

GEORGE MASON UNIVERSITY
COLLEGE OF EDUCATION AND HUMAN DEVELOPMENT
Advanced Studies in Teaching and Learning (ASTL)

EDCI 670-002: Advanced Methods of Teaching Science
3 credits, Spring Semester, 2017
Tuesdays, 7:20 – 10:00 pm, Thompson Hall 2020

Instructor: Mollianne Logerwell, PhD
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Tuesdays, 2 – 4 pm and by appointment

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Prerequisites/Corequisites

Admission to the ASTL program.

University Catalog Course Description

Application of major principles of education and psychology for the improvement of science teaching in secondary schools.

Course Overview

This course will focus on augmenting the knowledge of experienced science teachers by integrating the reading of current literature in education research that defines best practice with the application of these findings in the educational setting. The course will build on science teachers' existing knowledge and reflect on what it means to teach science, what it means to teach a diverse population of students, and how to develop, implement, and interpret authentic assessment (i.e., product based assessment such as portfolios). Participants will engage in action research to evaluate the impact of instructional modifications on student learning.

Course Delivery Method

EDCI 670 is designated as a lecture course; however, students are expected to come to class prepared and actively participate in discussions and other learning experiences.

Learner Outcomes/Objectives

Below is a list of the major course goals.

- Design and modify instruction based on theory, philosophy, educational research, and best practice.
- Incorporate findings from educational literature into instructional strategies to improve student learning.
- Create a learning environment in which all learners feel welcome and can be successful.
- Modify instruction and learning environment based on assessment of student learning, problems, and successes.
- Seek, implement, and evaluate best pedagogical practice within the context of a specific learning setting.

- Monitor the effects of instructional actions, selection of learning materials, and other instructional decisions on student learning.
- Design and modify instruction that is responsive to differences among learners.

Professional Standards

EDCI 670 is the first course in a three-course sequence of Advanced Studies in Teaching and Learning science courses for students seeking an advanced M.Ed. (ASTL). The course builds on students' knowledge of their subject matter and their current or former teaching experience. The course focuses on teacher as a reflective practitioner in science teaching and learning and meeting the diverse needs of learners as called for by the *Standards of Learning for Virginia Public Schools* and *National Science Education Standards* and as outlined by the National Council for Accreditation of Teacher Education (NCATE), the National Science Teachers Association (NSTA), and the Interstate New Teacher Assessment and Support Consortium (INTASC). EDCI 670 introduces students to action research in learning and teaching science, adapting inquiry-based lessons, assessment techniques, and the diverse needs of students. This course will also be directly connected to the Core Values of CEHD: Innovation, Research-Based Practice, Ethical Leadership, Social Justice, and Collaboration.

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

- Vary their teaching actions, strategies, and methods to promote the development of multiple student skills and levels of understanding.
- Successfully promote the learning of science by students with different abilities, needs, interests, and backgrounds.
- Successfully organize and engage students in collaborative learning using different student group learning strategies.
- Successfully use technological tools, including but not limited to computer technology, to access resources, collect and process data, and facilitate the learning of science. Understand and build effectively upon the prior beliefs, knowledge, experiences, and interests of students.
- Create and maintain a psychologically and socially safe and supportive learning environment.

Additionally, this course was designed with a vision for accomplished teaching, as indicated by NBPTS Science Standards for Early Adolescence and Adolescence and Young Adulthood's Five Core Propositions:

- 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

Keeley, P. (various). *Uncovering student ideas in science*. Arlington, VA: NSTA Press.

NOTE: This is a series of books. Choose one to purchase. You can pick a general volume or a subject-specific one. <http://www.nsta.org/publications/press/uncovering.aspx>

Llewellyn, D. (2013). *Teaching high school science through inquiry and argumentation*, 2nd ed.

Thousand Oaks, CA: Sage Publications.

Liu, X. (2010). *Essentials of science classroom assessment*. Thousand Oaks, CA: Sage Publications.

The online site for this course can be found at <http://mymasonportal.gmu.edu>. Students are expected to routinely check the online course portal for supplemental information, readings, etc.

Recommended Online Readings

- Achieve, (2013). Next Generation Science Standards (2013). Achieve, Inc. <http://www.nextgenscience.org/next-generation-science-standards>
- Commonwealth of Virginia (2010). *Standards of Learning for Virginia Public Schools*. Richmond, Virginia. <http://www.doe.virginia.gov/testing/index.shtml>
- Commonwealth of Virginia (2003). *Science Standards of Curriculum Framework Guides*. <http://www.pen.k12.va.us/VDOE/Instruction/sol.html#science>
- National Board for Professional Teaching Standards (2014). *Science Standards for Early Adolescence and Young Adulthood*. <http://boardcertifiedteachers.org/sites/default/files/EAYA-SCIENCE.pdf>
- National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press. http://www.nap.edu/openbook.php?record_id=4962
- American Association for the Advancement of Science (1993). *Benchmarks for Science Literacy*. <http://www.project2061.org/tools/benchol/bolframe.htm>

Other Recommended Readings

- Barnekow, D. J. (1998). *Graphic organizers for science*. Portland, ME: J. Weston Walsh.
- Bybee, R. W. (2002). *Learning science and the science of learning*. Arlington, VA: NSTA Press.
- Bybee, R. W., Powell, J. C., & Trowbridge, L. W. (2008). *Teaching secondary school science: Strategies for developing scientific literacy*. Upper Saddle River, NJ: Pearson.
- Cothron, J. H., Giese, R. N., Rezba, R. J. (2005). *Students and research*. Dubuque, Iowa: Kendall/Hunt.
- Hassard, J. (2005). *The art of teaching science: Inquiry and innovation in middle school and high school*. New York: Oxford University Press.
- Haysom, J., & Bowen, M. (2010). *Predict, observe, explain: Activities enhancing scientific understanding*. Arlington, VA: NSTA Press.
- Johnson, D. W. & Johnson R. T. (1999). *Learning together and alone: Cooperative, competitive, and individualistic learning*. Boston: Allyn and Bacon.
- Kagan, S. (1994). *Cooperative learning*. San Clemente, CA: Resources for Teachers, Inc.

- Keely, P. (2008). *Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning*. Arlington, VA: NSTA Press.
- Luft, L., Bell, R. L., Gess-Newsome, J. (2008). *Science as inquiry in the secondary setting*. Arlington, VA: NSTA Press.
- National Research Council. (2005). *How students learn: Science in the classroom*. Washington, DC: The National Academies Press.
- O'Brien, T. (2010). *Brain-powered science: Teaching and learning with discrepant events*. Arlington, VA: NSTA Press.
- Ritchhart, R., Church, M. & Morrison, K. (2011). *Making thinking visible: How to promote engagement, understanding, and independence for all learners*. San Francisco: Jossey-Bass.
- Slavin, R. E. (1995). *Cooperative learning*. Boston: Allyn and Bacon.
- Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Wormelli, R. (2007). *Differentiation: From planning to practice*. Portland, ME: Stenhouse Publishers.

Course Performance Evaluation

Students are expected to submit all assignments on time and in the manner outlined by the instructor (e.g., Blackboard, Tk20, hard copy).

Assignments

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 a two-way communication loop that informs both learning and teaching. All written assignments must be submitted through Blackboard. General formatting includes 1" margins, double-spacing, and Calibri (or equivalent) font.

Assignment	Points	Due Date
Pre-assessment and misconceptions	20	February 28
Learner profiles	20	April 4
Literature review	20	April 18
Unit plan	50	May 9
Data analysis and reflection	50	May 9
Presentation	20	May 2
Professionalism	20	Each class
TOTAL	200	

Science Instruction for Diverse Learners Research Project:

For this assignment, which will be completed in sections over the course of the semester, you will:

1. pre-assess student knowledge of a science concept,
2. identify key misconceptions related to the science concept,
3. select two students from your classes and develop learner profiles for them,
4. conduct a literature review in order to identify strategies to use to successfully teach the science concept, particularly to the selected students,
5. design and implement a unit to teach the science concept,
6. analyze assessment data related to student learning,
7. write a reflection that evaluates how successfully the unit met student needs, and
8. present a summary of your findings to the class.

All written components should be submitted via Blackboard. The assignment rubric can be found at the end of the syllabus. Information about each component is detailed below.

Pre-Assessment of Student Knowledge and Misconceptions

For a science concept that you will teach in mid/late-March to mid-April:

- Identify/develop an instrument that assesses students' prior knowledge
- Administer the instrument to a class that contains two students you would like to target for additional support
- Identify common misconceptions – from literature or another reputable source (e.g., <http://assessment.aaas.org>) – of the science concept

Your submission should include (1) an analysis of the pre-assessment data regarding students' strengths and weaknesses related to the science concept, and (2) a discussion of how your students compare to common misconceptions of the topic.

Learner Profiles

Develop learner profiles for the targeted students. Information for the profiles should be obtained from multiple sources, including your observations, interviews with the students, and interviews with colleagues (e.g., student's case manager, school psychologist/social worker, student's previous teachers). Your submission (one profile for each student) should include (1) an overview of the student and her/his background (e.g., demographic information, family information, co- and extra-curricular activities, academic history, IEP/504 information), (2) a description of classroom behavior (e.g., attendance, participation in activities, interactions with peers and teacher, academic performance), (3) a summary of the student's pre-assessment results, and (4) any other relevant information gleaned from the student interview.

Literature Review

Identify a minimum of five peer-reviewed research articles that identify strategies that will help you teach the identified science concept, particularly to the targeted students. Relevant articles can be found via Google Scholar (<http://scholar.google.com>) and/or the Mason library search engine (<http://library.gmu.edu>). Your submission should include: (1) a description of the research questions, participants, methodology, and measures, (2) a synopsis of the findings, and (3) a discussion of how the findings can/should influence your classroom practice. Be sure to provide APA citations for each article.

Unit Plan

Design and implement a unit plan to teach the selected science concept. Your plan should incorporate practical and theoretical aspects of science teaching, including safety, inquiry, differentiation, pedagogical methods, and assessment. Your unit plan submission should include: (1) a one-page unit schedule, (2) daily lesson plans, and (3) all support materials.

You may use any lesson plan format you would like; however, the following aspects should be included:

- Standards (e.g., SOLs, AP, IB, NGSS)
- Learning objectives written as measurable student behavior (e.g., SWBAT)
- Activity descriptions with sufficient detail (e.g., materials, directions, guiding questions) that a substitute could implement them
- Differentiation strategies
- Safety notes

For support materials, be sure to include copies of student handouts, assessments, rubrics, presentation materials, etc.

Data Analysis and Reflection

Select three assessments (two formative and one summative) from your unit plan to analyze in depth. At least one of these assessments must include a performance-based component. Collect data from the class containing the targeted students and analyze it for (1) evidence of student learning, (2) areas that need remediation, and (3) ways in which the assessments need to be adjusted. Item analyses should be done for multiple-choice questions.

Your submission should include the above analysis and a reflection that addresses: (1) how well the unit met the whole classes' learning needs, (2) how well the implemented strategies helped the targeted students, and (3) suggestions for improvement. Be sure to address the technical, contextual, and dialectical levels in your reflection.

Presentation

Make a 10-15 minute presentation to your classmates in which you (1) give an overview of the class and targeted students, (2) summarize the major activities from your unit plan, (3) describe the pedagogical and differentiation strategies implemented during the unit, (4) present key findings of your data analysis, and (5) reflect on how well the unit met students' learning needs as well as suggested improvements for future implementation.

Professionalism:

Learning depends on the active engagement of the participant and frequent checking by the instructor as to the progress of the learner. Your classmates depend on your comments to extend their learning. Preparation, attendance, and participation are necessary for each class.

Grading

High quality work and participation is expected on all assignments and in class. Attendance at all classes for the entire class is a course expectation. For each unexcused absence, the course grade will be reduced by 5% points. All assignments are graded and are due at the beginning of class on the day they are due. Late assignments will automatically receive a ten percent grade reduction.

A = 93-100%

A- = 90-92%

B+ = 88-89%

B = 80-87%

C = 70-79%

F = Below 70%

If circumstances warrant, a written request for an incomplete must be provided to the instructor for approval prior to the course final examination date. Requests are accepted at the instructor's discretion, provided your reasons are justified and that 80% of your work has already been completed. Your written request should be regarded as a contract between you and the instructor and must specify the date for completion of work. This date must be at least two weeks prior to the university deadline for changing incompletes to letter grades.

Professional Dispositions

Students are expected to exhibit professional behaviors and dispositions at all times.

Course Schedule

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

Date	Topic(s)	Reading Due	Assignment Due
Jan 24	Introduction to the Course What is Science?		Become familiar with the Blackboard course site
Jan 31	Reflective Practice	Articles in Bb	
Feb 7	Assessment/Interview Design	Keeley; Liu, 1/2/3	Assessment and rubric
Feb 14	(Mis)conceptions	Articles in Bb	
Feb 21	Nature of Science	Articles in Bb	
Feb 28	Inquiry Models	Llewellyn, 1/3/5	Pre-assessment and misconceptions
Mar 7	Inquiry Teaching	Llewellyn, 4/6/7	
Mar 14	NO CLASS – SPRING BREAK		
Mar 21	Peer Review and Teaching		Draft unit plan
Mar 28	Data Analysis	Liu, 4/6/8	Class set of data
Apr 4	Scientific Discourse	Llewellyn, 2/9/11	Learner profiles
Apr 11	NO CLASS – Work Time		
Apr 18	NO CLASS – Differentiation Module	Articles in Bb	Literature review
Apr 25	Individual Consultations		
May 2	Class Presentations		
May 9	NO CLASS – Remaining Assignments Due		

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 <http://oai.gmu.edu/the-mason-honor-code/>).
- 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 silenced 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/>.
- The Writing Center provides a variety of resources and services (e.g., tutoring, workshops, writing guides, handbooks) intended to support students as they work to construct and share knowledge through writing (see <http://writingcenter.gmu.edu/>).
- The Counseling and Psychological Services (CAPS) staff consists of professional counseling and clinical psychologists, social workers, and counselors who offer a wide range of services (e.g., individual and group counseling, workshops and outreach programs) to enhance students' personal experience and academic performance (see <http://caps.gmu.edu/>).
- The Student Support & Advocacy Center staff helps students develop and maintain healthy lifestyles through confidential one-on-one support as well as through interactive programs and resources. Some of the topics they address are healthy relationships, stress management, nutrition, sexual assault, drug and alcohol use, and sexual health (see <http://ssac.gmu.edu/>). Students in need of these services may contact the office by phone at 703-993-3686. Concerned students, faculty and staff may also make a referral

to express concern for the safety or well-being of a Mason student or the community by going to <http://ssac.gmu.edu/make-a-referral/>.

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

Science Instruction for Diverse Learners Research Project Rubric

	Exceeds Expectations	Meets Expectations	Approaching Expectations	Does Not Meet Expectations
Pre-Assessment of Student Knowledge and Misconceptions				
Analysis	Thorough and accurate analysis of data	Substantial and accurate analysis of data	Partial OR inaccurate analysis of data	Partial AND inaccurate analysis of data
Discussion	Thorough comparison of students to literature	Substantial comparison of students to literature	Partial comparison of students to literature	No comparison of students to literature
Learner Profiles				
Overview of Student	Thorough overview of student and background	Substantial overview of student and background	Partial overview of student and background	No overview of student and background
Description of Classroom Behavior	Thorough description of classroom behavior	Substantial description of classroom behavior	Partial description of classroom behavior	No description of classroom behavior
Pre-Assessment Results	Thorough summary of pre-assessment results	Substantial summary of pre-assessment results	Partial summary of pre-assessment results	No summary of pre-assessment results
Literature Review				
Articles	Five research-based articles from peer-reviewed journals; APA citations	Five research-based articles; APA citations	Five non-research-based articles; APA citations	Less than five articles AND/OR no APA citations
Description of Articles	Thorough description of research questions, participants, methodology, and measures	Substantial description of research questions, participants, methodology, and measures	Partial description of research questions, participants, methodology, and measures	No description of research questions, participants, methodology, AND/OR measures
Synopsis of Findings	Thorough synopsis of findings	Substantial synopsis of findings	Partial synopsis of findings	No synopsis of findings
Discussion of Application	Thorough discussion of application to classroom practice	Substantial discussion of application to classroom practice	Partial discussion of application to classroom practice	No discussion of application to classroom practice
Unit Plan				
Schedule		One-page schedule of unit activities		No schedule provided

	Exceeds Expectations	Meets Expectations	Approaching Expectations	Does Not Meet Expectations
Lesson Plan: Standards and Objectives	Relevant standards linked to measureable, student behavior-based objectives from a variety of cognitive levels	Relevant standards linked to measureable, student behavior-based objectives	Relevant standards linked to objectives, which are either not measureable OR not student behavior-based	Irrelevant OR no standards AND/OR objectives
Lesson Plan: Activities	Nearly all activities are inquiry-based and student-centered	Majority of activities are inquiry-based and student-centered	Some activities are inquiry-based and student-centered	Very few, if any, activities are inquiry-based and student-centered
Lesson Plan: Activity Sequence	Highly effective sequence	Effective sequence	Somewhat effective sequence	Ineffective sequence
Lesson Plan: Strategies	Research-based strategies for all students	Research-based strategies for targeted students	Strategies for targeted students	No strategies
Support Materials		All support materials are provided	Some support materials are provided	No support materials are provided
Data Analysis and Reflection				
Assessments		Two formative and one summative; performance-based component	Two formative and one summative	Less than two formative AND/OR no summative
Analysis: Student Learning	Thorough analysis of student learning	Substantial analysis of student learning	Partial analysis of student learning	No analysis of student learning
Analysis: Remediation	Thorough analysis of needed remediation	Substantial analysis of needed remediation	Partial analysis of needed remediation	No analysis of needed remediation
Reflection: Whole Class	Thorough reflection of how unit met whole classes' learning needs	Substantial reflection of how unit met whole classes' learning needs	Partial reflection of how unit met whole classes' learning needs	No reflection of how unit met whole classes' learning needs
Reflection: Targeted Students	Thorough reflection of reflection of how unit met targeted students' learning needs	Substantial reflection of reflection of how unit met targeted students' learning needs	Partial reflection of reflection of how unit met targeted students' learning needs	No reflection of reflection of how unit met targeted students' learning needs
Reflection: Improvements	Thorough reflection of how to improve the unit	Substantial reflection of how to improve the unit	Partial reflection of how to improve the unit	No reflection of how to improve the unit
Presentation				
Overview of Students	Thorough overview of class and targeted students	Substantial overview of class and targeted students	Partial overview of class and targeted students	No overview of class and targeted students
Summary of Unit	Thorough summary	Substantial	Partial summary of	No summary of

	Exceeds Expectations	Meets Expectations	Approaching Expectations	Does Not Meet Expectations
Plan	of major unit activities	summary of major unit activities	major unit activities	major unit activities OR all unit activities discussed
Description of Strategies	Thorough description of pedagogical and differentiation strategies	Substantial description of pedagogical and differentiation strategies	Partial description of pedagogical and differentiation strategies	No description of pedagogical AND/OR differentiation strategies
Analysis Results	Thorough discussion of key data analysis findings	Substantial discussion of key data analysis findings	Partial discussion of key data analysis findings	No discussion of key data analysis findings OR discussion of irrelevant findings
Reflection	Thorough reflection of how well unit met students' learning needs and suggested improvements	Substantial reflection of how well unit met students' learning needs and suggested improvements	Partial reflection of how well unit met students' learning needs and suggested improvements	No reflection of how well unit met students' learning needs AND/OR suggested improvements