Purpose

Students with learning disabilities demonstrate lower mathematics performance in 8th grade than peers without disabilities (NCES, 2017). With intervention, however, the mathematics trajectories of students with disabilities can improve (e.g., Krawec et al., 2012; Xin et al., 2005). Project STAIR (Supporting Teaching of Algebra Individual Readiness) framework is a systematic process that integrates instructional design principles with assessment data to support the algebra-readiness of middle school students at-risk and identified with specific learning disabilities in mathematics. The intent is to understand how to improve mathematics teaching practices of middle school students with disabilities through collaboration with middle school educators, including general and special education teachers, as well as school administrators.

The long-term goal of this model demonstration project is to contribute empirical evidence on the effectiveness of a system of instructional practices for supporting the algebra-readiness of middle school students with specific learning disabilities in mathematics. In this system, three theoretical and practical frameworks intersect: (1) the process of data-based individualization (DBI), (2) the principles of explicit and systematic instruction, and (3) key components of algebra readiness. Individually, each framework has a strong evidentiary basis for improving outcomes for students with disabilities. This project, however, seeks to amplify previous evidence of effectiveness by integrating these frameworks into a coordinated system of professional learning and practice that focuses on fidelity of implementation and sustainability.

DBI integrates assessment and instructional design principles to create individualized, responsive intervention for students with persistent learning needs. In this project, DBI serves as the overarching approach for addressing individual student's needs when learning algebra by (1) identifying students' misconceptions and errors in key algebraic concepts, (2) using evidence-based elements of explicit and systematic instruction to support students' learning, and (3) integrating principles of culturally responsive assessment and instruction. School-based educators develop capacity to implement these practices through professional development (both in-person and on-line) and coaching. As a result, the anticipated student-level outcomes are improved algebraic reasoning and overall mathematics achievement. There are three major aims of this project: (a) develop and iteratively refine a framework for integrating three evidence-based practices, (b) establish an implementation process that focuses on professional learning, fidelity of implementation, and sustainability of effective practices, and (c) develop and disseminate easily accessible training materials. All three aims are accomplished through continued collaboration and feedback from the districts with whom we are working.

Theoretical Framework

Our overall goal is to promote success in algebra-readiness concepts and skills for middle school students with disabilities who have intensive mathematics learning needs. Our model for designing individualized instructional support is grounded in the principles of DBI. DBI integrates instructional design principles and assessments to create individualized, responsive intervention for students with persistent learning needs. In this project, DBI serves as the overarching approach for addressing individual student needs when learning algebraic concepts by providing the context and rationale for the integration of formative assessment data with teachers' decisions about the selection and use of evidence-based instructional practices. In many

classrooms, assessment and instruction are not meaningfully integrated (Fuchs, Fuchs, & Stecker, 2010). DBI provides a framework for teachers to make meaning from assessment results and then apply their understanding about individual student's learning needs to their instructional decisions for those students. Project STAIR builds on evidence-based practices in designing individualized instructional support, implementing evidence-based instructional practices, and using reliable assessments in a formative manner to make valid decisions.

Methods and Data Sources

During the 2018-2019 school year, we conducted a pilot study. We recruited, attained consent, and implemented with 22 teachers across 4 sites in 2 states. Teachers were 33% male, 67% female and 71% White/European American, 14% Hispanic/Latino, 5% Black/African American, 5% Asian American/Pacific Islander, and 5% did not indicate. 58 students participated in this project across 6 sites in 2 states. Students were 43% male, 57% female and 52% Black/African American, 26% White/European American, 19% Hispanic/Latino, 3% identified as two or more races.

We conducted three in-person Core Professional Development (PD) sessions prior to and during the school year with participating teachers. These Core PD sessions included the following content: Day 1—overview of DBI, use of screening, progress monitoring, and diagnostic assessments; Day 2—specific steps in DBI and how to utilize these with students in the project, including a case study; and Day 3—Evidence-based practices in mathematics, explicit and systematic instruction, specific mathematics strategies including multiple representations, fluency, precise language, and word problem solving. These PD sessions were followed by ongoing coaching with a member of the research team, who met regularly either face to face or virtually with each teacher. A coaching routine was developed that included coaching activities for each session and a trial observation protocol. We encouraged teachers to utilize Tailored PD videos in between the Core PD and coaching sessions. These Tailored videos, developed by the research team, include content that addresses DBI, progress monitoring, data utilization, and evidence based mathematical strategies, and are meant to provide just in time follow up for each teacher, based on individual needs. Developed to be short in duration but include critical content, the Tailored videos were available to the teachers via YouTube and were included as follow up activities after coaching sessions. We filmed over 75 videos during 2018-2019 and 50 more are scheduled for the summer of 2019.

We administered survey instruments to teachers, and they participated in focus groups to determine the feasibility and social validity of the professional learning experiences. We utilized classroom observations that included fidelity and instructional quality measures to evaluate and revise the program. Proximal measures of algebra readiness and a distal measure (standardized mathematics achievement test) were used to examine the outcomes for students with disabilities. We administered social validity instruments to students and administrators. Descriptive data from teacher surveys, classroom observations, and student mathematics performance were used to iteratively revise the program, to determine feasibility, and to examine the potential impact on student mathematics achievement.

We screened students utilizing district screening measures (below 25th percentile) and a checklist that each teacher completed to determine students in the class who were struggling with mathematics and/or who were on Individualized Education Plans in mathematics. Following this initial selection and screening, students were then pre-tested by the research team using the Iowa Algebra Readiness Assessment (IARA) and 1 form each of 3 different measures of the Algebra

Readiness Progress Measures (ARPM; istation.com). The three ARPM measures included Quantity Discrimination, Number Properties, and Proportional Reasoning delivered via computer. Students also took the Diagnostic Online Mathematics Assessment (DOMA) to provide information to teachers on skill deficits related to algebraic readiness. Teachers completed a pre-test measure of knowledge and skills about teaching mathematics (Teacher Instructional Practice Survey, TIPS), and questions about self-efficacy in teaching mathematics. They also completed PD satisfaction surveys following each Core PD session. At post test, students completed the IARA, ARPM, and the DOMA. Teachers completed the TIPS, the self-efficacy survey, and also completed a post test survey regarding mathematics content knowledge (the Integrated Knowledge and Motivation Assessment—Multiplicative Reasoning; Jacobson et al., 2018).

We conducted focus groups with teachers following the pilot study and interviewed administrators to determine strengths and weaknesses of the methods and materials that we used.

Results

The ARPMs were given to students at pre- and posttest. Three measures were given: Number Properties (NP); Proportional Reasoning (PR) and Quantity Discrimination (QD). For NP, 56% of the 53 students made positive growth. For PR, 51% of 53 students made positive growth. For QD, 69% of students made positive growth. This provides an average of 59% of students who had improved rates of algebra readiness. While this did not achieve our target, this was our pilot study so we know that in the future our data will be stronger for child outcomes.

Students completed the Iowa Algebra Readiness Assessment pre/post. Of the 62 available individuals in the data, 42 had complete data for pre- and posttest IARA measure. 48% of these 42 individuals made positive change from pre- to posttest. While this did not achieve our target, this was our pilot study so we know that in the future our data will be stronger for child outcomes.

The TIP was administered pre/post-test to all teachers. For the 22 teachers who had available pre and posttest data, 60% made positive change in teacher knowledge of DBI, 18% made no change, and 22% decreased their score. We anticipate the percentage of growth will increase after we refine our materials, our implementation expectations, and support for implementation of DBI. For the 22 teachers who had available pre and posttest frequency of use data, 50% made positive change in teacher knowledge, 9% made no change, and 41% decreased their score.

Teachers were administered the Integrated Knowledge and Motivation Assessment--Multiplicative Reasoning (IKMA-MR; Jacobson et al., 2018) at post test as a measure of mathematical understanding and scored between 0% and 48% accuracy on assessment items. These items provided math problems, asked teachers to solve these problems, and then prompted them regarding their confidence in solving and how they would present these to students. Given the post test scores, we know that it is critical to continue to emphasize both pedagogy and content with our teachers.

As a result of our conversations with teachers and administrators following the pilot study, we determined that we would refine the coaching process/protocols for the coming years; conduct more frequent and targeted individual check-ins with teacher participants; and explore ways to navigate the collaborative nature of teaching (for instance, content-team planning) that might confound the control-treatment distinction of teachers in future studies.

Scientific and Scholarly Significance

This project targets teachers' mathematics instruction for students with intensive needs in middle schools. We work with teachers to provide early intervention for students with mathematics difficulty or disability who may be struggling to reach proficiency in algebraic knowledge and skills. By supporting middle-school students' understanding of and proficiency with these concepts, our goal is to prepare SWDs to be ready for Algebra 1 in high school. To reach this goal, we designed Project STAIR, a four-year model demonstration project that will contribute empirical evidence to the research and practitioner literature on the effectiveness of a system of instructional practices for supporting middle-school SWDs' readiness for algebra.

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