CENTER FOR YOUTH DEVELOPMENT

RESEARCH You May Have Missed

UNIVERSITY OF CALIFORNIA
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RESEARCH YOU MAY HAVE MISSED . . . provides brief summaries of recent research relevant to youth development practice. It is designed to help youth development professionals keep up-to-date with contemporary research.

Editor's Note: The focus of the articles reviewed in this issue is informal science learning. The articles range in topic from assessing informal science programs to learner diversity in informal science environments and contextual settings for informal science learning.

- Brody, M., Bangert, A., & Dillon, J. (2007).
Assessing learning in informal science contexts. (Commissioned Paper).
Washington, DC: National Research Council.
(Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html).

This paper, commissioned by the National Research Council for Science Learning in Informal Environments Committee, discusses assessment of outcomes in informal learning settings. Informal learning environments can include museums, nature centers, after school programs and other types of environments. The authors review 25 published evaluations of informal science contexts that have used phone surveys, personal journals, qualitative analysis of transcripts of verbal interactions, pretest-posttest designs, online surveys, and a variety of other methods to assess the impacts of informal science education programs. Both quantitative and qualitative data can be useful when evaluating the impacts of these types of settings. There is no single method that works 'best' in assessing the impact of a program; the appropriate methodology will depend on the particular context. Qualitative studies can include data gathering tools such as personal meaning or concept maps, which provide a visual representation of individuals' understanding of scientific concepts, such as extinction or climate change. Open-ended questions in focus group or individual interviews can allow for more in-depth responses. Observation may be used to examine individual or group behaviors within the context of an informal learning location where multiple activities may be available. The article also addresses proposals for funding based on such evaluations. Evaluations which are submitted for funding often lack technical information about the purpose and methodology of the evaluation. The article recommends that in writing grant proposals, authors should clearly state the purpose of the research proposal and the methods used to gather the data. Additionally, data from the studies reviewed indicated that while many were grounded in theory, theory around science learning in informal environments is limited and emergent rather than fully formed. Results from evaluations can be reapplied to the theoretical constructs in which the research was based to confirm, reject, alter, build on or expand existing theories. The ideology (the What?), the epistemology (the How?) and the axiology (the Why?) of each study must be aligned in order for conclusions to be valid and provide data to support a theoretical foundation. ***-KH***

- Forman, E., & Sink, W. (2006).
Sociocultural approaches to learning science in classrooms.
(Available at: http://www7.nationalacademies.org/bose/Forman_Commissioned_Paper.pdf).

This article reviews research investigating science learning in the classroom from a sociocultural perspective (Rogoff, 2003; Engle & Conant, 2002; Pickering, 1995) specifically addressing three questions, Who learns science in classrooms? How is science learned in classrooms? And What science is learned in classrooms? Forman and Sink contend, "who" is heavily influence by institutional organization (by age and academic tracks) of students that either support or curtail their science learning experience. In particular, this article analyzes literature at the institutional, interpersonal and personal levels to highlight the constraints and opportunities present for positive science learning and teaching experience in the classroom. Additionally, the researchers draw from Engle and Conant's framework (2002) for disciplinary engagement (challenging activities, student authority, scientific alliance, and access to resources) and Pickering's (1995) inclusion of time and unpredictability to reconceptualize productive disciplinary engagement as tracking longitudinal development of students' inquiry, argumentation complexities and generation of new ideas. Researchers argue programs that include design experiments facilitated positive attitudes and motivation with diverse learners. Additionally, the authors conclude an interdisciplinary approach would advance understanding of science learning in order to better meet the needs of students' science learning opportunities. The researchers recommend future science learning investigations include focus on K-3 students' science learning, students with disabilities, instructional approaches, interventions as professional development, use of diverse research methodology, learning-as-practice and collaboration between researchers and practitioners. ***-MTN***

■ Friedman, A.J. (ed.), Allen, S., Campbell, P.B., & Dierking, L.D., et al. (2008).
Framework for evaluating impacts of informal science education projects. (Report from a National Science Foundation Workshop.)
Washington, DC: The National Science Foundation.

This report provides a foundation for evaluating, specifically, NSF-funded informal science education projects, but the information is also applicable to other types of out-of-school science projects. Chapters review planning and evaluation for various types of informal education, such as youth and community programs, mass media, exhibitions, collaborations, and learning technologies. The authors recommend a framework for evaluation focusing on six types of impacts that science education projects may have on the audience the projects are reaching: (1) Awareness, knowledge, or understanding of science, engineering, or technology concepts and processes; (2) Engagement or interest in SET-related concepts or careers; (3) Attitudes towards SET topics and their own abilities; (4) Behaviors around SET concepts and careers; (5) Skill development in SET; and (6) Other project-specific impacts. Behavior change is often intended for projects related to environmental science; for example, reduction of energy use, or increased recycling. The first steps in developing a nonformal science education project are determining what impacts the project team wishes to have on the audience, and allowing those goals to determine the type and scope of the project. Some examples of goals could be creating awareness of SET-related careers, increasing SET-related interest and competencies in a target audience (for example, girls, underserved youth, etc.), or increasing knowledge of specific SET processes; for example, attendees will understand key aspects of plant chemistry and ecology. Once the goals have been articulated, the program can be designed to achieve those goals and an evaluation can be conducted to examine the effects specific to those goals. A variety of measures may be considered, such as key informant interviews, self-reports, surveys, observations, and documentation reviews. The heterogeneous audiences in informal education can present a challenge in evaluating the impacts of the program, and should be considered in planning programs and evaluations. Evaluations of youth programs should consider the audience; "what works" for one subgroup may not work with other youth. This report provides information that may be of use for practitioners as well as researchers and evaluators interested in informal science education. ***-KH***

■ Furtak, E.M. (2007).
Formative assessment in K-8 science education: A conceptual review. (Commissioned Paper).
Washington, DC: National Research Council.
(Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html)

The paper distinguishes between formative assessment and summative assessment in K-8 science education. Formative assessment can be thought of as assessment for learning rather than assessment of learning. In other words, assessment is a tandem goal of teaching in order to understand where the learner is in their goals and where they need to be. There are three components or stages of formative assessment: articulating clear criteria and goals, identifying the gap in knowledge, and feedback or closing the gap. It has been shown that making teaching goals explicit rather than tacit is more effective in achieving goals for learners. Identifying the gap in knowledge provides both the teacher and the learner with identifiable direction in learning. The effectiveness of feedback is dependant on quality of feedback such as the quality of written comments. The paper reviews several studies demonstrating how formative assessments impact student attitudes and performance. For example, providing written comments without grades has a more positive impact on student attitudes and showed improved performance compared to more summative assessments, such as grade only or even grades with comments. Lower achieving students were impacted more than higher achieving students by the type of feedback they received. The author explains the difference between formal formative assessments and informal formative assessments. Formal assessments are planned activities usually including an assessment of knowledge that is embedded in the curriculum. Informal formative assessments are not planned and occurs in student-teacher interactions at any given time. The author provides a continuum of formative assessments namely, i) on the fly assessments, ii) planned-for formative assessments and iii) formative assessments with embedded curriculum. There have been more studies on the effectiveness of the on the fly and planned-for strategies than formative assessments with embedded curriculum. The author claims that more research needs to be done in the area of formative assessments and their impact on learner performance and attitudes overall. Effective formative assessments characterize good teaching practices and can be relevant outside classroom-based delivery modes for the non-formal science educator. ***-AS***

- Heath, S.B. (2007).
  Diverse learning and learner diversity in "informal" science learning environments.
  (Commissioned Paper).
  Washington, DC: National Research Council.
  (Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html)

The author proposes that science learning in informal contexts needs to be understood as a cultural socialization process through: i) understanding how within families and communities the coherence of cultural socialization practices tie together (especially those tying language, self-agency, and a sense of the future); ii) identifying the larger socialization context of institutions and organizations which is tied to national and international economic growth; and iii) acknowledging the connections between practices, models and opportunities to play multiple roles that enable young learners to learn to think like scientists. The concept of a (re)generative learning environment which includes the following features is described: i) a range of roles available to members; ii) multiple agents with diverse skill sets and knowledge bases; iii) collaborative practices with goal agreement on desired outcomes and standards to assess attainment of these; iv) high valuation on iterative learning; v) learning that draws upon observation and trial-and-error opportunities; and vi) focused study of printed materials and targeted attention to instruction from experts. In order to establish these features, there also needs to be an acknowledgment of felt needs and incentives to set goals that meet these needs and a recognition of diverse talents, backgrounds and paths of socialization that are essential for the learning pool. This concept of creating (re)generative learning contexts is more meaningful than the distinction between informal and formal learning. The author compares middle and upper class families' socialization in science learning with lower income families. The former group tends to have greater access to out of school environments that can provide the necessary enrichment for learning in regenerative ways. Lower income families tend to access after-school opportunities that tend to be within school-based settings and are often an extension of the school day with respect to the kind of learning that takes place. The author suggests that community-based settings that are targeted towards lower income youth are especially important in bridging this gap by providing the type of context where, through the language and communities of practice in these settings, young people learn from experts. The author provides a case example of a program in Boston that teaches young people entrepreneurship as young artists but in the process also engages them in learning scientific concepts that are integral to the trade. The article provides a framework for thinking about learning through culturally embedded praxis. It also emphasizes the importance of community based positive youth development settings that can provide the type of learning environments that youth from underserved communities generally do not have access to in their daily lives. ***-AS***

- Horton, R.L., Gogolski, J., & Warkentien, C. (2007).
  Science, engineering, and technology (SET) programming in the context of 4-H youth development.
  Columbus, OH: Ohio State University Extension.

The 4-H SET Leadership Team commissioned this paper to identify standards in SET with which 4-H could align, and to identify life skill outcomes that would likely result from 4-H youth development programs. Science content standards were established in Project 2061 by the American Academy for the Advancement of Science (AAAS). These benchmarks for science literacy have been used by many states in developing content requirements for science education. (Project 2061's website is http://www.project2061.org/.) These benchmarks incorporate twelve categories: 1) The nature of science and scientific inquiry; 2) The nature of math (patterns and relationships, mathematical inquiry); 3) Technology, design, and systems; 4) The physical environment (the universe, earth, structure of matter, motion, forces of nature); 5) The living environment; 6) The human organism (identity, development, functions, health); 7) Human society (behavior, systems, interdependence, society); 8) The designed world (agriculture, materials, energy use, communication, information, engineering); 9) The mathematical world (numbers, symbolic relationships, shapes, reasoning); 10) Historical perspectives (history of science); 11) Common themes (systems, models, constancy and change, scale); 12) Habits of mind (values, attitudes, computation, estimation, observation). This paper reviews additional benchmarks by other groups as well. The authors see technology and engineering in context related to science, as some of the applications of scientific knowledge in the real world. A youth development approach to scientific learning allows the incorporation of cognitive theory into science education. Behaviors such as inferring, hypothesizing, measuring, estimating and experimenting help produce knowledge and understanding. The authors caution that many learning activities do not facilitate science understanding and ability in young people. Curricula frequently focus on teaching the content matter rather than developing abilities that young people need in scientific inquiry. However, increasing research points to the importance of active engagement in learning, so the experiential learning methodology is critical to developing science skills in youth. The authors recommend that 4-H adopt the National Science Education Standards as the guiding principles for SET curriculum planning and the 4-H SET Abilities Model listing 30 behaviors critical to science education. ***-KH***

- McKiley, B., Brayboy, J., & Castagno, A.E. (2007).
  How might Native Science inform "informal science learning"? (Commissioned Paper).
  Washington, DC: National Research Council.
  (Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html)

This paper was commissioned by the National Research Council for the Learning Science in Informal Environments Project, with the purpose of addressing informal science learning for Indigenous communities. An understanding of science education for Indigenous youth is important for several reasons. Indigenous students have been found to perform lower on standardized measures of science achievement than their peers; there is inadequate science instruction in most elementary schools and especially those serving children of color and from low-income and rural areas; and many Native youth avoid science by the time they reach middle school. Many older Indigenous students also find learning science especially challenging because of the specialized language involved. The authors review the literature on culturally responsive schooling (CRS) for Indigenous youth which is a successful strategy for improving the education and increasing the academic achievement of Native students in the US. This educational approach is a necessary shift in teaching methods, curricular materials, teacher dispositions, and school-community relations and is strongly encouraged as a method for engaging Native Students in learning. Although there are over 500 different tribal nations in the US, each with a unique history, language, and culture, in the US there is a tendency to essentialize tribal cultures, thus educators are strongly encouraged to engage in CRS because Indigenous students come to school with different learning styles and cultural practices that result in incongruity between teaching and learning. CRS is viewed as necessary because its goal is to produce students who are bicultural and thus knowledgeable about and competent in both mainstream society and tribal societies. Some differences and similarities in notions of science that the authors highlight include a) Western science appears to assume one truth arrived at through empirical observation and application, whereas Native/Indigenous science allows the possibility that there are multiple ways of obtaining knowledge and also that the physical world is intimately connected to the spiritual; b) Native science doesn't separate the observer from the observed, which is necessary for the objectivity of Western science; c) the presumed universalism of Western science is neither valued nor sought after in Native science; d) in contrast to Western science, Native science does not attempt to generalize observations to universal laws or to combine observations in order to make predictions abut nature; and e) Native science is more likely to see individuals as parts of a community, which includes a particular culture, history, place and time. The authors argue that multiple forms of science can be wedded and that both 'formal' and 'informal' uses of science can work together. The authors state that the 'formal-informal' dichotomy is very much a false distinction in many Indigenous communities and tribal nations and that it may be more accurate to use the terms school-based and out-of-school learning experiences. Using CRS and integrating science with culture may give Indigenous students a better opportunity to succeed in science education. ***-RC***

■ National Institute on Out of School Time, Wellesley College. (2007).
A review of the literature and the INSPIRE model: STEM in out-of-school time. (Commissioned paper).
Washington, DC: National Research Council.
(Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html)

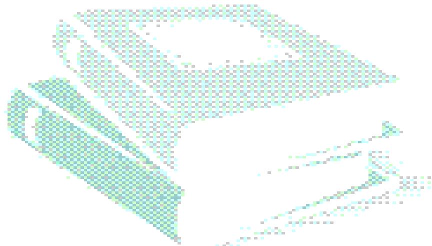
This article provides an overview of the literature on youth development outcomes in out-of-school time and specifically on youth outcomes with respect to STEM teaching in out-of-school contexts. There is an emphasis on the importance of the characteristics of out-of-school contexts for learning STEM especially for minority and underserved populations. The article describes a program, the INSPIRE model and reviews key literature that sheds light on what would make the program successful. The INSPIRE program is a three tiered program. For young people between 7 – 10th grade, the program engages researchers and engineers as role models and mentors. For older high school youth the program takes on inquiry-based scientific work. For college age youth there is a college internship program. Based on the literature on youth outcomes with successful STEM practices in out-of-school time contexts, the authors suggest that the success of the INSPIRE program to recruit and engage young people, especially those who are under-served would depend on successfully incorporating the following components that have been highlighted in the literature: hands-on learning, mentorship, self-directed and group learning, incorporating out-of-school time staff, more out-of-school time rather than more in-school time, connections to family and local environment and an attention to recruitment. The literature reviewed in this article and the components outlined that would likely enhance the success of the INSPIRE program, are relevant for youth development professionals interested in enhancing the success of other non-formal programs that seek to incorporate science, engineering and technology curriculum and practices for positive youth outcomes and learning. ***-AS***

■ Renninger, K.A. (2007).
Interest and motivation in informal science learning.
(Available at: http://www7.nationalacademies.org/bose/Renninger_Commissioned_Paper.pdf)

This article examines the role of interest and motivation in informal science learning (ISL) settings by highlighting how these constructs have traditionally been defined and contribute to the practice and support of participants' science learning and program development. ISL programs engage participants through science learning opportunities in settings such as museums, enrichment programs, clubs and groups. The article analyzes XLAB (ISL setting) and 2 participants' experience (composite of past research participants) within current studies of interest and motivation in ISL settings. In addition to ISL settings' diverse programs, agenda, focus, goals, expectations, and experience, participants also engage in ISL settings with different science interests and motivation; hence programs' attention to development, implementation and evaluation is important to facilitate participants' engagement in science learning. Generally, ISL settings focus on the enjoyment of science experiences with expectation that "fun" activities influences science interest and/or learning. Interest in ISL studies have been conceptualized as participation or engagement with science and are fueled by questions, whereas motivation is defined as decision making and goal setting. This article analyzes studies that document interest and motivation separately or in settings that are evaluated by curriculum achievement; however, Renninger concludes that research documenting the interrelationship between interest, enjoyment, engagement and motivation in inquiry-based settings without grades can potentially highlight how these components affect participants' learning experience and interest. The article makes suggestions for future research that acknowledges the interrelationship between motivation and interest, and poses possible research questions such as, What does the shift from exploration of science content to science literacy look like? What characterizes interest for science and does this differ among disciplines? And What is the relation of interest to goals, self-regulation, and effort in ISL settings—is it a mediator and/or outcome of their development? ***-MTN***

■ Schwartz, S.E.O., & Noam, G.G. (2007).
Informal science learning in afterschool settings: A natural fit? (Commissioned Paper).
Washington, DC: National Research Council.
(Available at: http://www7.nationalacademies.org/bose/Commissioned_Papers.html)

There have been federally mandated efforts to increase interest and achievement in science learning among K-12 students. However, a reaction to high stakes testing in math and literacy under No Child Left Behind has resulted in less in-school time for science learning. This paper was commissioned by the National Research Council for the Learning Science in Informal Environments Projects to examine the potential of afterschool science programs as a means to advance science learning and attitudes towards science among children and adolescents. While the fit between afterschool and science learning appears to be clear, with a philosophical overlap between the mission of afterschool time and the mission of informal science learning both emphasizing cooperative learning and authentic, hands-on-activities, there has not been an in-depth examination of the evidence for science learning in afterschool programs. The authors summarize the research literature on the following topics: a) defining afterschool science programs; b) theoretical arguments for science in afterschool programs; c) evaluation of afterschool science programs; d) evaluation of learning in afterschool programs; e) best practices in afterschool programs; and f) best practices in afterschool science programs. Studies show that afterschool science programs can make important contributions to students' understanding of STEM concepts and their ability to think scientifically and use science tools, and be effective in improving students' attitudes towards science. Research has indicated that afterschool is an effective delivery system for informal science learning because it reaches a larger audience, with often a majority of participants from underprivileged groups. However much of this research comes from studying science-specific afterschool programs rather than generic afterschool programs, which often have different populations. The authors recommend that more research of informal science learning in generic afterschool programs be undertaken in order to understand the full potential of afterschool programs to function as a large-scale delivery system for informal science learning. Additional research that is needed includes more information about what program qualities and practices are most effective in promoting science learning in afterschool settings. The authors are encouraged by the progress research in informal science learning has made particularly because its fit in an afterschool setting has the potential to reach children of all backgrounds; strengthening the connection between the two will be beneficial to all youth.
-RC



Book Reviews . . . on topics relevant to youth development will be periodically published. We encourage submissions for future editions. Reviews may be sent to Ramona Carlos (rmcarlos@ucdavis.edu).

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Reprints of articles reviewed may be obtained by contacting the 4-H Center for Youth Development at (530) 754-8433.

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