Table of Contents

Improving Algebra 1 Outcomes Across Alabama Using Math Nation

A. SIGNIFICANCE

A.1.a Algebra and Algebra Teachers

Without successful completion of high school-level algebra, a person in the United States is unlikely to be accepted into college and may be kept from entering many job training programs. Success in algebra opens the door for increased opportunities for college, careers, and future income (Loveless, 2013; Gaertner, et al., 2014; Byun, Irvin & Bell, 2015; Kim, et al., 2015; Goodman, 2019). In particular, Algebra 1 serves as a gateway for middle and high school students' enrollment and success in STEM related courses (Cirino, et al., 2019; Torbey, et al., 2020). In fact, students who complete Algebra 2 are more than twice as likely to graduate from college as students who do not (Maltese & Tai, 2011; Powell et al., 2019).

The Common Core State Standards-Mathematics (CCSS-M), adopted in 2010 in 45 states, suggested that much of the content previously addressed in Algebra 1 be moved downward into Grade 8 Standards and emphasizes algebra thinking beginning in kindergarten. The Algebra 1 course outlined in the CCSS-M included some advanced topics typically addressed in Algebra 2 (Stoellinga & Lynn, 2013). The CCSS-M resulted in a clearer and more focused scope of content for algebra leading to a ninth-grade Algebra 1 course, thus providing less-prepared students the advantage of being able to build knowledge progressively. But pushing algebra content down into lower grade levels meant that students needed to learn more demanding algebra content earlier and students failing to learn these foundational concepts can struggle when entering Algebra 1 (Stoelling & Lynn, 2013). In the University of Illinois Chicago Research on Urban Education Policy Initiative policy brief, Stoelling and Lynn (2013) suggest that "underprepared students need targeted, structured support in Algebra I."

Results on the National Assessment of Educational Progress (NAEP) show that students are struggling with uncomplicated algebra problems. For example, in 2017, less than half (49%) of 8th graders were able to determine the x- and y-coordinates of a given line (NCES, 2017). Only 66% of 8th graders were able to complete a table from a description of a linear relationship. Many students struggle with understanding the structure of algebraic expressions as well as transforming equations. As equations become more complex or as students are faced with solving algebraic word problems, these difficulties become compounded. Unfortunately, by middle school, fewer than 40% of US students have reached proficiency in mathematics and many students lack the conceptual foundations for algebraic reasoning (NCES, 2018; Loveless, 2008). For students in Alabama, recent NAEP results suggest that ***only 21% of 8th grade students reached proficiency in mathematics.*** Improving students' knowledge and success in Algebra 1, particularly in Alabama, thus requires finding effective pedagogical strategies, high-quality content, and innovative technologies and tools for supporting the learning of algebra, especially for those entering Algebra 1 underprepared.

A.1.b Lessons from Prior Interventions

Abundant visions exist for using technology to improve mathematics outcomes (U.S. Department of Education, 2017), but few rigorous experiments have identified factors that actually promote student success (NMAP, 2008). One significant benefit of technologies is the potential for improvements to student engagement and affect around the content (Bond & Bedenlier, 2019; Schuler, 2019; Baker, et al., 2008). Engagement, motivation, and interest are precursors to learning, effortful problem solving, and deep thinking (Rose & Meyer, 2002; Seligman, 1991; Sweller et al., 1998). If schools adopt digital programs to address COVID-19 learning loss, it is essential to maximize student engagement and opportunities to learn.

The International Association for K-12 Online Learning (iNACOL) has stated, “Personalization provides students with greater agency, voice, and choice in how they learn, what they learn, when they learn, and where they learn—and blended learning delivery models enable these shifts” (p.16, Powell et al., 2015). Studies of blended learning environments suggest the approach has promise in K-12 pre-algebra and algebra classes (e.g., Koedinger, et al., 1997; Koedinger, et al., 2010; U.S. Department of Education, 2010), especially for struggling students (Fazal & Bryant, 2019). Further, educational videos in these blended learning environments that include frequent use of worked examples and a casual, conversational style (e.g., Carroll, 1994; Clark & Mayer, 2003; Salden, et al., 2010) are associated with improved student learning and engagement. Videos that show elaborated assessment feedback can also have a positive impact on learning (Mory, 2004; Shute, 2008; Jaehnig & Miller, 2007; Van der Kleij, et al., 2015).

The personalization of learning through individual tutoring has long been known to improve student achievement (Bloom, 1984; Cohen, et al., 1982; Kulik, 1994), and technology offers promise for increasing its availability (Escueta, et al., 2017). Computerized tutoring has been shown to have a significant, positive impact on algebra performance (Koedinger, et al., 1997) and for preparation for standardized tests (Arroyo, et al., 2004; Beal, et al, 2007). More recently, it has been determined that, "Educational software designed to help students develop particular skills at their own rate of progress have shown enormous promise,... yet more research is needed to fully understand the underlying mechanisms for why certain educational software programs are more effective than others" (p. 2, J-PAL Evidence Review, 2019).

Descriptive studies and a limited number of experimental studies show that certain components of technology-based interventions can have an impact, such as high-quality assessments that inform teaching strategies (Roschelle et al., 2016). Research also suggests that technology-enhanced professional development (PD) can increase teachers' implementation of math interventions in rural schools (Blanchard et al., 2016). This research warrants further investigation into how an intervention that combines evidence-based components, including varied approaches to teacher PD (e.g., technology-enhanced), can impact success for all students in Algebra 1. In particular, policymakers and educators need to learn about the combined impact of such an intervention with instructional design that extends into the classroom. Education technology creators can also benefit from learning what features and components are seen as the most valuable. Educators also need to know how students of all backgrounds and ability levels can be best served by such interventions, particularly high-needs students.

This study is designed to address these needs. We propose to conduct a randomized controlled trial (RCT) across 80 schools in Alabama, randomly assigning half of the schools to use Math Nation for Algebra 1 while the control schools use business-as-usual Algebra 1 courses. The study will collect data on adoption, implementation, cost, scaling, and sustainability of Math Nation, while including an impact study to analyze Math Nation's effect on teachers' instructional activities, students' opportunities to learn, and students' achievement outcomes. The study will produce rigorous evidence and provide critical information for educators, policy makers, and education technology developers.

A.2.a Math Nation: An Evidence-based, Engaging Solution

Math Nation is a suite of customizable, online resources that provide support for students in Algebra 1. The program aligns these resources to pair with Illustrative Mathematics printed workbooks (see Appendix J.1). Illustrative Mathematics is used since it has strong usability and aligns to the CCSS-M, including all three EdReports Gateways: expectations for focus and coherence, rigor and balance, and well-designed and taking into account effective lesson structure and pacing (EdReports, 2020), and has been well received by teachers and students (e.g. Thomas, 2020). Math Nation also custom tailors the materials and resources as needed to align to the particular state's standards.

Math Nation uses technology innovations to tackle the root causes of why students are not succeeding in Algebra 1. The most common implementation model of Math Nation, and the focus of this study, is using it in class and out of class to create a blended learning environment (e.g., Leite et al., 2019). Students complete their Algebra 1 course including the integrated Math Nation features in class, in labs, and at home. For this study, teachers are expected to use the Illustrative Mathematics workbooks as their textbook and use Math Nation technology resources at least once a week in class or in a lab rotation where students rotate from teacher-led instruction to computer-assisted instruction within Math Nation. Rotations can be performed on a schedule or as needed to target particular concepts. In these sessions, teachers assign particular Math Nation videos, workbook lessons, and self-assessments (discussed below) around a certain topic to help students master a concept. Further, assignments can be given to the entire class or customized for individual student needs. Students who finish their required activities can then explore the additional resources within Math Nation.

A.2.b Math Nation: Additional Features

On-Ramp to Algebra 1. Since high-need students in participating schools may be coming into their Algebra 1 course without some fundamental mathematics content knowledge, the Math Nation program begins with every student completing the *On-Ramp*. The *On-Ramp* uses an interactive, diagnostic assessment of students' conceptual knowledge and creates a tailored, adaptive learning progression for each student to re-engage with the needed pre-algebra concepts. Students who are determined to need supplemental support complete a corresponding support track of activities, videos, and assessments (described below). Students may complete the required tasks at the beginning of the course, or throughout the course as needed. Such adaptive supports can increase student math learning (e.g. Sharp & Hamil, 2018; Crowley, 2018).

Study Expert Videos. The online space has additional organized supports for each Algebra 1 topic. These supports include engaging tutoring videos, led by Study Experts, aligned to the learning goals and problem sets in the student workbooks. Each Study Expert has a degree in math, education, or statistics, and at least two years of instructional experience. In the videos, Study Experts guide learning by explaining their mathematical thinking around the concepts to help students scaffold their knowledge throughout the course, which is an effective method for delivery (see C.3.b for literature review). Different types of videos are available, with some going deeply into a concept while others are more focused on review. Videos in Spanish are available to help to bridge the language gap for Spanish speakers, as needed. Each topic also has captioned videos for the hearing impaired.

Check Your Understanding (CYU). This feature is a three-question formative assessment that students complete online when they feel they have a solid understanding of the topic. The questions are aligned to the content in the student workbooks and corresponding videos. *CYU* provides immediate feedback. Student performance is also relayed to teachers in the *Teacher Area*, described below, to monitor and track student learning.

Test Yourself! This provides a summative assessment at the end of each section with rigorous, technology-enhanced questions, which students can repeat multiple times. The assessment uses a large item bank to populate new versions of the assessment, with each attempt to target areas where students need support. When complete, students are prompted to watch *Study Expert*

Videos that unpack the problems they struggled with and their solutions. Detailed reports are provided for teachers to monitor student progress.

EdgeXL. This is a platform for teachers to create customizable, standards-aligned assessments and practice problem sets with varying levels of difficulty. Teachers can assign these as a class or individually for students. Students receive immediate feedback on their answers, with correct or incorrect indicators and explanations using *Study Expert Videos.* Questions for each topic can be iterated so students can receive their own set of questions with unlimited practice attempts.

Student Walls. Students can get live homework support on the interactive Algebra 1 *Student Walls.* All walls are specific to states. Teachers, Study Experts, and even other students monitor the questions on the wall and can work with each other using a whiteboard space that features online graphing calculators and equation editors. Students earn "Karma Points" when they help other students answer questions and earn prizes each month from Math Nation.

Teacher Area. The *Teacher Area* provides teachers with support materials for effective implementation of resources (see Appendix J.2). Supports include instructional videos, assessment and activity examples, and guides for using assessment feedback. The area includes reporting capabilities to monitor student usage and progress in all activities. The area also provides a *Teacher Wall,* which is a space for teachers to share best practices.

Additional Student Features. Math Nation provides additional features that may be used. *Algebra 1 Boot Camp* is a mini-course that provides intensive review videos and self-guided assessments to prepare for the End-of-Course exam in Algebra 1. *Math in Action* contains on-location videos and activities that demonstrate math in real-world jobs and industries.

Teacher Professional Development. To use these resources effectively, teachers will complete a professional development program. The program includes a 1-hour Quick Launch, a 1–2 day

Deep Dive, a series of webinars, monthly support tools, and a dedicated email address for school personnel to use that reaches out to Math Nation for support (see Appendix J.3 for full details). Math Nation also provides continuous resources and communication within the *Teacher Area*.

A.2.c Math Nation: Prior Evidence

After co-development through the University of Florida Lastinger Center (Mitten, et al., 2016), Math Nation launched in 2013. Math Nation has been implemented in over 500 districts across 14 states, with over two million students who have accessed the program. There has been strong early evidence of impact, coupled with continuous research, evaluation, and improvement.

Research on Math Nation in Florida demonstrated a positive relationship with students' math knowledge, standardized test performance, and passing rates in Algebra 1. Collier and Leite (2015) found that schools with the highest frequency of platform use demonstrated an average course passing rate that was 20 percentage points higher than schools that did not use the program. Qiu (2018) found that schools with higher use of Math Nation had passing rates on their Algebra 1 End-of-Course (EOC) exams that were 26.6 percentage points higher. Niaki et al. (2019) found that a higher number of answered *Test Yourself!* questions correlated with higher scores on Algebra 1 EOC exams.

Sawilowsky (2019) found that schools in Detroit Public Schools using Math Nation had students with higher PSAT math scores than control schools. Specific components of the program have also been evaluated and have influenced the administration model. For example, Wang & Antonenko (2017) compared Math Nation videos to videos with similar content that did not feature a Study Expert, and found the Math Nation videos positively influenced perceived learning and satisfaction. In Mississippi, implementation of the Math Nation program included a notable increase (+7.2%) in the number of students from pilot schools that scored Proficient or

Advanced on the Mississippi Academic Assessment Program (MAAP) exams when compared to their counterparts in non-pilot schools (+4.8%) and students also felt more confident in their algebra skills (Sibley & Hauser, 2019).

Research has also established that Math Nation has helped overcome the persistent and significant challenges to student success for underserved and high-need students. Qiu (2019) found that students in Title I schools that used Math Nation consistently scored significantly higher on the Algebra-1 EOC test than similar students with limited use patterns. Leite et al. (2019) found that students struggling in math with higher usage of Math Nation performed significantly higher on the Algebra-1 EOC test than did comparable students with less use. Dickey (2018) found that Black students in South Carolina using Math Nation performed significantly higher on the state's math test than did Black students not using Math Nation.

In addition to the consistent and positive student outcomes, evidence suggests that teachers are also positively impacted by Math Nation implementation. Mitten et al. (2021) surveyed almost 600 teachers using Math Nation and found that teachers successfully integrated the program into their classroom instruction and used Math Nation study questions as an assessment after a lesson and as homework assignments. Seymour and Dechert (2017) found that teachers in Mississippi who used Math Nation, many in rural schools, relied much less heavily on textbooks and instead supplemented teaching with interactive, more differentiated instruction through the Math Nation program. They also found that Math Nation PD sessions before using the program were extremely effective, with almost three fourths of the teachers reporting that they felt well versed in Math Nation program usage. These findings have led to strong support from our state, Alabama, to scale this program across our schools (see Appendix C).

A.2.d Contribution of Proposed Study

Although Math Nation is widely implemented and a number of research evaluation studies have been published, there are no large-scale experimental studies to date. To assist with scaling, more rigorous evidence is needed in the form of a large-scale RCT. The proposed study aims to address that need and will include effects at the school, teacher, and student levels. Additionally, the study will include mediating and moderating variables to explore how the intervention is working, for whom, and under what conditions. The proposed project is significant because it will determine whether a standards-aligned, research-based, comprehensive support program can successfully improve Algebra 1 achievement in a largely rural setting with a high percentage of high-need students from across Alabama (see C.3.a).

The project will also build additional evidence of effectiveness, meeting a strong level of evidence as defined in the notice, around the strategies used by Math Nation to tackle a critical national issue. It will also unpack several of the educational problems and issues around implementing technology-based Algebra 1 support programs and will address how to navigate them. It will address how to succeed in rural environments and how to build an active collaborative community with appropriate supports (see B.1). The study will also show important ways to address barriers to scale, such as cost and implementation fidelity.

B. STRATEGY TO SCALE

B.1 Strategies for Overcoming Barriers to Scale

Math Nation is successfully used in a handful of states, including Florida, South Carolina, and Mississippi. However, as noted above, there has yet to be a rigorous, experimental evaluation of Math Nation that measures the program's impact and cost-effectiveness. This project will fill this important gap and document both Math Nation's effectiveness and measure critical components of the implementation process to inform scale-up efforts. Deeper knowledge about the scaling-up process will help Alabama implement Math Nation state-wide and, importantly, help other states successfully implement Math Nation.

There are three specific barriers that have been identified preventing systemic scale-up of Math Nation that will be addressed by this project. These barriers include 1) costs associated with Math Nation; 2) implementing a new curriculum, particularly one using technology; and 3) providing the necessary PD to ensure teachers are able to implement Math Nation with fidelity. To address these barriers, we will use the following strategies: 1) use grant funds to purchase Math Nation for all participating schools, evaluate costs, and conduct a cost-effectiveness study to document the relation between costs and student achievement impacts; 2) work with schools to foster a Math Nation Community, including earning teacher buy-in, creating a virtual community of practice that could scale to other states, coupled with face-to-face events, and providing school and teacher reinforcement through financial incentives; and 3) use grant funds to cover PD costs for all participating schools, including teacher time to attend training, regional coaching support that can push into schools, and virtual PD supports. Without this grant, these barriers would be difficult to overcome.

B.1.a. Overcoming Costs Associated with Math Nation

There are costs associated with implementing Math Nation, and those costs are typically negotiated at the state-level and are unique to the needs and wants of each state. Math Nation is a custom product and does not have an off-the-shelf price that includes all of the components, resources, professional development, and on-going coaching and technology support. For example, some districts in Florida are paying $21 per student per year for only the workbooks and digital access. That cost does not include unlimited tutoring, the embedded coaching from regional facilitators, or the full *Teacher Area*. However, if funded, this project will be able to provide access to all Math Nation components, including PD, to participating schools and the Alabama State Department of Education (ALSDE) will develop a plan to increase access to Math Nation for more schools and sustain it in the participating schools. The study will also be the first Math Nation study to conduct a full scale cost analysis comparing Math Nation and business-as-usual schools, so any positive findings can be interpreted with respect to cost. Diligently documenting every component of the cost, including costs in the business-as-usual schools will also allow Math Nation to create a plan to lower costs in key areas, if and as needed.

B.1.b. Fostering a Math Nation Community

While many teachers are local advocates for Math Nation and connect with each other through social media and Math Nation's *Teacher Area*, there needs to be a systematic plan for increasing opportunities for and the quality of collaboration. This is particularly true for rural teachers without access to local professional learning communities. There are several well funded educator platforms, such as Mighty Networks and Hivebrite, that could be used for this purpose. They have a wider range of features, including hosts and moderators; a native course builder with learning management system features; a social media structure to help find, connect, and directly communicate with targeted members; groups and group chats; document sharing; and being mobile friendly. However, these platforms can be costly, and Math Nation already has a *Teacher Wall* for communicating and sharing. ALSDE and WestEd will work with the Math Nation Community Lead to identify how the *Teacher Wall* can be improved with the new products as examples. New features will be built, beta tested by WestEd, and improved in the spring and summer of 2023 before the impact study begins.

Math Nation will build activities for teachers to connect to each other in the *Teacher Wall*, to build a sense of community. The activities will foster participation by everyone in the online community (Ghamrawi, 2022). These activities will help encourage teachers to ask questions, learn from each other, share resources, create helpful groups, and build a sense of community among them and Math Nation staff. Building community will increase teacher buy-in and, subsequently, increase the likelihood teachers implement the program as designed (Lee & Min, 2017). In addition, Math Nation will host regional face-to-face events at least once a year, where teachers can come together to present, learn from each other, and interact more with Math Nation staff. Participants' and Math Nation's costs will be covered by the grant.

During the impact study, study teachers will be asked to attend the face-to-face events and complete the *Teacher Wall* activities and regularly access the online community. The ALSDE will also communicate about the importance and benefits of using this community. Finally, teachers will receive up to $1,200 in financial incentive for participating in this study. The goal of these activities is to increase the likelihood that teachers use Math Nation in the future, in part because of the community and not a financial incentive.

B.1.c. Providing Professional Development and Regional Coaching

As described in the project activities, teachers will receive all the professional development support they need to successfully implement Math Nation in their classrooms. From prior work, Math Nation learned it is difficult to scale up an entire state (or significant sections of it) without a strong PD plan and support staff. This study will utilize their best system, which is having one designated Professional Development Lead for coordination, oversight, and support, and three regional facilitators to offer smaller, more local trainings. ALSDE will determine the optimal locations of the facilitators to provide teachers with the easiest access to coaching support. These coordinators will make sure the technology needs of the teachers are met and that, as needed, individualized or school-wide support is provided. The coordinators will support the needs expressed by teachers so that teachers expend minimal extra effort to begin using Math Nation. Additionally, Math Nation will build and provide a series of support guides for each step of initial implementation. They will also host virtual workshops for both IT personnel and teachers to help get Math Nation started. These synchronous and asynchronous tools will be iteratively developed and tested to ensure clarity and usability.

B.2 Management Plan

The ALSDE will lead the proposed project, collaborating closely with Math Nation and WestEd. Appendix J.4 provides an organizational chart, which illustrates the responsibilities of each staff member and organization. Figure 1 provides a high-level project timeline, while Table 1 lists the project objectives by year and responsible organization(s). The bolded font for an organization indicates that they are the lead on the milestone. Appendix J.5 provides a detailed timeline, with objectives and responsibilities designated for each month of the five-year project.

Figure 1. High-Level Project Timeline, by Objective

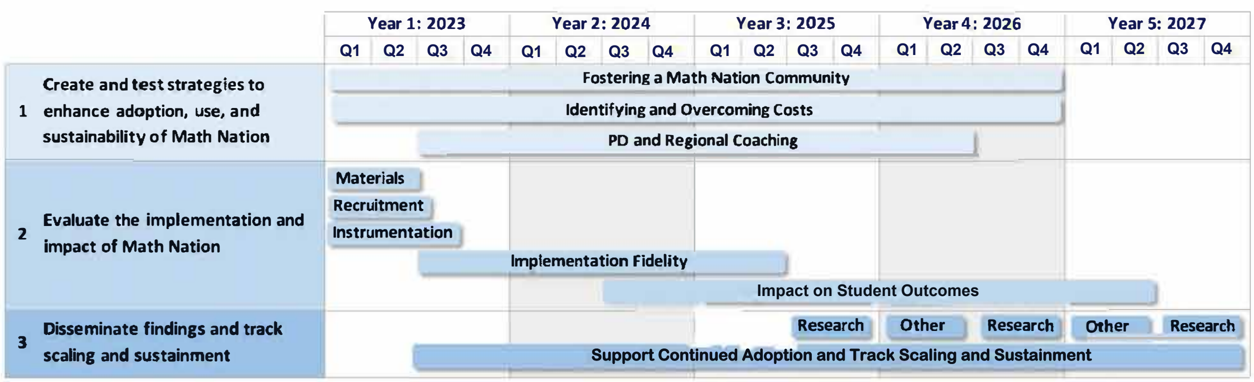

Table 1. Project Objectives and Responsibilities, by Organization and Project Year

Milestone	Y1	Y2	Y3	Y4	Y5	Responsible Organization
Objective 1. Create and test strategies to enhance adoption, use, and sustainability of Math Nation						
1.1. Overcoming Costs Associated with Math Nation	X	X	X	X	X	**MN**, WE
1.2. Fostering a Math Nation Community	X	X	X	X		**MN**, WE
1.3. Providing Professional Development and Regional Coaching	X	X	X			**ALSDE**, MN

Objective 2. Evaluate the implementation and impact of Math Nation						
2.1. Create and refine materials and train an onboarding team.	X					**WE**, ALSDE
2.2. Identify and randomly assign to treatment and control conditions.	X					**WE**, ALSDE
2.3. Prepare data collection instruments and procedures and train staff.	X					**WE**
2.4. Measure and assess implementation fidelity of Math Nation.	X	X	X	X		**WE**
2.5. Measure and assess the impact of Math Nation.		X	X	X	X	**WE**
Objective 3. Disseminate findings and track progress on scaling and sustainment						
3.1. Disseminate findings to research audiences.			X	X	X	**WE**, ALSDE
3.2. Disseminate findings to public, teacher, and policy audiences.				X	X	**WE**, ALSDE, MN
3.3. Support continued adoption and track scaling and sustainment.		X	X	X	X	**WE**, MN

B.3 Capacity to Bring the Project to Scale

The ALSDE, Math Nation, and WestEd are very capable of bringing the proposed project to scale. If funded, the ALSDE will hire a full-time project coordinator to oversee the identification and participation of schools and teachers and to lead internal project management. The ALSDE will also hire a project assistant to coordinate with IT and school personnel and to assist with support tasks as needed. Math Nation will hire three regional staff to assist with onboarding and manage the training and support of all participating schools and teachers. They will work closely with the CEO and senior staff of Math Nation in all five years of the project. WestEd staff include senior personnel with expertise in mathematics education, formative and summative evaluation, advanced quantitative methods and statistics, and research implementation. These staff have a proven track record of successfully executing projects of similar complexity, scope, and focus, including multiple large scale, multi-site RCTs.

Table 2 provides details on the capabilities of the proposed staff and their project roles. The ALSDE and Math Nation will be responsible for managing the project and ensuring progress on meeting objectives. They will also share responsibility for onboarding and implementation monitoring. Math Nation and WestEd will collaborate on the formative evaluation of strategies to enhance adoption. Math Nation will implement all training and support. WestEd will be responsible for leading the independent impact evaluation and leading implementation fidelity analyses. All parties will contribute to dissemination of study activities, learnings, and impact.

Table 2. Roles, Responsibilities, and Relevant Experience of Key Project Staff

Staff and Role	Primary Responsibilities and Relevant Experience
Alabama State Department of Education (Lead Grantee) Key Personnel	
[redacted] Project Director (Years 1-5)	[redacted] is the Assistant State Superintendent of Student Learning for the Alabama State Department of Education. In this role, she oversees various departments such as Instructional Services, ARI, Education Technology, Professional Learning, and AMSTI. [redacted] will serve as the key point of contact for OESE, MN, and WE; oversee the ALSDE staff and partner relationships; support the identification and onboarding of schools; and contribute to dissemination of results including annual reports.
WestEd (Independent Evaluator) Key Personnel	
[redacted] Co-Project Director and Onboarding Task Lead (27% - Years 1-5)	[redacted] is the Senior Director of STEM Research and Entrepreneurship at WestEd, and brings decades of experience managing large-scale research projects and Center grants. [redacted] will serve as WestEd's key point of contact, manage the project and partner relationships, lead onboarding for the efficacy study, and contribute to the dissemination of results.
[redacted] Co-Project Director and Implementation Fidelity Lead (50% - Years 1-5)	[redacted] is a Senior Associate of Curriculum and Evaluation at WestEd, where he leads an EIR early phase evaluation, manages and evaluates all Carnegie Math Pathways offerings, leads instrumentation on an IES efficacy study, and has led many evaluation and experimental research projects of educational technology programs, products, and PD. [redacted] will assist with project management and lead the development of measures, collection processes, and analyses of implementation data.
[redacted] Formative Evaluation Director (12% - Years 1-5)	[redacted] Director of Math Education Research and Evaluation at WestEd, has served as PI on a number of large-scale, federally funded projects designed to improve math teaching and learning, including experimental studies and partnerships with practitioners and researchers. He will monitor progress toward objectives and lead continuous improvement cycles for the strategies to address barriers to scale and will analyze feasibility and usability of all developed tasks and supports.
[redacted] Impact Evaluation Director (28% - Years 1-5)	[redacted], Senior Researcher at WestEd, has served as PI or lead methodologist on a number of large-scale, federally funded projects including experimental studies and partnerships with practitioners and researchers. [redacted] will oversee all aspects of the impact evaluation.
[redacted] Lead Statistician (10% - Years 1-5)	[redacted] is a Senior Research Associate at WestEd. He brings expertise and extensive experience in applied statistics and psychometrics and has led many research and measurement projects funded by the USDOE and NSF. [redacted] will lead the quantitative data analysis in all stages of the study.
Math Nation Key Personnel	

[redacted], Director and Scaling Lead (8% - Years 1-5)	[redacted] is the Founder, Director & CEO of Math Nation and has published in peer-reviewed journals. [redacted] was recognized as the 2018 Emerging Alumni Entrepreneur by the Entrepreneurship and Innovation Center at the Warrington College of Business. [redacted] will be Math Nation's key point of contact and oversee their responsibilities.
[redacted], Math Nation Community Lead (100% Years 1-4)	[redacted], Co-Director of Math Nation of South Carolina, works to support teachers, gather teacher learning and feedback, and promote interaction across schools. [redacted] will oversee all aspects of building and fostering the Math Nation Community in Alabama, including the online platform and the in-person events.
[redacted], Professional Development Lead (50% Years 1-4)	[redacted] the Director of Math Nation of South Carolina, where she creates, develops, and leads the implementation of Professional Development opportunities for math teachers throughout S.C. She also ensures quality standards-aligned content, ensures responsible stewardship, maintains and creates opportunities to expand the program. She also taught secondary math for over a decade.
[redacted] Lead Technology Manager (9% - Years 1-4)	[redacted] is Math Nation's Executive VP of Technology. [redacted] has led the creation of 10+ large-scale applications serving millions of users across multiple platforms. [redacted] is Lead Technology Manager and will manage Math Nation's technology team including Integration/ Technology Support Specialists and data analysts.

B.4 Mechanisms for Broad Dissemination, Further Development, and Replication

To reach research, policy, and practitioner audiences interested in issues related to implementation and impact, we plan to present research findings at national research conferences (e.g., American Educational Research Association, Society for Research on Educational Effectiveness, etc.) and publish findings in peer-reviewed journals (e.g., Journal of Research on Educational Effectiveness, Educational Researcher, etc.). In addition, we will submit presentations with at least one math leader from Alabama to national practitioner or policy annual conferences (e.g., National Council of Teachers of Mathematics, Innovative Schools Summit, National Rural Education Association, etc.). WestEd, the research partner, will also highlight key findings through all of its communication networks (e.g. WestEd.org, Insights blog, R&D Alert Online, WestEd E-bulletin, etc.)

Math Nation will use the findings from this study to inform other educators interested in the program about the evidence from this study. In Alabama, educators will be engaged and involved in Math Nation's iterative content and technology development processes through regular focus groups and monthly surveys. Math Nation will keep full-time staff based in Alabama who will attend statewide and local conferences, regularly visit schools, and provide unlimited, ongoing support to teachers and schools. It will disseminate positive findings on its website and through its communication channels to all existing and potential partner states.

The ALSDE will promote positive findings around Math Nation broadly within its state and across other states using its collaboration through the Council of Chief State School Officers and other partners. The ALSDE and its state superintendent have a strong communication capacity and related experience, such as channels through the Alabama Math, Science, and Technology Initiative (AMSTI). They will leverage tools, including websites, newsletters, and direct outreach to interested state leaders.

Additionally, the Math Nation program is constantly improved both in terms of content and technology. Content is regularly recreated to align with any changes in curriculum or real-world events. Technical developments include utilization of machine learning technology to improve engagement for students by optimizing recommendations of tutors and videos, helping students to achieve stronger results in their assessments.

C. PROJECT DESIGN

C.1 Conceptual Framework underlying the Research

While focusing on engaging materials and technology innovations derived from evidence-based design principles, Math Nation has generated a common theory which identifies four high-leverage drivers that contribute to increasing student learning and passing rates in Algebra 1: (1) a blended implementation structure; (2) aligned and adaptive course content; (3) instructional design supporting student engagement and faculty involvement; and (4) innovative course features to support mathematical learning. In the logic model (see Appendix G), these four drivers are represented as resources (or inputs) to the classroom activities (or outputs).

The theory of change is that each of the four inputs contributes to student and teacher actions that facilitate student engagement and learning. Thus, the Math Nation program, implemented with fidelity using all four inputs, will enhance teacher instructional activity and increase students' opportunities to learn. In turn, the increase in these activities is hypothesized to lead to more proximal outcomes, such as greater likelihood of passing the Algebra 1 course and increased scores on students' state standardized End-of-Course Assessment, as well as more distal outcomes, such as increased likelihood of enrollment and success in subsequent math courses. Further, the model identifies student and teacher factors that may moderate or mediate the short- and long-term outcomes. Prior research has found that (a) teachers can implement Math Nation with fidelity after receiving PD and coaching support (Dickey, 2018), (b) teachers have positive perceptions of Math Nation and continue using it (Sibley & Hauser, 2019), and (c) Math Nation improves student Algebra achievement (Collier & Leite, 2017; Mitten et al., 2015; Qui, 2018, 2019).

C.2 Project Objectives, Outcomes, and Measures

This project aims to scale and evaluate the efficacy of Math Nation in primarily rural schools serving high-need students. We expect the project will reach approximately 15,000 9th and 10th grade students across 80 schools in Alabama. To achieve all aims described above, we propose to (1) create and test strategies to enhance adoption, use, and sustainability; (2) implement and test the efficacy of Math Nation in our high-need sample; and 3) disseminate findings and track progress on scaling and sustainability (see Table 3 for details).

Table 3. Strategies, Outcomes, and Measures by Project Objective

Strategies	Outcomes	Measures
Objective 1. Create and test strategies to enhance adoption, use, and sustainability of Math Nation		
1.1. Overcoming Costs Associated with Math Nation	-Math Nation provides free PD and resources for treatment schools. -WestEd performs a detailed cost analysis of Math Nation and BAU. -Consider ways to control costs while scaling, as needed. -ALSDE builds a plan with Math Nation to control costs while scaling across the state.	-Math Nation successfully implements PD and provides free resources. -Identify costs associated with Math Nation implementation in AL, including PD and per student costs. -Identity costs associated with BAU. -Calculate cost effectiveness ratio. -ALSDE completes a cost plan for scaling with Math Nation.
1.2 Fostering a Math Nation Community	-Identify effective features of existing educator platforms that could be integrated into the *Teacher Wall* functionalities. -Build, test, and improve new features. -Provide two webinars on participating in the online community. -Build structured activities to implement during the impact study that require using the online community. -Plan, create, and lead regional events.	-At least 2 new *Teacher Wall* features built and released. -100% of teachers report understanding the purpose and functions of the *Teacher Wall*. -At least 95% of treatment teachers in the study will engage with the online community at least three times. -At least 3 structured activities are built and launched using the *Teacher Wall*. -Yearly events will be held in all three regions each year.
1.3. Providing Professional Development and Regional Coaching	-Professional Development Lead organizes all regional PD sessions. -Regional facilitators implement all components of the PD -Teachers feel prepared to teach Math Nation and use its resources.	-200 teachers complete the PD sequence (100 treatment and 100 control / delayed treatment). -100% of trained teachers report feeling prepared to teach Math Nation and use its resources.
Objective 2. Evaluate the implementation and impact of Math Nation		
2.1. Create and refine materials and train an onboarding team.	-Onboarding materials and resources; trained project onboarding staff.	-IRB-approved materials. -100% of project onboarding staff report clarity on onboarding approach.
2.2. Identify and randomly assign to treatment and control conditions.	-Principals and teachers at targeted schools agree to random assignment design. -Treatment and control school samples achieve baseline equivalence on primary characteristics.	-Signed memoranda of understanding from 80 schools in Alabama. -Completion of random assignment.
2.3. Prepare data collection instruments and procedures and train data collection staff.	-Finalize data collection instruments and procedures. -Train project data collection staff.	-Internal project QA reviewers approve final data collection instruments. -100% of project data collection staff report clarity on data collection procedures.
2.4. Measure and assess implementation fidelity of Math Nation.	-Fidelity of implementation data collected from teacher PD meetings, MN usage, and teacher logs and interviews*.	-Data collection progress and summary memos indicate at least 90% of teachers participated in PD and implemented at least ten weeks of MN as intended.

2.5. Measure and assess the impact of Math Nation on instruction, student achievement, and subsequent math course enrollment and success.	-Teacher log data collected (from treatment and control schools) and analyzed. -Student outcome and enrollment and success data collected (from treatment and control schools) and analyzed.	-At least 90% teacher response rates and 90% student Algebra 1 final grade data collected. -80% student response rates on all measures described in Section E. -At least 75% longitudinal student grade data collected. Impact memo indicates study meets WWC without reservations.
Objective 3. Disseminate findings and track progress on scaling		
3.1. Disseminate findings to research audiences.	-Project team submits papers and proposals summarizing study results to national research conferences and peer-reviewed journals.	-Presentation of research findings given at 3 national research conferences and published in 2 peer-reviewed journals.
3.2. Disseminate findings to public, teacher, and policy audiences.	-Partner leadership and project team submit at least one proposal to a national practitioner or policy conference.	-Presentations made with at least one math leader from Alabama at 2 national practitioner or policy conferences.
3.3. Continue to support adoption of Math Nation and track scaling and sustainment.	-Offer Math Nation to states and schools around the country. Support schools already using the program.	-Documentation of non-study schools adopting and using MN in Years 2-5 of the project, with a total 300 Alabama schools using MN at the end of Year 5 and 90% of high schools in the study still using MN through Year 5.

*Stipends will be provided to all teachers as incentives to complete PD and all study activities, up to [redacted] per teacher in total, prorated for each completed activity.

C.3.a Population Description. In this study, we define high-need students as "students at risk of educational failure or otherwise in need of special assistance and support, such as students who are living in poverty, who attend high-minority schools ... [or] who are far below grade level" (US DOE, 2012). Alabama has over 200,000 public high school students across 565 high schools. About 50,000 students enroll in an Algebra 1 course each year. The state has a diverse population of students including over 50% minority, and nearly 50% of its schools are in rural districts (see Tables 4 and 5). Alabama also has over 50% of students who are economically disadvantaged (ALSDE, 2020). Additionally, data from the Alabama Comprehensive Assessment Program showed that only 22% of all students and only 11% of rural students reached proficiency in math (Crain, 2021). NAEP data showed that only 21% of students in 8th grade are performing at or above proficient in mathematics (NCES, 2019).

Table 4. Alabama schools and student distribution by region type.

Region Type	*City*	*Suburban*	*Town*	*Rural*
Percent of school	22.0%	17.6%	14.8%	45.6%
Percent of students	23.7%	21.9%	14.6%	39.7%

Source: NCES (2016).

Table 5. Alabama public education enrollment, by race and ethnicity for 2019-2020.

Race / Ethnicity	*His*	*AI /AN*	*As*	*Bl*	*Haw / PI*	*Wh*	*Multi*
Percent of students	4.4%	0.2%	1.2%	47.7%	0.1%	43.1%	3.3%

Source: ALSDE (2020). AI / AN = American Indian/ Alaskan Native, As =Asian, Bl =Black, His =Hispanic, Haw / PI =Hawaiian Native or Pacific Islander, Wh = White Non-Hispanic, Multi / Unk =Multi-Ethnicity or Unknown.

C.3.b How Math Nation will Address Students' Needs

Math Nation will be made available statewide in Alabama for any interested districts. Recruitment will target over 50% rural schools and schools with high-needs students. Math Nation resources were built to be accessible for all students, particularly rural or low-income students where the internet may be less available. Math Nation videos can be downloaded on WiFi anywhere and then viewed offline at a later time (when students may have little or no access to the internet) on the free-to-download *Math Nation Mobile App* available for all devices up to six years old. All assessments and practice problems may be easily printed as well.

Math Nation's features were created with high-need students in mind. The features can also greatly support students who may be behind due to learning loss following COVID-19, as well as high-need students who require additional support. For example, the *On Ramp* tool specifically targets gaps in conceptual understanding and algebraic reasoning, which have been shown to hinder later success in algebra (Blanton & Kaput, 2005; Blanton, et al., 2015; Carpenter, et al., 2003; NMAP, 2008) and tailor learning progressions for every student.

The *Student Walls* are also geared to give students who need it access to additional support, particularly students who cannot afford tutors or who live in remote areas. The walls extend access to highly-qualified math teachers and tutors for both Algebra 1 and pre-algebra topics. Research has shown that this type of resource is an effective mechanism for student learning in online platforms (Patikorn, T. & Heffernan, 2020).

The instruction in the *Study Expert Videos* aims to scaffold understanding, model problem-solving strategies, and increase student ability to deal effectively with the task at hand. The instruction uses principles from social constructivism (Kozulin, 2000; Rogoff, 1998) and cognitive apprenticeship (Collins, et al., 1989; Rogoff, 1990) by providing opportunities for students to learn "with" the Study Experts acting as a cognitive partner, rather than "from" them.

Strong empirical support for interventions that combine formative assessment data for teachers and homework sessions for students with immediate feedback and personalized practice comes from the recent study of ASSISTments (Roschelle, et al., 2016). Math Nation builds on a problem-based learning approach by incorporating such a multi-layered assessment system, from daily formative assessments to adaptive summative assessments, which have shown to be effective (e.g. Gezer et al, 2021). These assessments with written and video feedback, paired with the workbooks and teacher follow-up, provide students the additional opportunities to learn.

D. PROJECT EVALUATION

WestEd will conduct an independent evaluation of the impact and implementation of Math Nation on 9th and 10th grade Algebra 1 classes (see Table 6). Research questions (RQ) 1–3 study the impact of the intervention on teacher and student outcomes. Questions 4 and 5 address implementation and are designed to provide formative feedback to guide the replication and scale-up of Math Nation. Questions 6–7 explore mediating and moderating effects. Questions 8–11 are also exploratory but will provide evidence of the long term impact of Math Nation, inform improvements to the program, explore potential impact of teacher experience with Math Nation, and could provide additional evidence of replicability, respectively.

Table 6. Evaluation Research Questions and Data Sources

Research Question	Primary Data Source(s)
Impact analyses	
1. What is the impact of Math Nation on the nature of teachers' instructional activities?	Study-administered teacher log
2. What is the impact of Math Nation on students' opportunities to learn?	Study-administered student survey
3. What is the impact of Math Nation on students' math achievement and course performance?	State standardized Algebra 1 scores; Algebra 1 grades
Implementation analyses	
4. To what extent are the key components of Math Nation (e.g., PD, *On-Ramp*, *Study Expert Videos*, *Teacher Area* activity) implemented with fidelity? How do teachers perceive the professional development?	Training sign-ins, Math Nation teacher and student data, teacher biweekly survey
5. How does implementation of the key components of Math Nation differ across school contexts and teacher and classroom characteristics? What factors hinder or facilitate the implementation of Math Nation?	Training sign-ins, Math Nation teacher and student data, teacher biweekly survey, including relevant background and demographic data.
Main mediating and moderating analyses (Exploratory)	
6. To what extent does the impact of Math Nation differ across school contexts, teacher and classroom characteristics, and student characteristics?	All data for RQs 1–3, including relevant background and demographic data.
7. To what extent is the impact of Math Nation on student outcomes mediated by instructional activities and opportunities to learn?	All data for RQs 1–3.
Exploratory analyses (other)	
8. What is the impact of Math Nation on students' enrollment and success in subsequent math courses?	School data for study participants for two years following impact study.
9. To what extent is the impact of Math Nation on student outcomes mediated by usage of Math Nation activities?	All treatment data for RQs 1–3, plus Math Nation teacher and student data
10. To what extent is the impact of Math Nation larger in teachers' second year of implementation?	All data for RQs 1–3
11. After the control teachers are trained, are their students' short-term outcomes comparable to the outcomes of the original treatment group?	Same data as RQ 3

The evaluation research questions align with the project's objectives and strategies and will be addressed using data collected from 80 high schools (with at least one Algebra 1 teacher) in diverse settings with over 46% classified as rural (see C.3). Recruitment will target and ensure over 50% rural schools in the sample. This design will allow participation from approximately 200 teachers (100 in each condition) and 20,000 students (10,000 in each condition) for the impact study. Also, 5,000 additional students will use Math Nation when the control schools onboard in 2025-26. The student sample will consist of students who are in 9th or 10th grade and enrolled in a high school Algebra 1 course.

Forty schools will be recruited for the 2023-2024 academic year. This allows for realistic recruitment goals for spring 2023 and ample resources for PD and regional support. Half of the 40 schools will be randomly assigned to implement Math Nation and the other half will continue with business-as-usual Algebra 1 instruction and materials as described below. This process will repeat for another forty schools for the 2024-2025 academic year. The proposed study is powered for a minimum detectable effect size of 0.11 to 0.13 for student outcomes, and 0.31 to 0.35 for teacher instructional activities. (See Appendix J.6 for details about the power analysis and Appendix J.7 for details about the statistical models for the impact analyses.)

D.1 Meeting WWC Standards Without Reservations

The evaluation of the impact of Math Nation will be based on a school-level randomized controlled trial designed to meet What Works Clearinghouse recommendation standards without reservations (WWC, 2020). Participating schools will be assigned to the treatment or control condition using stratified random assignment. Stratified sampling will consider demographic information and prior Algebra 1 performance (see Appendix J.7). Treatment schools will receive Math Nation training and their teachers and students will have full access to all of its features and resources. The control schools will administer business-as-usual Algebra 1 courses and will not have training with or access to Math Nation. These schools will use curriculum materials selected by their districts based on a list of state-approved textbooks, one of which is Illustrative

Mathematics. This business-as-usual condition for Algebra teachers in Alabama currently includes face-to-face PD offerings that focus on mathematics content as well as on preparation for the ACT (AMSTI, 2020). The PD is designed to provide information on teacher instructional practices and student learning within mathematics content strands using standards-based resources such as the Essential Understandings series from NCTM.

After randomization, Math Nation will begin enrolling treatment schools into its professional development sequence. All teachers in the treatment schools who plan to teach at least one Algebra 1 course in the coming year will be included. The school leaders will partner with Math Nation in informing and onboarding teachers to the study. Treatment teachers will be trained before the school year and will be asked to adhere to the program (as specified in A.2.a) during the impact study. Prior research has found that PD increases the impact of Math Nation on student outcomes and that teachers can successfully implement it for more than two years (Dickey, 2018; Mitten et al., 2021).

School-level random assignment was selected since schools typically implement Math Nation as a school-wide program, in which all Algebra 1 teachers receive PD and access to resources. Second, a teacher-level assignment would raise the threat of contamination, as teachers in a school may discuss, view, and share instructional materials and strategies. Also, based on prior school-level randomized studies (Davenport et al., 2019), particularly with the ALSDE's support, we expect minimal school-level attrition over the two-year impact study.

The analysis of the intervention's impacts will use an intent-to-treat (ITT) approach—schools and their teachers and students will be retained in their originally-assigned groups. The longitudinal component to the study will follow students over two years beyond their participation in the impact study. Student rosters will be collected at the start of the 2023-24 and 2024-25 school years to identify students in the ITT student impact sample. To get a comprehensive assessment of the instructional activities students experience in both implementation years, the primary impact analysis for teacher instructional activities will estimate ITT effects. Given that the proposed evaluation is based on a school-level RCT that is expected to have low cluster-level attrition and a student analytic sample where joiner bias is not a threat, the evaluation has the potential to produce strong evidence about the impact of Math Nation. In addition, based on research (Kim et al., 2020; Taylor & West, 2020) and our prior RCT experience, we anticipate manageable levels of student attrition over the two implementation years (i.e., less than 20%) and minimal differential student attrition across conditions (i.e., less than 5 percentage points), so the student impact analyses will likely meet WWC standards without reservations (see WWC attrition White Paper; WWC, 2017).

D.1.a Generalizability and Scalability. In partnership with the ALSDE, WestEd can evaluate Math Nation across a large number of economically disadvantaged schools, particularly in high-minority and rural settings. Findings based on this diverse study sample will provide valuable guidance for future replications of program implementation as the program scales across Alabama and into other states with similar populations. To inform generalizability, the evaluation will include a set of moderator analyses (RQ6) to assess the extent to which the effects of Math Nation are moderated by the characteristics of students, teachers/classrooms, and schools. Results from these exploratory analyses will guide future efforts to scale Math Nation, as they may identify where the program is particularly effective or less suited and how it can be improved accordingly. Appendix J.7 includes additional details on moderator analyses.

D.1.b Cost Effectiveness. The evaluation includes a cost analysis based on the Resource Cost Model (Levin & McEwan, 2002) to provide information about the cost of implementing Math

Nation, including associated PD and coaching, and whether it is cost effective relative to the BAU condition. Implementation and PD costs will be identified in both the Math Nation and BAU conditions using the "ingredients method" (Levin et al., 2017). Analyses will identify the costs associated with each component of the program, distinguish start-up costs from ongoing costs, and convert total costs to per-student costs. We will then combine the cost information and effect size estimates to describe the impact of Math Nation on a per dollar basis following the most up-to-date recommendations for cost analyses (Cost Analysis Standards Project, 2021).

D.2 Strategies for Replication

An important purpose of this study is to find how, when, and for whom the effective strategies incorporated throughout Math Nation are working. Math Nation has been successfully adopted in a handful of states, including Florida, Mississippi, and South Carolina. Each of these state-level implementations have included evaluation efforts (e.g., Sibley & Hauser, 2019 in MS; Dickey, 2018), but these evaluations have not included an experimental study or cost analyses. Yet, the experiences in each of these other states have informed the PD structure, including including regional coaches and developing a community of practice. The results of this study will provide additional information for future scaling, building on prior work, and advancing successful Math Nation implementation replications.

Our approach aims to make findings generalizable so they may impact the most students as the program expands (see D.1.a). Additionally, with the measures and methods developed by this study, on-going research can occur to ensure that the program is working for all students, and deficiencies can be identified and corresponding improvements made following the study. Math Nation will prioritize this using its own funds and potentially other grant monies. Math Nation's approach to entry using statewide or districtwide partnerships also makes the program scale quickly, which can provide future opportunities for replication studies in other areas. With the findings from this study, in particular from the implementation analyses (RQ4 and RQ5 in Table 6), Math Nation will be able to identify areas for cost-effectiveness improvement and will be better able to address any barriers to implementation found across various demographics. Math Nation can then perform a series of studies with new partners, using the tools and methods from this study, to analyze if the improvements made are leading to the desired outcomes.

D.3 Components, Mediators, Outcomes, and Acceptable Implementation

The design of the proposed evaluation is informed by clearly articulated key components, mediators, and outcomes of Math Nation as depicted in the conceptual framework presented in Appendix G. The impact analyses will be based on valid and reliable measures of (1) instructional activities, (2) opportunities to learn, and (3) student achievement outcomes. The evaluation will include moderator analyses (RQ6) and mediator analyses (RQ7) to explore the relationships among implementation context, intermediate outcomes (i.e., instructional activities and opportunities to learn), and student achievement outcomes. Implementation context data will be collected from multiple sources, including artifacts (e.g., sign-in sheets and agendas) from teacher trainings to determine participation and coverage, as well as data from Math Nation on the number and types of resources accessed and downloaded (i.e., activity guides).

Instructional Activities. To measure the quality of instructional activities (RQ1), WestEd will administer a teacher log three times across the year during the impact study to provide an accurate picture of the instructional activities over the entire school year. Prior studies of teacher logs indicate that they can be a valid and reliable measure of instruction (Rowan & Correnti, 2009). The log will include the following measures adapted from a RAND study of inquiry-based instruction (Le et al., 2006): inquiry-based practices intended to actively engage students and promote problem solving skills (α = 0.83), inquiry-based activities intended to facilitate critical thinking (α = 0.77), discussion (α = 0.74), and mathematical processes that include multiple representations and develop conceptual understanding (α = 0.58). Together, these measures capture the types of instructional activities Math Nation intends to promote in the classroom. (See Appendix J.8 for a detailed description of each measure.) In addition, WestEd will perform 10 observations of treatment and control classrooms each year of the impact study.

Student Opportunities to Learn. To measure students' opportunities to learn in their Algebra 1 course (RQ2), WestEd will administer a student survey at the end of each intervention year. The survey will include four opportunities-to-learn measures adapted from studies that provided evidence of sufficient validity and reliability for the measures (Rickles, et al., 2019; [redacted] et al., 2018): opportunities to make real-world connections (Cronbach's α = 0.84), opportunities to justify mathematical reasoning (α=0.82), opportunities to solve challenging math problems (α=0.78), and opportunities to demonstrate conceptual understanding (α=0.80).

Student Achievement Outcomes: Math Achievement, Course Performance, and Subsequent Courses. To measure students' outcomes for RQ3, WestEd will use the end-of-year state standardized Algebra 1 assessment, which is considered valid and reliable by the WWC standards, and students' final end-of-course grades. Course grades will be used as a supplemental measure of student achievement. Because grading practices differ from teacher to teacher, course grades will not be interpreted as a precise measure of student learning. Rather, they will be interpreted as a marker of course performance, which is policy relevant and a strong indicator of future academic success (Allensworth & Clark, 2020). Subsequent math course enrollment and corresponding course grades will be collected for two years following the impact study as a marker of future academic behaviors and success.

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