George Mason University
College of Education and Human Development
Secondary Education Program
EDUC 547.B01 – Scientific Inquiry and the Nature of Science
3 Credits, Summer 2018
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 June 4, 2018 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.

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, we need to reconfigure the "week." Since this is an 8 week course, we will split each week into two parts. Odd number weeks (1,3,5,7,9,11,13,15) will start on Monday and finish on Wednesday at midnight. Even numbered weeks (2,4,6,8,10,12,14) will begin Thursday and finish on Sunday at midnight. Our course week will begin on the day that our synchronous meetings take place as indicated on the Schedule of Classes.

- 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.
- 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.

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, Tk20, hard copy).

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.

Writing 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 (consultations)	50

Total Points: 500

A = 93-100%
A- = 90-92%
B+ = 88-89%
B = 80-87%
C = 70-79%
F = Below 70%

Professional Dispositions

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

Class Schedule

Date	Class topics and Assignments Due
June 4 Week 1	**Prior Knowledge and Overview** • Why teach science? • What is scientific inquiry and how is it related to the nature of science? • What do we know from research about how SI/NOS should be taught? • How do we go about assessing SI/NOS?
	Before class please read: Syllabus
	Class Activities: Requirements of the Course Forethought form VNOS-B Pre-Test Overview of Scientific Inquiry and the Nature of science ➢ Understanding Science: How Science Really Works http://undsci.berkeley.edu/ http://riaus.org.au/articles/consilience-in-science/#!
	Assignments Due: *None*

Date	Class topics and Assignments Due
June 7 Week 2	**Building Knowledge of SI/NOS** • How is classroom inquiry different from scientific inquiry? • What concepts about the scientific enterprise are appropriate for secondary students?
	Before class please read: Readings about SI and NOS ➢ Inquiry and the National Science Education Standards *http://www.nap.edu/openbook.php?record_id=9596&page=1* *Read Chapters 1, 3 and 4* ➢ Peters, E. E. (2006). Connecting inquiry and the nature of science. *The Science Education Review, 5 (*2), 37-44. *(available on Blackboard site)* ➢ McComas, W. F. (1998). *The principle elements of the nature of science: Dispelling the myths.* http://coehp.uark.edu/pase/TheMythsOfScience.pdf. ➢ Peters, E. E. (2006). *Why is teaching the nature of science so important?* (available on Blackboard) ➢ Project 2061 – The Nature of Science http://www.project2061.org/publications/sfaa/online/chap1.htm
	Class Activities: Nature of knowledge and ways of knowing Inquiry vs. NOS
	Assignments Due: *Respond to assignments on Blackboard*

June 11 Week 3	**What is NOS?** • What are the different models of NOS from the education research community? • What is common about the models? • What is distinct for each model? • Which model is most relevant for your teaching?
	Before class please read: ➢ Lederman NOS model ➢ McComas NOS model ➢ Erduran & Dagher NOS model
	Class Activities: Card Sort Graphic Organizer of similarities and differences Persuasive argument for relevancy for teaching – graphic organizer and document
	***Assignments Due**:* ➢ *Respond to assignments on Blackboard*

June 14 Week 4	**Personal/Social FRA - What constitutes empirical evidence?** • What makes empirical evidence different from other forms of evidence?
	Before class please read: Read about scientific approaches in making claims in a class activity ➢ Lawson, Anton E. (1999). A Scientific Approach to Teaching About Evolution & Special Creation". *The American Biology Teacher*, 61 (4), 266-274. ➢ Osborne, Erduran, Simon and Monk (2001) Enhancing the quality of argument in school science. ➢ http://thescienceteacher.co.uk/argumentation-in-science/
	Class Activities: Evidence to make claims in student activities

	➢ National Institutes of Health, (2005). Doing Science: The Process of Scientific Inquiry. http://science.education.nih.gov/Supplements/NIH6/inquiry/default.htm. Evidence to support ideas in science ➢ Differences between models and empirical evidence http://www.skepticalscience.com/empirical-evidence-for-global-warming.htm Perform a student activity that requires empirical evidence to make claims The World IS really flat! http://www.indiana.edu/~ensiweb/lessons/flaterth.html
	Assignments Due: *Responses to activities online*

June 18 Week 5	**Social Interactions FRA - Scientific knowledge is durable, but also tentative** ✓ How tentative is scientific knowledge?
	Before class please read: Lesson demonstrating tentativeness ➢ AAAS Science NetLinks – Abrupt Climate Change http://www.sciencenetlinks.com/lessons.php?Grade=9-12&BenchmarkID=1&DocID=323 How do scientists handle flux in major concepts? ➢ http://arstechnica.com/science/news/2006/10/5609.ars Different meanings of tentativeness ➢ http://physics.weber.edu/johnston/research/!TheMultipleMeaningsOfTentativeScience_IHPSTfi.PDF Dealing with tentativeness when teaching science ➢ http://www.actionbioscience.org/education/allchin2.html
	Class Activities: Plate Tectonic Theory Case Study – FAST3 Textbook series

	Dino-Data Performance SRL questions – learning about NOS
	Assignments Due: ✓ *Clinical interview questions – draft* ✓ *Responses to activities online*

June 20 Week 6	**Laws and Theories** • What is the difference between theories and laws?
	Before class please read: McComas, W. F. (2003). A Textbook Case of the Nature of Science: Laws and Theories in the Science of Biology. *International Journal of Science and Mathematics Education 1*(2), 141-155. (Reprint found on blackboard).
	Class Activities: Perform an online lesson that explicitly illustrates Theory ➢ AAAS Science NetLinks – Comparing Theories: Lamark and Darwin http://www.sciencenetlinks.com/lessons.php?Grade=9-12&BenchmarkID=10&DocID=0
	Assignments Due: ✓ *Concept Map Check #1*

June 25 Week 7	**Scientific Habits of Mind** • What habits of mind do scientists adopt?
	Please watch and read: **TED Talk: Battling Bad Science** **http://www.ted.com/talks/ben_goldacre_battling_bad_science**

About Implications of Heroic Science Stories

- Milne, C. (1998). Philosophically correct science stories? Examining the implications of heroic science stories for school science. *Journal of Research in Science Teaching*, *35*(2), 175-187.

Barber, B. (1961). Resistance by scientists to scientific discovery. *Science*, *134*, 596-602.

Listen to a portion of PRI's Creativity in Science series

Death Ray (it is at the top of the list on the right)
http://castroller.com/podcasts/PriScienceAnd/1312948

Plastics
http://castroller.com/podcasts/PriScienceAnd/1312949

Biomimicry
http://castroller.com/Podcasts/PriScienceAnd/2218598

Answer questions on the Blackboard site about this lab:

- http://www.teach-nology.com/worksheets/science/phy/lab1/ (Is this lab teaching laws, theories, neither or both?)

Class Activities:

Perform a lesson illustrating scientific habits of mind

- AAAS Science NetLinks – The Mozart Effect
http://www.sciencenetlinks.com/lessons.php?Grade=9-12&BenchmarkID=12&DocID=36

Perform online lesson illustrating how scientists strive for accuracy

- Opinion surveys
http://www.sciencenetlinks.com/lessons.php?Grade=9-12&BenchmarkID=12&DocID=451

Complete Self-Reflection form for Learning NOS (Link found on Blackboard)

Complete Forethought form for teaching NOS (Link found on Blackboard)

Assignments Due:

- ✓ *Responses to questions on BlackBoard*
- ✓ *Responses to* Self-Reflection form for Learning NOS
- ✓ *Responses to* Forethought form for teaching NOS

June 28 Week 8	**Explicit and Reflective NOS Instruction** • What do we know from educational research about the most effective ways to teach NOS? • Why is NOS difficult to translate into classroom practice?
	Before class please read: • Peters-Burton, E. E. (2017). Strategies for learning nature of science knowledge: A perspective from educational psychology. In M. R. Matthews (Ed.) H*istory, philosophy and science teaching: New Perspectives* (pp. 167-193). Dorchet: Springer. • Peters, E. E. (2012). Developing content knowledge in students through explicit teaching of the nature of science: Influences of goal setting and self-monitoring. *Science & Education, 21(6)* 881-898.
	Class Activities: Self-regulated learning processes Card Sort Parallels to explicit and reflective approaches to teaching NOS MPI-S Magnets unit
	***Assignments Due**:* ➢ *Consider who will be in your group to present* ➢ *Respond to questions on BlackBoard*

July 2 Week 9	**Decontextualized NOS and Contextualized NOS** • What is meant by Decontextualized NOS or Science-as-Process? • What are dangers of this type of teaching • What does the research say about how to incorporate NOS in instruction?
	Before class please read: ➢ Ault, C. R. & Dodick, J. (2010). Tracking the Footprints Puzzle: The Problematic Persistence of Science-as-Process in Teaching the Nature and Culture of Science. *Science Education, 94,* 1092-1122. ➢ Clough (2006) Learners' Responses to the Demands of Conceptual Change: Considerations for Effective Nature of Science Instruction

	Class Activities: Contextualized vs. Decontextualized NOS activities
	Assignments Due: ➢ *Consider who will be in your group to present* ➢ *Respond to questions BlackBoard*

July 5 Week 10	**How do you teach NOS explicitly and reflectively while still teaching science content?**
	Before class ➢ Prepare for Presentation #1
	Class Activities: Groups will present Presentation Part 1
	Assignments Due: ✓ **Post Presentation #1**

July 9 Week 11	**How do you teach NOS explicitly and reflectively while still teaching science content?**
	Before class ➢ Prepare for Presentation #1
	Class Activities: Groups will present Presentation Part 1
	Assignments Due: ➢ *Post Presentation #1*

July 12 Week 12	**How do you teach NOS explicitly and reflectively while still teaching science content?**
	Before class ➢ Prepare for Presentation #1
	Class Activities: Groups will present Presentation Part 1
	Assignments Due: ✓ **Post Presentation #1**

July 16 Week 13	**How do you teach NOS explicitly and reflectively while still teaching science content?**
	Before class ➢ Prepare for Presentation #2
	Class Activities: Groups will present Presentation Part 2 Groups presenting will fill out the Performance form after presenting VNOS post-test
	Assignments Due: ✓ *Template #2 for people who presented* ✓ *Performance form due for people who presented*

July 19 Week 14	**How do you teach NOS explicitly and reflectively while still teaching science content?**
	Before Class: ➢ Prepare for Presentation Part 2

	Class Activities: Groups will present Presentation Part 2 Groups presenting will fill out the Performance form after presenting
	Assignments Due: ✓ *Template #2 for people who presented* ✓ *Performance form due for people who presented*

July 23 Week 15	**How do you teach NOS explicitly and reflectively while still teaching science content?** **Measurement of growth in NOS knowledge**
	Before class ➢ Prepare for Presentation #2
	Class Activities: Groups will present Presentation Part 2 Groups presenting will fill out the Performance form after presenting Card Sort Self-Reflection form for Teaching NOS
	Assignments Due: ✓ *Template #2 for people who presented* ✓ *Performance form due for people who presented* ✓ *Final concept map*

July 26 Week 16	***Assignments Due:*** ✓ *Final Clinical Interview Report* ✓ Class Evaluation

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 http://ods.gmu.edu/).
- Students must follow the university policy stating that all sound emitting devices shall be turned off 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/ .

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 Science Education Standards A-L 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	Lists only a very limited array	Lists a good variety of preconceptions and misconceptions that	Developing plus links various alternative

for alternative conceptions.	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	Reviews the lesson objects for students, but teacher conducts summary of student	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'

student performance objectives.	learning without involving students.	some of the summary for the students.	understanding in relation to the lesson's 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)