George Mason University
College of Education and Human Development
Secondary Education Program (SEED)
EDUC 547-A01 – Scientific Inquiry and the Nature of Science
3 Credits, Summer 2024
Asynchronous Online – www.mymasonportal.gmu.edu

Faculty

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Prerequisites/Corequisites

None

University Catalog Course Description

Incorporates understanding about scientific knowledge in K-12 classrooms. Builds fundamental knowledge of scientific inquiry and the nature of scientific knowledge and skills to weave this knowledge explicitly in curriculum. Focuses on developing inquiry-based lessons for students to investigate science and assessing student understanding of science and the nature of science. Offered by Graduate School of Education. May not be repeated for credit.

Course Overview

In this course, we will be exploring the epistemic culture of science and ways of knowing in science. We will investigate the purpose behind teaching the nature of science and inquiry, the different competing paradigms of the nature of science, and pedagogies of the nature of science that have been found in research to be effective.

The format of this course is designed to reach two major goals:

1. To learn a deeper meaning of Scientific Inquiry (SI) and the Nature of Science (NOS)
2. To develop, implement, and assess Scientific Inquiry and the Nature of Science in secondary classrooms

We will begin by participating in an activity that reveals ideas about scientific inquiry and the nature of science, then we will use these ideas to delve deeper into the concepts of SI/NOS. Following instruction on the aspect of scientific inquiry and the nature of science, teachers will incorporate their understanding of SI/NOS into their teaching and will report the planning, implementation and assessment back to the group. Reporting the results of implementation and assessment of SI/NOS will not be treated as an endpoint, but rather as a reflection with the group so the activities can be enhanced and shared with other teachers.

Course Delivery Method

This course will be delivered online (76% or more) using an asynchronous format via Blackboard Learning Management system (LMS) housed in the MyMason portal. You will log in to the Blackboard (Bb) course site using your Mason email name (everything before @masonlive.gmu.edu) and email password. The course site will be available on May 13th at 8am.

Under no circumstances, may candidates/students participate in online class sessions (either by phone or Internet) while operating motor vehicles. Further, as expected in a face-to-face class meeting, such online participation requires undivided attention to course content and communication.

All SEED classes have designated delivery modes and specific modes for each class session (e.g., face-to-face, virtual synchronous, virtual asynchronous). The majority of SEED classes are held in a face-to-face mode. **Students are expected to attend every class session in the mode it is offered.** If you must miss a class session for illness or another valid reason, you are expected to proactively communicate (ahead of the class session) with your instructor about your expected absence.

Technical Requirements

To participate in this course, students will need to satisfy the following technical requirements:

- High-speed Internet access with standard up-to-date browsers. To get a list of Blackboard's supported browsers see: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support#supported-browsers

  To get a list of supported operation systems on different devices see: https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support#tested-devices-and-operating-systems

- Students must maintain consistent and reliable access to their GMU email and Blackboard, as these are the official methods of communication for this course.
- Students may be asked to create logins and passwords on supplemental websites and/or to download trial software to their computer or tablet as part of course requirements.
- The following software plug-ins for PCs and Macs, respectively, are available for free download:
  - Adobe Acrobat Reader: https://get.adobe.com/reader/
  - Windows Media Player: https://support.microsoft.com/en-us/help/14209/get-windows-media-player
  - Apple Quick Time Player: www.apple.com/quicktime/download/

Expectations

- Course Week:

Because asynchronous courses do not have a "fixed" meeting day and Session A is a condensed session, I have collapsed 3 classes into each week (Monday to Sunday at midnight). You will see that they say Part 1 of 3, Part 2 or 3 and Part 3 of 3 for each week. The due dates are indicated on the syllabus calendar and in Blackboard. Please plan to do all three parts in those 7 days.

- Log-in Frequency:
  Students must actively check the course Blackboard site and their GMU email for communications from the instructor, class discussions, and/or access to course materials at least 3 times per week.
- Participation:
  Students are expected to actively engage in all course activities throughout the semester, which includes viewing all course materials, completing course activities and assignments, and participating in course discussions and group interactions.
- Technical Competence:
  Students are expected to demonstrate competence in the use of all course technology. Students who are struggling with technical components of the course are expected to seek assistance from the instructor and/or College or University technical services.
- Technical Issues:
  Students should anticipate some technical difficulties during the semester and should, therefore, budget their time accordingly. Late work will not be accepted based on individual technical issues.
- Workload:
  Please be aware that this course is **not** self-paced. Students are expected to meet *specific deadlines* and *due dates* listed in the **Class Schedule** section of this syllabus. It is the student's responsibility to keep track of the weekly course schedule of topics, readings, activities and assignments due.
- Instructor Support:
  Students may schedule a one-on-one meeting to discuss course requirements, content or other course-related issues. Those unable to come to a Mason campus can meet with the instructor via telephone or web conference. Students should email the instructor to schedule a one-on-one session, including their preferred meeting method and suggested dates/times. Please allow up to 12 hours for a reply from the instructor. The instructor will check the blackboard site and email twice a day at a minimum, usually once in the morning and once in the evening.
- Netiquette:
  The course environment is a collaborative space. Experience shows that even an innocent remark typed in the online environment can be misconstrued. Students must always re-read their responses carefully before posting them, so as others do not consider them as personal offenses. *Be positive in your approach with others and diplomatic in selecting your words*. Remember that you are not competing with classmates, but sharing information and learning from others. All faculty are similarly expected to be respectful in all communications.
- Accommodations:
  Online learners who require effective accommodations to insure accessibility must be registered with George Mason University Disability Services.

Notice of mandatory reporting of sexual assault, interpersonal violence, and stalking: As a faculty member, I am designated as a "Responsible Employee," and must report all disclosures of

sexual assault, interpersonal violence, and stalking to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychological Services (CAPS) at 703-993-2380. You may also seek assistance from Mason's Title IX Coordinator by calling 703-993-8730, or emailing titleix@gmu.edu.

Learner Outcomes or Objectives

This course is designed to enable students to do the following:

Students will:	**CEHD Core Value**
Build knowledge in the historic, philosophical and social factors that have influenced the development of scientific knowledge	Social Justice Innovation
Be able to categorize lessons along the continuum of scientific inquiry	Ethical Leadership
Build a repertoire of science teaching and assessment strategies in scientific inquiry and the nature of science by reading, writing, observing, participating in, and reflecting on the teaching and learning of science;	Research-Based Practice Collaboration
Develop strategies to help students become scientifically literate, think critically and creatively, understand the nature of science, and see the importance of science as a way of knowing;	Social Justice Innovation Collaboration Research Based Practice Ethical Leadership
Utilize a professional learning community to improve lesson planning, implementation and assessment.	Collaboration Ethical Leadership Research-Based Practice
Construct more cohesive science units that focus on science as a way of knowing	Research-Based Practice Innovation

Professional Standards

EDUC 547 is designed to enable science education leaders to use strategies to implement and evaluate school change in science teaching and learning. Students need knowledge of effective instruction in science as well as vehicles for change so that they can be a catalyst for school improvement in mathematics. The course was developed according to the position statement of the National Science Teachers Association (NSTA) on Standards for Science Teacher Preparation.

These position statements indicate that the core knowledge expectations in science education include:

- Understand the historical and cultural development of science and the evolution of knowledge in their discipline.

- Understand the philosophical tenets, assumptions, goals, and values that distinguish science from technology and from other ways of knowing the world.
- Engage students successfully in studies of the nature of science including, when possible, the critical analysis of false or doubtful assertions made in the name of science.
- Understand the processes, tenets, and assumptions of multiple methods of inquiry leading to scientific knowledge.
- Engage students successfully in developmentally appropriate inquiries that require them to develop concepts and relationships from their observations, data, and inferences in a scientific manner.

Additionally, this course was designed with a vision for accomplished teaching, as indicated by NBPTS Science Standards for Early Adolescence (http://www.nbpts.org/userfiles/File/ea_science_standards.pdf) and Adolescence and Young Adulthood (http://www.nbpts.org/userfiles/File/aya_science_standards.pdf) the Five Core Propositions of the National Board for Professional Science Teaching:

- Proposition 1: Teachers are Committed to Students and Their Learning
- Proposition 2: Teachers Know the Subjects They Teach and How to Teach Those Subjects to Students
- Proposition 3: Teachers are Responsible for Managing and Monitoring Student Learning.
- Proposition 4: Teachers Think Systematically about Their Practice and Learn from Experience.
- Proposition 5: Teachers are Members of Learning Communities.

Required Texts

Required readings will be provided electronically by the instructor on the Blackboard site. Because this course is flexible to the needs of the teacher candidates, other articles/handouts than the ones indicated on this syllabus may be distributed in class or posted on-line at the course website

Course Performance Evaluation

Students are expected to submit all assignments on time in the manner outlined by the instructor (e.g., Blackboard).

Science education research shows that frequent assessment of small amounts of material is most effective for learning science. Therefore, in this class formal and informal

assessment will be continuously provided on assignments and class activities. Assessment is used as a tool for information that informs both learning and teaching, so this two-way communication loop is necessary for optimal learning.

1. Concept maps

The materials learned in this course tend to take a metacognitive approach. That is, the nature of science is a way of knowing the world, rather than a set of facts. Capturing this knowledge can be elusive, so to keep track of progress in the course, we will be using concept maps as a tool for displaying knowledge. Teachers will design their own concept maps and add to their maps after each class as a way of reflecting on what they have learned. The format of the concept map is up to the teacher, but it should be an effective means of communication about nature of science knowledge. There will be a formative assessment check on the concept map (see calendar for the date). The formative map should represent all of the information learned in the course at the time of the check. A final concept map will be turned in on the last class. This map should represent all of the knowledge learned during the course.

2. Clinical Interview

In this assignment, you will find an adolescent to interview about scientific inquiry and the nature of science. The purpose of this assignment is for you to gain experience in a one-on-one setting to understand individual student ways of knowing. You will be given more detailed instructions in class, but overall the task is to be completed in the following sequence:

- For concepts about the nature of scientific knowledge, write two easy questions, two moderately difficult questions, and two more difficult questions that are all related and lead up to a "big idea". Note the easy questions should get at the student's understanding of the concept from past experience that may or may not be the product of schooling. The questions can be about the nature of science without context or can be contextualized within a content area. However, the questions MUST be eliciting ideas about the nature of science from the adolescent.
- Audio tape an adolescent answering the questions and you probing for more understanding of the cognition of the student. I ask you to audio tape so that you can go back and quote in the paper, but I do NOT need a transcript of the interview. Please use a pseudonym for the student as well.
- Write a 3-4 page paper of the description of what occurred, an analysis of the learning of the anonymous student, and a reflection on what you learned.

3. Class Presentations

A major goal of this course is to enable teachers to incorporate more nature of science knowledge and scientific inquiry processes into their classes in an explicit and reflective way. To reach this goal, teachers will form groups to plan a lesson with explicit, reflective nature of science instruction and will present the objectives and assessment of the lesson and the ways they incorporate nature of science and scientific inquiry in their classes to their peers. Peers will conduct a "consultation" with the pairs of teachers, revealing and discussing strengths and weaknesses of their classroom activities. To prepare for the first

presentation, teachers will post any student materials needed for peers to understand the lesson's intent and assessment. During the second presentation, teachers will post lesson plans and Template 1 along with any revised student materials. The teachers will then teach the course in a 40 minute block. Detailed directions and Templates are found on Blackboard.

The Presentation-Part 1

The presentation should begin by having the presenting teacher pair or group explain on video an overview of the expectations of the lesson that was designed to teach content and emphasize ONE aspect of the nature of science. Teachers will post the student assignment and assessment materials for discussion by peers. The purpose of this discussion is to improve the explicit, reflective nature of science instruction. To aid in this discussion, we will identify the objectives for the content and the nature of science and the assessment plans for the content and the nature of science. Other issues such as possible reasons for misconceptions tend to come out of the discussions. The online discussion should always end on a positive note, focusing on the achievements of the teacher pair.

The Presentation-Part 2

The presenting teachers should post Template 1 (found on Blackboard) and the full lesson plan. As the presenting teachers explain the outline and lesson plan on video, the group can ask clarifying questions on the discussion board. Part 2 of the presentation of the lesson is to actually teach the lesson to the group. In doing so, the partners will implement the online lesson that was refined during the consultation with the group. At the end of the online lesson, we will conduct a discussion board about how the NOS aspect was taught explicitly and reflectively and the connection of the aspect to the content. Following the online discussion board, the teacher pair or group will individually fill out a reflective template (#2) and post to the professor.

4. Online Discussions

This class will be conducted online in order to facilitate the incorporation of the new information about the nature of science into classroom lessons. In order for this class to be successful, all learners need to participate in the online sessions. The sessions may be a discussion about a reading that was posted, comments on an online system of lessons, or suggestions for a posted lesson. Online discussions for the first part of the course will be a demonstration of your knowledge about NOS, and the online discussions at the end of the course will be reflective of your ability to incorporate accurate NOS knowledge in an explicit and reflective way.

5. Class Participation

Learning depends on the active engagement of the participant and frequent checking by the instructor as to the progress of the learner. Smaller assignments will be given as necessary in class in order to inform your learning and my teaching. Part of the class participation is providing feedback to peers when they present their lesson plans incorporating the nature of science (otherwise known as the consultations).

Grading

Since this is a graduate level course, high quality work is expected on all assignments and in online discussions. All assignments are due at the time indicated on the

assignment in blackboard. Graded assignments that are late will automatically receive a ten percent grade reduction (one full letter grade lower).

Assignments	**Points**
Concept mapping (check #1)	20
Concept mapping (final)	20
Clinical interview questions	10
Clinical interview report	50
Presentation Part 1	100
Presentation Part 2	100
Online discussions	150
Class participation (including consultations)	50

Total Points: 500

Grading Scale
A = 95-100%;
A- = 90-94%;
B+ = 87-89%;
B = 83-86%;
B- = 80-82%;
C = 70-79%;
F = Below 70%

Professional Dispositions

See https://cehd.gmu.edu/students/polices-procedures/

Class Schedule

Date	Class topics and Assignments Due
Class #1 Monday, May 13 – Sunday, May 19	**Part 1 of 3: Introduction to Scientific Inquiry and the Nature of Science** Learning objectives • get to know other students in the class • identify rationale for teaching science as a way of knowing • describe the relationship between inquiry and the nature of science, noting distinctions Activities and Assignments 1. Take course tour 2. Do Icebreaker in blog function 3. Why should we teach the nature of science? mini-lecture 4. Read Connecting inquiry and the nature of science 5. Connecting inquiry and the nature of science quiz (due 5/19)
	Part 2 of 3: Building Knowledge about Scientific Inquiry and the Nature of Science Learning Objectives • Describe the differences between science and school science • Describe scientific inquiry in the classroom • Describe concepts about the nature of science that are appropriate for secondary students Activities and Assignments 6. Read Why is Teaching the Nature of Science so Important? 7. Nature of Knowledge and the Nature of Knowing mini-lecture 8. Post nature of knowledge and nature of knowing on discussion board (due 5/19)
	Part 3 of 3: What are current models of NOS? Learning objectives • Identify three models of NOS from the educational research community • Determine common aspects among the three models • Determine differences across the models • Explain which model is most relevant for your teaching and why Activities and Assignments

	9. Read Keys to Teaching the Nature of Science (McComas model) 10. Read Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy (Lederman model) 11. Read Family Resemblance Approach to Characterizing Science (FRA model) 12. NOS models mini-lecture 13. Post graphic organizer of similarities and differences across NOS models with explanation on discussion board (due 5/19) 14. Persuasive argument for relevancy of teaching - template of argument and either written or verbal discussion on discussion board (due 5/19)

Week #2 Monday, May 20 – Sunday, May 26	**Part 1 of 3: What constitutes empirical evidence?** Learning objectives • Identify characteristics of empirical evidence • Explain why scientists rely on empirical evidence • Explain the role of empirical evidence in scientific argumentation Activities and assignments 1. The use of empirical evidence in science mini-lecture 2. The use of empirical evidence in science quiz (due 5/26) 3. Assignment - Turn in a draft of your clinical interview questions for review (due 5/26)
	Part 2 of 3: Social interactions of scientists - Scientific knowledge is durable, yet tentative Learning objectives • Determine the ways scientists work when there is not a consensus idea in science • Examine the ways that secondary lessons deal with the concept of tentativeness in science Activities and assignments 4. Watch Plate Tectonic Theory Case study mini lecture 5. Take Plate Tectonic Theory Case study quiz (due 5/26)

	6. Review one of the lessons and post your comments about the way they demonstrate tentativeness on discussion board (due 5/26) 7. Assignment - Concept Map Check #1 (due 5/26)
	Part 3 of 3: Laws, Theories, Models, Hypotheses and Predictions Learning Objectives • Describe the distinctions between Laws, Theories, Models, Hypotheses and Predictions Activities and assignments 8. Watch TED Ed lesson on the difference between a scientific law and a theory. 9. Laws, theories, models, hypotheses, and predictions video quiz (due 5/26) 10. Choose groups for Presentations #1 and #2
Monday May 27 – Sunday, June 2	**Part 1 of 3: What habits of mind do scientists adopt?** Learning objectives • Identify habits of mind that scientists use • Identify the ways that scientists are creative Activities and Assignments 1. Habits of mind of scientists mini-lecture 2. Read "Philosophically correct science stories? Examining the implications of heroic science stories for school science" 3. Whole group discussion board on Creating a List of Scientific Habits of Mind (due 6/2)
	Part 2 of 3: Explicit and Reflective NOS Instruction Lesson objectives • Explain at least two ways to teach NOS effectively based on educational research • Describe how you would employ these ways of teaching NOS in the secondary classroom Activities and Assignment 4. Read "Strategies for Learning Nature of Science Knowledge: A Perspective from Educational Psychology" 5. Listen to recap of Strategies for Learning NOS knowledge mini lecture

	6. Take Learning Strategies for NOS quiz (due 6/2) 7. Explain ways to teach NOS in your class on discussion board (due 6/2)
	Part 3 of 3: Decontextualized NOS and Contextualized NOS **Lesson Objective(s):** • Identify instances of decontextualized NOS • Identify instances of contextualized NOS • Explain pros and cons of teaching each way based on educational research Activities and Assessments 8. Contextualized and decontextualized NOS mini-lecture 9. Read "Tracking the Footprints Puzzle: The Problematic Persistence of Science-as-Process in Teaching the Nature and Culture of Science" 10. Post your video response to video questions on contextualized and decontextualized NOS instruction (due 6/2).

Monday, June 3 - Sunday, June 9	**Part 1 of 1: How do you teach NOS explicitly and reflectively while still teaching science content?**
	Presentation #1 Learning objectives • Describe your plan for lessons to teach NOS in a contextualized way • Identify the main NOS aspect that you will be teaching and how you will assess this • Reflect on feedback from the class Activities and assignments 1. Post Teacher Information Worksheet (by group) on discussion board (due June 7th) 2. Post Lesson Plan (by group) on discussion board (due June 7th) 3. Post video walk-through of lesson plan (by group) on discussion board (due June 7th) 4. Perform consultation on discussion board for feedback on lesson plan (due June 9th)

Monday, June 10 – Sunday, June 16	**Part 1 of 1: How do you teach NOS explicitly and reflectively while still teaching science content?**
	Presentation #2 Learning objectives • Carry out your plan for lessons to teach NOS in a contextualized way • Analyze the results of the student assessments of NOS • Reflect on feedback from the class Activities and assignments 1. Post Lesson (due June 14th) 2. For other groups, perform consultation for feedback on lesson with lesson rubric or by giving your narrative comments (due by June 16th). I have posted a word version of the rubric in the materials posting for this week that you can fill out for the groups and post in the discussion board for that group. 3. Presenting teachers post Teacher Reflection (due June 17) 4. Assignment - final concept map (due June 16)

Monday, June 17	**Part 1 of 1: Final Clinical Interview Report** Learning objectives Reflect on all of the awesome learning you did this summer on NOS Activities and assessments 1. Assignment - Final Clinical Interview Report (due 6/17)

Note: Faculty reserves the right to alter the schedule as necessary, with notification to students.

Core Values Commitment

The College of Education and Human Development is committed to collaboration, ethical leadership, innovation, research-based practice, and social justice. Students are expected to adhere to these principles: http://cehd.gmu.edu/values/.

GMU Policies and Resources for Students

Policies

- Students must adhere to the guidelines of the Mason Honor Code (see https://catalog.gmu.edu/policies/honor-code-system/).
- Students must follow the university policy for Responsible Use of Computing (see http://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).
- Students are responsible for the content of university communications sent to their Mason email account and are required to activate their account and check it regularly. All communication from the university, college, school, and program will be sent to students **solely** through their Mason email account.
- Students with disabilities who seek accommodations in a course must be registered with George Mason University Disability Services. Approved accommodations will begin at the time the written letter from Disability Services is received by the instructor (see https://ds.gmu.edu/).
- Students must silence all sound emitting devices during class unless otherwise authorized by the instructor.

Campus Resources

- Support for submission of assignments to Tk20 should be directed to tk20help@gmu.edu or https://cehd.gmu.edu/aero/tk20. Questions or concerns regarding use of Blackboard should be directed to http://coursessupport.gmu.edu/.
- For information on student support resources on campus, see https://ctfe.gmu.edu/teaching/student-support-resources-on-campus

For additional information on the College of Education and Human Development, please visit our website https://cehd.gmu.edu/students/.

Nature of Science and Scientific Inquiry Lesson Plan Rubric

Name of Students_____

Unacceptable (0 points)	**Needs Work (1 point)**	**Developing (2 points)**	**Proficient (3 points)**
A. Guiding Question(s): The goal of your lesson should be inquiry oriented. Students' attention should be focused on answering one or two key questions based on empirical evidence. Remember that teacher simply asking lots of questions does not an inquiry lesson make.			
Guiding question(s) not included	Guiding question(s) are included but are not appropriate to student inquiry and/or very poorly worded.	Guiding question(s) are included, are appropriate, but poorly worded.	Guiding question(s) are included, appropriate, and well worded.
B. Student Performance Objective(s): What, more specifically, are the students expected to know and be able to do at the end of the lesson? Include content knowledge, intellectual skills, and dispositions as appropriate. Your objectives should have readily observable behaviors or performance tasks. Students must be made aware of day-to-day objectives. Objectives should include BOTH content objectives and nature of science objectives.			
Poorly written objectives; written more like teacher goals; not performance-based; or not provided. Only NOS or only content objectives are provided.	Objectives are a mix of teacher goals and student performance-based tasks; objectives exhibit poor word choice and uses terms such as "understand" or "able to" for performance task. Only NOS or only content objectives are provided.	States unit's major and minor science content and intellectual process skills objectives using observable behaviors. Includes both NOS and content objectives	Developing plus includes due consideration for student dispositions. Includes both NOS and content objectives.
C. Science Content and Standards: List here the order of science content as it will be taught as well as the corresponding Virginia Standards of Learning.			
Fails to include alignment table between student activities and Virginia SOLs.	Includes a table showing alignment between some student activities and SOLs, but not all.	Includes a table showing alignment between major and minor student activities and SOLs.	Developing plus includes National Standards (NGSS) in alignment table as appropriate.
D. Alternative Conceptions: List here any alternative conceptions (preconceptions that students might bring to this subject matter and misconceptions that they might develop) as a result of studying the content of this lesson. Be certain to cite your reference(s).			
Little to no consideration for alternative conceptions.	Lists only a very limited array	Lists a good variety of preconceptions and misconceptions that	Developing plus links various alternative

	of students' alternative conceptions; doesn't not cite reference(s).	students have in relation to subject matter of unit. Clearly referenced.	conceptions to specific classroom activities.
E. Instructional Approach(es): Indicate which active learning strategies you will employ in this inquiry lesson such as discovery learning, interactive demonstration, inquiry lesson, inquiry lab, hypothetical inquiry, problem/project based learning, case study, discussion, etc. Good inquiry-oriented lessons also will include activities from each of the three following categories: individualized, small group, and whole group.			
More emphasis on didactic teaching; less emphasis on students constructing understanding from experiences; little to no consideration for student groupings.	A roughly equal mix of teacher-centered and student-centered pedagogy; equal emphasis on transmitting knowledge and discovering knowledge; some consideration for student groupings, but does not show planning required to use them effectively.	Provides a detailed overview of diverse and effective teaching procedures that are student student-centered; addresses classroom atmosphere and student management; explains how a variety of diverse student groupings will be used to construct meaning from science experiences and develop dispositions for further inquiry and learning.	Developing, and clearly includes use of formal cooperative learning strategies.
F. Focus of NOS aspect: Research demonstrates that to teach NOS effectively the lessons must be both explicit for the students AND allow the students to be reflective about their scientific thinking. Indicate how your lesson addresses both explicit and reflective NOS activities.			
Fails to provide explicit or reflective NOS instruction.	Provides either explicit or reflective NOS instruction but not directly connected to the content in the lesson.	Provides either explicit or reflective instruction but not both. Connected with the content in the lesson.	Provides both explicit and reflective instruction that is directly connected to the content of the lesson.
G. Checking for Understanding: How will you as teacher determine if the student performance objective(s) for the day's lesson has been achieved? How will you assess the objectives in an informal though meaningful manner?			
No consideration shown for student comprehension or no review of lesson's student performance	Reviews the lesson objects for students, but teacher conducts summary of student learning without involving students.	Reviews the lesson objectives for students, but does a poor job of eliciting students' input or alternative conceptions; provides	Reviews the lesson objectives for students, and does a good job of eliciting students' understanding in relation to the lesson's

objectives.		some of the summary for the students.	student performance objectives including alternative conceptions.
H. Extensions/Homework: Explain how you will teach explicitly about the nature of science, its unifying concepts, the philosophy of science, issues of science and technology and/or the processes of science during your lesson. What projects or homework activities will you assign to your students to help them internalize and better understand the intended learning of this lesson?			
No consideration given to any form of extension; no homework suggested.	Only extension or homework given, not both.	Gives both extension and homework information, but is a bit sketchy.	Gives both extension and homework information, and provides enough detail about the extension work that anyone could teach it given the information provided.
I. Materials and Safety: What materials will you need to teach your lesson? Do any of your materials represent a safety hazard? If so, what precautions will you take to protect your students?			
No consideration given for the use of materials.	Makes very limited use of instructional materials; no mention of safety considerations.	Make considerable use of only a limited amount of instructional materials; notes safety precautions as appropriate.	Uses a variety of material resources to conduct lesson including such things as demonstrations and/or simulations to provide for multiple modes of learning as appropriate; notes appropriate safety precautions if appropriate.
J. Backup Plan: No lesson plan should be written without considering the possibility that students will complete their tasks faster than expected. Every lesson plan should, therefore, include meaningful back up activities. The backup plan should not consist of having students work on an assignment intended for homework.			
No consideration given for activities that can be used to fill extra time in a meaningful fashion.	Uses homework for a back-up plan.	Provides an insubstantial or meaningless activity as a back-up plan.	Makes excellent use of extra time to introduce valuable and meaningful extension activities (e.g., NOS case studies)

The Secondary Education (SEED) Program "Seeds"

As illustrated by the model to the left, the SEED program is guided by five "Seeds" or principles that students are expected to understand and learn to apply in their teaching and professional lives: Social Justice, Inquiry and Reflection, Advocacy and Agency, Partnership and Collaboration, and Respect and Relationship. SEED students address each Seed in a developmental fashion, twice during their licensure program and once again during the master's teacher research capstone experience:

- Each Seed is introduced and students demonstrate initial understandings and consider initial applications to teaching of the Seeds (as determined by the program and course instructor) during one of the five pre-licensure courses (Foundations, Methods I, Human Development, Methods II, Content Literacy)
- All five Seeds are revisited and students demonstrate deeper conceptual understandings of and identify applications to their teaching of the Seeds (in a manner they determine) during internship and internship seminar
- All five Seeds are explored more deeply, and students demonstrate mastery understandings of, applications to their teaching and teaching inquiries (via their teacher research Methodologies), and future integrations of the Seeds into their teaching and teaching inquiries (via their teacher research Discussions)

Course	Seed/Definition	Key Assignment Description
Foundations of Secondary Education	**Advocacy and Agency** The SEED program educates teachers to develop a commitment to advocating for and developing agency in every young person. Teachers' advocacy activities begin with pedagogical interactions and extend into school and community contexts. Similarly, teachers' consideration of youths' agency begins with enabling them to act independently and make choices in their own best interests—in the classroom and beyond.	**Teacher Candidate Digital Portfolio** This digital portfolio is a website the teacher candidate creates to begin assembling products and artifacts that illustrate their emerging philosophy of teaching, experiences designing instructional materials, interviews and reflections from clinical experiences, and professional documents such as resumes and work experience. Pieces that teacher candidates add to the digital portfolio demonstrate their agency as educators inside and outside of classrooms, candidates' advocacy of critical issues relevant to secondary education, and candidates' thinking on how educators, their learners, policy makers, and community members all have different agency in making choices related to secondary education.
Methods I	**Social Justice** The SEED program educates teachers to develop a commitment to social justice. Such a commitment encompasses the belief that all members of our school, university, and broader communities can contribute to disrupting inequitable interactions, practices, and structures, with a focus on enhancing each individual's opportunity to learn and succeed. Social justice is also closely aligned with "equity," which involves the implementation of anti-oppressive and antiracist interactions, practices, and structures that ensure	**Lesson Plan** Using a provided format, the lesson plan must include objectives, standards, instructional plans, assessments, classroom layout(s), a teacher script, and all materials that would be given to students as part of the lesson. The lesson must demonstrate the teacher candidate's ability to integrate justice concepts/content into their instruction.

	that every individual has an unbiased, impartial, responsive, and appropriately-scaffolded opportunity for academic and professional success.	
Human Development and Learning	**Relationships with and Respect for Youth** The SEED program educates teachers to develop relationships with and respect for youths. When a school culture promotes respect, support for students' identities, senses of belonging, and tolerance, students are able to work as active participants in the classroom and the community. Secondary teachers who create a welcoming environment in their classrooms; who strive to know and honor students' backgrounds, preferences, and perspectives; who build relationships with young people based on trust and mutual understanding; and who connect curriculum to students' cultures hold the key to effective instruction. Their instruction will contribute to developing unique individuals who will be able to connect their life experiences to learning.	**Case Study/Student Application Project** The case study/student application project is a summative assessment of the teacher candidate's ability to use psychological theory to analyze problems in a classroom and practice approaches a thoughtful, ethically principled teacher would use to solve problems. The case study/student applicant project must demonstrate the teacher candidate's understanding of how and why teachers can use psychological theories and principles to develop relationships with and demonstrate respect for youths, with an ultimate goal of enhancing adolescents' school and life success.
Methods II	**Inquiry and Reflection** The SEED program educates teachers who appreciate and know how to ask questions about their practices and who are critically reflective of their pedagogies, empowered by evidence. The ability to inquire and reflect on one's teaching practice is foundational to educators' ongoing and self-directed professional growth across their professional lifespans. Educators who can inquire into and consistently implement effective instructional practices--and who can critically reflect on and evaluate their pedagogies--will be the most responsive teachers and will best inspire students to learn.	**Unit Plan/Lesson Implementation** Teacher candidates will use the "backwards design" process to develop a plan for teaching a unit which actively involves students in meaningful learning; individualize learning to accommodate the strengths and needs of students; and provide authentic assessments. Unit plans will include objectives, a calendar, and an outline of each day in the unit. One lesson of the unit must be taught/co-taught in the teacher candidate's clinical experience classroom, and the unit plan and lesson implementation must demonstrate the candidate's understanding of how and why teachers use inquiry and reflection to improve their pedagogical practices and enhance student learning.
Content Literacy	**Collaboration and Partnership** The SEED program educates teachers who value collaborative engagement in learning and teaching and supporting collaboration through different forms of partnership. Collaboration takes on many forms, including collaboration amongst teacher candidates and their peers, course instructors and faculty advisors, mentor teachers in schools, their students and their students' families and caregivers, and amongst experts in their fields of teaching. These collaborations occur through a shared understanding of partnership. By spanning multiple boundaries, the SEED program supports partnerships with local schools and their divisions, with state and national professional associations, and with international experiences in other countries.	**Disciplinary Literacy Inquiry Project** Teacher candidates complete an inquiry into methods of supporting students' comprehension in their respective content areas. Using resources from class and peer-reviewed articles, candidates develop an understanding of how to guide and deepen students' comprehension, addressing questions including "Why is it important to be literate in our respective subject areas?". The inquiry project must demonstrate the candidate's understanding of how and why teachers collaborate with other education professionals, students, families and caregivers and others to support students' subject area comprehension and literacy learning.

Internship and Internship Seminar	**All SEED Seeds: Applications to Teaching** All five Seeds are revisited and students demonstrate deeper conceptual understandings of and identify applications to their teaching of the Seeds during internship and internship seminar.
Teacher Research (for Master's students only)	**All SEED Seeds: Applications to Teaching and Teaching Inquiries** All five Seeds are explored more deeply, and students demonstrate mastery understandings of, applications to their teaching and teaching inquiries (via their teacher research Methodologies), and future integrations of the Seeds into their teaching and teaching inquiries (via their teacher research Discussions)