REL Appalachia Ask A REL Response

Literacy
February 2021

Question:

What does research say about students' science performance when literacy is integrated with science instruction at the secondary level? What are some best practices to incorporate literacy into secondary science instruction?

Response:

Thank you for your request to our REL Reference Desk regarding evidence-based information about integrating literacy with science instruction. 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 integrating literacy with secondary science instruction. We focused on identifying resources that specifically addressed the effects of integrating literacy with secondary science instruction on student outcomes. 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

Adams, A. E., & Pegg, J. (2012). Teachers' enactment of content literacy strategies in secondary science and mathematics classes. *Journal of Adolescent & Adult Literacy*, *56*(2), 151–161. Abstract retrieved from https://eric.ed.gov/?id=EJ982924; full text available at http://blogs.4j.lane.edu/literacyresources/files/2015/10/Literacy-Standards-Science-Math.pdf

From the abstract: "The incorporation of literacy strategies into content area instruction has been proposed as an effective way of improving student learning in the content areas.

However, few studies have examined how teachers incorporate content literacy strategies into their instruction and the specific nature of implementation. As part of an ongoing professional development project on content literacy in secondary science and mathematics classes, we conducted a qualitative inquiry which examined the nature of teachers' enactment of specific content literacy strategies through the analysis of classroom observations, teacher lesson plans, and teachers' online discussions. Results show that teachers were using content literacy strategies; however, the nature of their enactment of these strategies varied in ways that influenced the learning outcomes. In this paper, we describe a framework for characterizing these differences in enactment, provide examples of these variations, and discuss implications for enacting literacy strategies in these different ways."

Fang, Z., & Wei, Y. (2010). Improving middle school students' science literacy through reading infusion. *The Journal of Educational Research*, *103*(4), 262–273. Abstract retrieved from https://eric.ed.gov/?id=EJ879927; full text available at https://www.researchgate.net/publication/232880696_Improving_Middle_School_Students%27_Science_Literacy_Through_Reading_Infusion

From the abstract: "Despite recent calls for border crossing between reading and science, few studies have examined the impact of reading infusion in the science curriculum on students' science literacy. In this quasi-experimental study, the authors investigated the effects of an inquiry-based science curriculum that integrated explicit reading strategy instruction and quality science trade books on the development of science literacy among middle school students. Students in 10 sixth-grade science classes from 1 public middle school in the United States were randomly assigned to 2 conditions: inquiry-based science only (IS) and inquiry-based science plus reading (ISR). Results from the analyses of covariance showed that the ISR students significantly outperformed their IS peers on all measures of science literacy. It was suggested that even a modest amount of reading infusion could have a positive impact on middle school students' science literacy. The limitations and implications of the study were also discussed."

Greenleaf, C. L., Litman, C., Hanson, T. L., Rosen, R., Boscardin, C. K., Herman, J., Schneider, S., Madden, S., & Jones, B. (2011). Integrating literacy and science in biology: Teaching and learning impacts of reading apprenticeship professional development. *American Educational Research Journal*, *48*(3), 647–717. Abstract retrieved from https://eric.ed.gov/?id=EJ924276; full text available at https://www.researchgate.net/publication/254074795_Integrating_Literacy_and_Science_in_Biology_Teaching_and_Learning_Impacts_of_Reading_Apprenticeship_Professional_Development

From the abstract: "This study examined the effects of professional development integrating academic literacy and biology instruction on science teachers' instructional practices and students' achievement in science and literacy. The intervention consisted of 10 days of professional development in Reading Apprenticeship, an instructional framework integrating metacognitive inquiry routines into subject-area instruction to make explicit the tacit reasoning processes, problem-solving strategies, and textual features that shape literacy practices in academic disciplines. The study utilized a group-randomized, experimental design and multiple measures of teacher implementation and student learning and targeted groups historically unrepresented in the sciences. Hierarchical linear modeling procedures were used to estimate program impacts. Intervention teachers demonstrated

increased support for science literacy learning and use of metacognitive inquiry routines, reading comprehension instruction, and collaborative learning structures compared to controls. Students in treatment classrooms performed better than controls on state standardized assessments in English language arts, reading comprehension, and biology."

Krajcik, J. S., & Sutherland, L. M. (2010). Supporting students in developing literacy in science. *Science, 328*(5977), 456–459. Abstract retrieved from https://science.sciencemag.org/content/328/5977/456

From the abstract: "Reading, writing, and oral communication are critical literacy practices for participation in a global society. In the context of science inquiry, literacy practices support learners by enabling them to grapple with ideas, share their thoughts, enrich understanding, and solve problems. Here we suggest five instructional and curricular features that can support students in developing literacy in the context of science: (i) linking new ideas to prior knowledge and experiences, (ii) anchoring learning in questions that are meaningful in the lives of students, (iii) connecting multiple representations, (iv) providing opportunities for students to use science ideas, and (v) supporting students' engagement with the discourses of science. These five features will promote students' ability to read, write, and communicate about science so that they can engage in inquiry throughout their lives."

Pearson, P. D., Moje, E., & Greenleaf, C. (2010). Literacy and science: Each in the service of the other. *Science, 328*(5977), 459–463. https://www.researchgate.net/publication/43299103_Literacy_and_Science_Each_in_the_Service_of_the_Other

From the abstract: "We use conceptual and empirical lenses to examine synergies between inquiry science and literacy teaching and learning of K–12 (kindergarten through high school) curriculum. We address two questions: (i) how can reading and writing be used as tools to support inquiry-based science, and (ii) how do reading and writing benefit when embedded in an inquiry-based science setting? After elaborating the theoretical and empirical support for integrated approaches, we discuss how to support their implementation in today's complicated curricular landscape."

Additional Ask A REL Responses to Consult

Ask A REL Appalachia at SRI International. (2018). *What are evidence-based strategies or approaches to science instruction for secondary students and how do they impact student outcomes?* https://ies.ed.gov/ncee/edlabs/regions/appalachia/askarel/aar43.asp

Ask a REL Southeast at Florida State University. (2017). *What research has been conducted on teaching reading comprehension in science content classes?* https://ies.ed.gov/ncee/edlabs/regions/southeast/aar/l_01-2017.asp

Additional Organizations to Consult

American Museum of Natural History: https://www.amnh.org/

> *From the website:* Since its founding in 1869, the Museum has advanced its global mission to discover, interpret, and disseminate information about human cultures, the natural world, and the universe through a wide-ranging program of scientific research, education, and exhibition."
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> - Integrating literacy strategies into science instruction:
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> https://www.amnh.org/learn-teach/curriculum-collections/integrating-literacy-strategies-into-science-instruction

National Science Teaching Association: http://www.nsta.org

> *From the website:* "The National Science Teaching Association (NSTA) is a vibrant community of 40,000 science educators and professionals committed to best practices in teaching science and its impact on student learning. NSTA offers high quality science resources and continuous learning so that science educators grow professionally and excel in their career. For new and experienced teachers alike, the NSTA community offers the opportunity to network with like-minded peers at the national level, connect with mentors and leading researchers, and learn from the best in the field."
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> - Learning science and literacy together: https://www.nsta.org/learning-science-and-literacy-together
> - Literacy resources: https://www.nsta.org/topics/literacy

Methods:

Keywords and Search Strings

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

- (literacy OR ELA OR "language arts" or "English language arts" OR reading OR writing) AND (science OR "science instruction" OR biology OR chemistry OR physics OR "life science*") AND (strateg* OR intervention* OR practic* OR approach* OR "best practice*") AND ("high school" OR "middle school" OR "secondary")
- (literacy OR ELA OR "language arts" OR "English language arts" OR reading OR writing) AND (science OR "science instruction" OR biology OR chemistry OR physics OR "life science*") AND (achieve* OR outcome* OR impact* OR improve* OR score* OR perform* OR proficien*) AND ("high school" OR "middle school" OR secondary)

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 10 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 January 28, 2021. 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.