NORTHERN ARIZONA UNIVERSITY

College of Engineering, Forestry, and Natural Science
Center for Science Teaching and Learning

TSM 303: Knowing and Learning in Science
Fall 2016
3 credit hours - In person

Course Instructor:
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Course Prerequisites: TSM 102 with grade of C or better

Course Description: This course examines what it means to know and learn science. The course expands prospective teachers' understanding of current theories of learning science through examining their own assumptions about learning as well as the needs of a diverse student population. In addition, students explore the Next Generation Science Standards and the ways in which they impact science teaching and learning. Additionally, the course engages students in investigating and enacting effective instructional techniques aligned with modern learning theories in order to meet the needs of students in middle and high school science classrooms. A course fee is required.

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

1. Demonstrate understanding of relevant learning theories by discussing the relationship between lesson plan elements and predicted effect on student learning.
2. Demonstrate a personal theory of science teaching by designing effective lessons that utilize research-based pedagogies.
3. Demonstrate understanding of motivation by discussing the relationship between lesson plan elements and predicted effects on student engagement in the lesson.
4. Demonstrate competence in instructional strategies through classroom rehearsals.
5. Practice professional patterns of communication including writing at an undergraduate 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.

Textbook and Required Materials:

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

Additional readings posted on *BbLearn*

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

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

Basis for Evaluation: Your numeric grade for this class will be determined by your performance on the components listed below. All assignments must be completed **on time** in order to receive full credit.

Component	**Points**
Attendance & Participation: Students are expected to attend every class and engage with in-class activities. Points will be deducted on a pro-rated basis for not attending and not participating. Students will also be asked to complete two self-evaluations of their professional conduct in the class.	**160**
Annotated Bibliography: You will complete an annotated bibliography that will be collected periodically.	**160**
Fingerprint Clearance: Students must apply for fingerprint clearance by October 12th, 2016 and provide proof of this application to the instructor. This is a **signature assessment** for this course.	**40**
Professional Dispositions Module: The module is a self-contained and self-paced course in BbLearn that presents content related to the professional standards of practice, ethics, and relevant laws and policies of the teaching profession. CAEP Standard 3.6 requires program completers to demonstrate understanding of these topics. The module contains a single, multiple-choice quiz that candidates must pass (70% or better). You will have 3 attempts to pass the module. This is a **signature assessment** for this course. **Students should email a screen shot of passing to the instructor when completed by December 7th, 2016 at the latest.**	**40**
Tutoring: Students will be expected to complete 10 hours of tutoring at a school in the area. Students will be asked to turn in a reflection regarding their tutoring experience at the end of the semester. This is a **signature assessment** for this course.	**100**
Lesson Plans, Teaches & Discourse Circle: Throughout the semester, students will be writing lesson plans, enacting teaching, and leading discourse circles that align with the various methods taught in the classroom.	**200**
Philosophy of Learning: Students will write a philosophy of learning detailing their thinking about learning, how they view learning, and how that impacts the methods they will choose as a teacher. Students will write pre- and post- philosophy of learning.	**100**
Final Project: To inform this final project, groups of three 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: • **Mapping Student Learning Paper** • **Lesson Design, Enactment, and Evaluation** Students will complete these assignments as part of their final for the course.	**200**
Total:	**1000**

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

800-1000 points	A
600-799 points	B
400-599 points	C
200-399 points	D
0-199 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

- ***Signature Assessments:*** This course contains signature assessments. **It is NOT possible to pass this course without passing the signature assessments**. The signature assessments are a Fieldwork Requirement, Fingerprint Clearance, and a Professional Dispositions Module. These signature assessments must meet or exceed minimum criteria in order to be recommended for apprentice teaching. If you do not complete Field Experience, you WILL NOT pass the class. Additionally, all students will be evaluated on their professional dispositions.
- ***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:*** Homework will be collected regularly and will be due on a specified date. **Late homework will not be routinely accepted.** You should check with the instructor to determine if it is appropriate to submit homework after the deadline.
- ***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.
- ***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/.**

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):

Date	Topic	Readings & Assignment Due
8/29	• Course introduction • Using research to examine learning	• Reeves, D. B. (2004). The case against the zero. *Phi Delta Kappan, 86,* 324-325.
8/31	• Teaching for Conceptual Understanding • Introduction to Tutoring	• Teaching for Conceptual Understanding in Science – Ch. 1 • **Sign-up for tutoring**
9/5	**NO CLASS – LABOR DAY**	
9/7	• Materials Check-out • Fingerprint Clearance • Introduction to CSTL	• **Initial Philosophy of Learning**
9/9	**CSTL KICK-OFF 1:00pm – 3:00pm**	
9/12	• History of Science & Conceptual Understanding • Introduction to Final Project	• Teaching for Conceptual Understanding in Science – Ch. 2 • **Tutoring Contract (Paper Copy)**

9/14	• Nature of Science & Conceptual Understanding	• Teaching for Conceptual Understanding in Science – Ch. 3
9/19	• Overview of Learning Theories o Behaviorism o Piaget o Memory Theory o Social Constructivism	• Bodrova, E., & Leong, D. J. (2007). *Tools of the mind: The Vygotskian approach to early childhood education* (2nd ed.). Upper Saddle River, NJ: Pearson.
9/21	• Student Thinking & Conceptual Understanding	• Teaching for Conceptual Understanding in Science – Ch. 4
9/26	• Constructivism • Conceptual change • Demonstration Model	• Colburn, A. (2007). The prepared practitioner: Constructivism and conceptual change, Part 1. *The Science Teacher, 74*(7), 10. • Colburn, A. (2007). The prepared practitioner: Constructivism and conceptual change, Part 2. *The Science Teacher, 74*(8), 14. • Dial, K., Riddley, D., Williams, K., & Sampson, V. (2009). Addressing misconceptions: A demonstration to help students understand the law of conservation of mass. *The Science Teacher, 76*(7), 54-57. • Khourey-Bowers, C. (2011). Active Learning Strategies: The Top 10. *Science Teacher*, *78*(4), 38-42. • **Annotated Bibliography Check 1**
9/28	• Discourse	• Ambitious Science Teaching. (2015). *A discourse primer for science teachers*. Retrieved from: http://ambitiousscienceteaching.org/wp-content/uploads/2014/09/Discourse-Primer.pdf • Loper, S. & Baker, J. (2009). More than one "right" answer. *Science and Children, 47*(3), 33-35. • **Demonstration Model Teach Sign-Up** • **Discourse Circle Sign-Up**
10/3	• Demonstration Model Teach	• **Demonstration Model Lesson Plan due when you present** • **Assessment Draft**
10/5	• Demonstration Model Teach	• **Demonstration Model Lesson Plan due when your present**
10/10	• Experts vs. Novices • Motivation	• **Discourse Circle 1:** Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). Chapter 4: Embrace difficulties. In *Make it stick: The science of successful learning* (pp. 67-101). Cambridge, MA: The Belknap Press of Harvard University Press. • **Discourse Circle 2:** Dweck, C. (2007). The perils and promises of praise. *Educational Leadership, 65*(2), 34-39. • **Discourse Circle 3:** Vanides, J. Y., & Ruiz-Primo, M. A. (2005). Using concept maps in science classrooms. *Science Scope 28*(8), 27-31. • **Discourse Activity Lesson Plan** • **Revised Assessment**
10/12	• History of Science Education & Teaching for Conceptual Understanding	• Teaching for Conceptual Understanding in Science – Ch. 5 • **Discourse Circle 4:** Colburn, A. (2008). The prepared practitioner: shedding light on misconceptions. *The Science Teacher, 75*(9), 10. • **Fingerprint Clearance** • **Assessments Administered**
10/17	• Developing Conceptual Understanding & NGSS	• Teaching for Conceptual Understanding in Science – Ch. 6 • **Discourse Circle 5:** Campbell, T., Schwarz, C., & Windschitl, M. (2016). What We Call Misconceptions May Be Necessary Stepping-Stones Toward Making Sense of the World. *The Science Teacher*, *83*(3), 69-73.

10/19	• Engineering Design	• **Discourse Circle 6:** Crismond, D. (2013). Design Practices and Misconceptions. *The Science Teacher*, *80*(1), 50-54 • **Discourse Circle 7:** Wheeler, L. B., Whitworth, B. A., & Gonczi, A. L. (2014, December). Engineering design challenge. *Science Teacher, 81*(9), 30-36. • **Annotated Bibliography Check 2** • **Mid-term Professional Conduct Survey**
10/24	• Instructional Models Overview • Inquiry & the Practices • The 4 Question Strategy	• Teaching for Conceptual Understanding in Science – Ch. 7 • **Discourse Circle 8:** STEM Teaching Tool #32 • **Discourse Circle 9:** Bell, R. L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher, 72*(7), 30-34. • **Mapping Student Learning Paper**
10/26	• Argument-Driven Inquiry	• **Discourse Circle 10:** Sampson, V., Enderle, P., & Grooms, J. (2013). Argumentation in science education. *The Science Teacher*, *80*(5), 30-33. • **Discourse Circle 11:** Sampson, V., Grooms, J., & Walker, J. (2009). Argument-Driven Inquiry. *The Science Teacher,* 76(8), 42-47.
10/31	• Review of Theories & Instructional Models	• **Discourse Circle 12:** Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). Chapter 6: Get beyond learning styles. In *Make it stick: The science of successful learning* (pp. 131-161). Cambridge, MA: The Belknap Press of Harvard University Press. • **Engineering Design Brief**
11/2	• Instructional Strategies Overview • Metacognition	• Teaching for Conceptual Understanding in Science – Ch. 8 • **Discourse Circle 13:** Farenga, S., Ness, D., & Flynn, G. (2007). Strategies for learning and metacognition: Identifying and remembering big ideas. *Science Scope, 31*(2), 82-88.
11/7	• Assessment, Instruction & Learning	• Teaching for Conceptual Understanding in Science – Ch. 9 • **Discourse Circle 14:** McTighe, J., & O'Conner, K. (2005). Seven practices for effective learning. *Educational Leadership, 63*(3), 10-17. • **ADI Lesson Plan**
11/9	• Informal Education & Conceptual Understanding	• **Discourse Circle 15:** Teaching for Conceptual Understanding in Science – Ch. 10 • **Annotated Bibliography Check 3**
11/14	• Tying It All Together	• **Discourse Circle 16:** Mindset – Introduction & Ch. 1
11/16	• Work-day	• **Discourse Circle 17:** Mindset – Ch. 7 • **Lesson Plan Draft Meetings**
11/21	• Work-day	• **Discourse Circle 18:** TBD
11/23	**NO CLASS – THANKSGIVING**	
11/28	• Final project lessons	• **Final lesson plan due when your group presents**
11/30	• Final project lessons	• **Final lesson plan due when your group presents**
12/5	• Final project lessons	• **Final lesson plan due when your group presents**
12/7	• Work-day	• **Dispositions** • **Final Annotated Bibliography** • **Final Philosophy of Learning** • **Tutoring Reflection & Hours** • **Course Evaluation** • **Professional Dispositions Module MUST be passed (Email picture or screen shot of passing approval page)**
12/12	• Final 12:30-2:30pm	• **Final Project Papers** • **Final Professional Conduct Survey**

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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