Thank you for your request to our REL Reference Desk regarding research that has been conducted on differentiated instruction for Algebra I or algebra in general. Ask A REL is a collaborative reference desk service provided by the ten regional educational laboratories (REL) that, by design, functions much in the same way as a technical reference library. It provides references, referrals, and brief responses in the form of citations on research based education questions.

The information below represents the most rigorous research available. Researchers consider the type of methodology and give priority to research reports that employ well described and thorough methods. The resources were also selected based on the date of the publication with a preference for research from the last ten years. Additional criteria for inclusion include the source and funder of the resource.

Question: *What research is available on differentiated instruction for Algebra I or algebra in general?*

Key words and search strings used in the search: *individualizing instruction for Algebra I students; instructional strategies, differentiated instruction; Algebra I*

Note: We did not find any rigorous studies specific to this question; however, some related research citations are provided below.

Search databases and websites:

1. ERIC: http://www.eric.ed.gov/
2. JSTOR: http://www.jstor.org/action/showAdvancedSearch
3. Google Scholar: www.google.com/scholar
4. Institute of Education Sciences (IES) Resources: http://ies.ed.gov/pubsearch/
5. What Works Clearinghouse: http://ies.ed.gov/ncee/wwc/

Citations Retrieved: (NOTE: Abstracts and executive summaries are copied directly from the reports when possible to ensure accuracy):

Impecoven-Lind, L. S., & Foegen, A. (2010). Teaching algebra to students with learning disabilities. *Intervention in School and Clinic,* 46(1), 31–37. http://eric.ed.gov/?id=EJ897294

Abstract/Summary: Algebra is a gateway to expanded opportunities, but it often poses difficulty for students with learning disabilities. Consequently, it is essential to identify evidence-based instructional strategies for these students. The authors begin by identifying

three areas of algebra difficulty experienced by students with disabilities: cognitive processes, content foundations, and algebra concepts. The authors next describe three evidence-based strategies for addressing these needs: classwide peer-tutoring, cognitive strategy instruction, and explicit instructional routines. (Contains 1 figure.)

Lynch, K., & Star. J. R. (2014). Views of struggling students on instruction incorporating multiple strategies in algebra I: An exploratory study. *Journal of Research in Mathematics Education,* 45(1), 6–18. http://eric.ed.gov/?id=EJ1028273

Abstract/Summary: Although policy documents promote teaching students multiple strategies for solving mathematics problems, some practitioners and researchers argue that struggling learners will be confused and overwhelmed by this instructional practice. In the current exploratory study, we explore how 6 struggling students viewed the practice of learning multiple strategies at the end of a yearlong algebra course that emphasized this practice. Interviews with these students indicated that they preferred instruction with multiple strategies to their regular instruction, often noting that it reduced their confusion. We discuss directions for future research that emerged from this work.

Matthews, M. S., Farmer, J. L. (2008). Factors affecting the algebra I achievement of academically talented learners. *Journal of Advanced Academics,* 19(3), 472–501. http://eric.ed.gov/?id=EJ810758

Abstract/Summary: Understanding student performance in Algebra I is important because this course serves as the gateway to advanced coursework in mathematics and science through the remainder of high school and into postsecondary education. In the current study, we analyzed secondary data to evaluate the relationship between selected indicators of mathematics and the Algebra I performance of academically able and gifted learners who participated in above-level talent search testing. We used structural equation modeling to examine the relationship among selected variables and students' scores on a standardized measure of Algebra I achievement. Variables included prior mathematics ability, parental education level, whether a student was identified as gifted, participation in afterschool activities, the time spent on homework, and the amount of class time spent on discussions and lectures. Results indicate the strongest relationships were between mathematics reasoning and Algebra I achievement. Although gifted status was a strong predictor of mathematics reasoning, it was not strongly related to Algebra achievement, which supports the need for differentiated instruction for gifted learners. The amount of class time spent on discussion had a significant effect on the amount of time spent weekly on Algebra I homework. Rather than reliance on traditional lecture-based instruction, teachers should consider incorporating more classroom discussion on mathematical topics. (Contains 5 tables and 3 figures.)

Schacter, R., (2013). Solving our algebra problem: Getting all students through algebra I to improve graduation rates. *District Administration,* 49(5), 43–46. http://eric.ed.gov/?id=EJ1013968

Abstract/Summary: Algebra I has long served as a gateway to higher-level math courses and science courses, such as physics, and has been required for high school graduation as well as admission to most colleges. But taking algebra also can turn into a pathway for failure, from which some students never recover. In 2010, a national U.S. Department of Education study found that 80 percent of high school dropouts cited their inability to pass Algebra I as the primary reason for leaving school. What's more, failure to pass state algebra assessments is a more frequent problem for minority students and contributes to a serious achievement gap in math. In the 2012 results of the California Standards Test (CST) in Algebra I, for instance, just 39 percent of Hispanic eighth graders scored proficient or advanced, as did 20 percent of Hispanic ninth graders. The results for African American students in the two grades were 32 percent and 16 percent, respectively. In contrast, white students tested at 60 and 34 percent proficiency or better. It should come as no surprise that algebra poses a formidable challenge for all students, who must get used to a brave new world of variables, coefficients, and quadratic equations. The problems posed by algebra are numerous, though, say experts in mathematics education, math teachers, and administrators. So are the solutions that a number of school districts have implemented. And while those district leaders are looking toward the Common Core State Standards in Algebra I to uniformly improve the quality of algebra teaching and learning, they also have resorted in the meantime to their own innovative approaches. They include screening for students equipped to take the course as early as eighth grade, more effectively engaging all algebra students in the classroom, creating real-life, concrete examples of algebra in everyday life, and better managing individual student progress. These innovative approaches are described in this article.

Star, J. R., Caronongan, P., Foegen, A., Furgeson, J., Keating, B., Larson, M. R., Lyskawa, J., McCallum, W. G., Porath, J., & Zbiek, R. M. (2015). Teaching strategies for improving algebra knowledge in middle and high school students (NCEE 2014-4333). Washington, DC: National Center for Education Evaluation and Regional Assistance (NCEE), Institute of Education Sciences, U.S. Department of Education. http://eric.ed.gov/?id=ED555576

Abstract/Summary: 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. Appended are: (1) Postscript from the Institute of Education Sciences; (2) About the Authors; (3) Disclosure of Potential Conflicts of Interest; and (4) Rationale for Evidence Ratings. A Glossary is included.

What Works Clearinghouse (2016*). Cognitive tutor®. WWC Intervention Report.* Washington, DC: U.S. Department of Education. http://eric.ed.gov/?id=ED566735

Abstract/Summary: "Cognitive Tutor"® is a secondary mathematics curriculum developed by Carnegie Learning that focuses on how students think about and learn mathematics. Teachers facilitate student learning as students acquire and apply new information and discuss their work. The curriculum can be implemented using a textbook, adaptive software, or combination of textbook and software activities. This What Works Clearinghouse (WWC) intervention report focuses on studies of all "Cognitive Tutor"® secondary courses, which include: "Algebra I," "Algebra II," and "Geometry," as well as "Integrated Math I," "II," and "III," a three-course series that integrates numeric, algebraic, geometric, and statistical content. WWC identified six studies of "Cognitive Tutor® Algebra I" and one study of "Cognitive Tutor® Geometry" that both fall within the scope of the Secondary Mathematics topic area and meet WWC group design standards. Two studies of "Cognitive Tutor® Algebra I" meet WWC group design standards without reservations, and four studies of "Cognitive Tutor® Algebra I" meet WWC group design standards with reservations. Together, these six studies included 12,840 students in grades 8-13 in 118 locations. The one study of "Cognitive Tutor® Geometry" also meets WWC group design standards with reservations. This study included 669 students in grades 9-12 in eight locations. The following are appended: (1) Research details for: Cabalo et al. (2007), Ritter et al. (2007), Campuzano et al. (2009), Pane et al. (2014), Shneyderman (2001), Wolfson et al. (2008), and Pane et al. (2010); (2) Outcome measures for each domain; (3) Findings included in the rating for studies of: "Cognitive Tutor® Algebra I" for the algebra domain, "Cognitive Tutor® Algebra I" for the general mathematics achievement domain, and "Cognitive Tutor® Geometry" in the geometry domain; and (4) Description of supplemental findings of "Cognitive Tutor® Algebra I" for the general mathematics achievement domain. A glossary of terms is included.

What Works Clearinghouse (2016*). Saxon math. WWC Intervention Report.* Washington, DC: U.S. Department of Education. http://eric.ed.gov/?id=ED565884

Abstract/Summary: "Saxon Math" is a core curriculum for students in grades K-12 that uses an incremental approach to instruction and assessment. This approach limits the amount of new

math content delivered to students each day and allows time for daily practice. New concepts are introduced gradually and integrated with previously introduced content so that concepts are developed, reviewed, and practiced over time rather than being taught during discrete periods of time, such as in chapters or units. This review focuses on studies of "Saxon Math's" secondary courses, including "Saxon Algebra I", "Saxon Geometry", "Saxon Algebra II", and "Saxon Advanced Math". The What Works Clearinghouse (WWC) identified two studies of "Saxon Algebra I" that both fall within the scope of the Secondary Mathematics topic area and meet WWC group design standards. One study meets WWC group design standards without reservations and the other study meets WWC group design standards with reservations. Together, these studies included 198 secondary students in grades 8-9 in two locations. The findings in this report pertain to "Saxon Algebra I" only. No studies of "Saxon Geometry", "Saxon Algebra II", or "Saxon Advanced Math" fall within the scope of the Secondary Mathematics review protocol and meet WWC group design standards. "Saxon Algebra I" was found to have no discernible effects on algebra for secondary students. Five appendices are included: (1) Research details for Pierce (1984); (2) Research details for Peters (1992); (3) Outcome measures for the algebra domain; (4) Findings included in the rating for studies of Saxon Algebra I for the algebra domain; and (5) Description of supplemental findings for studies of "Saxon Algebra I" for the algebra domain. Contains WWC Rating Criteria and a glossary of terms.

Woodward, J., Beckmann, S., Driscoll, M., Franke, M., Herzig, P., Jitendra, A. Koedinger, K. R., & Ogbuehi, P. (2012). *Improving mathematical problem solving in grades 4 to 8: A practice guide* (NCEE 2012-4055). Washington, D.C.: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Abstract/Summary: The Institute of Education Sciences (IES) publishes practice guides in education to bring the best available evidence and expertise to bear on current challenges in education. Authors of practice guides combine their expertise with the findings of rigorous research, when available, to develop specific recommendations for addressing these challenges. The authors rate the strength of the research evidence supporting each of their recommendations. The goal of this practice guide is to offer educators specific, evidence-based recommendations that address the challenge of improving mathematical problem solving in grades 4 through 8. The guide provides practical, clear information on critical topics related to improving mathematical problem solving and is based on the best available evidence as judged by the authors. Appended are: (1) Postscript from the Institute of Education Sciences; (2) About the Authors; (3) Disclosure of Potential Conflicts of Interest; and (4) Rationale for Evidence Ratings. (Contains 9 tables, 21 examples and 303 endnotes.)

Referrals

Organizations:

Association of Mathematics Teacher Educators: https://amte.net/about
National Council of Teachers of Mathematics: http://www.nctm.org/

Federally Funded Resources:

- Institute of Education Sciences (IES), public search engine available at: http://ies.ed.gov/pubsearch/
- What Works Clearinghouse: http://ies.ed.gov/ncee/wwc/\\

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