



**Vision Statement**

We develop educational leaders who create tomorrow's opportunities.

**Mission Statement**

Our mission is to prepare competent professionals who will make positive differences for children, young adults, and others in schools.

**SCI 610: Science Teaching & Learning**  
**Fall 2016: Tuesdays 4:30 – 7:00pm SHB 549**  
**3 credit hours**

**General Information:**

Instructor's Name: Brooke A. Whitworth

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Office address: SHB 525

Phone: 928-523-5083

Office Hours: MTu 9:00-10:30am & by appointment

**Course Prerequisites:** Graduate status or admission to the teacher education program.

**Course Description:** Exploration of effective pedagogical strategies and teaching techniques to meet the needs of students in middle and high school science classrooms. Learning theories, and instructional applications will act as course foci.

**Student Learning Expectations/Outcomes:** As a result of this course, students will be able to:

- A. Demonstrate a personal theory of science teaching by designing effective lessons that utilize research-based pedagogies.
- B. Demonstrate understanding of various learning theories by discussing the relationship between lesson plan elements and predicted effect on student learning.
- C. Demonstrate understanding of motivation by discussing the relationship between lesson plan elements and predicted effect on student engagement in the lesson.
- D. Practice professional patterns of communication including writing at a Master's level.

**Course Structure/Approach:** Lecture, large and small group discussion, readings, active participation in science activities, small group activities, use of educational technologies, presentations and personal reflection in hybrid face-to-face or online formats.

**Standards addressed in this course:**

- National Science Teacher Association Standards:
  - 2b, 4a, 5a, 5b, 5d, 5e, 5f, 8a
  - [http://www.nap.edu/openbook.php?record\\_id=4962](http://www.nap.edu/openbook.php?record_id=4962)
- Arizona Professional Teaching Standards:
  - 1.3, 1.5, 1.7, 1.8, 1.13, 2.2, 2.4, 7.1 - 7.5, 8.1 - 8.4, 8.6 - 8.9, 8.12
  - <http://www.ade.state.az.us/certification/downloads/Teacherstandards.pdf>
- Interstate Teacher Assessment and Support Consortium (InTASC):
  - 1,3,4,6,7,8
  - [http://www.ccsso.org/Documents/2011/InTASC\\_Model\\_Core\\_Teaching\\_Standards\\_2011.pdf](http://www.ccsso.org/Documents/2011/InTASC_Model_Core_Teaching_Standards_2011.pdf)

**Textbooks and Required Materials:**

Konicek-Moran, R. & Keeley, P. D. (2015). Teaching for conceptual understanding in science. Arlington, VA: NSTA Press.

Additional readings available through Google Drive

**Recommended Materials:**

Arizona Department of Education. *Arizona academic content standards: Science standard articulated by grade level*. Available online:

<http://www.azed.gov/standards-practices/science-standard>

National Research Council. (2012). *Next Generation Science Framework*. Washington DC: National Academy Press. Available online: [http://www.nap.edu/catalog.php?record\\_id=13165](http://www.nap.edu/catalog.php?record_id=13165)

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press. Available online: <http://www.nextgenscience.org/>

**Course Evaluation:**

All assignments must be turned in through Google Drive	Points
<p><b>Attendance &amp; Participation:</b> Students are expected to attend every class and engage in class activities. Frequently, in-class activities will include individual and group written work. This grade is holistic and will be based on attendance, preparation, and willingness to engage in in-class activities as evidenced by these informal assignments. You must be present to receive credit for these written assignments. Points will be deducted on a pro-rated basis for not attending and not participating in these informal assessments. Students will also be asked to complete two self-evaluations of their professional conduct in class.</p>	125
<p><b>Annotated Bibliography:</b> You will complete an annotated bibliography that will be collected periodically.</p>	150
<p><b>Philosophy of Education:</b> Students will write a philosophy of education detailing their thinking about learning and teaching and how that impacts the methods they choose as a teacher. Students will write initial and final philosophy of education.</p>	100
<p><b>Lesson Plans &amp; Discourse Circle:</b> Throughout the semester, students will be writing lesson plans, and will have the opportunity to lead a discourse circle that aligns with the various methods taught in the classroom.</p>	150
<p><b>Final Project:</b> To inform this final project, students will select a big idea from science and choose a set of objectives that address this idea from the Next Generation Science Standards. Following this, they will investigate what is known about student learning regarding this topic and search for effective ways to teach it. This work will form the basis of two final class assignments:</p> <p><b>Mapping Student Learning Paper</b> After selecting a topic and learning objectives, students will use the relevant literature to identify student knowledge and reasoning about this topic. The <b>purpose</b> of this paper is to analyze student knowledge using findings from the related literature to understand what students know about this topic to focus the target of lesson to be taught. The findings from this paper should heavily inform the design of the lesson for the <b>Lesson Design, Enactment, and Evaluation</b> project.</p> <p><b>Lesson Design, Enactment, and Evaluation</b> After selecting a topic and learning objectives, students will design a whole class assessment of students' knowledge of this topic to be administered before and after instruction. Findings from the literature and analysis of the pre-assessments will be used to design and teach an effective lesson that employs the learning theories discussed in the course. The evaluation paper created for this assignment will include the lesson plan, a rationale for the design of the plan using the relevant literature, the quantitative evaluation of the learning of the class with a discussion that employs the learning theories explored in the course, and a reflection on what was learned to inform future teaching. The purpose of this assignment is to investigate what is learned as a result of instruction, and these findings should be used to revise and explain students' knowledge of teaching. Students will also provide a final presentation of what they learned.</p>	275
<b>Total Possible:</b>	<b>800</b>

## Grading System:

Your letter grade for this class will be determined using the following point scale:

640-800 points	A
480-639 points	B
320-479 points	C
0-319 points	F

The lower bound for each grade will not be set higher than what is listed above. However, it may be set lower depending on the class average and distribution.

## Course Policies:

- **Communication:** Contact the instructor immediately in case of any special circumstances or emergency situations. It is better to make contact earlier rather than later.
- **Attendance: Regular attendance is necessary for the successful completion of this course.** The only excused absences that will be considered are institutional excuses for university related events. Emailing, calling, or leaving a phone message or note saying you will not be attending class is appreciated but does not constitute a valid excuse. You will be counted absent for that day. Contact the instructor immediately in case of any special circumstances or emergency situations. **Any absence beyond the first one that is not pre-approved by the instructor will result in a reduction of points.**
- **Homework:** All assignments must be submitted to Google Drive by the beginning of class time **on or before** the due date. **Late homework will not be routinely accepted.** Points will be deducted at 10% per day of earned points up to one week late. Problems with computer hardware or software will not be accepted as excuses for handing in work after the due date. Additional assignments will NOT be given for extra credit.
- **Writing Assignments:** All written assignments must be word processed and submitted electronically in pdf or word format. Writing errors such as spelling, punctuation, grammatical errors, etc., will be taken into consideration; any assignment with more than four errors will be returned for revision before grading. All assignments should be professional in appearance. Students are permitted and encouraged to proofread each other's assignments. APA guidelines must be followed for formal papers.
- **Cell Phones:** Please turn off cell phones upon entering the classroom.
- **Academic Dishonesty:** Plagiarism is considered as a willful act when a person knowingly uses the work of others and attempts to present it as his/her own. Academic dishonesty will not be permitted. Appropriate measures, as stated in the NAU Student Handbook, will be applied. Assignments submitted as a requirement for another class should not be submitted for this class without permission from the instructor. All assignments should be the original work of the student completed for this class. If lab activities or lesson plans from another source are used and/or modified by the student for this course, a proper citation to the original author must be provided.
- **Instructor/Course Evaluations:** When it gets close to the end of the course, all students are asked to complete a course evaluation at: [http://www.nau.edu/course\\_evals/](http://www.nau.edu/course_evals/).

## Course Expectations:

- Students are expected to attend class and to participate in class discussions.
- Students are also expected to be respectful of others in the classroom by not causing distractions while others are speaking.
- Class time is primarily devoted to the presentation, exploration, and discussion of new material. Students are expected to make use of office hours to ask questions and receive guidance on assigned work.
- It is the student's responsibility to make the instructor aware of any content that presents difficulties.

The instructor reserves the right to revise the syllabus, assignments and course evaluation criteria. Students will be immediately notified of any of these changes in advance of any changes taking effect.

Course Outline (subject to change):

Week	Date	Topic	Assignments & Readings Due
1	8/30	<ul style="list-style-type: none"> <li>Course introduction</li> <li>Using Research to Examine Learning</li> </ul>	<ul style="list-style-type: none"> <li>Reeves, D. B. (2004). The case against the zero. <i>Phi Delta Kappan</i>, 86, 324-325.</li> </ul>
2	9/6	<ul style="list-style-type: none"> <li>Teaching for Conceptual Understanding</li> <li>History of Science &amp; Conceptual Understanding</li> <li>Nature of Science &amp; Conceptual Understanding</li> </ul>	<ul style="list-style-type: none"> <li><b>Initial Philosophy of Education</b></li> <li>Teaching for Conceptual Understanding in Science – Ch. 1-3</li> </ul>
3	9/13	<ul style="list-style-type: none"> <li>Overview of Learning Theories                             <ul style="list-style-type: none"> <li>Behaviorism</li> <li>Piaget</li> <li>Memory Theory</li> <li>Social Constructivism</li> </ul> </li> <li>Student Thinking &amp; Conceptual Understanding</li> </ul>	<ul style="list-style-type: none"> <li>Bodrova, E., &amp; Leong, D. J. (2007). <i>Tools of the mind: The Vygotskian approach to early childhood education</i> (2nd ed.). Upper Saddle River, NJ: Pearson.</li> <li>Teaching for Conceptual Understanding in Science – Ch. 4</li> </ul>
4	9/20	<ul style="list-style-type: none"> <li>Constructivism</li> <li>Conceptual Change</li> <li>Demonstration Model</li> <li>Discourse</li> </ul>	<ul style="list-style-type: none"> <li><b>Discourse Circle Sign-up</b></li> <li>Colburn, A. (2007). The prepared practitioner: Constructivism and conceptual change, Part 1. <i>The Science Teacher</i>, 74(7), 10.</li> <li>Colburn, A. (2007). The prepared practitioner: Constructivism and conceptual change, Part 2. <i>The Science Teacher</i>, 74(8), 14.</li> <li>Dial, K., Riddley, D., Williams, K., &amp; Sampson, V. (2009). Addressing misconceptions: A demonstration to help students understand the law of conservation of mass. <i>The Science Teacher</i>, 76(7), 54-57.</li> <li>Ambitious Science Teaching. (2015). <i>A discourse primer for science teachers</i>. Retrieved from: <a href="http://ambitiousscienceteaching.org/wp-content/uploads/2014/09/Discourse-Primer.pdf">http://ambitiousscienceteaching.org/wp-content/uploads/2014/09/Discourse-Primer.pdf</a></li> </ul>
5	9/27	<ul style="list-style-type: none"> <li>Experts vs. Novices</li> <li>Motivation</li> <li>History of Science Education &amp; Teaching for Conceptual Understanding</li> </ul>	<ul style="list-style-type: none"> <li><b>PEOE Lesson Plan</b></li> <li><b>Final Project Assessment Draft</b></li> <li>Vanides, J. Y., &amp; Ruiz-Primo, M. A. (2005). Using concept maps in science classrooms. <i>Science Scope</i> 28(8), 27-31.</li> <li><b>Discourse Circle 1:</b> Dweck, C. (2007). The perils and promises of praise. <i>Educational Leadership</i>, 65(2), 34-39.</li> <li>Colburn, A. (2008). The prepared practitioner: shedding light on misconceptions. <i>The Science Teacher</i>, 75(9), 10.</li> <li>Teaching for Conceptual Understanding in Science – Ch. 5</li> </ul>
6	10/4	<ul style="list-style-type: none"> <li>Developing Conceptual Understanding &amp; NGSS</li> <li>Engineering Design</li> </ul>	<ul style="list-style-type: none"> <li><b>Annotated Bibliography Check 1</b></li> <li>Teaching for Conceptual Understanding in Science – Ch. 6</li> <li>Campbell, T., Schwarz, C., &amp; Windschitl, M. (2016). What We Call Misconceptions May Be Necessary Stepping-Stones Toward Making Sense of the World. <i>The Science Teacher</i>, 83(3), 69-73.</li> <li><b>Discourse Circle 2:</b> Crismond, D. (2013). Design Practices and Misconceptions. <i>The Science Teacher</i>, 80(1), 50-54</li> <li><b>Discourse Circle 3:</b> Wheeler, L. B., Whitworth, B. A., &amp; Gonczi, A. L. (2014, December). Engineering design challenge. <i>Science Teacher</i>, 81(9), 30-36.</li> </ul>

7	10/11	<ul style="list-style-type: none"> <li>• Instructional Models Overview</li> <li>• Inquiry &amp; the Practices</li> <li>• The 4 Question Strategy</li> <li>• Argument Driven Inquiry</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Engineering Design Brief</b></li> <li>• <b>Mid-term Professional Conduct Check</b></li> <li>• Teaching for Conceptual Understanding in Science – Ch. 7</li> <li>• STEM Teaching Tool #32</li> <li>• Bell, R. L., Smetana, L., &amp; Binns, I. (2005). Simplifying inquiry instruction. <i>The Science Teacher</i>, 72(7), 30-34.</li> <li>• <b>Discourse Circle 4:</b> Sampson, V., Grooms, J., &amp; Walker, J. (2009). Argument-Driven Inquiry. <i>The Science Teacher</i>, 76(8), 42-47.</li> </ul>
8	10/18	<ul style="list-style-type: none"> <li>• Instructional Strategies Overview</li> <li>• Metacognition</li> <li>• Reviewing Theories, Instructional Models &amp; Strategies</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Mapping Student Learning Paper</b></li> <li>• Teaching for Conceptual Understanding in Science – Ch. 8</li> <li>• <b>Discourse Circle 5:</b> Farenga, S., Ness, D., &amp; Flynn, G. (2007). Strategies for learning and metacognition: Identifying and remembering big ideas. <i>Science Scope</i>, 31(2), 82-88.</li> <li>• Brown, P. C., Roediger, H. L., &amp; McDaniel, M. A. (2014). Get beyond learning styles. In <i>Make it stick: The science of successful learning</i> (pp. 131-161). Cambridge, MA: The Belknap Press of Harvard University Press.</li> </ul>
9	10/25	<ul style="list-style-type: none"> <li>• Assessment, Instruction &amp; Learning</li> <li>• Informal Education &amp; Conceptual Understanding</li> </ul>	<ul style="list-style-type: none"> <li>• <b>ADI Lesson Plan</b></li> <li>• Teaching for Conceptual Understanding in Science – Ch. 9 &amp; 10 (Write summary for your Ann. Bib.)</li> <li>• <b>Discourse Circle 6:</b> McTighe, J., &amp; O'Conner, K. (2005). Seven practices for effective learning. <i>Educational Leadership</i>, 63(3), 10-17.</li> </ul>
10	11/1	<ul style="list-style-type: none"> <li>• The 5 Practices</li> <li>• Cognitively demanding science tasks</li> <li>• Anticipating &amp; Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Annotated Bibliography Check 2</b></li> <li>• 5 Practices – Intro &amp; Ch. 1-3</li> </ul>
11	11/8	<b>ELECTION DAY – NO CLASS</b>	<ul style="list-style-type: none"> <li>• <b>Prior to today you should have completed your Final Project Lesson Plan Draft</b></li> </ul>
12	11/15	<ul style="list-style-type: none"> <li>• Selecting, Sequencing &amp; Connecting</li> <li>• Making Student Thinking Visible</li> </ul>	<ul style="list-style-type: none"> <li>• 5 Practices – Ch. 4 &amp; 5</li> </ul>
13	11/22	<b>THANKSGIVING WEEK – NO CLASS</b>	
14	11/29	<ul style="list-style-type: none"> <li>• Situating 5 Practices within Instruction</li> <li>• Leadership</li> </ul>	<ul style="list-style-type: none"> <li>• 5 Practices – Ch. 6 &amp; 7 (Write summary for Ann. Bib.)</li> <li>• Teacher Leadership Framework</li> </ul>
15	12/6	• <b>FINAL PROJECT PRESENTATIONS</b>	<ul style="list-style-type: none"> <li>• <b>5 Practices Lesson Plan</b></li> <li>• <b>Final Annotated Bibliography</b></li> <li>• <b>Final Professional Conduct Check</b></li> <li>• <b>Course Evaluation</b></li> </ul>
16	12/13	<b>FINAL – NO IN PERSON CLASS ALL ASSIGNMENTS DUE BY 7:00PM</b>	<ul style="list-style-type: none"> <li>• <b>Final Philosophy of Education</b></li> <li>• <b>Final Project Evaluation Paper</b></li> <li>• <b>Final Project Lesson Plan</b></li> </ul>

**NORTHERN ARIZONA UNIVERSITY**  
**Center for Science Teaching and Learning**  
**UNIVERSITY AND DEPARTMENT POLICIES**

**Course Pre-requisites and Placement:** Prior to enrollment in a course the student must have completed the course pre-requisites or have proper placement for the course. It is the student's responsibility to check that they are properly enrolled in a course and to drop the course if they are not. Failure to do so could result in not receiving credit for the course. The department may cancel student's registration in a course in which they are not properly enrolled. However, it is the student's responsibility to monitor his or her own enrollment.

**Administrative Drops:** An instructor may administratively drop from a course any student who is absent **one or more times** from class during the first week without contacting the instructor and receiving approval. Students who have not met all prerequisites for a course may be administratively dropped. However, it is the student's responsibility to monitor his or her own enrollment.

**Class Attendance:** Students are expected to assume full responsibility for class attendance and are accountable for work missed because of absences. Instructors are under no obligation to make special arrangements for students who have been absent unless such absence has been excused by a formal institutional excuse. Institutional excuses permit a student to be absent from classes to represent the University in athletics and extracurricular or academic activities. Institutional excuses must be hand-delivered to the instructor and arrangements made for the work missed prior to the planned absence from class.

**Dropping/Auditing a Course:** The last day you may drop/delete a course (*without the class appearing on your transcripts*) is **9/10/2015**. The last day you may drop a course (and receive a **W**) is **11/6/2015**. Academic policy requires that a student who never attended class or stopped attending class receive an **F** should the student fail to officially drop the course. The deadline to change from credit to audit or vice versa is **10/2/2015**. Once a student has registered and completed a class as an auditor, the audit grade cannot be changed to a credit-earning grade. The grade of **AU** is awarded to auditors for satisfactory attendance. See the most recent *Academic Catalog* for more information at: <http://catalog.nau.edu/>. The College policies on exceptions can be found at <http://nau.edu/CEFNS/Student-Resources/Advising/> at the bottom of the page.

**The Grade of Incomplete:** A grade of **I** is given by an instructor only if a student is unable to finish a course due to extraordinary, unforeseeable circumstances, and the deadline to drop has passed. An incomplete is only given to a student who was passing the course with a grade of **C** or higher at the time the student was forced to stop attending. Before a grade of **I** can be given the student and instructor must complete the official department form indicating the work to be completed, as well as the date(s) by which the work must be completed. A grade of **I** not removed within a one-year period automatically reverts to a grade of **F**.

**Final Examinations:** Final examinations are required in all classes and must be given at the scheduled times and dates indicated in the university final exam schedule. An exception to the official final examination schedule can be made if a student is scheduled to take more than two examinations in one day. For more information, see the schedule at: <http://nau.edu/Registrar/Important-Dates/Fall/>.

**NAU Policy Statements:** Students are responsible for the following policies: Safe Environment, Students with Disabilities, Institutional Review Board, Academic Integrity, and Academic Contact Hour. A copy of these policies may be downloaded from the website <http://www4.nau.edu/avpaa/policy1.html>

**Department Policy on Use of Portable Electronic Devices:** Cell phones, mp3 players and portable electronic communication devices, including but not limited to smart phones, cameras and recording devices, must be turned off and inaccessible during in-class tests. Any violation of this policy will be treated as academic dishonesty.

### **Other Information**

NAU has an **Emergency Textbook Loan Program**. Eligible students can apply for assistance with acquisition of textbooks for the semester. More information at: <http://nau.edu/LEADS-Center/Textbook-Loan-Program/>

The Student Learning Centers, TRIO Outreach programs, and Educational Support Services main office are back in the University Union, second floor. Specific room locations are below:

#### **Student Learning Centers**

- Tutoring-room 201
- Transfer and Commuter Connections office/lounge-Room 247
- Peer Jacks lounge and staff-room 201

#### **TRIO Outreach programs**

- Educational Talent Search (ETS)/Educational Opportunity Center (EOC)/Nizhoni-Room 241
- Upward Bound and Upward Bound Math Science-room 201

#### **Educational Support Services**

- Main office – Room 2