EDPSY 510A: Contemporary Perspectives on the Teaching and Learning of K-12 Science and Engineering

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Winter 2015 | Wednesdays 1:30 to 3:50pm | Miller 112

Prof. Philip Bell
LIFE Center
pbell@uw.edu

Shelley Stromholt
LIFE Center
stromhos@uw.edu

COURSE OVERVIEW

What theoretical perspectives help us understand science learning? How can we engage all learners in meaningful forms of the disciplinary practices of science and engineering? What concepts and strategies can help promote equity and social justice in science education? How do we promote increasing excellence and coherence in the educational system writ large around the teaching and learning of science and engineering? In this seminar we will be exploring contemporary views of the teaching and learning of science and engineering – especially as it connects to the implementation of the *Next Generation Science Standards* and the new vision for K-12 Science Education described in the underlying policy document from the National Academy of Sciences: *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*.

As a group, we will inquire into the relationship between the multiple purposes and forms of science education and the disciplinary practices of scientists and engineers in relation to the sense-making practices of "just plain folks." We will draw on the *Framework* and supporting research literatures to better understand relevant learning goals for school, career, and life. We will learn about the work of natural scientists and review a range of conceptual frameworks and perspectives from cognitive psychology, philosophy, anthropology, history, sociology, and linguistics that present specific images of scientific practice, thinking, and influence. We will leverage our collective experience and our personal interests to delve into the educational implications and manifestations of different practices of science and engineering — or try to understand their absence from the typical school day and from curriculum, or their presence in out-of-school learning environments. We will also concern ourselves with issues of epistemology—what images of science are embedded in the range of people's everyday life experiences, how they make sense of those discrepant images of science, and what images are privileged in education? We will foreground the public's understanding of the nature and purposes of science in contemporary society and highlight specific research agendas for science education.

This is an important moment where scholars can support the implementation of a new vision for K-12 science education. Individuals in the course will have the opportunity to directly join in this work and help develop professional learning resources to support specific dimensions of implementation and human capacity development. Individuals are encouraged to pursue how the themes of the course relate to their own scholarly goals and educational contexts of interest.

LEARNING GOALS FOR THE COURSE

By the end of the course:

1. You will have learned about and developed a critical interpretation of the new vision for K-12 Science and Engineering Education outlined in the NRC Framework and Next Generation Science Standards. You will be able to help researchers and teachers understand important dimensions of the new vision.
2. You will become familiar with the underlying science studies research literature as they relate to contemporary trends in the science education and learning sciences literatures—and identify areas of correspondence and possible coordination, or disconnect and tension.
3. You will learn about the implementation work needed to further refine, relate and support the vision with respect to a range of formal and informal learning environments.
4. You will *either*: (a) learn how to produce resources that support the implementation of the vision in collaboration with researchers and practitioners, or (b) learn practices related to developing an academic paper related to a theme of the course and to your professional goals.

CLASS ASSIGNMENTS

1. Class Participation. All class members are expected to read the assigned readings and actively participate in class discussions and activities each week.

2. Write Blog Posts & Identify Discussion Points on Specific Readings. We are going to ask individuals to identify two articles on the syllabus and compose a public blog post with 2 accompanying discussion points for class (i.e., a critical question and a reflection on the piece). We will have individuals sign up for readings during class in Week 1. The blog posts should relate to the themes of the piece, and they will be posted on a public course blog. Discussion points should include one important point or critical reflection and one substantive discussion question brought up by the reading. They should be submitted the Tuesday before class by noon on the Canvas Discussion area for that week so that others in class can review and offer their thoughts. The blog post will then be posted to the public blog after we meet in class. The URL is: http://UWscienceed.blogspot.com/

3. Practice Brief. New resources will be needed to support implementation of the vision outlined in the *NRC Framework*. The UW Institute for Science + Math Education has recently launched a web site with tools to support the new vision called STEM Teaching Tools. Core to the strategy is to craft "practice briefs"—short, informative documents focused on illuminating a particular problem of educational practice leveraging our best knowledge from research and practice. We will ask individuals to craft a practice brief using a template about a specific problem of practice of personal interest. Alternatively, multiple individuals can co-author a corresponding number of briefs. We will provide feedback on the drafts. The resulting practice briefs can be nominated for inclusion in the public web site for use broadly. Practice brief drafts will be due on Week 6.

4. Everyday Science Mapping. As a group we are going to self-document personal, everyday encounters with "science" over the course of two weeks of the class. We will be trying to understand: *When* is science / STEM in our everyday lives—what moments get set aside as being related or relatable to science? *What images of science* do we each

encounter in our everyday activities? And, *how do we personally interpret* these different images? Specific instructions will be given out in class during Week 3.

5. Final Assignment: Choose one of the following options based on your personal goals:

   Option 1: Resource Creation. Building upon the practice brief assignment above, individuals can author three practice briefs as their culminating assignment. Groups can collaborate on a corresponding number of briefs (i.e., three per person). Final resources are due *by Monday, March 16th at noon* uploaded on Canvas.

   - *Resource Proposal:* Each group that forms to author practice briefs should propose what specific tools they intend to develop. Resource proposals should be finalized by Week 4 at the latest and uploaded on Canvas.
   - You can review an initial collection of STEM Teaching Tools at:
     http://stemteachingtools.org/
     http://twitter.com/STEMTeachTools/
     http://pinterest.com/stemeducation/

   Option 2: Final Research Paper or Proposal. (8-12 pages, double-spaced)
   If you choose, the final product for the course will be an academic paper related to a theme of the course or you may elect to draft a research proposal for a specific professional purpose (e.g., scholarship application, dissertation proposal). The paper / proposal *must be* directly related to the themes of the course. Final course papers are due *by Monday, March 16th at noon* uploaded on Canvas.

   - *Bibliography for Final Paper or Proposal:* Each of you will be asked to compose a final research paper or proposal. This bibliography would be specifically associated with your culminating paper or proposal. Bibliographies should be turned in on Canvas by Week 5.

GRADING POLICY

We expect all assignments to be completed in a timely fashion. All written work will be held to high standards and should conform to rules of proper grammar, usage, punctuation, and spelling. You should conform to standard APA format unless you have a good argument to do otherwise. Because of time pressures, *late papers will not be accepted unless prior written confirmation has been given by the instructors.* Assignments will be weighed according to this scheme:

Class Participation	15%
Blog & Discussion Point Assignment	20%
Practice Brief	20%
Everyday Science Mapping Assignment	5%
Developed Resources or Paper/Proposal	40%

Please double-space all written work to be turned in and use a 12-pt. font.

REQUIRED TEXT

National Research Council. (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on Conceptual Framework for the New K-12 Science Education Standards, Board on Science Education, National Research Council. Washington, DC: The National Academies Press.

Free PDF Download - http://tinyurl.com/ScienceFramework

SCHEDULE OF READINGS & ASSIGNMENTS

Week 1, 1/7 **Introduction to the Class, the NRC Framework, and NGSS**

ORIENTING READINGS & VIDEOS

Explore the resources linked from the STEM Teaching Tool:
Next Generation Science Standards: What's different, and do they matter?

Report Brief on NRC Framework for K-12 Science Education (download from this page)
http://sites.nationalacademies.org/DBASSE/BOSE/Framework_K12_Science/

FAQ about the NRC Framework
http://sites.nationalacademies.org/DBASSE/BOSE/DBASSE_071971

Parent Q&A Resource about the Next Generation Science Standards
http://www.nsta.org/docs/NGSSParentGuide.pdf

NGSS App for iOS and Android
http://ngss.nsta.org/2013/08/12/get-the-free-next-generation-science-standards-app/

FAQ about the Next Generation Science Standards
http://www.nextgenscience.org/frequently-asked-questions

Week 2, 1/14 **Overview of the New Vision for K-12 Science & Engineering Education**

READINGS

Rudolph, J. L. (2002). Portraying epistemology: School science in historical context. *Science Education, 87*, 64-79.

NRC Framework (2011) - Chapters 1, 2 & 11 (pp. 1-37; 277-295)

National Research Council. (2013). Introduction & Appendix A. In *Next Generation Science Standards: For States, By States* (pp. xiii-xxv, Appendices 1-4). Washington, DC: The National Academies Press.

National Research Council. (2014). Literacy for science in English language arts and science standards (Chapter 2). In *Literacy for science: Exploring the intersection of the Next Generation Science Standards and Common Core for ELA Standards: A workshop summary*. (pp. 7-18). Washington, DC: The National Academies Press.

National Research Council. (2014). Summary. In *Developing assessments for the Next Generation Science Standards* (pp. 1-9). Washington, DC: The National Academies Press.

OPTIONAL READING

National Research Council. (2007). Conclusions and recommendations (Chapter 11). In Duschl, R., Schweingruber, H. A., & Shouse, A. (Eds.), *Taking science to school: Learning and teaching science in grades K-8* (pp. 333-355). Washington, D.C.: The National Academy Press

ASSIGNMENTS

Assign: SCIENCE magazine "Images of the Practices" Exercise

Week 3, 1/21 Introduction to Disciplinary Practices & Inquiry

READINGS

Schwab, J. (1962). The teaching of science as enquiry. In P.F. Brandwein (Ed.), *The teaching of science* (pp. 3-103). Cambridge, MA: Harvard University Press.

NRC Framework (2011) - Chapter 3 (pp. 41-82)

Penuel, W. R. (in press). Studying science and engineering learning in practice. *Cultural Studies of Science Education*.

OPTIONAL READING

Schatzki, T. (2001). Introduction: Practice theory. In Schatzki, T., Knorr Cetina, K., & von Savigny, E. (Eds.), *The Practice Turn in Contemporary Theory* (pp. 10-23). London: Routledge.

ASSIGNMENTS

Discuss: SCIENCE magazine "Images of the Practices" Exercise

Assign: "Everyday Science Mapping" Exercise

Due: Proposed Practice Brief topic

Week 4, 1/28 Learning Across Settings

READINGS

National Research Council. (2009). Theoretical perspectives, Conclusions and recommendations. In Bell, P., Lewenstein, B., Shouse, A.W. & Feder, M.A. (Eds.), *Learning science in informal environments: People, places, and pursuits* (pp. 27-53, 291-314). Washington, DC: The National Academies Press.

Azevedo, F. S. (2013). The tailored practice of hobbies and its implication for the design of interest-driven learning environments. *Journal of the Learning Sciences*, 22(3), 462-510.

Bricker, L. A., & Bell, P. (in review). "I want to be an engineer": Network, framing, and positioning dynamics associated with youth STEM learning and expertise development in and out of school.

Penuel, W. R., Lee, T. R., & Bevan, B. (2014). *Designing and building infrastructures to support equitable STEM learning across settings*. Research+Practice Collaboratory Research Synthesis.

OPTIONAL READING

Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J. & Watkins, S.C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.

ASSIGNMENTS

Due: Option 1—Resource Creation Proposal. Be ready to pitch the idea in class.

Week 5, 2/4 Implementation Strategies & Resources

READINGS

NRC Framework (2011) - Chapters 10 and 13 (pp. 241-275; 311-327)

Penuel, W. R., & Fishman, B. (2012). Large-scale science education intervention research we can use. *Journal of Research in Science Teaching*, *49*(3), 281-304.

Small Group / Individual Reading of a NARST Report on "Supporting the Implementation of NGSS through Research" about: Accountability, Assessment, Curriculum Materials, Engineering, Equity, Informal Science Education, Teacher Education, and Professional Development.

Supplemented with relevant pieces of:

National Research Council. (forthcoming). *Guide to implementing the Next Generation Science Standards*. Washington, DC: The National Academies Press.

Reiser, B. (2013). What professional development strategies are needed for successful implementation of the Next Generation Science Standards?

ASSIGNMENTS

Due: Option 2—Final Paper/Proposal Bibliography Due. Be ready to pitch the idea in class.

Discuss: The "Everyday Science Mapping" Assignment

Week 6, 2/11 Equity, Race, Culture & Practices

READINGS

Barton, A. C., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching*, *46*(1), 50-73.

Bang, M., Warren, B., Rosebery, A. S., & Medin, D. (2012). Desettling expectations in science education. *Human Development*, *55*, 302-318.

Carlone, H., Scott, C. M., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, *51*(7), 836-869.

National Research Council. (2013). Appendix D & Case Studies. In *Next Generation Science Standards: For states, by states* (pp. 25-39). Washington, DC: The National Academies Press.

OPTIONAL READINGS

National Research Council. (2009). Diversity and equity (Chapter 7). In Bell, P., Lewenstein, B., Shouse, A.W. & Feder, M.A. (Eds.), *Learning science in informal environments: People, places, and pursuits* (pp. 209-247). Washington, DC: The National Academies Press.

Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, *94*(6), 1008-1026.

Banks, J. A., Au, K. H., Ball, A. F., Bell, P., Gordon, E. W., Gutierrez, K., Heath, S. B., Lee, C. D., Lee, Y., Mahiri, J. , Nasir, N. S., Valdes, G. & Zhou, M. (2007). *Learning in and out of school in*

diverse environments: Life-Long, Life-Wide, Life-Deep. Seattle, WA: UW Center for Multicultural Education & The LIFE Center.

ASSIGNMENTS

Due: Practice Brief Draft. Be ready to discuss them in class.

Week 7, 2/18 Cultural Perspectives on Scientific Practices

READINGS

Latour, B. (1995). The "Pedofil" of Boa Vista: A photo-philosophical montage. *Common Knowledge, 4*(1), pp. 144-187.

Pickering, A. The mangle of practice: Agency and emergence in the sociology of science. *American Journal of Sociology*, *99*(3), 559-589.

Warren, B., Ogonowski, M., & Pothier, S. (2003). "Everyday" and "Scientific": Rethinking dichotomies in modes of thinking in science learning. In A. Nemirovsky, A. S. Rosebery, J. Solomon, & B. Warren (Eds.), *Everyday matters in mathematics and science education* (pp. 119–152). Mahwah, N.J.: Erlbaum.

Manz, E. (2014). Representing student argumentation as functionally emergent from scientific activity. *Review of Educational Research*, 1-38.

OPTIONAL READINGS

Rouse, J. (1994). Engaging science through cultural studies. *Philosophy of Science Association*, *2*, 396-401.

Suchman, L. (2000). Embodied practices of engineering work. *Mind, Culture and Activity*, *7*(1-2), 4-18.

ASSIGNMENT

Discuss: Practice Brief drafts

Week 8, 2/25 Linguistic & Rhetorical Perspectives on Scientific Practices

READINGS

Ochs, E., Gonzales, P., & Jacoby, S. (1996). "When I come down I'm in the domain state...": Grammar and graphic representation in the interpretive activity of physicists. In E. Ochs, E. Schegloff & S. Thompson (Eds.), *Interaction and Grammar* (pp. 328-369). New York: Cambridge University Press.

Kress, G. R., Jewitt, C., Ogborn, J. & Tsatsarelis, C. (2001). Rhetorics of the science classroom: A multimodal approach (Chapter 1 -skim) & Analyzing action in the science classroom (Chapter 3). In *Multimodal teaching and learning: The rhetorics of the science classroom* (pp. 10-41 [skim], 60-98). London: Continuum.

Brown, B. (2011) Isn't that just good teaching? Disaggregate instruction and the language identity dilemma. *The Journal of Science Teacher Education*, 22,679-704.

OPTIONAL READING

Quinn, H., Lee, O., & Valdés, G. (2012). Language demands and opportunities in relation to Next Generation Science Standards for English language learners: What teachers need to know. Commissioned Papers on Language and Literacy Issues in the Common Core State Standards and Next Generation Science Standards, 94, 32.

ASSIGNMENTS

Discuss: Practice Brief drafts

Week 9, 3/4	**Cognitive Perspectives on Scientific Practices**

READINGS

Dunbar, K. (1995). How scientists really reason: Scientific reasoning in real-world laboratories. In R.J. Sternberg, & J. Davidson (Eds.). *Mechanisms of insight* (pp. 365-395). Cambridge MA: MIT press.

Berland, L. K., & McNeill, K. L. (2010). A learning progression for scientific argumentation: Understanding student work and designing supportive instructional contexts. *Science Education*, *94*(5), 765-793.

Linn, M. C. (2006). The knowledge integration perspective on learning and instruction. In K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences (1st ed.)* (pp. 243-264). Cambridge: Cambridge University Press.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction*, *16*(1), 3-118.

OPTIONAL READING

Bell, P. (2004). Promoting students' argument construction and collaborative debate in the science classroom. In M. C. Linn, E. A. Davis, & P. Bell (Eds.), *Internet environments for science education* (pp. 115-143). Mahwah, NJ: Erlbaum.

ASSIGNMENT

Discuss: Practice Brief drafts

Week 10, 3/11	**CULMINATING CLASS**

Administrative Notes about Teaching at the University of Washington

If you have any concerns about the course or your instructor, please see the instructor about these concerns as soon as possible. If you are not comfortable talking with the instructor or not satisfied with the response that you receive, you may contact Associate Dean Joy Williamson Lott, joyann@uw.edu.

Academic Accommodations

Your experience in this class is important to us, and it is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you experience barriers based on disability, please seek a meeting with DRS to discuss and address them. If you have already established accommodations with DRS, please communicate your approved accommodations to your instructor at your earliest convenience so we can discuss your needs in this course.

Disability Resources for Students (DRS) offers resources and coordinates reasonable accommodations for students with disabilities. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. If you have not yet established services through DRS, but have a temporary or permanent disability that requires accommodations (this can include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability@uw.edu.