REL Appalachia Ask A REL Response

Educator Effectiveness
May 2019

Question:

What are some research-based practices for closing racial, socioeconomic, and disability-based achievement gaps in science for elementary, middle, and high school students?

Response:

Thank you for your request to our REL Reference Desk regarding evidence-based information about closing achievement gaps in science. Ask A REL is a collaborative reference desk service provided by the 10 Regional Educational Laboratories (RELs) that, by design, functions much in the same way as a technical reference library. Ask A REL provides references, referrals, and brief responses in the form of citations in response to questions about available education research.

Following an established REL Appalachia research protocol, we searched for peer-reviewed articles and other research reports on achievement gaps in science. We focused on identifying resources that specifically addressed strategies or practices to narrow achievement gaps for elementary, middle, and high school students of varying races, poverty levels, and disability status. The sources included ERIC and other federally funded databases and organizations, research institutions, academic research databases, and general Internet search engines. For more details, please see the methods section at the end of this document.

The research team did not evaluate the quality of the resources provided in this response; we offer them only for your reference. Also, the search included the most commonly used research databases and search engines to produce the references presented here, but the references are not necessarily comprehensive, and other relevant references and resources may exist. References are listed in alphabetical order, not necessarily in order of relevance.

References

ACT, Inc. (2017). *STEM education in the U.S.: Where we are and what we can do*. Iowa City, IA: Author. Retrieved from https://eric.ed.gov/?id=ED581665

From the abstract: "ACT's annual Condition of STEM reports provide essential national data on student interest and achievement in STEM subjects. The latest report—'STEM Education in the U.S.: Where We Are and What We Can Do'—takes the data one step further by

pairing the latest findings with promising practices aimed at improving STEM achievement and preparedness. These practices include examples from states, nonprofits, businesses, and other groups committed to closing STEM achievement and opportunity gaps. The report also challenges local, state, and national policymakers to meet, within the next four years, a number of actionable goals for improving the STEM pipeline."

Carlone, H. B., Haun-Frank, J., & Webb, A. (2011). Assessing equity beyond knowledge- and skills-based outcomes: A comparative ethnography of two fourth-grade reform-based science classrooms. *Journal of Research in Science Teaching*, *48*(5), 459–485. Abstract retrieved from https://eric.ed.gov/?id=EJ921595; full text available at https://libres.uncg.edu/ir/uncg/f/H_Carlone_Assessing_2011.pdf

From the abstract: "When evaluating equity, researchers often look at the 'achievement gap.' Privileging knowledge and skills as primary outcomes of science education misses other, more subtle, but critical, outcomes indexing inequitable science education. In this comparative ethnography, we examined what it meant to 'be scientific' in two fourth-grade classes taught by teachers similarly committed to reform-based science (RBS) practices in the service of equity. In both classrooms, students developed similar levels of scientific understanding and expressed positive attitudes about learning science. However, in one classroom, a group of African American and Latina girls expressed outright disaffiliation with promoted meanings of 'smart science person' ('They are the science people. We aren't like them'), despite the fact that most of them knew the science equally well or, in one case, better than, their classmates. To make sense of these findings, we examine the normative practice of 'sharing scientific ideas' in each classroom, a comparison that provided a robust account of the differently accessible meanings of scientific knowledge, scientific investigation, and scientific person in each setting. The findings illustrate that research with equity aims demands attention to culture (everyday classroom practices that promote particular meanings of 'science') and normative identities (culturally produced meanings of 'science person' and the accessibility of those meanings). The study: (1) encourages researchers to question taken-for-granted assumptions and complexities of RBS and (2) demonstrates to practitioners that enacting what might look like RBS and producing students who know and can do science are but pieces of what it takes to achieve equitable science education."

Curran, C., & Kellogg, A. (2016). Understanding science achievement gaps by race/ethnicity and gender in kindergarten and first grade. *Educational Researcher*, *45*(5), 273–282. Abstract retrieved from https://eric.ed.gov/?id=EJ1106561; full text available at https://mdsoar.org/bitstream/handle/11603/11915/Curran%20and%20Kellogg%20-%20ER%20-%20Science%20Achievement%20Gaps%20-%20Accepted%20Version%20for%20Archiving.pdf

From the abstract: "Disparities in science achievement across race and gender have been well documented in secondary and postsecondary school; however, the science achievement gap in the early years of elementary school remains understudied. We present findings from the recently released Early Childhood Longitudinal Study, Kindergarten Class

of 2010 – 2011 that demonstrate significant gaps in science achievement in kindergarten and first grade by race/ethnicity. We estimate the Black-White science gap in kindergarten at -0.82 SD but find only a small gender gap by first grade. Large disparities between Asian student performance in science as compared to mathematics and reading are documented. Student background characteristics and school fixed effects explain nearly 60% of the Black-White and Hispanic-White science achievement gaps in kindergarten. Implications for policy and practice are discussed."

Halpern, D. F., Aronson, J., Reimer, N., Simpkins, S., Star, J. R., & Wentzel, K. (2007). *Encouraging girls in math and science*. (NCER 2007-2003). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Retrieved from https://eric.ed.gov/?id=ED498581

From the abstract: "This National Center for Education Research (NCER) Practice Guide is the second in a series of IES guides in education. The goal of this practice guide is to formulate specific and coherent evidence-based recommendations that educators can use to encourage girls in the fields of math and science. The target audience is teachers and other school personnel with direct contact with students, such as coaches, counselors, and principals. The practice guide includes specific recommendations for educators and the quality of evidence that supports these recommendations. This practice guide provides five recommendations for encouraging girls in math and science. These recommendations together form a coherent statement: To encourage girls in math and science, we need to begin first with their beliefs about their abilities in these areas, second with sparking and maintaining greater interest in these topics, and finally with building associated skills. The five recommendations are: (1) Teach students that academic abilities are expandable and improvable; (2) Provide prescriptive, informational feedback; (3) Expose girls and young women to female role models who have succeeded in math and science; (4) Create a classroom environment that sparks initial curiosity and fosters long-term interest in math and science; and (5) Provide spatial skills training. Technical information on the studies is appended."

Jackson, J. K., & Ash, G. (2012). Science achievement for all: Improving science performance and closing achievement gaps. *Journal of Science Teacher Education*, *23*(7), 723–724. Abstract retrieved from https://eric.ed.gov/?id=EJ985259; full text available at https://www.tandfonline.com/doi/full/10.1007/s10972-011-9238-z

From the abstract: "This article addresses the serious and growing need to improve science instruction and science achievement for all students. We will describe the results of a 3-year study that transformed science instruction and student achievement at two high-poverty ethnically diverse public elementary schools in Texas. The school-wide intervention included purposeful planning, inquiry science instruction, and contextually rich academic science vocabulary development. In combination, these instructional practices rapidly improved student-science learning outcomes and narrowed achievement gaps across diverse student populations."

Kang, D., & Martin, S. N. (2018). Improving learning opportunities for special education needs (SEN) students by engaging pre-service science teachers in an informal experiential learning course. *Asia Pacific Journal of Education*, *38*(3), 319–347. Abstract retrieved from https://eric.ed.gov/?id=EJ1197224; full text available at https://www.tandfonline.com/doi/full/10.1080/02188791.2018.1505599

From the abstract: "Inclusive education (IE) has the potential to improve special education needs (SEN) students' learning outcomes, but IE requires teachers receive adequate training to be effective. We introduce an approach to pre-service teacher preparation using experiential learning in an informal learning environment to educate beginning teachers about effective science teaching for SEN students. Using data collected from observations, survey, interviews, and autobiographical reflections, we explored how teachers' engagement in an informal teaching experience impacted their perceptions about SEN students, their beliefs about the value of teaching science to SEN students, and their beliefs about their future responsibilities to support SEN students in inclusive classrooms. Findings expand our understanding of how to prepare new science teachers to improve science learning for students who are routinely marginalized in formal educational settings. Building from these findings, we discuss the need for transforming pre-service teacher education using university-based experiential learning courses that simultaneously offer SEN students targeted, high quality content learning experiences that could also have a positive impact on SEN students' attitudes about and achievement in science. We conclude by raising questions about the need for expanded policy, teacher preparation programmes, and additional research focused on improving science teaching and learning for SEN students."

Olszewski-Kubilius, P., Steenbergen-Hu, S., Thomson, D., & Rosen, R. (2016). Minority achievement gaps in STEM: Findings of a longitudinal study of Project Excite. *Gifted Child Quarterly*, *61*(1), 20–39. Abstract retrieved from https://eric.ed.gov/?id=EJ1122872; full text available at https://journals.sagepub.com/doi/pdf/10.1177/0016986216673449

From the abstract: "This longitudinal study examined the outcomes of Project Excite on reducing minority students' achievement gaps in STEM over 14 years. Project Excite was designed to provide intensive supplemental enrichment and accelerated programming for high-potential, underrepresented minority students from third through eighth grades to better prepare them for advanced math and science courses in high school. This study compared the performance of Project Excite participants with that of students from their local school districts and the state on the Illinois Standards Achievement Test, the Eplore test, the Measures of Academic Progress, and on rates of placement in above-grade-level math courses in ninth grade. Project Excite participants consistently outperformed their Black, Latino, and low-income peers, and they came close to the performance levels of White, Asian, and non-low-income students. They were more likely to be placed in above-grade-level math courses than their minority peers in ninth grade."

Qian, X., Nandakumar, R., Glutting, J., Ford, D., & Fifield, S. (2017). *Gender and minority achievement gaps in science in eighth grade: Item analyses of nationally representative*

data. (Research Report ETS RR-17-36). Princeton, NJ: Educational Testing Services. Retrieved from https://eric.ed.gov/?id=EJ1168600

From the abstract: "In this study, we investigated gender and minority achievement gaps on 8th-grade science items employing a multilevel item response methodology. Both gaps were wider on physics and earth science items than on biology and chemistry items. Larger gender gaps were found on items with specific topics favoring male students than other items, for example, an earth science item requiring visual-spatial ability. Minority students were more likely than White students to score lower on harder constructed-response (CR) items. Some teachers were more likely to reduce minority achievement gaps on easier CR items than other teachers. Implications for instruction in terms of improving visual-spatial awareness, efficacy of female students, and modeling scientific literacy for minority students were discussed."

Rizzo, K. L., & Taylor, J. C. (2016). Effects of inquiry-based instruction on science achievement for students with disabilities: An analysis of the literature. *Journal of Science Education for Students with Disabilities*, *19*(1), 1–16. Retrieved from https://eric.ed.gov/?id=EJ1169429

From the abstract: "In comparison to the past, more students with disabilities are being included in the general education classroom for science instruction. Though inquiry-based instruction has not shown to be an effective practice for students with disabilities, it is vastly becoming the dominant practice in science education. The purpose of this review is to examine the effects of inquiry-based instruction on science achievement for students with disabilities. The twelve studies, meeting selection criteria, report improvement in science achievement using inquiry practices. The participants and settings, variations of inquiry-based instruction, science achievement measures, and teacher training were addressed in this review. Two major contributions have resulted from analyzing the twelve studies. First, students with disabilities require supports to participate in an inquiry-based lesson and demonstrate progress on science achievement measures. Second, science achievement improves when components of explicit instruction are utilized in both the general and special education setting for students with disabilities."

Additional Ask A REL Responses to Consult

Ask A REL Midwest at American Institutes of Research. (2018). *What research and resources are available on the implementation of work-based learning experiences in STEM fields, particularly for high-need students?* Retrieved from https://ies.ed.gov/ncee/edlabs/regions/midwest/askarel/2018/STEM-work-based-learning.aspx

Ask A REL Northeast & Islands at Education Development Center. (2017). *What does the research say about encouraging women and girls to pursue careers in STEM?* Retrieved from https://ies.ed.gov/ncee/edlabs/regions/northeast/AskAREL/Response/25

Ask A REL Northeast & Islands at Education Development Center. (2017). *What empirical information is there about reducing the inequity gap through school practices and/or policy*

reform? Retrieved from https://ies.ed.gov/ncee/edlabs/regions/northeast/AskAREL/Response/40

Additional Organizations to Consult

National Education Association: http://www.nea.org/

From the website: "NEA offers a wide range of programs, products, and resources to engage and support state affiliates and members in closing the achievement gaps. The question most often heard when educators confront the reality of the achievement gaps in their school is 'What can I do in my classroom?' NEA resources provide support for answering this question by:

- Offering research-based suggestions for what educators can do now to create a learning environment in which diverse students can learn;
- Providing training and resources that challenge educators to meet accountability demands while still offering quality instruction to those students who need the most help;
- Developing training and materials to help educators meet the needs of English language learners; and
- Providing connections to additional resources that spark even more ideas for how to be successful with all students."

Effective Practices in Closing Achievement Gaps: http://www.nea.org/home/20609.htm

National Girls Collaborative Project: https://ngcproject.org/about-ngcp

From the website: "The vision of the NGCP is to bring together organizations throughout the United States that are committed to informing and encouraging girls to pursue careers in science, technology, engineering, and mathematics (STEM)."

National Science Teachers Association: https://www.nsta.org/

From the website: "The National Science Teachers Association (NSTA), founded in 1944 and headquartered in Arlington, Virginia, is the largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all. NSTA's current membership of 50,000 includes science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in and committed to science education."

Stanford Center for Education Policy Analysis: https://cepa.stanford.edu/

From the website: "The Stanford Center for Education Policy Analysis (CEPA) is a research center created in 2009 to unite an interdisciplinary array of nationally prominent scholars from across the campus to provide the depth and scale of research needed to affect education practice and policy in meaningful ways. Our work is known for its understanding of the educational context, innovative use of data, and rigorous analyses that result in real solutions to real problems. Our strategic partnerships with educational practitioners and

our engagement with policymakers ensure that our work is meaningful and leads to continuous improvement for all students. The work of CEPA's scholars spans a range of education policy issues including Poverty and Inequality; Federal and State Education Policy; Technological Innovations in Education; and Teaching and Leadership Effectiveness. The CEPA community includes Stanford faculty, post-doctoral fellows, graduate and undergraduate students as well as visiting scholars and students from across the world."

- The Educational Opportunity Monitoring Project: https://cepa.stanford.edu/educational-opportunity-monitoring-project/overview

Methods

Keywords and Search Strings

The following keywords and search strings were used to search the reference databases and other sources:

- ("achievement gap" OR "opportunity gap") AND (science or STEM) AND (socioeconomic OR poverty OR "economically disadvantaged" OR "low income")
- ("achievement gap" OR "opportunity gap") AND (science OR STEM) AND (rac* OR minorit*)
- ("achievement gap" OR "opportunity gap") AND (science OR STEM) AND (disabilit* OR LD OR SWD)

Databases and Resources

We searched ERIC, a free online library of more than 1.6 million citations of education research sponsored by the Institute of Education Sciences (IES), for relevant resources. Additionally, we searched the academic database ProQuest, Google Scholar, and the commercial search engine Google.

Reference Search and Selection Criteria

In reviewing resources, Reference Desk researchers consider—among other things—these four factors:

- Date of the publication: Searches cover information available within the last ten years, except in the case of nationally known seminal resources.
- Reference sources: IES, nationally funded, and certain other vetted sources known for strict attention to research protocols receive highest priority. Applicable resources must be publicly available online and in English.
- Methodology: The following methodological priorities/considerations guide the review and selection of the references: (a) study types—randomized controlled trials, quasi experiments, surveys, descriptive data analyses, literature reviews, policy briefs, etc., generally in this order; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected), study duration, etc.; (c) limitations, generalizability of the findings and conclusions, etc.

- Existing knowledge base: Vetted resources (e.g., peer-reviewed research journals) are the primary focus, but the research base is occasionally slim or nonexistent. In those cases, the best resources available may include, for example, reports, white papers, guides, reviews in non-peer-reviewed journals, newspaper articles, interviews with content specialists, and organization websites.

Resources included in this document were last accessed on May 5, 2019. URLs, descriptions, and content included here were current at that time.

This memorandum is one in a series of quick-turnaround responses to specific questions posed by education stakeholders in the Appalachia region (Kentucky, Tennessee, Virginia, and West Virginia), which is served by the Regional Educational Laboratory Appalachia (REL AP) at SRI International. This Ask A REL response was developed by REL AP under Contract ED-IES-17-C-0004 from the U.S. Department of Education, Institute of Education Sciences, administered by SRI International. The content does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government.