

## REL Southwest Ask A REL Response

Mathematics  
January 2019

### Question:

*What types of interventions are effective for enhancing learner engagement in Algebra I?*

### Response:

Thank you for the question you submitted to our REL Reference Desk. We have prepared the following memo with research references to help answer your question. For each reference, we provide an abstract, excerpt, or summary written by the study's author or publisher. Following an established Regional Educational Laboratory (REL) Southwest research protocol, we conducted a search for research reports as well as descriptive study articles on interventions that enhance student engagement in Algebra I.

We have not evaluated the quality of references and the resources provided in this response. We offer them only for your reference. Also, we searched the references in the response from the most commonly used resources of research, but they are not comprehensive, and other relevant references and resources may exist. References provided are listed in alphabetical order, not necessarily in order of relevance. We do not include sources that are not freely available to the requestor.

### Research References

Barbieri, C., & Booth, J. L. (2016). Support for struggling students in algebra: Contributions of incorrect worked examples. *Learning and Individual Differences, 48*(1), 36–44.  
<https://eric.ed.gov/?id=ED566951>

*From the ERIC abstract:* “Middle school algebra students (N = 125) randomly assigned within classroom to a Problem-solving control group, a Correct worked examples control group, or an Incorrect worked examples group, completed an experimental classroom study to assess the differential effects of incorrect examples versus the two control groups on students’ algebra learning, competence expectancy, and sense of belonging to math class. The study also explored whether prior knowledge impacted the effectiveness of the intervention. A greater sense of belonging and competence expectancy predicted greater learning overall. Students’ sense of belonging to math and competence expectancies were high at the start of the study and did not increase as a result of the intervention. A significant interaction between prior knowledge and incorrect worked examples on post-

test scores revealed that students with low prior knowledge who struggle with learning math benefit most from reflecting on highlighted errors within an incorrect worked examples intervention. The unique contributions of these findings as well as educational implications are discussed.”

Bell, C. V. (2013). Uptake as a mechanism to promote student learning. *International Journal of Education in Mathematics, Science and Technology*, 1(4), 217–229.  
<https://eric.ed.gov/?id=EJ1057556>

*From the ERIC abstract:* “This study is a descriptive examination of uptake that occurred during classroom discourse in 33 Algebra I classrooms in nine U.S. states. Uptake refers to the act of taking up mathematical comments, questions, and constructions as objects of discourse. Uptake is important because it can be used for scaffolding authentic opportunities to learn and promoting productive dispositions toward learning. Data used in this study were taken from video-recorded and transcribed observations of 63 class sessions—30 participating teachers were observed twice and 3 were observed only once. Coding of uptake data resulted in 5 categories of types of utterances being taken up and 16 categories of how the utterance was used in the episode of uptake. Analysis across all categories indicates that teachers most frequently provided mathematical explanations and reasoning, even when asking for students’ reasoning and explanations, which limited students’ opportunities to express mathematical reasoning. Episodes of uptake resulting in more dialogic interaction did occur, but were relatively rare. Findings of this study have potential to help teachers and teacher educators become more aware of using uptake to strategically foster more authentic, student-centered discourse environments and increase students’ opportunities to learn.”

Bissell, A. N. (2012). Architecture and impact of an open, online, remixable, and multimedia-rich Algebra 1 course. *Journal of Asynchronous Learning Networks*, 16(5), 49–59.  
<https://eric.ed.gov/?id=EJ1000090>

*From the ERIC abstract:* “Less than half of the students in the United States graduate from high school and are ready to take college-level math courses. Many years and varieties of remedial math programs have failed to dramatically improve outcomes, especially at scale. The question we face is whether technology in general, and open educational resources in particular, might offer some solutions for improving math scores across the nation. Herein, we describe the work of the Monterey Institute for Technology and Education, and specifically the design and early evidence of impact of their multimedia Algebra and Developmental Math resources. We believe that the structure and function of these open educational resources can effectively meet the diverse needs of the nation’s math teachers and learners, perhaps paving the way to more personalized teaching and learning practices.”

Gilbert, J. E., Arbuthnot, K., Hood, S., Grant, M. M., West, M., McMillian, Y., et al. (2008). Teaching algebra using culturally relevant virtual instructors. *The International Journal of Virtual Reality*, 7(1), 21–30. Retrieved from  
<https://www.researchgate.net/publication/220222148>

*From the abstract:* “When culture is integrated into the mathematics classroom, it improves students’ academic achievement [3], helps move classrooms towards an equitable learning environment [30] [31], helps students have positive beliefs about mathematics [23], and integrates mathematics with other disciplines [56], [58]. Moreover, if you observe today’s kids, the use of video games in their daily and/or weekly routines is significant. Lastly, the predominant genre among African-American youth is hip-hop/rap. These facts led to the African-American Distributed Multiple Learning Styles System (AADMLSS pronounced ‘adam less’) City Stroll, an adaptive, electronic, speech-enabled algebra learning system that uses culture to influence learning in the form of an animated, music-led interface.”

Hodgson, T. R., Cunningham, A., McGee, D., Kinne, L. J., & Murphy, T. J. (2017). Assessing behavioral engagement in flipped and non-flipped mathematics classrooms: Teacher abilities and other potential factors. *International Journal of Education in Mathematics, Science and Technology*, 5(4), 248–261. <https://eric.ed.gov/?id=EJ1151444>

*From the ERIC abstract:* “There is a growing evidence that flipped classrooms are associated with increased levels of student engagement, as compared to engagement in ‘traditional’ settings. Much of this research, however, occurs in post-secondary classrooms and is based upon self-reported engagement data. This study seeks to extend existing flipped classroom research by assessing behavioral engagement in flipped and non-flipped settings using observational instruments in three precollege settings. Contrary to widely-reported results, this study found an increase in engagement in only one of the three observed settings. Analyses of the classroom contexts and teachers’ actions in the three settings suggests that student engagement is not solely a function of instructional strategy (flipped versus non-flipped), but is also affected by student characteristics and teachers’ skill and expectations.”

McCaffrey, T., & Matthews, P. (2017). An emoji is worth a thousand variables. *Mathematics Teacher*, 111(2), 96–102. Retrieved from <https://www.researchgate.net/publication/319254337>

*From the abstract:* “In this article, the authors discuss the potential of the icon-based mathematical games, emoji math and mobile math, to promote student engagement with and understanding of algebra. They describe how these games serve as accessible entry points for algebraic thinking and that, in contrast to traditional symbolic algebra, the use of these icon-based games appears to be more meaningful to many students. Because the games correspond to symbolic algebra, the authors suggest that they may serve as powerful bridging functions for fostering students’ understanding of symbolic algebra in typical classrooms.”

Norton, A., & Rutledge, Z. (2006). Measuring task posing cycles: Mathematical letter writing between algebra students and preservice teachers. *Mathematics Educator*, 19(1), 32–45. <https://eric.ed.gov/?id=EJ882223>

*From the ERIC abstract:* “In a secondary school mathematics teaching methods course, a research team engaged 22 preservice secondary teachers (PSTs) in designing and posing tasks to algebra students through weekly letter writing. The goal of the tasks was for PSTs to elicit responses that would indicate student engagement in the mathematical processes described by NCTM (2000) and Bloom’s taxonomy (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956), as well as student engagement in the highest levels of cognitive activity described by Stein, Smith, Henningsen, and Silver (2000). This paper describes our efforts to design reliable measures that assess student engagement in those processes as a product of the evolving relationship within letter-writing pairs. Results indicate that some processes are easier to elicit and assess than others, but that the letter-writing pairs demonstrated significant growth in terms of elicited processes. Although it is impossible to disentangle student factors from teacher factors that contributed to that growth, we find value in the authenticity of assessing PSTs’ tasks in terms of student engagement rather than student-independent task analysis.”

Robertson, W. H., Meyer, R. D., & Wilkerson, T. L. (2012). The mathematics of skateboarding: A relevant application of the 5Es of constructivism. *Journal of Education and Learning*, 1(2), 32–36. <https://eric.ed.gov/?id=EJ1081355>

*From the ERIC abstract:* “Getting high school students to enjoy mathematics and to connect concepts to their daily lives is a challenge for many educators. The Mathematics of Skateboarding demonstrated innovative and creative ways to engage students in content and skills mapped to state requirements for high school students in Algebra and Geometry.”

Star, J. R., Foegen, A., Larson, M. R., McCallum, W. G., Porath, J., & Zbiek, R. M. (2015). *Teaching strategies for improving algebra knowledge in middle and high school students*. (NCEE 2015–4010). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. <https://eric.ed.gov/?id=ED555576>

*From the ERIC abstract:* “Mastering algebra is important for future math and postsecondary success. Educators will find practical recommendations for how to improve algebra instruction in the What Works Clearinghouse (WWC) practice guide, ‘Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students’. The methods and examples included in the guide focus on helping students analyze solved problems, recognize structure, and utilize alternative approaches to solving algebra problems. Each recommendation includes the level of supporting research evidence behind it, examples to use in class, and solutions to potential implementation roadblocks. Teachers can implement these strategies in conjunction with existing standards or curricula. In addition, these strategies can be utilized for all students learning algebra in grades 6-12 and in diverse contexts, including during both formative and summative assessment. Administrators and professional development providers can use the guide to implement evidence-based instruction and align instruction with state standards or to prompt teacher discussion in professional learning communities.”

## Additional Organizations to Consult

The Algebra Project – <https://algebra.org/wp/>

*From the website:* “The Algebra Project’s founder and participants have worked in classrooms for two decades to develop classroom teaching methods, teacher professional development, and community development that will enable students to succeed in a typical Algebra I course in late middle school or early high school.

Originally, the project targeted classrooms with large proportions of African American students. Recently, the project has been invited to work in sites with large Latino/a populations with varying heritage (e.g. Yuma, AZ; Boston; Chicago; Miami), and has been contacted by sites with other underserved populations.

Originally, the project targeted middle schools, addressing the transition from arithmetic to algebraic thinking. In 1995, founder Robert Moses began addressing high school mathematics, working at Lanier High School, the lowest performing high school in Jackson, MS, and with interested university mathematicians, resulting in NSF grants in 2002 and 2006 to develop instructional materials for high school beginning algebra.

The Algebra Project received a four-year NSF grant in 1997 for teacher professional development and site community development. Recently, the project’s youth initiative (the Young People’s Project) received an NSF grant to develop college and high school mathematics literacy workers who lead out-of-school sessions for younger students upon invitation from community based organizations.”

*REL Southwest note:* Two relevant case studies from The Algebra Project are available in ERIC:

Gilbert, J. E., Eugene, W., Swanier, C., Arbuthnot, K., Hood, S., Grant, M. M., et al. (2008). Culturally relevant design practices: A case study for designing interactive algebra lessons for urban youth. *Journal of Educational Technology*, 5(3), 54–60. <https://eric.ed.gov/?id=EJ1097826>

Grant, M. R., Crompton, H., & Ford, D. J. (2015). Black male students and The Algebra Project: Mathematics identity as participation. *Journal of Urban Mathematics Education*, 8(2), 87–118. <https://eric.ed.gov/?id=EJ1086176>

The Nellie Mae Education Foundation – <https://www.nmefoundation.org>

*From the website:* “The Nellie Mae Education Foundation has been committed to reshaping the high school learning experience by working with districts, schools and organizations to implement the principles of student-centered learning—learning that is personalized, engaging, competency-based and happens anytime, anywhere.

We have been excited to see the scaling of student-centered practices and personalization through New England and nationwide. Yet too often the spread of such practices is not defined by rigorous or equitable distributions.”

*REL Southwest note:* One relevant resource from the Nellie Mae Education Foundation is available at <https://www.nmefoundation.org/resources/assessment/the-better-math-teaching-network-lessons-learned>.

What Works Clearinghouse (WWC) What Works in Math—<https://ies.ed.gov/ncee/wwc/Math/>

*From the website:* “What Works in Math?”

There’s no single answer to that broad question. Instead, what works varies by grade, subject, and even delivery model.

WWC products allow educators to better understand what works in different contexts. WWC intervention reports show which tools increase mathematics achievement by grade, while WWC practice guides show effective practices for topics such as fractions. Search our publications [here](#).”

## Methods

### *Keywords and Search Strings*

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

- (“Student engagement” OR “learner engagement”) AND (“Algebra I” OR “Algebra 1”)

### *Databases and Resources*

We searched [ERIC](#) for relevant, peer-reviewed research references. ERIC is a free online library of more than 1.7 million citations of education research sponsored by the Institute of Education Sciences (IES). Additionally, we searched the [What Works Clearinghouse](#).

### *Reference Search and Selection Criteria*

When we were searching and reviewing resources, we considered the following criteria:

- *Date of the publication:* References and resources published from 2004 to present, were included in the search and review.
- *Search priorities of reference sources:* Search priority is given to study reports, briefs, and other documents that are published and/or reviewed by IES and other federal or federally funded organizations, academic databases, including ERIC, EBSCO databases, JSTOR database, PsychInfo, PsychArticle, and Google Scholar.

- *Methodology*: The following methodological priorities/considerations were given in the review and selection of the references: (a) study types—randomized control trials, quasi-experiments, correlational studies, descriptive data analyses, literature reviews, mixed methods analyses, and so forth; (b) target population, samples (representativeness of the target population, sample size, volunteered or randomly selected, and so forth), study duration, and so forth; and (c) limitations, generalizability of the findings and conclusions, and so forth.

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This memorandum is one in a series of quick-turnaround responses to specific questions posed by stakeholders in the Southwest Region (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas), which is served by the Regional Educational Laboratory (REL) Southwest at AIR. This memorandum was prepared by REL Southwest under a contract with the U.S. Department of Education’s Institute of Education Sciences (IES), Contract ED-IES-91990018C0002, administered by AIR. Its 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.