

REL Pacific Ask A REL Response

Math
August 2020

Question:

What are evidence-based strategies for math pathways and math education strategies that focus on equity?

Response:

Following an established REL Pacific research protocol, we conducted a web-based search for resources related to evidence-based math pathways and strategies that focus on equity (see Methods section for search terms and resource selection criteria). We first prioritized our search on studies in the Pacific and other indigenous contexts for greater relevancy to our partners in the Pacific region; however, we included studies with more generalizable findings due to the limited amount of research available in these contexts.

References are listed in alphabetical order, not necessarily in order of relevance. Descriptions of the resources are quoted directly from the publication abstracts. We have not evaluated the quality of references and the resources provided in this response. We offer them only for your reference. Also, our search included the most commonly used research resources, but they are not comprehensive and other relevant references and resources may exist.

Research References

Bouck, E. C., Satsangi, R., & Park, J. (2018). The concrete-representational-abstract approach for students with learning disabilities: An evidence-based practice synthesis. *Remedial and Special Education, 39*(4), 211–228. <https://eric.ed.gov/?id=EJ1185546>

From the abstract: “As researchers and practitioners have increasingly become interested in what practices are evidence based and for whom in education, different sets of quality indicators and evidence-based practice standards have emerged in the field of special education. Practices are commonly suggested as evidence based, even without a best evidence synthesis on the existing research, such as the case with the concrete—representational—abstract (CRA) instructional framework to support students with disabilities in mathematics. This study sought to support the classification of the CRA instructional framework as an evidence-based approach for students with learning disabilities by applying quality indicators and standards of evidence-based practice by Cook et al. (2014). Based on the application of the indicators and standards, the CRA instructional framework was determined to be an evidence-based practice for students with learning disabilities who struggle in mathematics relative to computational problems, such as addition, subtraction, and multiplication, largely with regrouping.”

Cooper, C. R., Chavira, G., & Mena, D. D. (2005). From pipelines to partnerships: A synthesis of research on how diverse families, schools, and communities support children's pathways through school. *Journal of Education for Students Placed at Risk (JESPAR)*, 10(4), 407–430. <https://eric.ed.gov/?id=EJ717936>

From the abstract: “This article maps recent progress on 5 key questions about the ‘academic pipeline problem’ of different rates of persistence through school among ethnically diverse students across the nation. The article shows the complementary development of the Overlapping Spheres of Influence Theory and Sociocultural Theory and aligns concepts and measures across theories. Evidence from the Center for Research on Education, Diversity, and Excellence and other studies points to 5 major findings. First, tracing demographics across ethnicity, income, and geography can contribute to opening the academic pipeline. Second, families are key to students' developing and sustaining educational and career aspirations and school achievement, not only among college-educated families, but also among low-income, minority, and immigrant families. Third, it is important to recognize how early children's pathways in math and language divide as they move through school if successful pathways are to be sustained. Fourth, across age, ethnic, and income groups, the most successful students build links across their families, schools, peers, and communities, who in turn support students' pathways. Fifth, sustained educational partnerships draw on long-term data to connect measurable goals from childhood to college and careers. Finally, an agenda is outlined for advancing science, policy, and practice.”

Finkelstein, N., Fong, A., Tiffany-Morales, J., Shields, P., & Huang, M. (2012). *College bound in middle school & high school? How math course sequences matter*. Center for the Future of Teaching and Learning at WestEd. <https://eric.ed.gov/?id=ED538053>

From the abstract: “As California competes for jobs in an increasingly competitive global economy, the state faces a looming shortage of highly educated workers (PPIC, 2012). For a variety of reasons, the need for individuals with degrees in science, technology, engineering, and mathematics (STEM) is of particular concern. Nowhere is this more true than in the discipline of mathematics where understanding develops cumulatively, requiring that students master progressively more complex building-block concepts and skills in order to be successful in each next-higher-level course. Prior research confirms that success in high-level mathematics in high school is predictive of postsecondary success and careers in STEM fields. This study, funded by the S.D. Bechtel, Jr. Foundation and the Noyce Foundation, digs deeper into this middle- and high-school connection as it applies to STEM, in order to better understand the degree to which California students stay on the trajectory for STEM-related attendance eligibility at California's public universities and, if students veer off the trajectory, to better understand when and why. Thus, researchers examined math and science course-taking patterns for a representative cohort of some 24,000 California students who were enrolled in grade 7 in 2004/05 and stayed in their district through grade 12 in 2009/10. Although the study looked at students' science course-taking, this report focuses more tightly on the mathematics-related findings, partly because it turns out that course-taking patterns and performance in science are quite similar to, though less complex than, those in mathematics and partly because mathematical understanding, while not sufficient, is essential to student success in some key high school science courses, such as chemistry and physics. The math findings include: (1) Math performance in grade 7 is predictive of high-school math course-taking; (2) While the majority of students who achieved at least Proficient on their math CSTs are those who took algebra 1 in grade 8, geometry in grade 9, and algebra 2 in grade 10, in general this accelerated pathway does

not support students who are not proficient in math in grade 7; (3) Many students repeat algebra, but few repeaters achieve proficiency on their second attempt; (4) Districts are keenly aware of poor student performance in mathematics but less aware of coursetaking patterns; and (5) Districts feel great urgency to improve algebra outcomes. Data Source is appended.”

Fitzpatrick, L. P., & Sovde, D. (2018). *K–12 and postsecondary collaboration to improve mathematics course alignment: Recommended process and case studies*. Austin, TX: Charles A. Dana Center at The University of Texas at Austin. https://www.utdanacenter.org/sites/default/files/2018-10/Launch-Years-Brief-Number-3_FINAL.pdf

From the abstract: “Promoting a productive and effective process for aligning K–12 and higher education mathematics is a challenge because structures are not typically in place to foster ongoing and deep collaboration between higher education and K–12 faculty. Achieving full alignment of high school and college expectations requires ongoing communication between both levels. This brief draws on lessons learned from the Charles A. Dana Center’s many collaborations with the K–12 and higher education sectors on mathematics education, sharing recommendations and presenting two case studies from Ohio and Texas to demonstrate this work in practice. It is intended for K–12 and higher education system-level and policy leaders and mathematics faculty leaders to support their efforts to improve K–16 alignment.”

Froiland, J. M., Davidson, M. L., & Worrell, F. C. (2016). Aloha teachers: Teacher autonomy support promotes Native Hawaiian and Pacific Islander students’ motivation, school belonging, course-taking and math achievement. *Social Psychology of Education: An International Journal*, 19(4), 879–894. <https://eric.ed.gov/?id=EJ1124886>

From the abstract: “Among 110 Native Hawaiians and Pacific Islanders, teacher autonomy support in 9th grade significantly predicted intrinsic motivation for math in 9th grade as well as math course-taking over the next 2 years, both of which in turn significantly predicted math achievement by 11th grade. In a second model, teacher autonomy support was positively associated with sense of school belonging; however, school belonging did not predict math achievement. Because of the Hawaiian cultural concept of Aloha and the effect of teacher autonomy support on intrinsic motivation, school belonging, math course-taking, and math achievement, researchers may wish to develop interventions for Hawaiian students that focus on elevating intrinsic motivation and belonging via increasing teacher autonomy support. Because Native Hawaiians and most other Pacific Islanders are involuntary minorities, this research may have implications for other involuntary minorities across the world, such as the Buraku in Japan, and the Maori people of New Zealand.”

Note: REL Pacific was unable to locate a free link to the full-text version of this resource. Although REL Pacific tries to provide publicly available resources whenever possible, this resource may be of sufficient interest to the reader to warrant finding it through university or public library systems.

Koon, S., & Davis, M. (2019). *Math course sequences in grades 6–11 and math achievement in Mississippi* (REL 2019–007). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southeast. <https://eric.ed.gov/?id=ED597299>

From the abstract: "Description: Effective with the 2014/15 school year, Mississippi adopted new academic standards and courses aligned to these new standards. The new courses included both a subject-specific mathematics sequence (that is, algebra I, geometry, and algebra II) as well as an integrated mathematics sequence (that is, integrated I, integrated II, and integrated III). In addition to differences in course content, students also could elect to begin their sequences at different grades (for example, algebra in grade 8 versus grade 9) and complete their sequences in different order. The Mississippi Department of Education is interested in understanding the student and school demographic profiles by mathematics sequences (for example, integrated versus subject specific) which were followed under these new course options. Findings from this study will provide this information and will inform professional development activities at the state and school district levels for individuals responsible for advising students and for providing mathematics instruction, facilitate discussions across districts with similar demographic profiles but differences in mathematics sequences and mathematics achievement, and, if needed, help determine the likely number of students who would be affected by future changes to the approved courses list in Mississippi. Research Questions: The study will be guided by the following research questions: (1) What are the mathematics sequences taken by students who started grade 9 in 2014/15?; (2) How are mathematics sequences related to student demographic characteristics for students who started grade 9 in 2014/15?; and (3) How are mathematics sequences related to college-ready performance on the American College Testing (ACT) Mathematics for students who started grade 9 in 2014/15? Study Design: The statistical package 'TraMineR' will be used to both identify and group similar mathematics sequences taken by students, and then examine how the sequences are related to explanatory factors (for example, gender, race/ethnicity) in correlational analyses. Associations between mathematics sequence and college-ready performance will be modeled using multilevel logistic regression analyses. The sample for this study includes students who entered high school in 2014/15 in the Mississippi public school system under the state's new mathematics standards and continued enrollment through grade 11 in 2016/17."

Nomi, T., & Raudenbush, S. W. (2016). Making a success of "algebra for all": The impact of extended instructional time and classroom peer skill in Chicago. *Educational Evaluation and Policy Analysis, 38*(2), 431–451. <https://eric.ed.gov/?id=EJ1100477>

From the abstract: "In 2003, Chicago launched 'Double-Dose Algebra,' requiring students with pretest scores below the national median to take two periods of math—algebra and supplemental coursework. In many schools, assignment to Double Dose changed the peer composition of the algebra classroom. Using school-specific instrumental variables within a regression-discontinuity design (RDD), we find that attending a lower skill classroom reduced math achievement for median-skill students. As a result, the Double-Dose policy had little or no effect for median-skill students in schools that exposed them to low-skill classrooms. However, the effects of Double Dose were substantially positive in schools that did not do so. We consider policy implications and interpretations of the results from RDDs."

Snipes, J., & Finkelstein, N. (2015). *Opening a gateway to college access: Algebra at the right time*. San Francisco, CA: WestEd, Regional Educational Laboratory West. <https://eric.ed.gov/?id=ED559739>

From the abstract: “Four years of math in high school, with a strong foundation in algebra that builds from middle school, is key to higher education access. Therefore, ensuring that middle and high school students succeed in math—and in algebra in particular—is an important issue for policy and practice. This research brief examines three recent Regional Educational Laboratory West (REL West) studies that shed important light on policies and practices that affect student success in algebra and preparation for higher-level math courses. Key findings included: (1) Middle school students who repeat algebra after initially failing the course have relatively low chances for becoming proficient in algebra; (2) The proportions of students who fail algebra and have to repeat the course are even higher among vulnerable populations, including low-income students, Hispanic students, and English language learners; and (3) Students must score well above the thresholds for proficiency in prior math courses in order to have even a 50-50 chance of success when placed into algebra.”

Additional Organizations to Consult

Charles A. Dana Center at the University of Texas at Austin. <https://www.utdanacenter.org/>

From the website: “Drawing from more than two decades of research and experience, our work centers on K–16 mathematics and science education with an emphasis on strategies for improving student engagement, motivation, persistence, and achievement.”

Methods

Keywords and Search Strings

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

- "math pathways" AND "equity"
- "math pathways" AND "minority"
- "math pathways" AND "gender"
- "math" AND "girls"
- "girls" AND "STEM"
- "math pathways" OR "math sequences"
- "math sequences" AND "equity" AND "Pacific Islander"
- "STEM pathways"

Databases and Resources

We searched ERIC, a free online library of over 1.6 million citations of education research sponsored by the Institute of Education Sciences, for relevant resources. We also searched the academic databases Google Scholar and ProQuest.

Reference Search and Selection Criteria

REL Pacific searched ERIC and other academic journal databases for studies that were published in English-language peer-reviewed research journals within the last 15 years. We also utilized resource harvesting to find relevant research, research briefs, and other resources. Sources included in this document were last accessed in August 2020.

REL Pacific prioritized documents that are accessible online and publicly available, and prioritized references that provide practical information based on peer-reviewed research for the education system stakeholders who requested this Ask A REL.¹ Because this request specifically requested evidence-based practices, we prioritized studies that have met What Works Clearinghouse standards and/or used randomized control trials and quasi-experiments. If we were unable to find studies that met these criteria, we expanded the search to those studies with additional methodologies, including meta-analyses, case studies, and literature reviews, considering aspects such as target population, sample size, study duration, limitations, and generalizability of the findings and conclusions.

¹ This memorandum is one in a series of quick-turnaround responses to specific questions posed by educational stakeholders in the Pacific Region (American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, Hawai'i, the Republic of the Marshall Islands, and the Republic of Palau), which is served by the Regional Educational Laboratory (REL Pacific) at McREL International. This memorandum was prepared by REL Pacific under a contract with the U.S. Department of Education's Institute of Education Sciences (IES), Contract ED-IES-17-C-0010, administered by McREL International. 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.