Science Methods

Urban Institute for Teacher Education
EDU 5375/6375 Section 001
Spring 2016

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Location: SAEC 2151

Dates: January 11- April 26, 2016

Time: Thursdays, 4:35-7:05pm

"I will forever have a desire to learn, but I grow weary of being taught" – Winston Churchill

Information in this Syllabus

Course Description

Science Methods will emphasize fostering student scientific literacy and developing the ability to translate the theories of science education into classroom practice.

Course Objectives

The purpose of this course is to provide you, the future teacher, with the skills, knowledge and resources for providing quality science learning experiences for all students. This begins with an emphasis upon you as a science learner. Over time, the shift will move toward you as a science teacher. Specific objectives addressed during the course include:

a. Articulate and refine personal understandings of science and science teaching
b. Develop deeper understandings of the nature of science and specific science content
c. Demonstrate proficiency with identifying the essential features of inquiry-based science teaching and the variations within those features
d. Create developmentally appropriate lessons that demonstrate the effective application of important ideas and skills, including inquiry and process skills
e. Collaborate with other education professionals while examining issues related to teaching science for all students, including culturally-relevant science learning and social justice issues related to science
f. Identify instructional approaches that facilitate learning by students from populations typically underrepresented in science, English Language Learners and special education students

Course Performance Outcomes

New teachers are required to take the Praxis Principles of Learning and Teaching test. During this course, each student will demonstrate their progress toward becoming proficient in the following standards, as set forth on the Praxis:

I. Students as Learners
    A. Students as diverse learners
II. Instruction and Assessment
    A. Instructional strategies
    B. Planning instruction
    C. Assessment strategies
IV. Profession and Community
    A. The reflective practitioner

Course Materials

In lieu of a textbook, you will need to purchase a student membership in the National Science Teachers Association (http://www.nsta.org); see page 9. Your NSTA membership will provide you with online access to a wealth of journal articles related to science teaching.

You also will need access to the following websites:

- Utah State Office of Education Science site - http://www.usoe.k12.ut.us/curr/science/
- Salt Lake City School District Science site – http://www.slc.k12.ut.us/staff/larmad/science/

The following books may be checked out from the instructor:

- Hammerman, E. (2005). *8 essentials of inquiry-based science, K-8*. Thousand Oaks, CA: Corwin Press.
- Luft J., Bell R. L. & Gess-Newsome J. (Eds.). (2008). *Science as inquiry in the secondary setting*. National Science Teachers Association: NSTA Press.

Course Bibliography

The framework for this course is based on the following materials:

- American Association for the Advancement of Science. (1993). *Benchmarks for science literacy*. New York: Oxford.
- National Research Council. (1996). *National science education standards*. Washington: National Academy.
- Olson, S. & Loucks-Horsley, S. (Eds.). (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, DC: National Academy Press.
- Renner, J. W. & Marek, E. A. (1988). *The learning cycle and elementary school science teaching*. Portsmouth, NH: Heinemann.
- Michaels, S. Shouse, A. & Schweingruber, H. (2007). *Ready, set, science!: Putting research to work in K-8 classrooms.* Washington, DC: National Research Council

Course Evaluation

This grading scale will be used to determine letter grades at the end of the semester. Points possible have been determined based upon the expected amount of effort and care required to complete the assignments. It is usually misleading and confusing to attempt converting individual assignments into letter grades. Missing two points on a ten-point assignment does not represent a failure. Nevertheless, remaining attentive and vigilant to the work and expectations is absolutely necessary to earn the higher grades. Each student is graded upon his or her own performance (except for group assignments) and grades are not scaled so only a certain proportion of the class earns a given grade.

Grade	Percentage
A	94% to 100%
A-	90% to 93.9%
B+	87% to 89.9%
B	84% to 86.9%
B-	81% to 83.9%
C+	78% to 80.9%
C	75% to 77.9%
C-	72% to 76.9%
D	69% to 71.9%
E	0% to 68.9%

It is your responsibility to regulate your learning. If something is unclear it is up to you to take steps necessary to correct this situation. You must attend to the purposes of assignments and activities. You must self-monitor your comprehension. You must identify and access those resources that will clarify and strengthen your knowledge. Don't expect that you can simply absorb knowledge as it flows by—you must take the initiative and make the effort to incorporate information into what you already know.

Class sessions are predominantly interactive with a heavy emphasis upon collaborative efforts. As a consequence, in-class activities for which points are assigned cannot be "made up" outside of class time. It is imperative for you to attend all class sessions. It is your responsibility to communicate to the instructor when class attendance is not possible.

EDU 5375 Course Assignments

Nature of Science paper ..... ***50 points***

This paper should be 3-5 pages using Times Roman 12-point font and double-spaced. A grading rubric for this paper is available on page 10 of this Syllabus. Your paper should include:

- A clear definition of "science"
- Discussion about what science is "not"
- Discussion about science processes
- Discussion about the role of science in society
- Discussion about how this assignment has changed the way you view science

- Clear ideas about how you will incorporate this new knowledge into your classroom instruction

Two Inquiry-Based Lesson Plans (75 points each) ..... ***150 points***
The effective teaching of science requires a thoughtful combination of direct experiences for students, a shifting of roles by the teacher, a clear sense of purpose, and a skillfully orchestrated discussion. A complete lesson plan includes student performance objectives, Science Core Curriculum connections, outline of lesson sequence, list of materials, and a student record sheet. A template for the lesson plans and a grading rubric are included on pages 11-12 of this Syllabus.

Article Reflections* ..... **90 Points 15/reflection**
See detail description below.

Science Fair Project……..……..……***65 points***
You will design a scientific experiment and present the results to the entire class. This is an individual activity and is your chance to demonstrate your competence at learner-centered scientific inquiry.

Professionalism/Participation ..... ***45 points***
You will be evaluated for your dispositions toward the profession in terms of these descriptors: scholarly, courteous, punctual, respectful, conscientious, enthusiastic, empathetic, inquisitive, contemplative, and resourceful. You are expected to attend and actively participate in all course sessions.

EDU 5375 Total Points ……...……...***400 points***

EDU 6375 Course Assignments

You will complete all of the assignments for EDU 5375 with the following modification:

- **Nature of Science paper must be 5 pages in length**

Science Teaching paper ……..…***100 points***
The paper must be 10 pages using Times Roman 12-point font and double-spaced. It should address the following topics in depth:

- Identify the essential features of inquiry-based science teaching and the variations within those features. Discuss how you incorporated these into the lesson plans you developed.
  - Useful references may include those in the Course Bibliography and NSTA journal articles.
- Describe what inquiry-based science will look like, sound like and feel like in your classroom.
- Discuss the types of inquiry-based lessons that are developmentally appropriate for different grade levels
- Identify and discuss instructional approaches for inquiry-based science that accommodate the learning of students from populations typically underrepresented in science, special education, English Language Learners, and gifted and talented students

EDU 6375 Total Points ……...***500 points***

**** Article Reflections***
You will select and read articles from National Science Teachers Association (NSTA) journals, available online. To access the articles, you will need to join NSTA as a student member. By joining NSTA, you join the community of educators who are teaching science at all grade levels. Some of the benefits you'll receive with your membership include:

- A monthly journal, *Science & Children*, *Science Scope* or *The Science Teacher*, that is filled with inquiry-based lesson plans and other resources
- Resources for teachers at each grade band in the 'Choose Your Classroom' section
  - Search and access PDF files of past journal articles
  - Opportunities for online interaction via blogs, forums and list serves (access from the 'Online Interaction' section)
- Resources for 'Preservice and New Teachers' in the 'NSTA Portals' section
- Weekly and monthly e-newsletters (sign up in the 'Newsletter Signup' section)

Your NSTA membership will provide you experience in locating and using online professional resources.

Directions for signing up and for getting the discount are on page 9 of this syllabus.

Guidelines for Article Reflections……..90 Points 15/reflection

- You will write 6 article reflections
- Articles must be selected from NSTA journals
- Articles must relate to topic(s) covered in EDU 5375/6375 class sessions
  - At least **two** articles must address science teaching and learning by students typically underrepresented in science, culturally-appropriate science, science for English Language Learners, special education and/or gifted and talented students
- You may only write one reflection per EDU 5375/6375 class session
- Article reflections need to respond to **<u>two or more</u>** of the following questions:
  - In what ways is the nature of science illustrated in this article?
  - What aspects of inquiry are addressed in this article, and how?
  - In what ways is assessment addressed in this article? How might you utilize the assessment strategies in this article when teaching other topics?
  - What topics in the Utah Core Curriculum (Intended Learning Outcomes and/or Standards) are addressed in this article, and how?
  - What student misconceptions are addressed in this article, and how?
  - What aspects of 'science and society', 'underrepresented populations', 'special populations' or 'technology integration' are addressed in this article, and how?
  - How can technology be integrated into your classroom and your grade level using scientific inquiry, hands-on learning and deeper thinking?
- You must print a copy of each reflection and paste it in your EDU 5375/6375 Science Notebook
- See the Tentative Schedule in this syllabus for Article Reflection due dates

Cell Phone, Text Messaging, and Laptop Computer policy

It is expected that students will maintain a respectful and civil atmosphere during class meetings. Thus, expectations are that students:

- Prevent disruptions by turning off and refraining from use of beepers and cell phones (including text messaging) and by putting away extraneous reading materials. Use of laptop computers in class is not allowed without the instructor's permission.
- Adhere to the University of Utah code for student conduct.

Americans with Disabilities Act (ADA)

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

Cautionary Information Regarding Academic Misconduct

In order to be an effective teacher, one must rely upon the wise use of a variety of resources. It is unreasonable to expect a novice teacher to create every activity, lesson plan, and assessment tool from scratch. Good teachers are always making use of ideas and materials they have gathered from others. On legal and moral grounds, it is acceptable for teachers to use other's work with the understanding that the use is for educational purposes and no monetary profit will be made by this "intellectual borrowing" of materials that came from elsewhere. One example is the allowance for using copyrighted materials: if the sole purpose is for educational then making copies of an article or picture are usually not in dispute.

Nevertheless, as a student you are going to be graded based upon the quality of your work. The situation is very similar to an educational consultant who is paid to create materials. If a consultant "borrowed" someone else's work, pretended it was their own, and was compensated for that act, then this deception is a form of thievery. The same applies to work you turn in for college classes. If you turn in a work product and are compensated with a grade, then the understanding is that the work is your own effort. Should you attempt to pass off someone else's work (whether taken from the Internet, from a teacher, from a published resource, or from another student) as your own, which means you neglected to indicate where the information originated, then you have engaged in Academic Misconduct as defined by the University of Utah's Code of Student Rights and Responsibilities. When you are told "do not plagiarize" the definition and consequences are clearly identified below:

SECTION I: GENERAL PROVISIONS AND DEFINITIONS…

A. General Provisions

The mission of the University of Utah is to educate the individual and to discover, refine and disseminate knowledge. The University supports the intellectual, personal, social and ethical development of members of the University community. These goals can best be achieved in an open and supportive environment that encourages reasoned discourse, honesty, and respect for the rights of all individuals. Students at the University of Utah are encouraged to exercise personal responsibility and self-discipline and engage in the rigors of discovery and scholarship. Students at the University of Utah are members of an academic community committed to basic and broadly shared ethical principles and concepts of civility. Integrity, autonomy, justice, respect and responsibility represent the basis for the rights and responsibilities that follow. Participation in the University of Utah community obligates each member to follow a code of civilized behavior.

The purposes of the Code of Student Rights and Responsibilities are to set forth the specific authority and responsibility of the University to maintain social discipline, to establish guidelines that facilitate a just and civil campus community, and to outline the educational process for determining student and student organization responsibility for alleged violations of University regulations. University policies have been designed to protect individuals and the campus community and create an environment conducive to achieving the academic mission of the institution. The University encourages informal resolution of problems, and students are urged to discuss their concerns with the involved faculty member, department chair, dean of the college or dean of students. Informal resolution of problems by mutual consent of all parties is highly desired and is appropriate at any time. …

B. Definitions

As used in the Student Code:

2. "Academic misconduct" includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information, as defined further below. It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct. …
    c. "Plagiarism" means the intentional unacknowledged use or incorporation of any other person's work in, or as a basis for, one's own work offered for academic consideration or credit or for public presentation. *Plagiarism includes, but is not limited to, representing as one's own, **without attribution**, any other individual's words, phrasing, ideas, sequence of ideas, information or any other mode or content of expression*. …

SECTION V: STUDENT ACADEMIC CONDUCT

A. Standards of Academic Conduct

In order to ensure that the highest standards of academic conduct are promoted and supported at the University, students must adhere to generally accepted standards of academic honesty, including but not limited to refraining from cheating, plagiarizing, research misconduct, misrepresenting one's work, and/or inappropriately collaborating.

B. Academic Misconduct

A student who engages in academic misconduct as defined in Part I.B. may be subject to academic sanctions including but not limited to a grade reduction, failing grade, probation, suspension or dismissal from the program or the University, or revocation of the student's degree or certificate. Sanctions may also include community service, a written reprimand, and/or a written statement of misconduct that can be put into an appropriate record maintained for purposes of the profession or discipline for which the student is preparing.

Tentative Schedule

Date	Topic	Assignments
Jan 14	Nature of Science	
Jan 21	Science and Society: Race, class, culture and science; underrepresented populations in science	
Jan 28	Core Curriculum: Intended Learning Outcomes & Content Standards Lesson Planning	
Feb 4	Inquiry Science Fair	**Nature of Science paper due**
Feb 11	Assessment	
Feb 18	Scientific Processes and Data Collection Making Science Accessible for All Students	
Feb 25	Inquiry Examples	**Lesson Plan 1 due**
March 3	Inquiry Examples	**3 Article Reflections due by this date**
March 10	Astronomy Teacher Professional Development Capitalizing on Outreach Organizations	
March 24	Misconceptions Differentiating between Cultural & Religious Beliefs and Science Concepts	
March 31	Moving from Cookbook Labs to Student Inquiry	**Lesson Plan 2 due**
April 7	Moving from Cookbook Labs to Student Inquiry	**3 Article Reflections due by this date**
April 14	Moving from Cookbook Labs to Student Inquiry	
April 21	Science Fair	**Science Fair project due** **EDU 6375 Science Teaching paper due**

How to Join the National Science Teachers Association

1. Go to www.nsta.org
2. Select "Membership" in the top menu.

3. Select "Join NSTA Now!"
4. Fill in your information on the application form

   - Select your interests in the Areas of Interest
   - Select your Membership type: **Student - $35 or New Teacher - $35,** choose 1 journal and the 1 year option below.
     - For **Student** - For students; proof of current registration and an instructor's signature is required. Send proof of your registration to: NSTA, attn: Member Services, P.O. Box 90214, Washington, DC 20090-0214
     - For **New Teacher** - available only to teachers who are in their first five years of teaching. Send a copy of your teaching certificate or a letter from your administrator to: NSTA, attn: Member Services, P.O. Box 90214, Washington, DC 20090-0214

   - Choose your Membership Journal for the grade band you plan to teach

5. **Write down your member number**

6. Send a copy of your teaching certificate or a letter from your administrator to: NSTA, attn: Member Services, P.O. Box 90214, Washington, DC 20090-0214

Go to http://www.nsta.org/membership/benefits.aspx to see all of your member benefits
Free resources: http://www.nsta.org/publications/freebies.aspx

Nature of Science Paper Grading Rubric

	Excellent	Good	Poor	Unacceptable
Definition of science	11-15 - Clear and insightful definition of what science is and is not. Ideas supported by logical arguments or examples.	6-10 - Clear definition of science AND discussion of what science is not.	1-5 - Definition of science absent or minimal OR discussion of what science is not absent or minimal.	0 - No attempt at definition of what science is and is not.
Science processes and role of science in society	8-10 - Clear and insightful discussion of science processes and the role of science in society. Ideas supported by logical arguments or examples.	4-7 - Discussion of science processes AND the role of science in society.	1-3 - Discussion of science processes absent or minimal. OR Discussion of the role of science in society absent or minimal	0 - No discussion of science processes and the role of science in society.
Affect on your view of science	8-10 - Clear and insightful discussion of how the readings, activities and group discussion changed or affected your view of science.	4-7 - Discussion of how the readings, activities and group discussion changed or affected your view of science.	1-3 - Brief discussion of how the readings, activities and group discussion changed or affected your view of science.	0 - No discussion of how the readings, activities and group discussion changed or affected your view of science.
Classroom application	8-10 - Clear and insightful discussion of how you plan to incorporate your understanding of the nature of science into your classroom instruction. Ideas supported by clear examples	4-7- Discussion of how you plan to incorporate your understanding of the nature of science into your classroom instruction. Ideas supported by a few or non-explicit examples.	1-3 - Brief discussion of how you plan to incorporate your understanding of the nature of science into your classroom instruction OR ideas not supported by examples.	0 - No discussion of how you plan to incorporate your understanding of the nature of science into your classroom instruction and not examples.
Structure	2-2.5 - Paper shows clear, coherent and logical structure with well-reasoned ideas presented in sequence and with support.	1-1.5 - Paper shows logical structure, with ideas presented in sequence and with support.	0.5 - Paper shows a general logical structure, but some ideas are presented out of sequence or without support.	0 - No discernable logical structure to paper. Ideas are disjointed and confusing.
Grammar, punctuation, spelling and presentation	2-2.5 - No spelling, grammar and/or punctuation errors. Text is typed.	1-1.5 - Few spelling, grammar and/or punctuation errors. Text is typed.	0.5 - Occasional spelling, grammar and/or punctuation errors OR text is handwritten.	0 - Frequent spelling, grammar and/or punctuation errors OR text is illegible due to messy handwriting or printer errors.

Lesson Plan Template

Name:

Date:

Lesson Title:

Grade Level(s):

Rational for Lesson:
(Why you are planning to teach the lesson in this way, as opposed to another way. Why this lesson topic and teaching approach are developmentally appropriate for the target grade level.)

Utah State Core Curriculum ILO(s) and Content Standard, Objective and Indictor(s):

Vocabulary Focus:

Preparation/Materials:

Lesson Description: *(include inquiry learning and timing)*

Assessment:

Adaptations for Gifted/Talented, ELL and Special Education:

Lesson Plan Grading Rubric

	Excellent	Good	Poor	Unacceptable
Rationale for this particular lesson	5 - Clear rationale and purpose for choosing this particular lesson is evident	3 -Rationale is somewhat clear for choosing this particular lesson but there are still questions as to the rationale	2 - Reasons are not logical or well thought out	0 - No reason stated for choosing this particular lesson
Core Curriculum ILO(s) and Content Standard	5 - Content and ILOs are listed & clearly addressed throughout the lesson and assessment	3 - Content and ILOs are listed and addressed throughout the lesson	2 - Content and ILOs are listed	0 - No objectives stated
Vocabulary Focus	5 - Vocabulary list complete for topic; list of assumed previously-learned vocabulary words	3 - Vocabulary list complete for topic	2 - Vocabulary list incomplete for topic	0 - No vocabulary focus stated
Preparation	5 - A clear picture of what will occur via the room arrangement and materials list evident	3 - Materials listed with relatively clear description of what will occur in terms of preparation & room arrangement	2 - Materials listed with vague/unclear description of materials and preparation	0 - Vague/Unclear description of what materials are needed, how to prepare them & room arrangement
Lesson Description: Describe how the lesson will work. Describe the lesson so that another teacher could understand it and implement it without your presence	25 - The narrative explanation of the learning activity is substantial and complete. The description explains both the curriculum content and ILOs of the plan. A teacher reading the description could reproduce all of the essential elements without further research. Time-line is present.	15 - The narrative explanation of the learning activity is substantial and complete. The description explains both the curriculum content and ILOs of the plan. A teacher reading the description could reproduce all of the essential elements without further research.	5 - The narrative explanation of the learning is incomplete or vague in part. The description may not include an explanation of both the curriculum content and ILOs. A teacher reading the description would get the central concept of the lesson, but have to do additional research before teaching the plan.	0 - The narrative explanation of the learning lacks sufficient detail. A teacher reading the description would not easily grasp the central concepts of the lesson.
Inquiry	10- Student centered. Students are making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of the student's experimental evidence; using tools to gather, analyze and interpret data; proposing answers, engaging in explanations, and predictions; and communicating the results.	7 - Students are able to engage in science processes but activities are driven by protocol. Example: traditional labs	3 - Students are able to pose questions. Discussions occur but answers and discussion is teacher dependent. Students are not engaged actively in the process of science.	0 - Teacher directed/dependent Teacher centered Lecture driven Worksheets Textbook driven
Assessment	15 - Assessment consistently reflects ILOs/lesson Content, and provides flexibility of learning styles Assessment is evident throughout the lesson and is authentic in nature	10 - Assessment consistently reflects ILOs/lesson Content, and provides flexibility of learning styles	5 - Assessment does not consistently reflect ILOs/lesson Content, or provide flexibility of learning styles	0 - Assessment is traditional/summative in nature and or does not measure stated objectives
Adaptations for G/T, ELL, Special Ed	5 - Adaptations for each of the 3 special populations clearly described and based on best practices	3 - Adaptations for 2 special populations described	2 - Adaptations for 1 special population described	0 - No adaptations described

Suggested Readings about Diverse Classrooms from NSTA Journals

Science and Children (for elementary school teachers)

Amaral, O., Garrison, L., & Duron-Flores, M. (2006). Taking inventory: A science kit inventory introduces students to tools and vocabulary, paving the way for successful science experiences. *Science and Children*, *43*(4), 30-33.
Describes a technique for motivating and increasing students' focus by engaging them in conducting inventories of science materials and predicting how the materials will be used during lessons.

Anderson, K. L., Martin, D. M., & Faszewski, E.E. (2006). Unlocking the power of observation: Activities to teach early learners the fundamentals of an important inquiry skill. *Science and Children*, *43*(4), 32-35.
Provides easy-to-implement inquiry activities for early childhood classrooms that focus on observation, mathematics, and communication.

Brown, P. L., & Abell, S. A. (2007). Cultural diversity in the science classroom. *Science and Children*, *44*(9), 60-61.
Provides an overview of research studies and suggestions for how teachers can best support diverse cultural backgrounds when teaching inquiry-based science.

Cox-Petersen, A., & Olson, J. K. (2007). Alternate assessments for English language learners: Using drawings and interviews to measure student learning. *Science and Children*, *44*(6), 46-48.
Provides suggestions for using student drawings to assess ELL students' understanding of science.

Gagnon, M. J., & Abell, S. K. (2009). ELLs and the language of school science. *Science and Children*, *46*(5), 50-51.
Provides an overview of research studies and suggestions for how teachers can best support ELL students when teaching inquiry-based science.

Gooding, J., & Metz, B. (2012). Collaborating for communication. *Science and Children, 49(9)*, 26-31.
Discusses the use of an engineering challenge to foster teamwork, communication skills and assess the different learning styles of students.

Hansen, L. (2006). Strategies for ELL success: Simple strategies to incorporate into inquiry science for English language learners. *Science and Children*, *43*(4), 22-25.
Suggests adaptations to incorporate into the learning cycle in science that are especially appropriate for English language learners.

Husty, S., & Jackson, J. (2008). Multisensory strategies for science vocabulary: Support learning about properties of matter for ELL – and all—students with these techniques. *Science and Children*, *46*(4), 32-35.
Provides directions for organizing a classroom so students can see, hear, touch, manipulate, name, and discuss the differences in the properties of matter and related vocabulary.

Irwin, L., Nucci, C., & Beckett, E. C. (2003). Science centers for all: Suggestions on using classroom science centers to engage every learner. *Science and Children*, *40*(5), 35-37.
Provides suggestions for establishing science centers in the classroom in order to enhance science learning for diverse groups of students.

McCaffrey, R. (2012). Birds across borders. *Science and Children, 49*(7), 31-35.
Summarizes an ecological pen pal exchange between schools in Montana and Scotland. Students learned about biodiversity of bird species and made cross-cultural connections as well.

Nelson, V. (2010). Learning English learning science. *Science and Children*, *48*(3) 48-51.
Offers ideas for using science notebooks to enhance ELL students' and parents' science content and processing while developing English language competence.

Olson, J. K., Levis, J. M., Vann, R., & Bruna, K. R. (2009). Enhancing science for ELLs: Science strategies for English language learners that benefit all students. *Science and Children*, *46*(5), 46-48.
Provides practical teaching strategies to help build the language and content knowledge of ELL students.

Schon, I. (2010). Libros de ciencias en Español. *Science and Children*, *47*(7), 68-71.
List of recently published Spanish or bilingual science texts. Most of the titles are for grades K–2.

Shaw, D. G., Cook, C., & Ribelin, T. (2000). Science fairs for all. *Science and Children*, *38*(2), 14-19.
Describes how one full-inclusion classroom conducted scientific investigations through completing science fair projects.

Shea, L. M., & Shanahan, T. (2011). Talk strategies: How to promote oral language development through science. *Science and Children, 49*(3), 62-66.
Describes how to incorporate academic *talk strategies* to provide English learners opportunities for oral language production.

Steele, M. M. (2007) Science Success for students with special needs: Strategies for helping all students master science standards. *Science and Children*, *45*(2), 48-51.
Provides instructional techniques and test-taking strategies to prepare students with mild learning challenges for success in science class.

Weinburgh, M., Silva, C., Malloy, R., Marshall, J., & Smith, K. (2012). A science lesson or a language lesson? *Science and Children 49(9),* 72-76.
Outlines and describes an application of the 5R Instructional Model during a unit on soil erosion with English language learners.

<u>*Science Scope* (for middle school teachers)</u>

Allen, H., & Park, S. (2011). Science education and ESL students. *Science Scope, 35*(3), 29-35.
A consideration of the challenges ESL/ELL students face in learning science and a summary of effective teaching strategies to address those challenges. Includes a sample lesson and assessment.

Bittel, K., & Hernandez, D. (2006). Kinesthetic writing, of sorts. *Science Scope*, *29*(7), 37-39.
Describes the construction and use of flipbooks to aid mainstream, ELL, and special education students in learning science.

Bricker, P., Rogowski, N., Hedt, M., & Rolfe, N. (2010). Transporting students into thin air: Using science to enhance reading. *Science Scope*, *34*(2), 37-43.
Describes a unit that blended science, language arts, mathematics, and social studies goals through a combination of independent reading, thought-provoking conversations, reflective writing, and hands-on science investigations. Reading strategies are highlighted.

Fetters, M, Pickard, D. M. & Pyle, E. (2003). Making science accessible: Strategies to meet the needs of a diverse student population. *Science Scope*, *26*(5). 26-29.
Provides specific guidelines for adapting science activities to students with a variety of disabilities.

Gómez, C. R., & Jimenez-Silva, M. (2010). From speaking to writing in the structured English immersion science classroom. *Science Scope*, *34*(1), 52-56.
Provides a framework called the mode continuum to address the linguistic and content-area needs of ELLs in the mainstream classroom.

Jackson, J., Tripp, S., & Cox, K. (2011). Interactive word walls: Transforming content vocabulary instruction. *Science Scope, 35*(3), 45-49.
Discusses supporting ELLs by adding student-generated material and visual reinforcements to word walls.

Jones, T., & Sterling, D. R. (2011). Cooperative learning in an inclusive science classroom. *Science Scope, 35*(3), 24-28.
Outlines three steps to incorporating cooperative learning strategies to actively engage special education students in the general science classroom.

Kaldenberg, E., Therrien, W., Watt, S., Gorsh, J., & Taylor, J. (2011). Three keys to success in science for students with learning disabilities. *Science Scope, 35*(3), 36-39.
Explores the use of big ideas, graphic organizers and mnemonics as strategies to support students with learning disabilities in learning science content.

Lincoln, F., & Beller, C. (2004). English language learners in the science classroom. *Science Scope*, *28*(1), 28-31.
Provides strategies for teachers to meet the needs of ELL students without compromising content.

Marino, M.T., Basham, J.D., & Beecher, C. C. (2011). Using video games as an alternative science assessment for students with disabilities and at-risk learners. *Science Scope*, *34*(5), 36-41.
Describes how teachers can improve the science performance of their students with disabilities using video games that incorporate principles of the Universal Design for Learning (UDL) framework.

Saunders, G., Page, H., & Wood, G. (2011). Great science for autistic students. Science Scope 35(3), 20-23.
Outlines major characteristics of students with Asperger's Syndrome as learners and discusses features of the science classroom and modifications that work well with those characteristics.

Steele, M. M. (2007). Helping middle school students with learning disabilities pass the federally mandated science tests: Science instruction, study skills, and test-taking strategies. *Science Scope*, *31*(3), 74-80.
Provides instructional modifications, study skills, and test-taking strategies to help students with LD succeed in science class.

Struble, J. (2007). Using graphic organizers as formative assessment. *Science Scope*, *30*(5), 69-71.
Describes different types of graphic organizers and their implementation, noting their use facilitates science learning for ELL students or students with disabilities.

Sutton, K. K. (2001). Curriculum compacting: Teaching science in a heterogeneous classroom. *Science Scope*, *24*(4), 22-27.
Presents a technique called curriculum compacting for self-guided learning among gifted and other

students in heterogeneous classrooms.

Verma, G., Martin-Hansen, L., & Pepper, J. B. (2008). Using sheltered instruction to teach English language learners. *Science Scope*, *32*(3), 56-59.
Describes sheltered instruction, which uses various instructional strategies to help students who have spoken English but not academic English to speak and understand academic language.

The Science Teacher **(for high school teachers)**

Bautista, N. & Castañeda, M. (2011). Teaching science to ELLs, part I: Key strategies every science teacher should know. *The Science Teacher*, *78*(3), 35-39.
Provides key research-based strategies for science teachers to better accommodate ELLs in the science classroom. Five levels of language proficiency are presented along with strategies for planning and implementing science instruction.

Bruna, K. R., Chamberlin, D., Lewis, H., & Ceballos, E. M. (2007). Teaching science to students: Learning more about ELL students' communities of origin. *The Science Teacher*, *74*(8), 36-40.
Reports on a teacher's visit to the rural Mexican town of origin for many of his students. Provides insight into his students' needs and how to create meaningful experiences in the science classroom.

Colburn, A., & Nguyen, H. T. (2012). Every word you speak. *The Science Teacher 79*(4), 58-61.
An examination of common instructional methods that can be used to help ELLs acquire the language of science, new concepts, and develop academic abilities.

Castañeda, M., & Bautista, N. (2011). Teaching science to ELLs, part II: Classroom-based assessment strategies for science teachers. *The Science Teacher*, *78*(3), 40-44.
Provides four classroom-based assessment strategies in science that are effective for ELL students.

Chapman, C. (2009). A smoother acceleration: Addressing transition issues that arise for accelerated gifted students. *The Science Teacher*, *76*(3), 42-45.
Describes the challenges that gifted students may face when accelerating, particularly when skipping an entire academic year. Provides strategies to lessen the intensity and duration of these challenges.

Cooper, J., & Matthews, C. (2005). A decade of concern: A review of multicultural science education issues in The Science Teacher. *The Science Teacher*, *72*(3), 49-52.
Provides a review of published articles of *The Science Teacher* from 1995 to 2005 with the goal of helping teachers understand the importance of multicultural science education. Provides a list of resources teachers can refer to for additional information and activity ideas.

DeLuca, E. (2010). Unlocking academic vocabulary: Lessons from an ESOL teacher. *The Science Teacher*, *77*(3), 27-32.
Describes six scaffolds that help teachers access and develop academic English vocabulary for ELL and other students.

Duran, E., Duran, L., Haney, J., & Scheuermann, A. (2011). A learning cycle for all students: Modifying the 5E instructional model to address the needs of all learners. *The Science Teacher*, *78*(3), 56-60.
Suggests modifying the 5E model by inserting a conscious pause in the learning cycle—the Express phase—to assess and ensure that students of all levels, including ELLs and special needs students, are progressing adequately through the early phases of the cycle.

Edmonds, L. M. (2009). Challenges and solutions for ELLs: Teaching strategies for English language learners' success in science. *The Science Teacher*, *76*(3), 30-33.
Describes some of the difficulties ELLs may have with science content and offers techniques teachers can use to facilitate student understanding and participation.

Martin, S. F., & Green, A. (2012). Striking a balance. *The Science Teacher 79*(4), 40-43.
Describes how to use learning centers to differentiate instruction for ELLs and all students.

Johnson, C. C. (2006). Enabling all students to learn science: Using portfolios for instruction. *The Science Teacher*, *73*(2), 32-37.
Describes the use of portfolios to teach secondary science and English as a second language.

McDonnough, J.T., & Cho, S. (2009). Making the connection: Practical techniques for accommodating English language learners in the science classroom. *The Science Teacher*, *76*(3), 34-37.
Provides practical, research-based suggestions to help science teachers better accommodate the needs of ELL students.

Medina-Jerez, W., Clark, D. B., Medina, A., & Ramirez-Marin, F. (2007). Science for ELLs: Rethinking our approach. *The Science Teacher*, *74*(3), 52-56.
Provides some research-based strategies to provide ELL students with meaningful science experiences.

Ricketts, A. (2011). Using inquiry to break the language barrier. *The Science Teacher, 78*(8), 56-58.
Discusses example modifications made to aid ELL students in completing a science fair project and the importance of engaging ELLs in inquiry.

Siegel, M. A., Wissehr, C., & Halverson, K. (2008). Sounds like success: A framework for equitable assessment. *The Science Teacher*, *75*(3), 43-46.
Describes a framework for creating assessments that are equitable across a classroom of diverse learners and provides practical examples in using the framework.

Watson, S., & Johnston, L. (2007). Assistive technology in the inclusive science classroom: Devices and services can help science students with a wide variety of needs. *The Science Teacher*, *74*(3), 34-38.
Discusses the application of a wide variety of assistive technologies (ATs) in seven instructional areas that are useful in the secondary science classroom for both special needs and regular-education students.

Westervelt, M. (2007). Schoolyard inquiry for English language learners: ELL students learn life science concepts through outdoor inquiry activities. *The Science Teacher*, *74*(3), 47-51.
Provides examples of outdoor inquiry activities that aid English language learners in understanding concepts in life science.

Science Content and Inquiry Bibliography

Science Content

American Association for the Advancement of Science. (1989). *Science for all Americans*. New York: Oxford University Press.

> Offers a comprehensive look at science, both in terms of science content and society's relationship to science. Topics range from physicals, anatomy, environment, technology, communication, agriculture, to the history of scientific thought.

Hazen, R. M., & Trefil, J. (1991). *Science matters: Achieving scientific literacy.* New York: Anchor Books.

> Provides science content in all areas of science, including physics, chemistry, life science, earth science, astronomy, and more. It is both accessible and provides in-depth understandings of content needed in science classrooms.

Sussman, A. (2006). Dr. Art's guide to science: Connecting atoms, galaxies, and everything in between. San Francisco: Jossey-Bass.

> Easy-to-read descriptions and explanations of scientific concepts from matter to energy to earth science, space science, ecosystems, evolution, genetics, and beyond… This is an exciting book to read.

Stop Faking It! series by William Robertson. For example:

Robertson, W. (2005). *Stop faking it: Finally Understanding science so you can teach it (electricity and magnetism).* Arlington, VA: NSTA Press.

> This series provides easy-to-understand explanations and descriptions of many scientific topics, helping teachers develop a deeper understanding of scientific principles. The author uses fun examples, accessible language, and accurate explanations to teach in a stress-free way. Perfect for K–8 teachers, the books provide activities your students can do with simple equipment. The books in the series include: Force & Motion; Energy; Light; Sound; Electricity & Magnetism; Air, Water, & Weather; Chemistry Basics, All books are available to order from the NSTA website.

Inquiry Teaching

Michaels, S. Shouse, A., & Schweingruber, H. (2007). Ready, Set, SCIENCE!: Putting Research to Work in K-8 Science Classrooms. Washington, D.C.: National Research Council (National Academies Press).

> Provides a synthesis of research into teaching and learning science in K-8. This book offers classroom case studies that bring to life the research findings and help readers to replicate success. Most of these stories are based on real classroom experiences that illustrate the complexities that teachers grapple with every day. They show how teachers work to select and design rigorous and engaging instructional tasks, manage classrooms, orchestrate productive discussions with culturally and linguistically diverse groups of students, and help students make their thinking visible using a variety of representational tools. Free to download the PDF.

Abruscato, J., & DeRosa, D. A. (2010). *Teaching children science: Discovery methods for elementary and middle grades*. Boston: Pearson Education.

Describes methods for teaching through inquiry science. Included are chapter on cooperative learning, questioning and active listening, planning and managing inquiry units, assessing students' learning, and integrating science across the curriculum.

Assessment

Uncovering student ideas in science series by Page Keeley, et al. For example,

Keeley, P., Eberle, F., & Farrin, L. (2005). *Uncovering student ideas in science: 25 formative assessment probes*. Arlington, VA: NSTA Press.

This series of books helps teachers uncover the preconceptions students may have about science topics, in order to monitor learning and adjust teaching accordingly. The book is comprised of 25 "probes"—brief, easily administered activities designed to determine students' thinking on 44 core science topics (grouped by light, sound, matter, gravity, heat and temperature, life science, and Earth and space science). Detailed teacher materials that accompany each probe review science content; give connections to *National Science Education Standards* and Benchmarks; present developmental considerations; summarize relevant research on learning; and suggest instructional approaches for elementary, middle, and high school students. The authors have produced several volumes of this series, with new formative assessment probes in each volume. Two volumes are subject-specific (life science and physical science).

Online Resources

Genetic Science Learning Center

http://learn.genetics.utah.edu - materials for students
http://teach.genetics.utah.edu - materials and resources for teachers

This animated, interactive website content includes (a) basic genetics, (b) advanced genetics, (c) evolution, and (d) Great Salt Lake ecology, and e) cell biology. Virtual labs include DNA extraction, gel electrophoresis, PCR, and DNA microarray. Instructor support materials include videos of scientists' lectures and PDFs describing hands-on activities designed to support and extend the online materials.

Annenberg Foundation

http://learner.org/resources/browse.html?discipline=6&grade=0

Free online videos covering a variety of science topics for elementary and secondary grades. Topics include those in the disciplines of earth and space science, life science, and physical science. An example of some of videos offered: Earth Revealed, Essential Science for Teachers: Life Science, The Habitable Planet: A Systems Approach to Environmental Science, Intimate Strangers: Unseen Life on Earth, Journey North, The Mechanical Universe...and Beyond, The Mind: Teaching Modules, The World of Chemistry.

NSTA (see description in syllabus)