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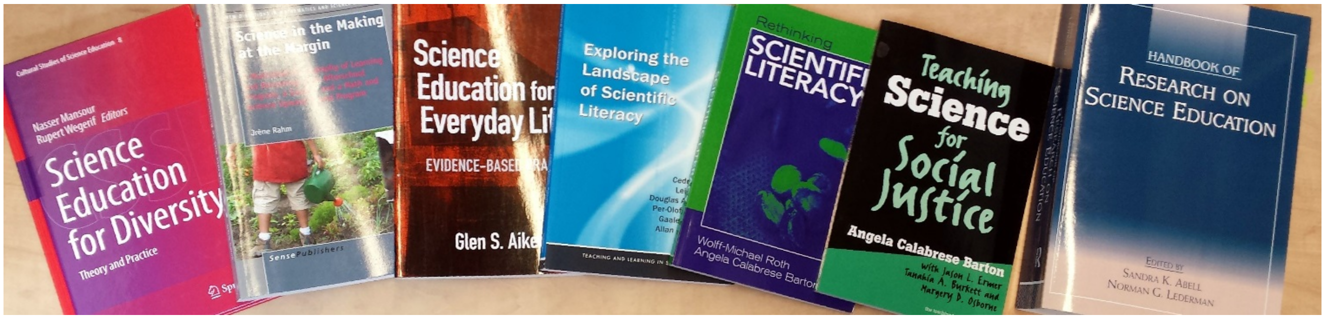

Bibliography: Science Education for Diversity & Equity

By Steven Worker, July 2014

Theoretical Considerations: *What Counts as Science?*

Mansour, N., & Wegerif, R. (Eds.) (2013). *Science education for Diversity: Theory and practice* (Cultural Studies of Science Education, 8). New York: Springer. 379 pages.
The book is comprised of seventeen chapters touching on issues of learning and pedagogy, educator preparation, and cultural issues touching on tensions including conceptions of diversity and the influence of cultural groupings and individual differences. Most of the authors contend that the canonical, authoritarian science as decontextualized truth alienates youth from non-mainstream populations. Instead of trying to address specific issues of gender differences or particularly ethnic groups, a paradigm shift is required where science education embraces openness, responsiveness, and multiple ways of sense making.

Lee, O., & Luykx, A. (2007). Science education and student diversity: Race/ethnicity, language, culture, and socioeconomic status. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of Research on Science Education* (Ch. 7, pp. 171-197). New York: Routledge.
Although taking a school-based perspective, Lee & Luykx provide an overview to issues of diversity in science education on topics of curriculum, learning and instruction, assessment, teacher education, organizational policies, and future research needs. While achievement gaps persist for students from diverse racial/ethnic and socioeconomic backgrounds, the research literature base is growing in examining complex relationships influencing student outcomes.

Roberts, D. A. (2007). Scientific literacy/Science literacy. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of Research on Science Education* (Ch. 25, pp. 729-780). New York: Routledge.
Based on a comprehensive review of the literature, Roberts defined a heuristic to understand two historical visions of scientific literacy that guide science education: Vision I (canonical science) and Vision II (everyday and community science). Vision I starts with professional scientists and their identification of core products and processes, evident in science standards (e.g., NGSS). Alternatively, Vision II starts with the situation, a citizen's point of view, and pulls relevant science to the situation at hand, but incorporates economic, aesthetic, political, ethical, and social perspectives. The Vision adopted by a program (typically implicitly) guides the learning objectives, selection of curricula, educator development, and assessment. Science education focusing on inclusiveness and diversity have typically employed a Vision II perspective.

Roth, W-M., & Calabrese Barton, A. (2004). *Rethinking scientific literacy.* New York: Routledge. 227 pages.
This book starts with the assumption that scientific literacy cannot be delivered to youth away from the world, community practice, or social consciousness, but rather science education should empower young people to

contribute to, critique, and partake in a just society. Roth and Calabrese Bartin reason that in order to be relevant to the lives of young people, science education and civic engagement must go hand-in-hand which is evidenced by increased agency. This perspective of scientific literacy necessarily position science as one of many resources people draw upon in collective activity, others include economics, politics, power, and values. The authors urge educators to explore citizen science and science for social justice as two powerful pedagogical strategies.

Russ, R.S. (2014). Epistemology of science vs. epistemology for science. *Science Education, 98*(3), 388-396.
Science educators often operate from the perspective that youth learn science best by engaging in the practices of professional scientists (assuming that if scientists do X and Y that learners should do X and Y). Russ points to flaws in this reasoning, such as the requirement of a priori definition of what counts as science (and what does not) which assumes people rationally decide when and when not to use a scientific mindset; the fact that scientific practices are not equivalent to the processes of learning; and a reliance on an expert-novice model which reinforces a deficit viewpoint of learners. As an alternative, Russ advances a shift away from science education as epistemologies *of* science to thinking about learners adopting epistemologies *for* science- broadening our conception of what should count as science- and redefining what science is; at its core, science is about sense making and knowledge construction. Rather than evaluating learners doing "correct" science, the perspective should be on nurturing learners making sense of the world in the moment. Epistemologies *for* science decentralizes the role of professional scientists and what constitutes "correct" science and instead focuses on effective means for supporting learners growing competence in constructing knowledge of the world.

Learning and Becoming through Science Education

Brickhouse, N. (2011). Scientific literacy for bringing in the outsiders. In C. Linder, L. Ostman, D.A. Roberts, P-O. Wickman, G. Erickson, A. MacKinnon (Eds.), *Exploring the Landscape of Scientific Literacy* (Ch. 13, pp. 193-204). New York: Routledge.
Taking a sociocultural perspective, specifically an identity formation lens, Brickhouse posits that the ways in which science curriculum is framed (e.g., Vision I or II) influences which kinds of students choose to engage more deeply in science education. Educators designing spaces for girls must attend to desired social identities and cultural expectations; success at school, an academic identity, is insufficient for girls to be interested in science.

Rahm, J. (2010). *Science in the making at the margin: A multisited ethnography of learning and becoming in an afterschool program, a garden, and a math and science upward bound program.* (New Directions in Mathematics and Science Education, Vol. 18). Boston: Sense Publishers. 326 pages.
Rahm (2010) employed a sociocultural perspective in studying youth participation, meaning making, and identity development in three out-of-school time science programs. She found that learning and becoming in the programs were intertwined and that being able to contribute to scientific practice was an essential component of learning. Youth participation in doing, social interaction, and negotiation, stretched across the artifacts of the programs, leading youth to position themselves as agents of science that were not available in school.

Pedagogical Considerations

Aikenhead, G.S. (2006). ***Science education for everyday life: Evidence-based practice.*** **New York: Teachers College Press. 185 pages.**
Contesting the "pipeline" metaphor – funneling capable students into STEM fields – Aikenhead embraces a humanist approach perspective for science education, preparing youth to use science for everday life towards practical ends. The book provides evidence-based findings around curriculum, materials, teacher development, and student learning to support a humanist science curriculum. To move forward, Aikenhead acknowledges the need to address power and politics of pipeline enthusiasts as they protect the status quo and canonical science's privileged status.

Calabrese Barton, A. (2003). ***Teaching science for social justice.*** **New York: Teachers College Press. 195 pages.**
Employing critical/feminist perspectives and using the power of stories, Calabrese Barton highlights how youth apply scientific mindsets to solve problems, the areas of science that might interest youth, and social relations and identity. Throughout the stories, she weaves issues of power, youth making science their own, using science to bring about change, and building communities supportive of youth science practices.

Cammarota, J., & Fine, M. (Eds.). (2008). ***Revolutionizing education: Youth participatory action research in motion.*** **New York: Routledge.**
Participatory action research is a method to bring communities together to identify issues, gather and interpret data, and implement solutions- one of the most critical tasks is ensuring the research question is generated by the community. In this book, Cammarota & Fine bring together authors to describe their work with engaging adolescents in identifying research questions that then serves as the basis for a youth-led research project.

Roth, W-M., & Lee, S. (2004). Science education as/for participation in the community. ***Science Education, 88*****(2), 263-291.**
This article reframes traditional definitions of science education as a collective property instead of an individual attribute, that scientific literacy is an emergent and collective activity. In addition, Roth and Lee argue that scientific knowledge is one of many forms of knowledge and must be understood in combination with politics, economics, aesthetics, philosophy, and everyday knowledge. Finally, given lifelong participation in community endeavors, they posit that if science education emphasizes an aspect of community life, youth may continue to make relevant science contributions beyond limited participation in school or a program.

Vossoughi, S., Escude, M., Kong, F., Hooper, P. (2013). ***Tinkering, learning & equity in the after-school setting.*** **Paper presented at the FabLearn Conference, Stanford, CA.**
Making, together with tinkering, has been recognized as a practice that facilitates learning and development. Vossoughi et al. take an equity lens to learning in making and tinkering youth programs (their ethnographic research is conducted in Boys & Girls Clubs). They argue that equity lies in the how of teaching and learning: specific ways of designing making environments, using pedagogical language, integrating students' cultural and intellectual histories, and expanding the meaning and purposes of STEM learning. For science specifically, they find that tinkering offers a "valuable access point to science for learners who might not otherwise engage in scientific activities."

Cooperative Extension & 4-H Youth Development

Smith, M.H., Worker, S., Ambrose, A., & Schmitt-McQuitty, L. (in press). "Anchor points" to define youth scientific literacy within the context of California 4-H. *California Agriculture.*
Scientific literacy is an important educational and societal goal. Measuring scientific literacy, however, has been problematic because there is no consensus regarding the meaning of the construct. Most definitions focus on content and processes of major science disciplines (Vision I), ignoring social factors and citizens' needs. A definition of scientific literacy for the California 4-H Program was developed from the citizen's perspective (Vision II), concentrating on authentic science-related situations. The definition includes four anchor points: science content; scientific reasoning skills; interest and attitude; and contribution through applied participation. The definition provides California 4-H with a consistent framework for future science curriculum and program development and implementation, educator professional development, and evaluation.

Ripberger, C., & Blalock, L.B. (2011). *4-H science in urban communities: Promising practices guide.* Retrieved from http://urban4hscience.rutgers.edu
The guide highlights eighteen case studies of exemplary work engaging youth in 4-H science programs in urban areas. The authors found four promising practices of 4-H professionals: attending to program design and sustainability; creating strategic partnerships; building staff capacity; and sharing success stories.

Bruyere, B.L., & Salazar, G. (2010). Engaging Latino audiences in out-of-school program about science. *Journal of Extension, 48*(3). Article Number 3RIB4. Retrieved from http://www.joe.org/joe/2010june/rb4.php
Through ten parent focus groups in 2 Colorado counties, Bruyere and Salazar identified four implications for reaching Latino populations: i) interesting in science programs was high; ii) a preference for family participation in programs; iii) parents were unaware of science programs; iv) practical barriers (cost, transportation, time) were deterrents but not prohibitive.

Worker, S. (2013). Embracing scientific and engineering practices in 4-H. *Journal of Extension, 51*(3). Article Number 3IAW3. Retrieved from http://www.joe.org/joe/2013june/iw3.php
The 4-H Science Initiative has renewed efforts to strengthen 4-H programmatic and evaluation efforts in science and engineering education. A fundamental component of this initiative is to provide opportunities to youth to aid in their development of science process skills; however, emerging research stresses the importance of engaging youth in authentic practices of science and engineering. Refocusing 4-H efforts on a sociocultural framework of science education that emphasizes a participation-oriented framework towards learning scientific and engineering practices ensures 4-H programs are affording youth high-quality learning experiences.

Spiegel, A.N., Rockwell, S.K., Acklie, D., Frerichs, S.W., French, K., & Diamond, J. (2005). Wonderwise 4-H: Following in the footsteps of women scientists. *Journal of Extension, 43*(4). Article Number 4FEA3. Retrieved from http://www.joe.org/joe/2005august/a3.php
The Wonderwise 4-H program introduced 8 to 12 year old girls to female scientist role models through hands-on science activities in museums. Wonderwise 4-H improved youths' attitudes about science through engaging activities and realistic videos that made science real and accessible, engaged youth in actual scientific activities, increased their understanding of what science is, broadened their view of scientists, and increased their understanding of the possibilities of a science career.