CARTHAGE
COLLEGE

Effectively Teaching Science in the Elementary/Middle School

— EDU 3260 | SYLLABUS | SPRING, 2020 —

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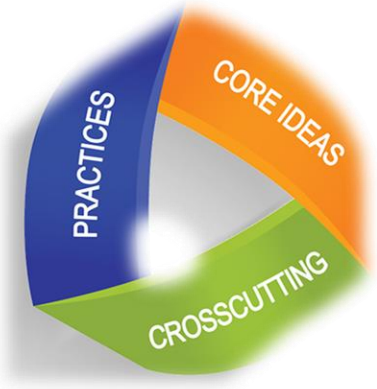
COURSE DESCRIPTION

> This course is designed to provide elementary/middle school preservice teachers with knowledge of the developmental sequence of scientific ideas and concepts and fluency in the pedagogical concepts and skills needed for student success. The focus of this course is on the content, methods of teaching, and curricula as taught at the early childhood, elementary, and middle school levels. A wide range of teaching and learning experiences will be demonstrated and practiced. The course experiences include collaborating with the instructor and cooperating teachers who are involved in our partnerships with local schools in planning, implementing, and evaluating classroom science instruction. Environmental education will be incorporated into this course. Field experience required.

PREREQUISITES

Admission to the Teacher Education Program Fall/Spring



- Disciplinary Core Ideas
- Crosscutting Concepts
- Science & Engineering Practices

http://www.nextgenscience.org/three-dimensions

Contents

Required Texts

Online Subscription

NSTA. (2020). NSTA Learning Center. https://learningcenter.nsta.org

Open Source

National Academies of Sciences and Engineering. (2017). *Seeing Students Learn Science: Integrating Assessment and Instruction in the Classroom* (A. Beatty & H. Schweingruber, Eds.). The National Academies Press. https://doi.org/10.17226/23548

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Wisconsin Department of Public Instruction. (2018). *Wisconsin's standards for science*. Author. https://dpi.wi.gov/sites/default/files/imce/science/WI-Standards-for-Science-2017.pdf

Wisconsin Department of Public Instruction. (2018, May). *Wisconsin standards for environmental literacy & sustainability*. Author. Retrieved from http://eeinwisconsin.org/Files/eewi/2018/Wisconsin_Standards_for_Environmental_Literacy_and_Sustainability_2018.pdf

Recommended Texts

National Research Council. (2001). *Knowing What Students Know: The Science and Design of Educational Assessment* (J. W. Pellegrino, N. Chudowsky, & R. Glaser, Eds.). The National Academies Press. https://doi.org/10.17226/10019

National Research Council. (2005). *How students learn: Science in the classroom*. National Academies Press. https://doi.org/10.17226/11102

Wiggins, G. P., & McTighe, J. (2005). Understanding by Design, Expanded 2nd Edition. Alexandria, Va.: Association for Supervision and Curriculum Development. ISBN: 9781416600350.

Course Goals

It will be useful to keep in mind the general goals for school science provided in Figure 1.

*Figure 1: **Goals for School Science** (National Research Council, 1996, p. 13)*

- experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern;
- increase… economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in… careers.

In support of the goals for science education, you will be challenged in this course to develop your ***understanding***, ***skills***, and ***scientific habits of mind*** applied to each of the following inquiry focus questions:

- **Vision**: Why teach natural science?
- **Discipline**: What is science? What is scientific inquiry? School science?
- **Epistemology and Cognition**: How do children learn science?
- **Curriculum**: What science should I teach, to what depth, and in what sequence?
- **Assessment**: How do I ascertain what the learner knows, is able to do, and values?
- **Pedagogy & Learning Environment**: How is science taught (including local contexts, resources, and issues)? How will I achieve a safe and effective learning environment?
- **The profession**: What does it mean to be a professional science educator?

STUDENT LEARNING OUTCOMES

By the end of this course, the teacher-candidate will:

1. **NGSS 3-D**: Demonstrate understanding of 3-dimensional science identified by the *Next Generation Science Standards* and *Wisconsin's Standards for Science* and be able to describe how these build on students' prior knowledge and lay foundations for deeper understanding.
2. **Curriculum**: Explain how the *Next Generation Science Standards* provide a foundation for planning curriculum.
3. **NOS**: Demonstrate understanding of the nature of scientific inquiry and be able to explain its relationship to elementary science curricula and methodologies.
4. **Praxis**: Develop and implement a repertoire of teaching methods and strategies, supported by current educational research, that are authentic, developmentally appropriate science instruction that promotes active learning for all students in the clinical service classroom.
5. **Assessment**: Characterize the role of assessment in science teaching and develop and utilize authentic assessment tools in clinical service classrooms.
6. **Equity** & **Inclusion**: Develop an awareness of the personal, cultural, or social biases that affect equitable science teaching, and develop and implement strategies to promote equity in science classrooms.
7. **Technology**: Demonstrate competence in the effective use of technology as a source of information for professional development, for planning and presenting instruction, for enhancing inquiry-based science instruction, and as an organizational tool for a variety of educational and professional purposes.
8. **Professionalism**: Demonstrate the professional behavior and skills that are expected of those engaged in the teaching profession.

METHODS OF INSTRUCTION

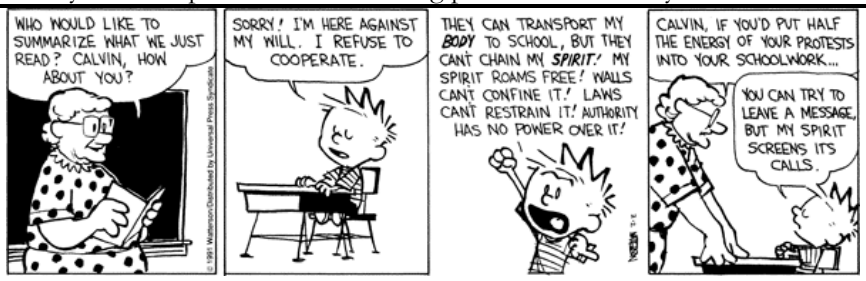
A ***collaborative inquiry*** approach (Garmston & Wellman, 2013) is the overarching instructional methodology of the course. Specific activities and investigations will include, but are not limited to, collaborative group work and investigations, individual and group presentations, individual study and writing, library and internet research, and small group/whole-class discussion.

COURSE ACTIVITIES

Example course activities are shown with relative weights assigned for reporting purposes. Specific details for all assignments will be provided at group meetings and/or on Schoology LMS.

Figure 2: Overview of Course Activities

Element	Description	Relative Weight:	
Philosophy	Update your personal philosophy statement to reflect 21st Century literacy.		1
NOS/SI/STS Research Brief	Write a **formal research brief** on the nature of science, scientific inquiry, technological design, or the interplay of science, technology and society.		2
NGSS EQuIP Curriculum Evaluation	Carefully select and evaluate an NGSS curriculum relevant to your anticipated teaching assignment. Your report must evaluate the storyline coherence of NGSS 3-D lessons. Reports also must explicitly evaluate the strength of association with specific learning standards, incorporate key ideas from research-based texts, and provide analysis of representative assessments.		3
Collaborative Research Lesson	During the semester you will design, teach (possibly re-teach), evaluate, and author a report on a "Collaborative Research Lesson" (CRL). You are encouraged to participate in other research lessons at the host school.	Design: Report:	3 2
Performance Assessments	Sessions will include formative and summative assessments (which can be traditional or embedded) of class experiences, performance tasks, and readings.		1
Your Choice	Demonstrate SLO #4 Praxis… (Page 4) through a service project of your choice. Options include, for example, volunteering at the Carthage Makerspace, hosting a display at a STEM fair, assisting on an environmental studies field trip, giving a popup demonstration on campus, etc. Record a reflection on Schoology and provide a brief informal presentation about your experience in class.		3
Clinical Service	EDU 3260 is strongly coupled with EDUC 3260 (Clinical). Complete clinical service requirements (provided on Schoology), clinical service reflections, CLR research lesson observations, and the Teacher Candidate Dispositions report.		5
Professional Service	All are expected to contribute as a **community of inquiry and service**. Professional collaboration requires timeliness, full attendance, journaling, and active participation at meetings, during clinical experiences, and in special events.		3
Capstone	Complete a portfolio demonstrating mastery of SLOs and serving as a viable toolkit for your anticipated student teaching placement and early career.		5



COURSE POLICIES AND PRACTICES

ACADEMIC INTEGRITY

Academic and professional integrity is unequivocally expected. Cheating, plagiarism, fabrication, or any form of academic dishonesty will **not** be tolerated, per: https://www.carthage.edu/community-code/academic-concerns/academic-honesty-guidelines/

ATTENDANCE, PARTICIPATION, AND READINGS

- Attendance matters. Tardiness, absence, and past-due assignments—regardless of the legitimacy of cause—reduces one's ability to effectively learn, contribute, collaborate, and complete commitments. These will reflect directly in collaboration metrics. Likewise, certain course elements simply cannot be "made up" if missed. Therefore, **the natural consequence of tardiness, absence, and/or past-due assignments can be a significant reduction in earned grade**.
- This class meets for 14 sessions. Missing more than **2** sessions can result in an "Incomplete" or failure.
- Participation includes active collaboration during group meetings, online, and in the clinical service setting. Consistent professional behavior is expected in every aspect of this course.
- Readings are to be completed prior to the meeting for which they are assigned. Arrive prepared to actively contribute to discussions.

PROFESSIONAL BEHAVIOR

Early in this course, we will examine and discuss the "critical dispositions" of professional learning and ethical practice (CCSSO, 2013). In this class we will strive to engage in exemplary professional behaviors of professional educators.

Human Subjects

As a student in this class, you may be expected to complete projects that may require you to interact with and/or collect data from other people -- from students in schools, from teachers, or perhaps from your colleagues in this class. Whenever we gather data from the lives and experiences of other human beings, we must be especially sensitive to the ethical implications of what we are doing. Keep in mind that the information you collect -- whether it is collected orally, in writing, through observation, or through existing records or artifacts – is research data. You must make every effort to handle these data professionally and to conduct research in an ethical manner.

Personal Technology

Technology use for professional purposes is welcome. However, class sessions or group meetings are not appropriate times for personal communication with electronic devices (e.g., voice, text or email) or distractions. This would be both unprofessional and non-collaborative.

PROGRESS MONITORING AND REPORTING– COURSE LESSON #1

In this course we will distinguish between the concepts ***assessment*** and ***grading***. The following concepts relate to the distinct requirements of educative feedback and progress reporting.

Regarding Assessment

Assessment refers to a broad variety of means by which educators, students, and other stakeholders (parents, school administrators, etc.) collect and interpret evidence of what a student knows or is able to do: knowledge, skills, and/or dispositions. *Assessment is not synonymous with grading.*

> *The first thing that comes to mind for many people when they think of "classroom assessment" is a midterm or end-of-course exam, used by the teacher for summative grading purposes. But such practices represent only a fraction of the kinds of assessment that occur on an ongoing basis in an effective classroom.* (National Research Council, 2001, p. 225)

Formative Assessment provides ongoing feedback integral to instruction with two specific purposes: (1) to **inform the student** so that she/he can advance their own learning; and, (2) to **inform the educator** so that he/she can adapt instruction as indicated to help students learn. Paul Black and Dylan Wiliam's seminal "Black Box" report (1998), and a large body of subsequent research, has shown both the efficacy of formative assessment as productive ***feedback***, and how this can be subverted when grades are assigned. Simply put, students tend to focus on the grade and miss the benefits of constructive feedback…

> *When the classroom culture focuses on rewards, "gold stars," grades, or class ranking, then pupils look for ways to obtain the best marks rather than to improve their learning.* (Black & Wiliam, 1998)

Reflecting this conclusion, James Popham's (2011) ASCD professional practice guide asserts that "*formative assessment should never be graded.*" It is our position to keep the focus on learning.

Checkpoint Assessments are regular graded benchmark or interim assessments used to report progress toward learning goals and mastery.

Summative Assessments are used to evaluate and report the degree of mastery of learning standards at the end of a unit. Standards not mastered by individual students or groups of students may be remediated and re-assessed as provided by our standards-based assessment policy.

Performance Tasks may include writing assignments, exhibitions, projects, presentations, or other forms of performance undertaken to advance proficiency and demonstrate relevant knowledge, skills, and dispositions. These are designed to provide relevant and authentic learning with more authentic assessment of learning progression.

Writing Tasks are performance tasks in support of the goals of Carthage College *Writing Across the Curriculum* (WAC). In particular, benefits are at once "writing to learn" and "learning to write" in the professional education discipline. Toward these ends, emphasis is given to the process of writing for clear and effective professional communication.

Assessment Policy and Practices

Students are expected to monitor their learning progression and assume responsibility for maintaining productive study and work ethic; including time management, on-task engagement, and high-quality work products. In support of personalized learning, this course is implementing proficiency-based assessment linked to professional practice standards.

Grades in a ***standards-based system*** indicate the degree of achieved **proficiency** (a.k.a., **mastery**) of learning standards—knowledge, skills and dispositions. Standards-based grades are **criterion referenced** since they refer to standards as source of assessment criteria. This is in contrast to norm-referenced systems in which an individual's grade is based on relative position (score) within a ***normal*** distribution of scores from a norming group.[1] In standards-based assessment, scores represent a comparison to a standard (a.k.a., learning target) while in norm-referenced systems scores

[1] Teachers typically assume that the distribution is sufficiently normal and that the referent group is a sufficiently representative sample with respect to performance and the tested population.

are a comparison to the scores of others. The differences are consequential and deserve serious consideration. This is a matter of study in this course.

Note that calculating **percentages** for reporting grades is **not applicable** in a standards-based assessment system and causes confusion. *Percent*, which means *per 100*, implies that discrimination of performance quality would be reasonable at 100 levels or more. While humans can reasonably and reliably differentiate qualities of assessment items into a few categories (e.g., high, medium, and low quality), rarely is it possible to sort student work into 100 distinct bins!

For our purposes, we define five proficiency levels (see Figure 3). Proficiency is recorded as ordered categories or **levels** represented with **ordinal numbers**. This means that the numbers simply act as names or labels for categories as defined in Figure 3. The numbers also show that the categories have a meaningful order. For example, Level 3 represents higher proficiency than does Level 2. Notice however, that Level 4 is not twice Level 2. Indeed, the intervals between categories are almost certainly not equal. Therefore, simple averages of "levels" yields distortion. (Think about it!)[2] For the purpose of summative reporting, the individual's pattern of performance is mapped to letter grades—which are themselves ordinal categories (Figure 4).

Figure 3: Standards-based assessment model: Classification of assessment elements

Level	Proficiency Level
4	Distinguished: exceptional and uncommon qualities (rare)
3	**Proficient**: evident competence as intended by the standard
2	Developing: substantial progress toward the proficiency standard
1	Emerging: evident initial progress toward proficiency standard
0	Not Observed: missing, incomplete, or insufficient evidence found

Figure 4: Standards-based assessment model: Summative letter grade determination

Grade	Description
A	Proficiency with regular Level 4 achievement.
B	**Proficiency (Level 3) demonstrated for all standards.**
C	Nearly all standards demonstrated; none less than Level 2.
D	Standards not demonstrated/observed exceeds 2:10 ratio.
F	Standards not demonstrated/observed exceeds 4:10 ratio.

CARTHAGE COLLEGE SUPPORT SERVICES

LEARNING ACCESSIBILITY SERVICES

Carthage College strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers due to your disability (including mental health, learning disorders and chronic medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, you also need to register with Diane Schowalter in Learning Accessibility Services (dschowalter1@carthage.edu).

[2] For help on this, see http://www.socialresearchmethods.net/kb/measlevl.php

ACADEMIC SUCCESS AND HEALTH

Good health can help you achieve academic success. The Health and Counseling Center (HCC) supports students by addressing physical, mental, and emotional well-being. All services are free and confidential and are provided by experienced and licensed professionals. Services are available to all full-time, undergraduate students. | TARC 2240 | 262-551-5710 | Website |

Health Services are available during walk-in hours (M-F, 8:30am-1:00pm) for the assessment and treatment of minor illness and injury. Diagnostic testing, complimentary over-the-counter medications, and referrals to off-campus providers are all available to students.

Counseling Services are available by appointment and during walk-in hours (M-F, 11:30am-1:00pm). Students often see counselors to discuss a wide variety of topics: depression, anxiety, relationship concerns, stress management, indecision about a major or career path, and academic concerns. HCC also supports students who are feeling suicidal or who are in crisis.

- Suicide Prevention Lifeline: 1-800-273-8255
- Emotional Support: Text "HOPELINE" to 741741.

COURSE SCHEDULE

A ***tentative*** course schedule follows. This model is intended to provide an initial overview of major themes, course topics, and tasks (*scope*); associated session dates (*sequence*); and interrelationships of themes (*coordination*). It is very probable, however, that **the schedule will change**! This is in keeping with constructivist position that conceptual development, not the calendar, should have primacy in determining the pace of instruction. Major changes to the schedule will be discussed, and possibly negotiated, in class.

EDU 3260 | Effectively Teaching Science in the Elementary/Middle School | Spring, 2020

Driving Inquiry Questions

Why teach natural science?
What is science? Scientific inquiry? School science?
How do children learn science?
How do I ascertain what the learner knows, is able to do, and values?
What science should I teach, to what depth, and in what sequence?
How will I achieve a safe and effective learning environment?
What does it mean to be a professional science educator?

Our primary Inquiry Questions transcend boundaries of class sessions, overlap complementary questions, and progress from general views of professional societies toward a more specific focus on the individual professional educator of the natural sciences.

	Date-Description	Benchmarks
1	**02/10**-Why teach science? Becoming a Science Teacher… Syllabus | Clinical| edTPA Portfolio | Personal Philosophy	**Due**: *NSTA Learning Center*
2	**02/17**-*NRC Framework*: A Vision for K-12 Science Education Historical and contemporary perspectives | NoS/SI/STS	**Due**: Read SFAA Chapter 1 **Due**: *Personal Philosophy*
3	**02/24**-NGSS 3-D Science | Scientific Inquiry | BSCS 5E *NoS Research Brief* share & refine	**Due**: *NoS Research Brief (draft)*
4	**03/02**-NGSS Performance Expectations & Storylines NGSS Science Curriculum | EQuIP Curriculum Evaluation	**Due**: *NoS Research Brief (final)*
	Spring Break	
5	**03/16**- Collaborative Research Lesson (CLR) Introduction EQuIP Curriculum Evaluation presentations	**Due**: *Curriculum Evaluation*
6	**03/23**- How students learn science | Conceptual change Collaborative Research Lesson share & refine	**Due**: *CLR Plan (draft)*
7	**03/30**-Planning effective science teaching and programs Collaborative Research Lesson share & refine	**Due**: Read SFAA, Ch. 13 **Due**: *CLR Plan (revised)*
8	**04/06**- Assessment *for* science learning | SBG revisited Collaborative Research Lesson plan presentations	**Due**: *CLR Plan (revised)*
	Easter Break	
9	**04/20**-Preparing tools for student teaching and early career. Time for science! | Capstone Project workshop	**Due**: *CLR Plan (final)*
10	**04/27**-Learning Environments-schools without walls Seven forms of PBL | Gold Standard PBL | Science Safety	**Due**: "*Your Choice*"
11	**05/04**- Collaborative Research Lesson presentations of observations and post-lesson discussion summary.	**Due**: CLR ***R****esearch* ***L****esson!!!*
12	**05/11**- Capstone Project workshop | Professional Engagement *Personal Philosophy* revisited.	**Due** *(end of day)*: *Capstone Project* **Due**: *Clinical Service Reflections*
13	**05/19 Final 8:00AM-10:00AM**-Capstone Presentations!	**Due**: Peer Reviews

REFERENCES

Black, P. J., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, *80*(2), 139–148.

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APPENDICES

NATIONAL SCIENCE TEACHERS ASSOCIATION PRESERVICE STANDARDS (2012)

NSTA Standard 1: **Content Knowledge** Effective teachers of science understand and articulate the knowledge and practices of contemporary science. They interrelate and interpret important concepts, ideas, and applications in their fields of licensure. Preservice teachers will:

1a) Understand the major concepts, principles, theories, laws, and interrelationships of their fields of licensure and supporting fields as recommended by the National Science Teachers Association.

1b) Understand the central concepts of the supporting disciplines and the supporting role of science-specific technology.

1c) Show an understanding of state and national curriculum standards and their impact on the content knowledge necessary for teaching P-12 students.

Assessment: This Standard is usually met using Assessments 1- state licensure exam and Assessment 2 - comprehensive content exams or science courses' GPA and content analysis form.

NSTA Standard 2: Content Pedagogy Effective teachers of science understand how students learn and develop scientific knowledge. Preservice teachers use scientific inquiry to develop this knowledge for all students. Preservice teachers will:

2a) Plan multiple lessons using a variety of inquiry approaches that demonstrate their knowledge and understanding of how all students learn science.

2b) Include active inquiry lessons where students collect and interpret data in order to develop and communicate concepts and understand scientific processes, relationships and natural patterns from empirical experiences. Applications of science-specific technology are included in the lessons when appropriate.

2c) Design instruction and assessment strategies that confront and address naïve concepts/preconceptions.

Assessment: This Standard is usually met using Assessment 3 - Unit Plan.

NSTA Standard 3: Learning Environments Effective teachers of science are able to plan for engaging all students in science learning by setting appropriate goals that are consistent with knowledge of how students learn science and are aligned with state and national standards. The plans reflect the nature and social context of science, inquiry, and appropriate safety considerations. Candidates design and select learning activities, instructional settings, and resources--including science-specific technology, to achieve those goals; and they plan fair and equitable assessment strategies to evaluate if the learning goals are met. Preservice teachers will:

3a) Use a variety of strategies that demonstrate the candidates' knowledge and understanding of how to select the appropriate teaching and learning activities – including laboratory or field settings and applicable instruments and/or technology- to allow access so that all students learn. These strategies are inclusive and motivating for all students.

3b) Develop lesson plans that include active inquiry lessons where students collect and interpret data using applicable science-specific technology in order to develop concepts, understand scientific processes, relationships and natural patterns from empirical experiences. These plans provide for equitable achievement of science literacy for all students.

3c) Plan fair and equitable assessment strategies to analyze student learning and to evaluate if the learning goals are met. Assessment strategies are designed to continuously evaluate preconceptions and ideas that students hold and the understandings that students have formulated.
3d) Plan a learning environment and learning experiences for all students that demonstrate chemical safety, safety procedures, and the ethical treatment of living organisms within their licensure area.
Assessment: This Standard is usually met using Assessment 3 - Unit Plan.

NSTA Standard 4: Safety Effective teachers of science can, in a P-12 classroom setting, demonstrate and maintain chemical safety, safety procedures, and the ethical treatment of living organisms needed in the P-12 science classroom appropriate to their area of licensure. Preservice teachers will:
4a) Design activities in a P-12 classroom that demonstrate the safe and proper techniques for the preparation, storage, dispensing, supervision, and disposal of all materials used within their subject area science instruction.
4b) Design and demonstrate activities in a P-12 classroom that demonstrate an ability to implement emergency procedures and the maintenance of safety equipment, policies and procedures that comply with established state and/or national guidelines. Candidates ensure safe science activities appropriate for the abilities of all students.
4c) Design and demonstrate activities in a P-12 classroom that demonstrate ethical decision-making with respect to the treatment of all living organisms in and out of the classroom. They emphasize safe, humane, and ethical treatment of animals and comply with the legal restrictions on the collection, keeping, and use of living organisms.
Assessment: This Standard is usually met using Assessments 3 - Unit Plan and Assessment 4- Student Teaching Observation Form.

NSTA Standard 5: Impact on Student Learning Effective teachers of science provide evidence to show that P-12 students' understanding of major science concepts, principles, theories, and laws have changed as a result of instruction by the candidate and that student knowledge is at a level of understanding beyond memorization. Candidates provide evidence for the diversity of students they teach. Preservice teachers will:
5a) Collect, organize, analyze, and reflect on diagnostic, formative and summative evidence of a change in mental functioning demonstrating that scientific knowledge is gained and/or corrected. 5b) Provide data to show that P-12 students are able to distinguish science from nonscience, understand the evolution and practice of science as a human endeavor, and critically analyze assertions made in the name of science.
5c) Engage students in developmentally appropriate inquiries that require them to develop concepts and relationships from their observations, data, and inferences in a scientific manner.
Assessment: This Standard is usually met using Assessment 5 – Evidence of P-12 student learning.

Standard 6: Professional Knowledge and Skills Effective teachers of science strive continuously to improve their knowledge and understanding of the ever changing knowledge base of both content, and science pedagogy, including approaches for addressing inequities and inclusion for all students in science. They identify with and conduct themselves as part of the science education community. Preservice teachers will:

6a) Engage in professional development opportunities in their content field such as talks, symposiums, research opportunities, or projects within their community.
6b) Engage in professional development opportunities such as conferences, research opportunities, or projects within their community.
Assessment: This Standard is usually met using Assessment 6 – Evidence of Professional Knowledge and Skills.