional unit, develop a new unit, or prepare to teach a unit. To address this, we will work on these questions in this course:

1. How do we kick off investigations in a unit?
2. How do we work with students to motivate the next step in an investigation?
3. How do we help students use practices to figure out pieces of the science ideas?
4. How do we push students to go deeper and revise the science ideas we have built together so far?
5. How do we help students put together pieces of the disciplinary core ideas and crosscutting concepts?

What should I know and be able to do by the end of the course?

- Describe a vision of learning, knowing, and doing science for the middle school student in relation to the national vision articulated in the NRC Framework for the Next Generation Science Standards (the Framework) and the Next Generation Science Standards (NGSS)
- Identify phenomena and that provide a motivating and productive context for student investigations
- Anticipate and frame questions that leverage student’s prior conceptions and curiosity to motivate next steps and future investigations.
- Use the Framework and NGSS to unpack the most relevant and useful pieces of the target science ideas
- Develop Next Generation Science Standards (NGSS) style formative and summative performance expectations and related assessment items and artifacts for high school students
- (Re)design instructional materials to engage all students in three-dimensional learning
- (Re)design investigations to engage all students in the generation of evidence that lends itself to having them figure out important new pieces the puzzle and key science ideas.
- Create storylines for instructional units that support coherence across multiple lessons
- Plan for and use instructional supports designed to support access and equity for all students
- Practice discussion and questioning techniques that help elicit students’ prior knowledge, facilitate cross talk between students, foster argumentation from evidence, and establish consensus in the classroom learning community.
- Analyze student artifacts for evidence of student learning.
- Reflect on your experiences in this class with your colleagues to refine your beliefs about effective science teaching and learning for the middle school student and connect this to a broader model for how you believe people learn.
Northwestern University Conceptual Framework for Teacher Education

Mission. Our mission is to prepare knowledgeable, reflective, and innovative teachers who will lead and inspire students.

Vision. The Teacher Education Program at Northwestern University is guided by a conceptual framework for teacher education, organized around a vision of learning, learners and teaching. The conceptual framework focuses on

A vision of learning that includes:
1.1. how students come to understand and think about subject matter;
1.2. an emphasis on inquiry and reflection;
1.3. the importance of collaboration and social interaction; and
1.4. experiential activities that are relevant and engaging.

A vision of learners that includes:
2.1. the belief that every person is capable of learning;
2.2. that development is shaped by social contexts; and
2.3. equitable experiences for all.

A vision of teaching that includes:
3.1. connecting theory and practice;
3.2. inquiry, reflection, collaboration, and innovation;
3.3. creating a climate of learning for all students; and
3.4. acting professionally, responsibly, and ethically.

Dispositions Dispositions are habits of professional action and moral commitment to teaching. The program will help candidates acquire the following dispositions to the level of proficiency:

1. Ability to systematically reflect on one’s own practice and make changes as appropriate. (NUCF 3.2)
2. A belief in the value of seeing students as individuals. (NUCF 2.1)
3. Sense of responsibility to support every student. (NUCF 2.1)
4. Commitment to collaborate with all stakeholders. (NUCF 3.2)
5. Ability to engage students. (NUCF 1.4)
6. Willingness to incorporate innovations in teaching, including the use of new technologies. (NUCF 3.2)
7. Commitment to conducting one’s self professionally, responsibly, and ethically. (NUCF 3.4)

ILLINOIS PROFESSIONAL TEACHING STANDARDS (2013)

- Standard 1 - Teaching Diverse Students – The competent teacher understands the diverse characteristics and abilities of each student and how individuals develop and learn within the context of their social, economic, cultural, linguistic, and academic experiences. The teacher uses these experiences to create instructional opportunities that maximize student learning.
• Standard 2 - Content Area and Pedagogical Knowledge – The competent teacher has in-depth understanding of content area knowledge that includes central concepts, methods of inquiry, structures of the disciplines, and content area literacy. The teacher creates meaningful learning experiences for each student based upon interactions among content area and pedagogical knowledge, and evidence-based practice.

• Standard 3 - Planning for Differentiated Instruction – The competent teacher plans and designs instruction based on content area knowledge, diverse student characteristics, student performance data, curriculum goals, and the community context. The teacher plans for ongoing student growth and achievement.

• Standard 4 - Learning Environment – The competent teacher structures a safe and healthy learning environment that facilitates cultural and linguistic responsiveness, emotional well-being, self-efficacy, positive social interaction, mutual respect, active engagement, academic risk-taking, self-motivation, and personal goal-setting.

• Standard 5 - Instructional Delivery – The competent teacher differentiates instruction by using a variety of strategies that support critical and creative thinking, problem-solving, and continuous growth and learning. This teacher understands that the classroom is a dynamic environment requiring ongoing modification of instruction to enhance learning for each student.

• Standard 6 - Reading, Writing, and Oral Communication – The competent teacher has foundational knowledge of reading, writing, and oral communication within the content area and recognizes and addresses student reading, writing, and oral communication needs to facilitate the acquisition of content knowledge.

• Standard 7 - Assessment – The competent teacher understands and uses appropriate formative and summative assessments for determining student needs, monitoring student progress, measuring student growth, and evaluating student outcomes. The teacher makes decisions driven by data about curricular and instructional effectiveness and adjusts practices to meet the needs of each student.

• Standard 8 - Collaborative Relationships – The competent teacher builds and maintains collaborative relationships to foster cognitive, linguistic, physical, and social and emotional development. This teacher works as a team member with professional colleagues, students, parents or guardians, and community members.

• Standard 9 - Professionalism, Leadership, and Advocacy – The competent teacher is an ethical and reflective practitioner who exhibits professionalism; provides leadership in the learning community; and advocates for students, parents or guardians, and the profession.

Academic Integrity
Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: http://www.northwestern.edu/provost/policies/academic-integrity/index.html.

Accommodations for Students with Disabilities
Any student with a disability requesting accommodations must register with Services for Students with Disabilities (ssd@northwestern.edu; 847-467-5530) and request an SSD accommodation notification for his/her professor, preferably within the first two weeks of class. All information will remain confidential.
How Are Grades Determined for This Course?

1. Weekly in-class participation (15%)

Weekly attendance is required. Among a teacher’s greatest tools are shared experiences, honest feedback from peers, and the opportunity to critique one’s own practice. Willingness to participate fully is a must.

2. Weekly Pathway work – outside of class (15%)

We will be using an on-line professional learning pathway to explore various tools, artifacts, and ideas associated with this course. That pathway will have a series of steps we complete together in class. It will also have some steps that you will be asked to complete on your own. Each step involves a short posting for you to make in regard to a reflection, reading, or analysis task. Posting and commenting others posts, for the steps assigned to be completed out of class, is a required weekly assignment.

3. Preparing and teaching your lessons (30%)

All students will teach three lessons that they designed during the course after school at a local school. Lessons will be 55-60 minutes long. The lessons will be targeting one or more disciplinary core ideas from the Framework that is appropriate to learn for upper middle school or early high school science. Your instructional design for each lesson is an application of the theory behind the course and the focus of the Next Generation Science Standards - attempting to engage students in 3-dimensional learning.

For each lesson there are four parts you will need to complete for each lesson:

- **part a** is completion and submission of all the documents you developed to prepare for the lesson and the related instructional resources that students will use in the lesson. These are to be shared with the instructor by the date indicated on the syllabus.
- **part b** is a virtual meeting you will schedule with your instructor, for 30 minutes, when the whole team can meet to review feedback from the instructor, for the upcoming lesson.
- **part c**: is where you will teach the lesson with your group. You will implement the lesson with other group members for a group of students at the end of the students’ school day. You will need record the lesson.
- **Part d**: is where you will analyze the work students produced from the lesson and your own implementation of the lesson, using the video you recorded and other artifacts you collected.

4. Final Presentation and Project Portfolio (30%)

**Final Presentation** This is a 30-40 minute group presentation of the work that your group did over the quarter that you will present to your peers on the last day of the course.

**Project portfolio** This is a cumulative portfolio of the assignments you built across the course of the unit and a final revision of these, in light of what you learned from the course. It should include video artifacts as well as written student artifacts. You will turn in this final revised portfolio on the last day of the course.

5. Final Individual Reflection (10%)

This is an individual reflection of your journey through this course. Use this assignment to capture your essentials wonderings and discoveries over the 10 weeks of the course, and where you want to head as an educator in the future. Group your responses into these categories:

- What questions did you have when you started this course?
- What were the most important things you figured out?
- What next steps do you need to take to apply what you figured out? And/or what new (or unanswered) questions do you have
What is Plan the for Each Week? What is Due When?

All students in this class will teach three lessons that they design with their fellow team members during the quarter, after school at a local school middle school. They will be 55-60 minutes long. The lessons will be targeting one or more disciplinary core ideas from the Framework for middle school. The instructional design for each lesson is an application of the theory behind the course and the focus of the Next Generation Science Standards - attempting to engage students in three-dimensional learning through a coherent instructional sequence (a storyline).

This week-by-week timeline below is provided as an overview of what the quarter will entail. However, it is possible that this timeline may change in response to your needs as learners. Each week, your instructor provide you with an update about what your out of class assignments and readings are. Most in-class work and out of class assignments are focused on planning for, implementing, analyzing, and summarizing the four lessons described above. If you are not clear about what you are supposed to do from week to week, please stop us and ask. Course content is aligned with the Illinois Professional Teaching Standards (IPTS), as well as Northwestern University’s Conceptual Framework (NUCF).

<table>
<thead>
<tr>
<th>Week</th>
<th>Question(s) to Investigate</th>
<th>Topic</th>
<th>IPTS &amp; NUCF Standards Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1: 4/3</td>
<td>What does figuring out vs. learning about look and feel like?</td>
<td>A shared vision for science learning</td>
<td>IPTS: 1B, 2A-C, 9A,9D NUCF 3.1</td>
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<td></td>
<td></td>
<td>The vision of NGSS and the framework</td>
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<tr>
<td>Week 2: 4/10</td>
<td>How do we kick off investigations in a unit?</td>
<td>Anchoring Phenomenon routine</td>
<td>IPTS: 1B, 2A-C, 9A,9D NUCF 3.1</td>
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<tr>
<td></td>
<td></td>
<td>Unpacking the science &amp; identifying related phenomena</td>
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<tr>
<td>Week 3: 4/17</td>
<td>What does it look like when students use practices and put together pieces of the disciplinary core ideas and crosscutting concepts to explain phenomena and design solutions?</td>
<td>Analyzing three-dimensional assessments</td>
<td>IPTS: 1B, 2P, 3D, 3G, 4E, 5G, 5H, 6H, 6K, 7A, 7B, 7E, 7F, 7G, 7J-7M, 7O</td>
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<tr>
<td></td>
<td></td>
<td>Brainstorming candidate phenomena</td>
<td>NUCF 1.1, 1.3</td>
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**Lesson 1 Group Milestones (NUCF 1.4, 2.1, 3.2-3.4)**

**Milestone 1a is due by end of the day Saturday 4/21**
- Initial unpacking of your target learning goals from NGSS
- Anchoring Phenomenon lesson plan and student activity sheets

**Milestone 1b is due at least 24 hours before Milestone 1c**
- Pre-teaching conference for 30 min. via. virtual meeting with instructor. Weekend meetings are a possibility.

**Milestone 1c should be completed before the start of class for week 4 (4/24)**
- **Piloting Your Anchoring Phenomenon** - Your team will implement the first lesson of your unit with a small group (8-16) students at a cooperating school. The goal of this lesson is to elicit prior knowledge, initial explanations, and questions related to phenomena that could be explained for your target learning goal(s) with a small group (or individuals) middle grade students at a cooperating school location. Record a video of the lesson and collect artifacts.

**Milestone 1d is due by the start of class for week 4 (4/24)**
- Bring your video of the lesson and artifacts you collected from it to class.
<table>
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<tr>
<td>Week 4: 4/24</td>
<td>What will it look like when students put together pieces of the disciplinary core ideas and crosscutting concepts to explain a target phenomenon?</td>
<td>Analyzing student ideas, Designing three-dimensional assessments, Unpacking revisited</td>
<td>IPTS: 1 (all), 2D, 2,E, 2K, 2N, 2O, 3C, 3J, 3M, 3Q, NUCF 1.4, 2.1, 2.2</td>
</tr>
<tr>
<td>Week 5 5/1</td>
<td>How do we work with students to motivate the next step in an investigation? How do we help students use practices to figure out pieces of the science ideas?</td>
<td>Supporting Connected investigations</td>
<td>IPTS: 2K, 5C-G, 5I-K, 5M, 5R, 5S, NUCF 1.4, 2.1</td>
</tr>
</tbody>
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**Lesson 2 Group Milestones (NUCF 1.4, 2.1, 3.2-3.4)**

**Milestone 2a is due by end of the day Saturday 5/4**
- Lesson 2: connected investigation lesson plan and student activity sheets
- Draft storyline for lessons 1-4.

**Milestone 2b is due at least 24 hours before Milestone 1c**
- Pre-teaching conference for 30 min. via. virtual meeting with instructor. Weekend meetings are a possibility.

**Milestone 2c should be completed before the start of class for week 6 (5/8)**
- **Lesson 2 Implementation.** Your team will implement the second lesson of your unit with a small group (8-16) students at the cooperating school you worked with last time. The focus of the lesson is to conduct an investigation into one or more of the questions the students’ raised in the prior lesson. The investigation should have students engaged in 3-dimensional learning. Practice using talk moves to help students ask questions of each other build off one another’s ideas in small groups. Bring a tablet or laptop to record video of your lesson to analyze.

**Milestone 2d is due by the start of class for week 4 (5/8)**
- Bring your video of the lesson and artifacts you collected from it to class.

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<tbody>
<tr>
<td>Week 6 5/8</td>
<td>How do we push students to go deeper and revise the science ideas we have built together so far? How can talk moves and discourse norms build an invested community of learners?</td>
<td>Problematizing routine, Supporting academic talk through talk moves</td>
<td>IPTS: 2K, 5C-G, 5I-K, 5M, 5R, 5S, NUCF 1.4, 2.1</td>
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**Lesson 3 Group Milestones (NUCF 1.4, 2.1, 3.2-3.4)**

**Milestone 3a is due by end of the day Saturday 5/11**
- Lesson 3: connected investigation lesson plan and student activity sheets
- Revisions to draft storyline for lessons 1-4.

**Milestone 3b is due at least 24 hours before Milestone 1c**

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• Pre-teaching conference for 30 min. via. virtual meeting with instructor. Weekend meetings are a possibility.

**Milestone 3c should be completed before the start of class for week 7 (5/15)**

- **Lesson 3 Implementation** Your team will implement the third lesson of your unit with a small group (8-16) of students at the cooperating school you worked with last time. The focus of the lesson is to conduct an investigation into one or more of the questions the students raised in the prior lesson. The investigation should have students engaged in 3-dimensional learning. Practice using talk moves to help students ask questions of each other build off one another’s ideas in small groups. Bring a tablet or laptop to record video of your lesson to analyze.

**Milestone 3d is due by the start of class for week 7 (5/15)**

- Bring your video of the lesson and artifacts you collected from it to class.

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</thead>
<tbody>
<tr>
<td>Week 7 5/15</td>
<td>How do we help students put together pieces of the disciplinary core ideas and crosscutting concepts?</td>
<td>Putting pieces together routine</td>
<td>IPTS: 1B, 2G, 2K, 2L, 2O, 3H, 4A-C, 4I-Q, 6S  NUCF 1—all, 3.1</td>
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<td></td>
<td></td>
<td>Explanation, Modeling and Argumentation</td>
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<td>Week 8 5/22</td>
<td>How can I assess what my students know and can do? How can we support coherence across subsequent cycles of lessons?</td>
<td>EQuiP rubric introduced Formative and summative assessments</td>
<td>IPTS: 1B, 2G, 2K, 2L, 2O, 3H, 4A-C, 4I-Q, 6S  NUCF 1—all, 3.1</td>
</tr>
<tr>
<td>Week 9: 5/29</td>
<td>How can we analyze and redesign for coherence across any set of lessons? How can we share what we figured out with others?</td>
<td>Extending our storylines Principles and Methods for designing, building, and sustaining a classroom culture of figuring out</td>
<td>IPTS: 2G, 2L, 2Q, 3H, 4I-Q, 6S  NUCF 1—all</td>
</tr>
<tr>
<td>Week 10: 6/5</td>
<td>How can we apply what we learned to future instruction?</td>
<td><strong>Group Final Presentation</strong> <strong>Final Portfolio Due and Individual Reflection Due</strong></td>
<td>IPTS: 2F, 2I, 3A, 3B, 3F, 3I, 8B, 8D, 8E, 8J-L, 8O, 8S, 9E, 9N, 9O, 9P  NUCF 2.1, 3.1, 3.2</td>
</tr>
</tbody>
</table>

**Group Final Project Portfolio:**

- An update to your unpacking in milestone 1, in light of your implementation
- Resources from milestones 2-4, updated where appropriate.
- Your finalized storyline

**Individual Reflection:**

- A 3-5 page paper summarizing:
  - What questions did you have when you started this course?
  - What were the most important things you figured out?
  - What next steps do you need to take to apply what you figured out? And/or what new (or unanswered) questions do you have?
Where Are the Lesson Sites Located?

The sites and contact information for the cooperating teacher at each site will be provided during week 2 of class.

What Texts Are Required?

This will need to be purchased:

These are all free and available online:

Please note: A pdf file of each these texts are available online at:
- http://www.nextgenscience.org/final-print-version-framework-k-12-science-education-now-available
- http://www.nextgenscience.org/