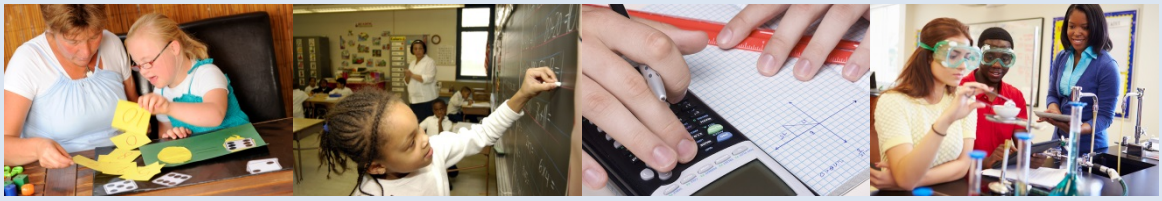
A Compendium of Math and Science Research Funded by NCER and NCSER: 2002-2013



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Plus Alpha Research & Consulting

NCER 2016-2000
U.S. DEPARTMENT OF EDUCATION

ies INSTITUTE OF EDUCATION SCIENCES

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Disclaimer

The Institute of Education Sciences at the U.S. Department of Education contracted with Westat and Plus Alpha Research & Consulting (subcontractor) to develop a compendium that describes the math and science research funded by its National Center for Education Research (NCER) and National Center for Special Education Research (NCSER) from 2003 through 2013. The views expressed in this report are those of the authors, and they do not necessarily represent the opinions and positions of the Institute of Education Sciences or the U.S. Department of Education.

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Disclosure of Potential Conflict of Interest

Westat Inc. is the prime contractor for the NCER Analysis and Research Management Support project, with subcontractors Mathematica Policy Research Inc. and Plus Alpha Research & Consulting, LLC. Plus Alpha Research & Consulting staff led the work on this compendium. Professor Douglas Clements, Kennedy Endowed Chair in Early Childhood Learning and the Executive Director of the Marsico Institute of Early Learning and Literacy at the University of Denver's Morgridge College of Education, served as the math content advisor for this compendium. Stephanie Wilkerson, founder and president of Magnolia Consulting specializing in evaluations of STEM programs, served as the science content advisor for this compendium.

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Contents

Preamble from the Institute of Education Sciences

In 1999, the National Research Council published a report on the state of education research in the United States. The panel concluded,

> One striking fact is that the complex world of education—unlike defense, health care, or industrial production—does not rest on a strong research base. In no other field are personal experience and ideology so frequently relied on to make policy choices, and in no other field is the research base so inadequate and little used.
>
> National Research Council (1999, p. 1)

Three years later with the passage of the Education Sciences Reform Act of 2002, Congress established the Institute of Education Sciences (Institute) and charged it with supporting rigorous, scientifically valid research that is relevant to education practice and policy. To meet this charge, the Institute established long-term programs of research within the National Center for Education Research (NCER) and the National Center for Special Education Research (NCSER) that address topics of importance to education practitioners and leaders, clearly specify methodological requirements for projects, and establish a scientific peer review system for reviewing grant proposals.

Since the Institute's founding in 2002, NCER has funded a broad range of work targeted toward providing solutions to the education problems in our nation. NCSER became part of the Institute with the 2004 reauthorization of the Individuals with Disabilities Education Act (IDEA) that gave the primary authority for special education research within the U.S. Department of Education to the Institute (IDEA, 2004). NCSER began operations in 2005 and began funding a comprehensive program of special education research designed to expand the knowledge and understanding of infants, toddlers, and children with or at-risk for disabilities in 2006. Both centers fund four general types of research: exploratory research that contributes to our core knowledge of education; development and piloting of education interventions (e.g., instructional interventions, policies, and technologies); evaluation of the impact of interventions; and development and validation of measurement instruments.[1]

Compendia of Research Funded by the Institute

This compendium is part of a series of documents intended to summarize the research investments that NCER and NCSER are making to improve student education outcomes in specific topical areas. This compendium organizes and describes projects pertaining to math and science. Other compendia explore social and behavioral research and education technology research, respectively. The Institute provided the contractors with the structured abstracts, which became the basis for the project descriptions. It is the Institute's intent that this compendium presents information to a wide array of education stakeholders in an accessible, usable format.

[1] See the Institute's website for additional discussion of these research types (http://ies.ed.gov/funding/).

Executive Summary

Between 2002 and 2013, the Institute of Education Sciences (Institute) funded over 300 projects focused on math and science. The majority of this work has been funded through Mathematics and Science Education research topics of the National Center for Education Research (NCER) and the National Center for Special Education Research (NCSER). Both centers also support projects focusing on math and science through other research topic areas, including programs such as Cognition and Student Learning, Early Learning Programs and Policies, Educational Technology, and Teacher Quality. Together, researchers funded by NCER and NCSER have developed or tested more than 215 instructional interventions (e.g., packaged curricula, intervention frameworks, and instructional approaches), 75 professional development programs, 165 educational technologies, and 65 assessments in math and science. In addition, they have published over 850 peer-reviewed articles and reports based on these projects thus far.[2]

This compendium organizes information on the math and science projects sponsored by NCER and NCSER into two main sections: Mathematics and Science. Within each section, projects are sorted into chapters based on content area, grade level, and intended outcome. In determining the chapters, we considered the emerging college- and career-readiness standards. Many states have formed and adopted such standards to help create guidance for their K-12 school systems. Thus, we have separate chapters for prekindergarten, the K-12 system, and adult and postsecondary education system within each section to reflect the states' use of college- and career-readiness standards. Because projects may have multiple foci (e.g., math and science assessment), some projects were assigned to multiple sections and chapters. (See Appendix A: Compendium Process for a discussion of the process used during the compendium's development.)

Each project included in this compendium is represented by a brief description that contains an overview of the major components of the project. Readers who would like more information about a project may follow the hyperlinked award number in each project description to access the Institute's online search engine, which contains the full abstracts upon which the compendium's descriptions are based.

Mathematics

The Mathematics section includes 203 projects divided into 13 chapters based on the primary focus of the project. Some projects are included in more than one chapter because they had more than one focus or included student populations that bridged into or beyond the K-12 system (i.e., preschool students or postsecondary and adult students). Figure ES-1 shows the distribution of projects within the Mathematics section. Due to multiple listings, the total number of projects shown is 251.

[2] Readers interested in finding information about publications stemming from the projects included in this compendium should refer to the online abstracts for the projects. Each award number is hyperlinked to the abstract on the IES website.

Figure ES-1: Projects focused on mathematics, by domain or key outcome (N = 251)

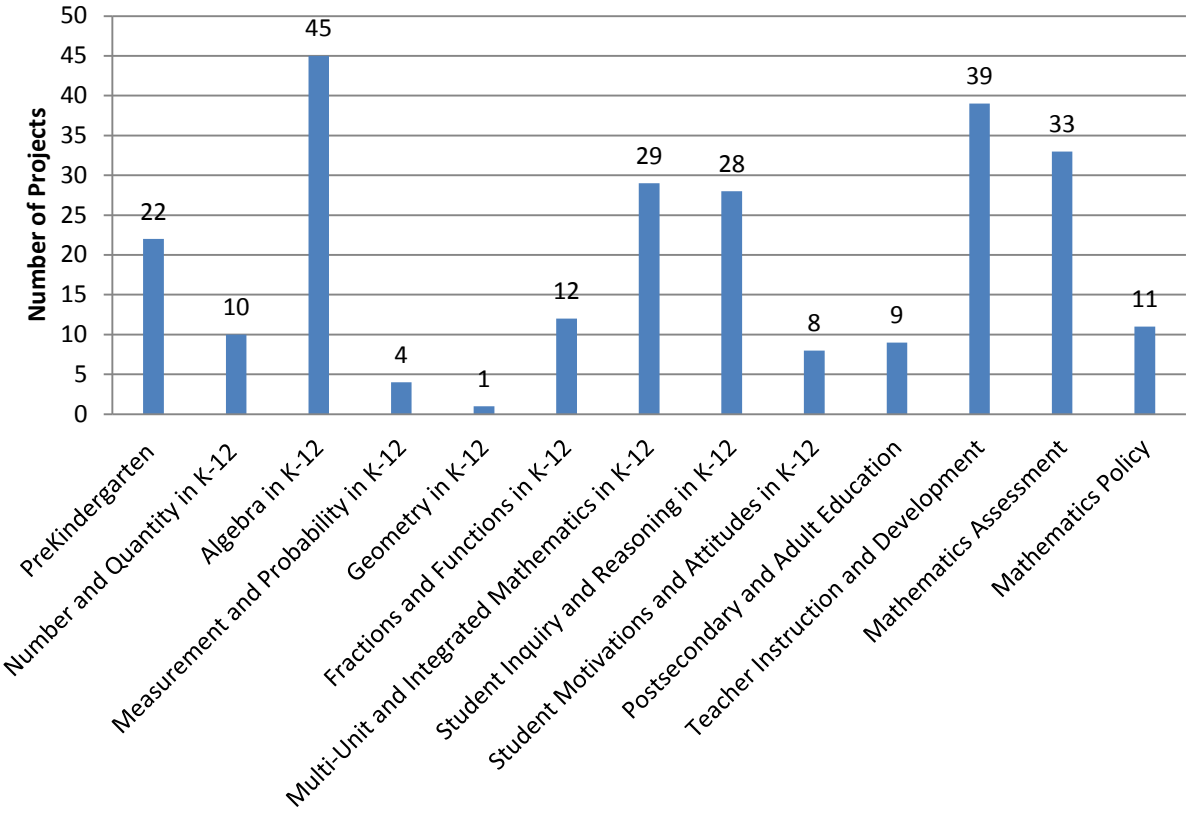

Figure Reads: Of the projects addressing mathematics, 22 focused on mathematics in prekindergarten settings; 10 focused on number and quantity in K-12 settings; 45 focused on algebraic thinking, equations, and Algebra in K-12 settings; 4 focused on measurement, data, statistics, and probability in K-12 settings; 1 focused on geometry in K-12 settings; 12 focused on fractions and functions in K-12 settings; 29 focused on multi-unit and integrated mathematics in K-12 settings; 28 focused on student mathematics practices, inquiry, and reasoning; 8 focused on student perceptions, motivations, attitudes, and anxiety about mathematics; 9 focused on mathematics in postsecondary and adult education settings; 39 focused on teacher instruction and development in mathematics; 33 focused on mathematics assessment; and 11 focused on mathematics policy.
Note: Projects may be categorized in multiple chapters based on project focus. The total number of projects in the figure (N = 251) is larger than the unique number of projects under mathematics (N = 203).

Science

There were 139 projects with a science focus. These were sorted into 12 chapters based on the primary focus of the project. Because some of these projects had more than one focus area or included student populations that bridged into or beyond the K-12 system (i.e., preschool students or postsecondary and adult education students), the projects may be assigned to more than one chapter. Figure ES-2 shows the distribution of projects within the Science section. The total project count across the Science chapters is 180, reflecting the multiple listing for some projects.

Figure ES-2: Projects focused on science, by domain or key outcome (N = 180)

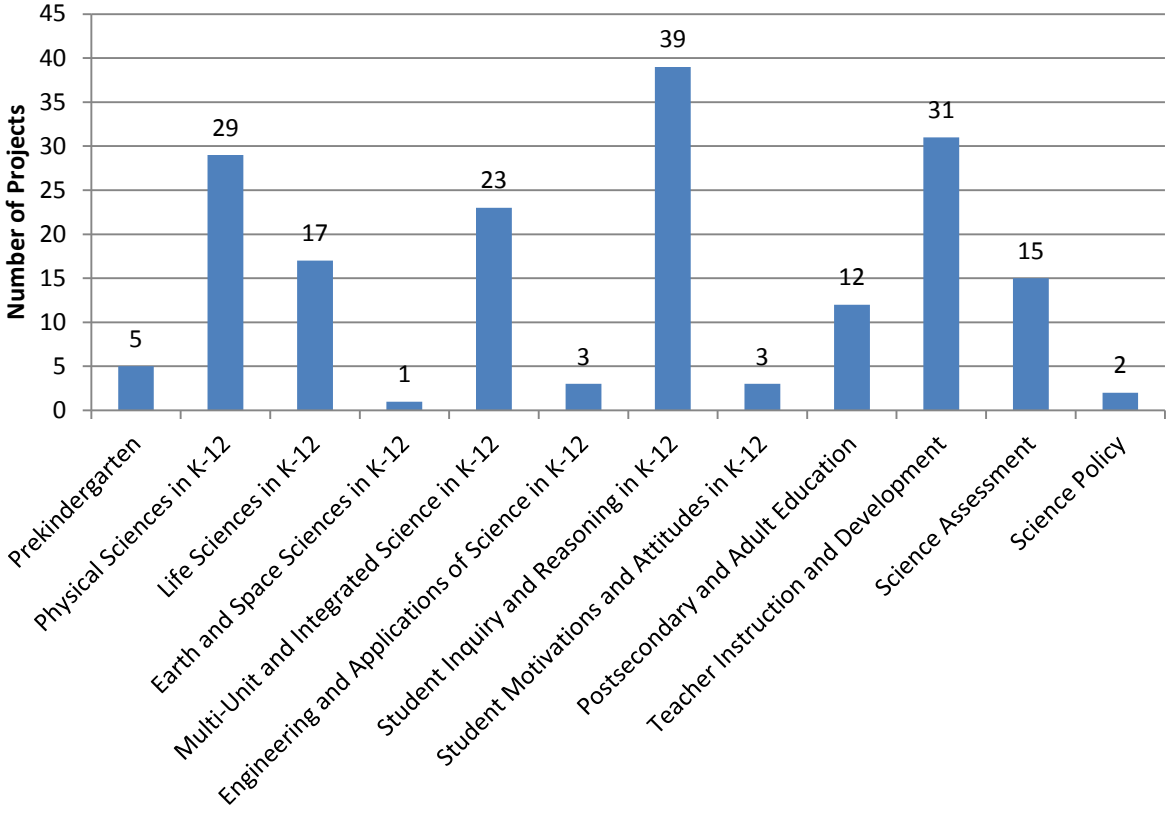

Figure Reads: Of the projects addressing science, 5 focused on science in prekindergarten settings; 29 focused on physical science in K-12 settings; 17 focused on life science in K-12 settings; 1 focused on Earth and space science in K-12 settings; 23 focused on multi-unit and integrated science in K-12 settings; 3 focused on engineering, technology, and applications of science in K-12 settings; 39 focused on student practices, inquiry, and reasoning in science; 3 focused on student perceptions, motivations, attitudes, and anxiety about science; 12 focused on science in postsecondary and adult education settings; 31 focused on teacher instruction and development in science; 15 focused on science assessment; and 2 focused on science policy.

Note: Projects may be categorized in multiple chapters based on project focus. The total number of projects in the figure (N = 180) is larger than the unique number of projects under science (N = 139).

Introduction

Purpose of the Compendium

The purpose of this compendium is to catalog NCER's and NCSER's contributions to math and science research. This compendium organizes information for practitioners, policymakers, and other education stakeholders and provides accessible information on the breadth of math and science projects sponsored by NCER and NCSER. Research undertaken as part of these projects is contributing to a knowledge base that ultimately aims to improve academic outcomes for students. Through its research program on mathematics and science education, the Institute supports research on the improvement of math and science knowledge and skills of students from prekindergarten through adulthood, with and without disabilities or at risk for disabilities. These projects have different primary purposes, including exploration, development of interventions (practices and policies), evaluation of interventions, and development and validation of measurement tools.

This compendium is part of a series of compendia that will highlight different areas of NCER- and NCSER-funded research. Other compendia explore social and behavioral research and education technology research, respectively.

Compendium Process

NCER and NCSER identified 326 research projects funded from 2002 through 2013 for inclusion in this compendium. Projects were categorized across two sections: Mathematics and Science. Some of the projects in this compendium contain both math and science outcomes and outcomes relevant to other areas of education (e.g., reading, postsecondary access), but all contain a math or science focus.

The contractors, external content advisors, and Institute staff worked together to identify chapters within the two sections and sort projects into sections and chapters. With input from Institute staff, the contractor assigned each project to chapters based on key outcomes. The chapters are also divided to focus on prekindergarten, K-12 content areas aligned with recent nationwide efforts states are undertaking to revise standards in mathematics and science,[3] student-level characteristics, postsecondary settings, teacher practices, assessments, and policies. To determine the assignments to chapters and prepare the project descriptions, the contractor used the structured abstracts provided by the Institute to write descriptions of each project. Projects were also tagged for specific focal populations and products.

For this compendium, projects with multiple foci (e.g., math and science assessment) could occur in both sections and in multiple chapters with a section. When a project focused on students matriculating into or out of the K-12 system or included populations outside and inside the K-12

[3] Common Core State Standards (Common Core) and the Next Generation Science Standards (NGSS) are examples of college- and career-readiness standards that some states have adopted. Other states have formed their own standards. All of the efforts, however, attempt to identify learning goals and trajectories.

system, it was assigned to multiple chapters. Similarly, if a project had a focus on a specific math or science area (e.g., algebra, life science) as well as a focus on a more general concept (e.g., student motivation, teacher instruction), it could be assigned to more than one chapter. If, however, a project was focused on more than two specific math or science areas in the K-12 system, it was assigned to the "Multi-Unit and Integrated Mathematics/Science" chapters. This was done to help minimize redundancy in the document. For additional detail regarding the assignment of projects to sections and chapters, see Appendix A.

Stylistic Conventions

NCER and NCSER fund research under a goal structure that includes exploration, development of interventions (e.g., instructional interventions, policies, and technologies), evaluation, and development and validation of assessments. To orient readers and align project descriptions with these research goals, the contractor developed a set of common verbs and sentence stems associated with each goal. For example, exploration projects begin with sentence stems such as, "In this project, researchers explored the relationship between…" or "In this project, researchers explored how…" to help denote the project's goal. Authors used the past tense for all projects, including those that were ongoing at the time of the initial writing, to ensure consistency across the project descriptions as a whole. (See Appendix A: Compendium Process for a description of the stylistic conventions used in the compendium.)

Project Tables

Each chapter includes project descriptions that are displayed in a table format. These tables provide the project title and award number; the principal investigator and affiliation; a short project description; and indication of relevant grade levels, focal populations, and products (see Figure 1). Project tables are ordered by grade-level within each chapter. Within grade level, projects are further ordered by project award year, starting with projects funded in 2002 and ending with projects funded in 2013. Finally, within project award year, projects are sorted by the award number.

Figure 1. Sample compendium project table

A Randomized Trial of a Tutor-Based Mathematics and Attention Intervention for Low-Performing Preschoolers at Risk for Mathematical Difficulties in School	
Award # R324A120410 Marcia Barnes, University of Texas, Houston, Health Science Center	
In this project, researchers evaluated the impact of the Pre-K Mathematics Tutorial on preschool children who were especially low performing in mathematics. Pre-K Mathematics Tutorial was a year-long program comprised of 21 scripted activities delivered in small, ability-matched groups by a tutor outside of the classroom for 4 days a week. The researchers tested the intervention when delivered by itself and also when delivered in combination with attention training.	**Grade Levels:** EC **Focal Populations:** SWD **Products Developed / Tested:** 

For example, the table shown in Figure 1 features a project wherein researchers evaluated a prekindergarten mathematics intervention. The first row provides the project title. The second row

provides the award number (a unique number used by the Institute to identify grants and contracts), the name of the principal investigator, and the institution that received the award. The third row provides a short project description (left column) and tags for grade level, focal population, and type of product developed or tested in the project (right column). The award number is hyperlinked to the full abstract on the Institute website.

The following abbreviations and icons are used in the tables.

- Early Childhood (EC) includes settings up through prekindergarten; Elementary School (ES) includes kindergarten through grade 5; Middle School (MS) includes grades 6 through 8; High School (HS) includes grades 9 through 12; and Postsecondary and Adult Education (PA) includes settings for students who are over 16 years old, outside of the K-12 system, and participating in adult or postsecondary education.
- Practitioners and education leaders often seek guidance on English language learners (EL) and students with disabilities or at-risk for disabilities (SWD). If a project focused specifically on one or both of these two student populations, it was coded accordingly. Blank cells indicate that the project did not focus on either of these specific groups.
- Each project was also coded to indicate whether it focused on developing or testing one or more of the following: instructional intervention (book icon), professional development (apple icon), educational technology (computer icon), or an assessment (checkmark icon). Blank cells indicate that no products of those specific types were developed or tested as part of the project.

The project descriptions, which are necessarily short in order to follow the compendium's stylistic guidelines (see Appendix A, Project Descriptions), may not contain reference to all the elements denoted by the abbreviations and icons. Readers who wish to learn more about the projects (e.g., population sampled; instructional intervention, professional development, technology, assessment, or education policy that was developed or evaluated; publications stemming from the project) should refer to the online abstract, which is hyperlinked to the award number in the project description table.

Each chapter includes a table key to help guide readers.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

Index and Appendixes

This compendium includes an extensive index that identifies projects by keywords, specific phrases, and topics (e.g., project setting, subject areas). Each index entry includes the award number and the compendium page number on which the project description can be found.

Appendix A describes the process used to develop the compendium. Appendix B identifies projects that developed or tested instructional interventions (e.g., packaged curricula, intervention frameworks, and instructional approaches), and Appendixes C, D, and E identify projects that developed or tested professional development interventions, educational technologies, and assessments, respectively.

Section I: Mathematics

This section features 203 projects focused on mathematics from pre-kindergarten through postsecondary and adult education. Each chapter in this section represents a major research focus area. These range from student-level characteristics, to content areas and assessments, to teacher practices and policies. In choosing chapter topics or foci, in particular the content area chapters (e.g., "Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings"), we looked to the college- and career-readiness standards, such as the Common Core State Standards. The standards states are creating and adopting often have an organization that reflects developmental categories within content areas generally recognized within the field and to other supporting skills and practices, such as student mathematical inquiry.

Each chapter within this section introduces a major research focus, such as algebraic thinking or student inquiry in mathematics, and then presents relevant projects in table format. The tables provide the project title and award number; the principal investigator and affiliation; a short project description with tags to indicate the grade level(s) on which the project focused; the project's focal population, i.e., English language learners or students with disabilities; and the types of products developed or tested through the project.

1. Mathematics in Prekindergarten Settings

In preparation for kindergarten, students learn counting, cardinality, and basic math concepts, such as number sequence, number order, and number names. The What Works Clearinghouse Practice Guide, *Teaching Math to Young Children*, recommends using developmental progression to teach math skills, progress monitoring to build on what each child knows, teaching children to view and describe their world mathematically, and integrating math instruction throughout the school day (Frye et al. 2013). Early math skills are associated with school readiness (Clements and Sarama 2011; Magnuson, Ruhm, and Waldfogel 2007) and have been linked to long-term success in school (Duncan et al. 2007; National Research Council 2009, 2012). This chapter includes programs, instructional practices, curricula, technologies, and assessments for improving basic math concepts of children 5 years old and younger, prior to kindergarten.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Using Cognitive Analyses to Improve Children's Math and Science Learning

Award # R305H020060 Robert Siegler, Carnegie Mellon University

In this project, researchers explored the relationship between differences in children's initial conceptual understandings of mathematics and science and children's later performance on mathematics and science tasks. The researchers also iteratively developed and tested a strategy for teaching children to overcome their misconceptions regarding numerical magnitudes.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Learning From Symbolic Objects

Award # R305H020088 David Uttal, Northwestern University

In this project, researchers explored the relationship between children's experiences with visually attractive, concrete representations of letters and numbers and their understanding and use of numbers, mathematical symbols, and letters. The researchers also explored the relationship between the use of concrete manipulatives and learning two-digit subtraction. The primary purpose of this study was to understand how symbolic learning and interaction with concrete objects are related to concept formation in the areas of early numeracy and emergent literacy.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

An Examination of the Impact of Big Math for Little Kids on Pre-K and Kindergarten Students' Learning of Math

Award # R305K040001 Margaret Clements, Education Development Center, Inc.

In this project, researchers evaluated the impact of the mathematics curriculum, Big Math for Little Kids, on prekindergarten and kindergarten students. Researchers aimed to determine if the curriculum provided young children who were at-risk for poor mathematics achievement with a stronger mathematics foundation. Big Math for Little Kids included a structured sequence of activities in both mathematics content and related verbal expression. Lessons were organized into six major content strands: number, shape, measurement, operations on numbers, patterns and logic, and space. The lessons included games, activities with manipulatives, explorations, stories, writing and reading mathematics, and various other activities.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Improving Children's Pure Numerical Estimation

Award # R305H050035 Robert Siegler, Carnegie Mellon University

In this project, researchers iteratively developed and tested a board game, called The Great Race, and a classroom activity, called the 150 Procedure, for preschool and elementary school children. The goal of these games was to help students acquire linear representations of numerical magnitudes. The Great Race focused on linear representations of numerical magnitude for numbers between 0-10, and the 150 Procedure focused on estimation skills on number lines from 0-1,000.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Developing an Intervention to Foster Early Number Sense and Skill

Award # R305K050082 Arthur Baroody, University of Illinois, Urbana-Champaign

In this project, researchers iteratively developed and tested three computer-aided approaches (indirect, semi-direct, and direct) to help prekindergarten through first-grade students at risk for developing difficulties learning mathematics to become fluent in basic addition and subtraction facts. The indirect approach was based on the assumptions that computational fluency stems from number sense and that instruction should focus on constructing an explicit understanding of big ideas and discovering relations among basic facts. The semi-direct approach involved teaching reasoning strategies, such as the decomposition-to-ten strategy. The direct approach entailed extensive fact drills.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Scaling Up TRIAD: Teaching Early Mathematics for Understanding With Trajectories and Technologies

Award # R305K050157 Douglas Clements, State University of New York (SUNY), Buffalo

In this project, researchers evaluated the impact of the Technology-enhanced, Research-based, Instruction, Assessment, and professional Development (TRIAD) mathematics intervention implemented at scale in diverse geographical areas with diverse prekindergarten populations. Researchers posited that the TRIAD intervention would increase math achievement in young children, especially those at risk, by improving the implementation of the Building Blocks math curriculum. Building Blocks was a research-based curriculum that addressed geometric and spatial skills, as well as numeric and quantitative ideas and skills. TRIAD not only included this curriculum but also provided professional development through distance education, a website that supported teaching based on learning trajectories, and classroom coaching.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Scaling Up the Implementation of a Prekindergarten Mathematics Curriculum in Public Preschool Programs

Award # R305K050186 Prentice Starkey, University of California, Berkeley

In this project, researchers evaluated the impact of a prekindergarten mathematics intervention implemented at scale across two types of public preschool programs serving low-income children (Head Start and state-funded preschools). The intervention aimed to improve children's school readiness and subsequent achievement in math through a classroom component (small-group math activities, math software, and a math learning center), a home component (math activities and materials for families), and a professional development package that included a train-the-trainer model and distance education tools.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Development of Assessment Technologies for Early Childhood: Phase I

Award # ED06PO0895 Christopher Camacho, Children's Progress, Inc.

In this project, researchers iteratively developed a prototype of a "response error analysis" software component to work with the Children's Progress Academic Assessment (CPAA), a dynamic computer assessment that measured language arts and math abilities in pre-kindergarten to second-grade students. The real-time response error analysis component for CPAA was designed to monitor all student errors during the assessment while targeting two specific error types: errors associated with content (e.g., arithmetic errors) and errors associated with response behavior (e.g., response times). It was also designed for at-home or school use and to provide feedback reports for parents.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Numbers Plus: A Comprehensive Approach to Early Mathematics Education

Award # R305K060089 Ann Epstein, HighScope Educational Research Foundation

In this project, researchers iteratively developed and tested Numbers Plus, a targeted, research-based preschool mathematics curriculum for children in Head Start, faith-based, and private preschool programs. The curriculum aimed to supplement the overall HighScope educational approach by focusing on key mathematics content areas such as classification, seriation, number, space, and time. Numbers Plus also included a teacher professional development program and assessment tools.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality

Award # R305A070068 Mable Kinzie, University of Virginia

In this project, researchers iteratively developed and tested My Teaching Partner, an integrated science and math curriculum for preschool children at risk for early school failure. The intervention aimed to improve students' academic achievement in math and science through detailed lesson plans that linked to demonstration videos of high-quality implementation, along with a range of teaching resources. My Teaching Partner provided teachers with instructional sequencing, required weekly activities, and opportunities to choose from weekly menus those activities best suited to their students' needs.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

An Economical Improvement In Literacy and Numeracy

Award # R305B070542 Robert Pasnak, George Mason University

In this project, researchers evaluated the impact of a cognitive intervention for children in Head Start who had difficulty mastering reading and math knowledge and skills appropriate for kindergarten. The intervention aimed to improve learning outcomes for young children through small-group activities to help children learn two basic abstract thinking concepts: the oddity principle and insertion-into-series. The oddity principle required children to recognize similarities and differences, to sort into categories, and to categorize objects hierarchically into basic, subordinate, and superordinate classes. Insertion-into-series required children to arrange objects by size or some other ordinal dimension.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Improving Children's Numerical Understanding

Award # R305A080013 Robert Siegler, Carnegie Mellon University

In this project, researchers evaluated the impact of The Great Race, a board game based intervention for preschool and elementary school children, developed to teach children linear representations of numerical magnitude for numbers between 0-10 (for preschool students) and 0-100 (for second-grade students). The goals of this project were to test whether the intervention increased children's ability to learn arithmetic; whether Head Start personnel working with small groups of children effectively executed the intervention; and whether lengthening the intervention increased learning. Researchers also extended the intervention to middle school students to address their understanding of rational numbers (fractions, decimals, percentages).

Grade Levels:
EC, ES, MS
Focal Populations:

Products Developed / Tested:

Closing the SES Related Gap in Young Children's Mathematical Knowledge

Award # R305A080697 Prentice Starkey, WestEd

In this project, researchers evaluated the impact of a preschool math intervention for 3 and 4 year-olds on children's mathematical knowledge. The intervention, Pre-K Mathematics, includes seven units: Number Sense and Enumeration, Arithmetic Reasoning, Spatial Sense and Geometric Reasoning, Pattern Sense and Pattern Construction, Arithmetic Reasoning, Measurement and Data Representation, and Logical Relations. The intervention aimed to close the socioeconomic gap in early mathematical knowledge through teacher-guided small group activities and a software component that accommodated children's individual learning styles.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Increasing the Efficacy of An Early Mathematics Curriculum With Scaffolding Designed to Promote Self-Regulation

Award # R305A080700 Douglas Clements, University of Denver

In this project, researchers evaluated the impact of an intervention that combined a mathematics curriculum with one component of a social behavioral intervention. The two interventions included Building Blocks, an early childhood mathematics curriculum, and the Scaffolding Self-Regulation component of Tools of the Mind, an intervention with specific pedagogical strategies to improve young children's self-regulation competencies and academic achievement.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Building Math Readiness in Young Deaf/Hard-of-Hearing Children: Parents as Partners

Award # R324A090145 Karen Kritzer, Kent State University

In this project, researchers iteratively developed and tested an online program to help parents of preschool children ages 3 to 5 with hearing impairments increase their child's readiness for school mathematics. The intervention was based on natural, daily activities and increased parents' awareness of their role in mediating their child's learning. The researchers investigated whether involvement in the program influenced parent behavior in their interactions with their children, the degree to which this affected children's understanding of fundamental mathematics concepts, and the extent to which the presentation of that intervention (in-person vs. online) was related to that change.

Grade Levels:
EC
Focal Populations:
SWD
Products Developed / Tested:

MathemAntics Preschool --> 3: Development and Evaluation of Mathematics Software for Children From Preschool to Grade 3

Award #R305A100267 Herbert Ginsburg, Columbia University, Teachers College

In this project, researchers iteratively developed and tested a software system, MathemAntics, for preschool through third-grade students. The intervention aimed to provide mathematics instruction to children in an attractive and enjoyable, yet challenging, virtual world. The intervention had three major components: a special world consisting of "posichicks" and "negacylces" (which represented positive and negative numbers); various mathematical tools, such as boxes for grouping numbers, number lines, virtual manipulatives; and formal mathematical symbols, such as standard algorithms. Graphical tools allowed students to operate virtual objects in ways not possible with physical manipulatives, and an avatar provided instruction, feedback, and support.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood

Award #EDIES11C0044 Eugene Galanter, Children's Progress, Inc.

In this project, researchers developed and tested the Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood, an additional assessment that was to supplement an existing assessment in order to identify "gifted" students in pre-kindergarten through second grade. The prototype of this additional assessment was developed under an earlier IES award. The existing assessment, Children's Progress Academic Assessment, measured language arts and math abilities in pre-kindergarten to second-grade students. The new software aimed to identify "gifted" children through computer adaptive methods that measured children's ability profiles in analytic, practical, and creative domains.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Numbers Plus Efficacy Study

Award # R305A110483 Larry Schweinhart, HighScope Educational Research Foundation

In this project, researchers evaluated the impact of Numbers Plus, a mathematics curriculum for preschool children developed to improve their math proficiency, especially for those from low-income backgrounds. The curriculum addressed five content areas: number and operations, geometry, measurement, algebra, and data analysis. Numbers Plus sequenced children's mathematical learning within (rather than across) activities, and each activity had a built-in progression and associated adult scaffolding strategies. Experienced coaches provided a variety of tools and strategies to help teachers understand early math development and effectively implement Numbers Plus in their classrooms.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

A Randomized Trial of a Tutor-Based Mathematics and Attention Intervention for Low-Performing Preschoolers at Risk for Mathematical Difficulties in School

Award # R324A120410 Marcia Barnes, University of Texas, Houston, Health Science Center

In this project, researchers evaluated the impact of the Pre-K Mathematics Tutorial on preschool children who were especially low performing in mathematics. Pre-K Mathematics Tutorial was a year-long program comprised of 21 scripted activities delivered in small, ability-matched groups by a tutor outside of the classroom for 4 days a week. The researchers tested the intervention when delivered by itself and also when delivered in combination with attention training.

Grade Levels:
EC
Focal Populations:
SWD
Products Developed / Tested:

A Randomized Study of the Efficacy of a 2-Year Mathematics Intervention for At-Risk Prekindergarten and Kindergarten Students

Award # R305A120262 Prentice Starkey, WestEd

In this project, researchers evaluated the impact of the Pre-kindergarten Mathematics and Early Learning in Mathematics curricula on low-income prekindergarten and kindergarten students' mathematical knowledge. The curricula included small-group math activities that used concrete manipulatives and daily activities that were sent home to parents for additional practice outside of school.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Award #R305A120631 Mable Kinzie, University of Virginia

In this project, researchers evaluated the impact of MyTeachingPartner-Mathematics and Science (MTP-M/S) curricula and professional development supports on Head Start teachers' instructional practices and children's early mathematics and science knowledge and skills. The curriculum aimed to strengthen children's inquiry skills and knowledge of key concepts in science and mathematics through two mathematics and two science activities that teachers implemented every week across the school year. The MTP-M/S implementation support system for teachers included video of high-quality, high-fidelity implementation; video-based challenges; teaching tips; instructional adaptations; and curricular extensions.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Recognition and Response: Addressing Early Learning Difficulties in Math through an RtI Model for Pre-K

Award # R324A120059 Virginia Buysse, University of North Carolina, Chapel Hill

In this project, researchers iteratively developed and tested Recognition and Response, an instructional system for preschool mathematics teachers developed to improve the quality of math practices for all children and provide additional supports for some children to ensure that every child was ready for kindergarten. The intervention consisted of three components: recognition, which involved gathering formative assessment information by screening all children and periodically monitoring those who needed more targeted intervention; response, which involved providing an effective core curriculum and targeted interventions linked to formative assessment results; and professional development to support problem solving based on collaboration among teachers, parents, and specialists.

Grade Levels:
EC
Focal Populations:
SWD
Products Developed / Tested:

2. Number and Quantity in Kindergarten through 12th Grade Settings

Researchers have found that strong number sense in early elementary grades is associated with mathematics achievement in upper elementary grades and middle school (Salaschek, Zeuch, and Souvignier 2014; Jordan, Glutting and Rameneni 2010; Jordan, Glutting, Dyson, Hassinger-Das et al. 2012). This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student learning and outcomes related counting and cardinality, number and operations in base 10, and the number system.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Developing an Intervention to Foster Early Number Sense and Skill

Award # R305K050082 Arthur Baroody, University of Illinois, Urbana-Champaign

In this project, researchers iteratively developed and tested three computer-aided approaches (indirect, semi-direct, and direct) to help prekindergarten through first-grade students at risk for developing difficulties learning mathematics to become fluent in basic addition and subtraction facts. The indirect approach was based on the assumptions that computational fluency stems from number sense and that instruction should focus on constructing an explicit understanding of big ideas and discovering relations among basic facts. The semi-direct approach involved teaching reasoning strategies, such as the decomposition-to-ten strategy. The direct approach entailed extensive fact drills.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:


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Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Making Sense of Concrete Models for Mathematics

Award # R305A080287 Kelly Mix, Michigan State University

In this project, researchers iteratively developed and tested the effects of various instructional approaches to using mathematics manipulatives (e.g., place value blocks, Montessori beads, or trading chips) with first-grade students. The project was designed to determine whether using manipulatives improves students' performance on multi-digit calculations and, if so, under what conditions. During the development period, researchers manipulated how much contact students had with the manipulatives, e.g., direct contact with concrete place value blocks; virtual place value blocks, teacher demonstration only with no direct contact, or no blocks at all.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Fostering Fluency With Basic Addition and Subtraction

Award # R305A080479 Arthur Baroody, University of Illinois, Urbana-Champaign

In this project, researchers evaluated the impact of a set of computer-based activities on the fluency with single-digit, basic addition and subtraction skills of K-2 students identified as having mathematical learning difficulties and as at-risk for academic failures. The intervention aimed to enhance at-risk students' fact fluency through four features: unstructured discovery learning, structured discovery learning, structured discovery learning plus active modeling reasoning strategies, and structured discovery learning plus active modeling and decomposition training.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Foundations of Mathematical Understanding: Developing a Strategic Intervention on Whole Number Concepts

Award # R324A090341 Ben Clarke, University of Oregon

In this project, researchers iteratively developed and tested a core mathematics intervention, FUSION, for students in first grade who were at risk for mathematics difficulties and disabilities. The intervention aimed to increase students' mathematical achievement through a multi-tiered approach to instruction that provided increasingly intense levels of instruction based on the results from frequent progress monitoring of students. The intervention had two major components: mathematics content, which focused on whole number concepts, and research-based instructional design and delivery features.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Project NumberShire: A Game-Based Integrated Learning and Assessment System to Target Whole Number Concepts

Award # EDIES11C0026 Marshall Gause, Thought Cycle, Inc.

In this project, researchers iteratively developed and tested NumberShire, a web-based mathematics game, and researched its usability, feasibility, and promise. The intervention aimed to integrate a learning and assessment gaming system to assess and teach whole number concepts to first-grade students with or at risk for mathematics disabilities. NumberShire included narrative-based mini-games in which students built an idyllic fairytale village by applying math concepts. Tasks included setting goals, advancing to more challenging levels, and engaging in competition.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

KinderTEK: Teaching Early Knowledge of Whole Number Concepts Through Technology

Award # R324A110286 Mari Strand Cary, University of Oregon

In this project, researchers iteratively developed and tested KinderTEK, an iPad-based mathematics intervention for at-risk kindergarten students developed to improve their whole number understanding. The KinderTEK intervention was based on three components: critical content pertaining to whole number concepts (counting and cardinality, operations and algebraic thinking, and number and operations in base 10); research-based instructional design and delivery features (e.g., explicit instruction, scaffolding, visual representation, practice); and research-based technological design and delivery features.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Development of a Game-based Integrated Learning and Assessment System to Target Whole Number Concepts (Project NumberShire)

Award # R324A120071 Hank Fien, University of Oregon

In this project, researchers iteratively developed and tested NumberShire-K, an intervention for first-grade students at risk for math disabilities developed to help students learn and apply the mathematical concepts and skills of whole numbers. NumberShire-K was a browser-based, educational video game with research-based instructional design and delivery features that included scaffolded explicit instruction, opportunities for practice to improve fluency, goal setting, performance monitoring, and gaming elements to promote student motivation and engagement.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

A Randomized Control Trial of a Tier 2 Kindergarten Mathematics Intervention

Award # R324A120304 Ben Clarke, University of Oregon

In this project, researchers evaluated the impact of ROOTS, a mathematics intervention for kindergarteners with or at risk for mathematics disabilities. ROOTS provided instruction on number sense and whole number concepts, including counting, cardinality, number operations, base 10, and place value. Researchers tested two versions of ROOTS, a high-intensity version with two students in each intervention group and a low-intensity version with five students in each intervention group.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Teachley: Math Facts - Design and Development of Intervention Software Promoting Single-Digit Operational Fluency

Award # EDIES13C0044 Kara Carpenter, Teachley, Inc.

In this project, researchers iteratively developed and tested MathFacts, a web-based game developed to support elementary students with math learning difficulties. The prototype of MathFacts was developed under a previous IES award. MathFacts was an application for touchscreen tablets that encouraged single-digit operational fluency, conceptual understanding, strategy awareness, and self-understanding. In the game, students learned content through mini-lessons, engaged with problems in practice and speed rounds, and received formative feedback on their performance. Researchers also developed a teacher management system to support professional development and produce reports to guide instruction.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

3. Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings

Researchers have consistently confirmed the importance of algebra for college and career readiness (Allensworth and Easton 2005, 2007), and algebra is often viewed as a gateway to higher-level mathematics and postsecondary education (Matthews and Farmer 2008; Walston and McCarroll 2010). As such, elementary-level students are learning algebraic problem solving and equation structures to promote algebra-readiness skills (Xin, Zhang, Park, Tom et al 2011; Stephens, Knuth, Blanton, Isler et al. 2013), and the importance of algebra persists throughout the K-12 system. This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student learning and outcomes related to early algebra skills, algebraic thinking and operations, and algebraic expressions and equations.

Table Key

Grade levels:

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Focal populations:

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Using Contrasting Examples to Support Procedural Flexibility and Conceptual Understanding in Mathematics

Award # R305H050179 Jon Star, Harvard University, Graduate School of Education

In this project, researchers iteratively developed and tested an instructional approach for fifth- and seventh-grade students to foster flexible mathematical problem solving in algebra and computational estimation. The instructional approach used contrasting examples wherein students were shown a pair of worked examples illustrating different solutions to the same problem and were asked to compare and contrast the solution procedures. The research team anticipated that this approach would foster students' awareness of critical features of the procedures and abstract their common underlying structure.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Natural Math: An Empirically Derived Software for Mathematics Education

Award # ED06PO0921 Dmitri Droujkov, Natural Math

In this project, researchers iteratively developed a prototype of software for elementary school students that used metaphors to show how mathematical principals manifest in the real world. The software included activities to help students learn multiplication and related concepts and included two modules called Natural Math Grids and Natural Math Mirrors. The prototype also included a web-based student collaboration feature.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation

Award # R305M060057 Nicole Kersting, University of Arizona

In this project, researchers designed and validated video-analysis assessments for three pre-algebra topic areas (fractions, ratio and proportion, and equations) in order to measure elementary and middle school teachers' knowledge of teaching mathematics. Each video-analysis assessment (administered online) consisted of a set of video clips and an analysis task. Teachers analyzed each clip and recorded their responses in text fields.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Arithmetic Practice that Promotes Conceptual Understanding and Computational Fluency

Award # R305B070297 Nicole McNeil, University of Notre Dame

In this project, researchers iteratively adapted and tested traditional arithmetic practice problems for second-grade students to promote students' understanding of math equivalence while improving computational fluency. Researchers incorporated modifications that they found to improve student learning into arithmetic practice workbooks.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Arithmetical and Cognitive Antecedents and Concomitants of Algebraic Skill

Award # R305A110067 Paul Cirino, University of Houston

In this project, researchers explored the relationship between fifth-grade mathematical performance and algebra performance in eighth and ninth grades. The researchers aimed to identify the arithmetical or other cognitive factors that surface during early schooling and that may either limit or facilitate algebraic problem solving. Researchers used longitudinal data collected from a cohort of students when they were in third, fourth, and fifth grade, which were linked to the students' performance in their eighth or ninth grade first-year algebra courses.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

Improving Children's Understanding of Mathematical Equivalence

Award # R305A110198 Nicole McNeil, University of Notre Dame

In this project, researchers iteratively developed and tested a comprehensive intervention for elementary school children to help them achieve a mastery-level understanding of mathematical equivalence. The intervention included four components: non-traditional arithmetic practice, lessons that introduced the equal sign outside of arithmetic contexts, "concreteness fading" exercises that strengthened the mappings between real-world relational contexts and the corresponding mathematics symbols, and activities that required children to compare and explain different problem formats and problem-solving strategies.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

WebFluidMath

Award # EDIES13C0032 Donald Carney, FluidMath

In this project, researchers iteratively developed and tested a prototype of WebFluidMath, a software program to support fifth-grade students who were learning basic algebra principles. To use the WebFluidMath program, students wrote math expressions and made drawings on the screen of a tablet computer. The software recognized the handwritten math formulae and generated solutions in the form of algebraic expressions, computations, graphs, and dynamic animations.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

NumberShire II: Development of a Second Grade Game-Based Integrated Learning System to Target Whole Numbers and Operations in Base Ten and Operations and Algebraic Thinking

Award # EDIES13C0045 Marshall Gause, Thought Cycle, Inc.

In this project, researchers iteratively developed and tested NumberShire II, an integrated mathematics learning and assessment gaming system to foster the pre-algebraic thinking of second-grade students with or at risk for disabilities. The prototype of NumberShire II was developed under a previous IES award. The web-based game provided explicit, systematic, and frequent instruction, differential learning pathways, and goal setting and formative assessment-based performance monitoring.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Promoting Discriminative and Generative Learning: Transfer in Arithmetic Problem Solving

Award # R305A130082 Charles Kalish, University of Wisconsin, Madison

In this project, researchers explored the relationships between malleable factors of instructional practice and fluent, transferable learning. Researchers explored a set of malleable factors linking forms of arithmetic practice to specific memory models to identify a range of outcomes of mathematics instruction by testing 2nd grade students in classroom studies and undergraduate students in lab experiments. Researchers wanted to highlight distinct goals for mathematics education and provide a set of design principles for achieving those outcomes and goals.

Grade Levels:
ES, PA
Focal Populations:

Products Developed / Tested:

Algebra Learning for All (ALFA)

Award # R305M030154 James Stigler, LessonLab, Inc.

In this project, researchers iteratively developed and tested a video- and internet-based professional development program to improve sixth-grade pre-algebra teachers' mathematics instruction. The intervention instructed teachers how to identify, design, and present problems in challenging forms as part of their regular classroom teaching. The researchers evaluated the impact of the two training programs on teachers' knowledge of mathematical content for classroom use, teachers' ability to present rich problems in their lessons, and students' mathematics achievement.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet

Award # R305H040099 Michael Russell, Boston College

In this project, researchers designed and validated a set of computer-based algebra short tests—or testlets—for eighth- and ninth-grade algebra teachers. These testlets were to provide information about students' misconceptions of specific algebraic concepts to enable teachers to use that information to guide their instruction. Researchers instructed teachers on how to use the testlets and examined whether teachers could use them to identify students' misconceptions and to respond appropriately.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Algebraic Interventions for Measured Achievement

Award # R305K040003 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested a curriculum designed to strengthen students' mastery of core algebra skills. The curriculum focused on key "trouble spots" in algebra that typically caused difficulty because students lacked prerequisites or misunderstood the content or because the material was complex and students needed more time and practice with the topic. The targeted curriculum had both multiple modules that provided learning experiences to reinforce, refresh, or re-teach important concepts introduced in the classroom and teacher support materials and a professional development component.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Algebra Connections: Teacher Education in Clear Instruction and Responsive Assessment of Algebra Patterns and Problem Solving

Award # R305M040127 Barbara Radner, DePaul University

In this project, researchers iteratively developed and tested a professional development program for middle school algebra teachers to improve their practice and student learning, particularly for African-American or Latino students from low-income communities. In-service teachers completed three graduate courses in algebra and one course in responsive assessment of mathematics learning and received weekly in-school support.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Does Visual Scaffolding Facilitate Students' Mathematics Learning? Evidence From Early Algebra

Award # R305H060097 Martha Alibali, University of Wisconsin, Madison

In this project, researchers explored the relationship between visual scaffolding (e.g., pointing, representational gestures, diagrams, and other methods of highlighting visual information) and learning in the context of middle school mathematics learning in early algebra. The researchers aimed to document how teachers used visual scaffolding in naturalistic instructional communication; to investigate whether visual scaffolding promoted students' comprehension of instructional language and, therefore, their learning; and to investigate a possible mechanism by which visual scaffolding may promote learning-namely, by facilitating students' encoding of visual information.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Effectiveness of Cognitive Tutor Algebra I Implemented at Scale

Award # R305A070185 John Pane, RAND Corporation

In this project, researchers evaluated the impact of the Cognitive Tutor® Algebra I curriculum on middle school students' mathematics achievement when the curriculum was implemented at-scale. Cognitive Tutor® aimed to promote students' understanding of algebraic concepts and principles, problem-solving skills, and mastery of higher order mathematical concepts. A central component of the Cognitive Tutor® was an automated computer-based tutor that provided individualized instruction to address students' specific needs. The individualization was built into the software and was facilitated by detailed computational models of student thinking in algebra.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Bridging the Bridge to Algebra: Measuring and Optimizing the Influence of Prerequisite Skills on a Pre-Algebra Curriculum

Award # R305B070487 Philip Pavlik, Carnegie Mellon University

In this project, researchers iteratively developed and tested an intelligent computer tutor for middle school students to help them learn pre-algebra skills key to success in algebra. The researchers designed the computer tutor to deliver practice sessions that targeted discrete prerequisite math skills. The system used a personalized model of each student's learning to determine when and how much practice was needed for each prerequisite skill. Using personalized models of instruction allowed the computer tutor to target needed prerequisite skills for each student while avoiding unnecessary review of skills the student had already mastered.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

An On-Line Professional Development Program for FluidMath

Award # EDIES09C0012 Donald Carney, Fluidity Software, Inc.

In this project, researchers iteratively developed and tested an online professional development platform for the FluidMath software and researched its usability, feasibility, and promise. Researchers designed FluidMath to recognize handwritten math formulas and sketches drawn on the screen of a pen-enabled computer. In this project, researchers aimed to create a platform for training teachers to integrate FluidMath into basic algebra practice. The project also examined teacher use of the technology and its promise in increasing student understanding of algebra.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Efficacy Study of AnimalWatch: An Intelligent Tutoring System for Pre-Algebra

Award # R305A090197 Steve Schneider, WestEd

In this project, researchers evaluated the impact of the AnimalWatch System on students in pre-algebra. AnimalWatch System was an online computer-based intelligent tutor developed to build students' proficiency with pre-algebra mathematics operations with a specific focus on word problems and basic skills. The system provided students with individualized guided practice, immediate feedback to support self-correction and transfer, and opportunities to practice computational fluency.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Learning by Teaching Synthetic Student: Using SimStudent to Study the Effect of Tutor Learning

Award # R305A090519 Noboru Matsuda, Carnegie Mellon University

In this project, researchers iteratively developed and tested SimStudent, an intelligent tutoring system for eighth- and ninth-grade Algebra I students developed to help students master algebra concepts related to solving linear equations. In this intelligent tutoring system, students selected linear equations for SimStudent to solve and monitored SimStudent's performance, providing hints and feedback. The tutoring system enabled students to improve their understanding of algebraic concepts, remediate their own misconceptions, and strengthen their problem-solving ability and procedural knowledge of solving linear equations.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Perceptual and Adaptive Learning Technologies: Developing Products to Improve Algebra Learning

Award # EDIES10C0024 Philip Kellman, Insight Learning Technology, Inc.

In this project, researchers iteratively developed and tested adaptive learning technologies and researched their usability, feasibility, and promise. The project team aimed to enhance middle school student learning in pattern recognition and fluency in algebra. In their efforts to enhance student learning, the team developed the architecture, databases, and interface to make two existing perceptual learning modules (i.e., units that aim to develop students' ability to recognize and use structure, patterns, and relationships by having them interact with information, PLMs) appropriate for web-based delivery. Next, they developed new web-delivered PLMs for algebra learning. Then the team produced Score Reporter, a program for progress monitoring and assessment. The researchers also developed and iteratively refined a teacher manual.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Linear Functions for Teaching: An Efficacy Study of Learning and Teaching Linear Functions

Award # R305A100047 Steve Schneider, WestEd

In this project, researchers evaluated the impact of professional development in algebra to improve teachers' mathematics understanding and to improve mathematics teaching practices. The professional development also aimed to increase students' algebra proficiency, learning, and achievement. The project targeted middle schools serving high numbers of traditionally underrepresented students, including English learners, African American students, Latino students, and socioeconomically-challenged students.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

A Theory-Driven Search for the Optimal Conditions of Instructional Guidance in Algebra Tutor

Award # R305A100109 John Anderson, Carnegie Mellon University

In this project, researchers explored the cognitive processes of seventh- through ninth-grade students as they solved algebra problems in the context of the Carnegie Learning's Algebra Tutor software. The researchers used computer simulations of individual students (synthetic student models) to find the optimal conditions of instructional guidance a student needs to receive to master an algebra problem.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Transforming Algebra Assignments

Award # R305A100150 Mary Suzanne Donovan, Strategic Education Research Partnership (SERP) Institute

In this project, researchers iteratively developed and tested a set of Algebra I assignments for middle and high school students to help them develop a better understanding of mathematics concepts and to learn more quickly. The assignments interwove worked examples and prompts for self-explanation with problems that math students must solve on their own. Researchers designed the correct and incorrect examples used in the assignments to directly target key mathematical concepts and common misconceptions that students hold about those concepts. In addition, researchers developed teacher professional development materials and assessments to accompany the algebra assignments.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Creating Cross-Grade Assessments of the Development of Core Algebraic Constructs

Award # R305A100518 Malcolm Bauer, Educational Testing Service (ETS)

In this project, researchers designed and validated two types of assessments for middle school math teachers: periodic locator assessments to provide profiles of groups of students who require different instructional approaches and incremental assessments to inform ongoing instructional decisionmaking. Researchers aimed to improve student learning and instruction by providing teachers with assessments that they could readily incorporate into their existing curricula. The curriculum focused on three key concepts in algebra: equality, notion of a variable, and multiplicative reasoning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation

Award # R305A110060 David Landy, University of Richmond

In this project, researchers iteratively developed and tested Pushing Symbols, an intervention for middle, high school, and remedial college students developed to enhance students' understanding of algebraic notations. The intervention used a set of verbal, physical, and computer-based visualizations to allow students to interact physically and dynamically with expression elements.

Grade Levels:
MS, HS, PA
Focal Populations:

Products Developed / Tested:


Learning and Teaching Algebra (LTA)

Award # R305A110451 Albert Cuoco, Education Development Center, Inc.

In this project, researchers iteratively developed and tested Learning and Teaching Algebra (LTA), an intervention for middle school teachers developed to help them build the mathematical understanding and practices needed to model and help build mathematical thinking. LTA had two components: a professional development program for teachers, including a detailed implementation guide, model lessons, pacing guides, and assessments; and a professional development program for coaches, including mathematical background for coaches, strategies for setting up teacher discussion groups, and essays by existing coaches.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Expanding Audio Access to Mathematics Expressions by Students With Visual Impairments via MathML

Award # R324A110355 Lois Frankel, Educational Testing Service (ETS)

In this project, researchers iteratively developed and tested a standardized synthetic speech rendering tool of math for instruction, test preparation, and testing for students in grades 8 through 11 with visual impairments. The tool aimed to enable math expressions to be presented usefully through assistive technology to students with visual impairments so that they could improve their comprehension. The tool consisted of four components: standardized synthesized speech for rendering mathematical content (ClearSpeak), navigation tools for students, ClearSpeak integration capability with Microsoft Word, and customizable authoring tools for teachers.

Grade Levels:
MS, HS
Focal Populations:
SWD
Products Developed / Tested:

Efficacy Study of a Pre-Algebra Supplemental Program in Rural Mississippi Schools

Award # R305A120045 Tedra Clark, Mid-continent Research for Education and Learning (McREL)

In this project, researchers evaluated the impact of a supplemental mathematics curriculum, Every Day Counts Algebra Readiness (EDC Algebra Readiness), on the algebra readiness of seventh-grade students and the Algebra I achievement of these same students in eighth and ninth grades. The EDC Algebra Readiness program aimed to help students express conceptual thinking about mathematics and to understand critical algebra readiness concepts and skills by using visual models to lead students in consistent, incremental daily practice.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

AnimalWatch-VI Suite: A Comprehensive Program to Increase Access to Mathematics for Students With Visual Impairments

Award # R324A120006 Carole Beal, University of Arizona

In this project, researchers iteratively developed and tested Animal Suite-VI, an intervention for middle and high school students with visual impairments to help them master core algebra-readiness mathematics skills to succeed in high school and beyond. The intervention was a set of 14 web-delivered, accessible instructional modules covering computation, fractions, and variables and expressions. Each module included word problems and instructional scaffolding accessible via self-voicing software, accompanied by braille and tactile graphics. The researchers also developed training materials for teachers.

Grade Levels:
MS, HS
Focal Populations:
SWD
Products Developed / Tested:

Promoting Algebra Readiness: Developing a Strategic Intervention On Rational Number Concepts (Project PAR)

Award # R324A120115 Ben Clarke, University of Oregon

In this project, researchers iteratively developed and tested the curriculum Promoting Algebra Readiness (PAR) for sixth-grade students with or at risk for learning disabilities in mathematics. The intervention aimed to help students with disabilities gain mastery in algebra in a general education setting. PAR included instructional features appropriate for this population, like optimal sequencing of lessons, pre-teaching prerequisite knowledge, and providing opportunities for practice. The curriculum focused on conceptual understanding and procedural fluency with rational numbers and equivalent representations.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Project AIM: Algebra-readiness Intervention Modules for At-Risk Students

Award # R324A120364 Diane Bryant, University of Texas, Austin

In this project, researchers iteratively developed and tested Algebra-readiness Intervention Modules (AIM), instructional modules for sixth- and seventh-grade students, especially those with or at risk for mathematical disabilities. AIM's modules aimed to strengthen students' rational number knowledge and rational number sense, thereby improving mathematics outcomes. Researchers embedded instructional design principles in the modules to optimize the instructional sequence, to pre-teach prerequisite knowledge, to appropriately sequence instructional examples, and to provide ample opportunities for practice and review to promote procedural fluency.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Connecting Mathematical Ideas through Animated Multimodal Instruction

Award # R305A130016 Martha Alibali, University of Wisconsin, Madison

In this project, researchers explored how to most effectively link ideas in algebra instruction using Gesturing Avatar for Learning and Education (GALE) with middle school students. GALE is a software-based system with a human-like avatar used to understand which ways of communicating connections between ideas are most effective for fostering student learning in mathematics. The researchers aimed to improve curriculum design, teacher education, and instructional practices.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Neural Markers of Effective Learning

Award # R305H030016 John Anderson, Carnegie Mellon University

In this project, researchers iteratively developed and tested an algebra unit focused on conceptually challenging word problems and added it to a ninth-grade algebra cognitive tutor program. The intervention aimed to improve the computer-based algebra tutor using both behavioral and brain imaging techniques. The researchers also examined various markers of successful learning in college students, using brain-imaging techniques to observe the learners' brain activity when insight and deep understanding were achieved and to observe the brain activity of high school students as they solved problems with the algebra computer tutor.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

Venture Map

Award # ED06PO0931 Barry Minott, MW Productions, Inc.

In this project, researchers iteratively developed a prototype of a new formative assessment feature for VentureMap, a project-based curriculum that teaches students algebra concepts by having them manage a fictional music company. VentureMap was a tool that had students apply algebra principles to keep their company functioning by having them track sales, cost, and profit data, come up with production plans to increase profits, and design 2- and 3-dimensional marketing and packaging materials.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Algebra Intervention for Measured Achievement-Full Year Curriculum

Award # R305A070105 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested the Algebraic Interventions for Measured Achievement curriculum for 9th and 10th-grade students who were low achieving in math. The curriculum aimed to target typical trouble spots in algebra to facilitate student mastery of key algebra skills. Previously, researchers developed the first-semester curriculum materials for the program. In this project, researchers added an additional four topic areas: beginning number theory, rational numbers, variables and equations, and data and probability. Researchers constructed this curriculum to model effective instruction and provided support for teachers as well.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Democratizing Access to Core Mathematics Grades 9-12

Award # R305B070430 Stephen Hegedus, University of Massachusetts, Dartmouth

In this project, researchers iteratively developed and tested SimCalc Connected Math Worlds, a curriculum developed to deepen high school students' understanding of core concepts within first- and second-year algebra, and connect and sustain the development of mathematical ideas across higher mathematics classes. SimCalc Connected Math Worlds included curriculum materials and software that researchers integrated with a wireless network. The software allowed teachers and students to have simultaneous access to student solutions, thus enabling teachers to provide immediate feedback to students as they solved algebraic problems.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Successful Transitions to Algebra I: A Randomized Control Trial of Two Theories of Ninth Grade Algebra Instruction

Award # R305B070508 Robert Balfanz, Johns Hopkins University

In this project, researchers evaluated the impact of the Transition to Advanced Mathematics Algebra I sequence on student achievement and credit accumulation in Algebra I for ninth-grade students who were 1 to 4 years below grade level in mathematics. Students who received the intervention spent a semester learning and practicing intermediate mathematics skills and mathematical reasoning before beginning Algebra I. In the second semester, students learned Algebra I course content.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Agent and Library Augmented Shared Knowledge Areas (ALASKA)

Award # R305A080667 Eric Hamilton, Pepperdine University

In this project, researchers iteratively developed and tested ALASKA (Agent and Library Augmented Shared Knowledge Areas), a tool for ninth-grade Algebra I students. ALASKA integrated four technologies: collaborative workspaces, learning object digital libraries, pedagogical agents, and tablet computers. While using the program, students worked with automated tutors who scaffolded and supplied information; students communicated with teachers or peers; and teachers viewed students' work and communicated with students. ALASKA also included a teacher professional development component to engage teachers in reflective practice and curriculum customization that supplemented the scaffolding resources available to them.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

National Research & Development Center on Instructional Technology: Center for Advanced Technology in Schools

Award # R305C080015 Eva Baker, University of California, Los Angeles

In this project, researchers evaluated the impact of a computer game designed to challenge and motivate ninth-grade students, particularly underperforming students, to participate and succeed in math. The researchers aimed to improve student learning of critically important math concepts such as pre-algebra and algebra. To succeed in the game, students used math skills to maneuver through levels that varied in difficulty via an embedded self-assessment component.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Professional Development for Algebra Progress Monitoring

Award # R324A090295 Anne Foegen, Iowa State University

In this project, researchers iteratively developed and tested Professional Development for Algebra Progress Monitoring, a professional development system for algebra teachers to help them better monitor the algebra learning of students with disabilities. The intervention included online instructional modules that trained teachers to use algebra progress monitoring measures. The system also included online tools for scoring and data management to support teachers' scoring of the measures.

Grade Levels:
HS
Focal Populations:
SWD
Products Developed / Tested:

Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts

Award # R305A100074 Julie Booth, Temple University

In this project, researchers iteratively developed and tested a computer program for Algebra I high school students to help them overcome misconceptions in algebra through the use of incorrect examples and self-explanation exercises. The intervention provided high school students with different types of self-explanation exercises: typical self-explanation (designed to help them discover and strengthen correct strategies) and corrective self-explanation (designed to help them understand why ineffective strategies were incorrect).

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Assessing the Efficacy of Online Credit Recovery in Algebra I for At-Risk Ninth Graders

Award # R305A110149 Jessica Heppen, American Institutes for Research (AIR)

In this project, researchers evaluated the impact of offering an online Algebra I course for first-time ninth graders who failed the second semester of Algebra I. Researchers aimed to produce rigorous evidence about credit recovery programs by conducting three studies: the first study compared the impacts of the online course to a traditional in-class summer course, the second study examined whether schools offering the online Algebra I course showed improved student academic outcomes versus schools that did not, and the third study compared how students who succeeded in their credit recovery course did versus ninth-grade students who passed Algebra I.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Interleaved Mathematics Practice

Award # R305A110517 Douglas Rohrer, University of South Florida

In this project, researchers iteratively developed and tested a set of materials with "interleaved" practice problems in algebra drawn from textbooks already used by teachers. The researchers hypothesized that "interleaved" practice (i.e., practice where different problem types are presented) provided students with an opportunity to learn to select the appropriate strategy to solve the problem, just as they would do when they encountered a problem in later courses or standardized tests.

Grade Levels:
HS
Focal Populations:
Products Developed / Tested:

Algebra Screening and Progress Monitoring

Award # R324A110262 Anne Foegen, Iowa State University

In this project, researchers designed and validated a series of algebra screening and progress monitoring measures developed to enable teachers of high school students with disabilities to better monitor students' learning in algebra. The assessment system included six algebra progress monitoring measures with three measures focusing on traditional algebra instruction (e.g., symbolic manipulation) and three reformist measures targeting conceptual understanding and problem solving.

Grade Levels:
HS
Focal Populations:
SWD
Products Developed / Tested:

Doubling Up? The Impact of Remedial Algebra on Students' Long-Run Outcomes

Award # R305A120466 Joshua Goodman, Harvard College

In this project, researchers evaluated the impact of the double-dose algebra policy on high school students' long-term outcomes such as advanced math coursework and performance, ACT scores, high school graduation rates, and college enrollment. Double-dose algebra was a scheduling mechanism in which students in need of math remediation were required to take two periods of algebra per day instead of one.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

4. Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings

Beginning in elementary school, students learn the principles of measurement through activities like learning time, counting money, and measuring in standard units (e.g., volume, area, perimeter, and mass). As they progress, students learn about statistics and probability through activities that focus on statistical variability and distributions, random sampling to draw inferences about a population (or inferences about two populations), probability and conditional probability, and patterns of association in bivariate data. Taken together, these activities teach students how to collect data and measure the world around us and to look at variability and distributions. Mills and Holloway (2012) found that eighth grade student exposure to and learning of statistics-related concepts lagged behind standards. This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student learning and outcomes related to measurement, data, statistics, and probability.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


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The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Assessing Data Modeling and Statistical Reasoning

Award # R305K060091 Richard Lehrer, Vanderbilt University

In this project, researchers designed and validated a formative and summative assessment system to evaluate elementary and middle school students' skills and understandings related to data modeling and statistical reasoning. The researchers used the Berkeley Evaluation and Assessment Research model to develop construct maps for each of four strands of data modeling: measurement, representation, data structures, and statistical inference. The construct maps guided the selection of assessment items based on progress variables, hypothetical developmental trajectories of learning based on current knowledge about how students in this age band typically reason about these concepts.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:


Data Modeling Supports the Development of Statistical Reasoning

Award # R305A110685 Richard Lehrer, Vanderbilt University

In this project, researchers evaluated the impact of the Data Modeling curriculum on sixth-grade students' learning and attitudes toward the mathematics of data and statistics. The intervention aimed to focus on foundations of statistical reasoning, including structuring variability in data as distributions, relating data distribution to chance, and generating models of chance to guide statistical inference. The curriculum directed students to investigate data display, statistics, and chance processes and to construct models of chance processes. Teachers received a guide to teaching key ideas, a set of formative and summative assessment items, and a professional development model and tools.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System

Award # R305A120217 Mark Wilson, University of California, Berkeley

In this project, researchers designed and validated a computerized formative assessment system around the topics of statistics and modeling to provide teachers with diagnostic information about middle school students' learning. The researchers designed assessments for six constructs from the Assessing Data Modeling and Statistical Reasoning curriculum, including data display, meta-representational competence, conceptions of statistics, chance, modeling variability, and informal inference. The online assessment considered students' learning progressions, incorporated complex item formats that evaluated constructed responses, and included sophisticated item response modeling techniques.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Fathom Dynamic Data Software

Award # ED06PO0930 William Finzer, KCP Technologies

In this project, researchers iteratively developed a prototype of Fathom Dynamic Data Software, an interactive tool and web-based curriculum focused on data analysis and statistics. Fathom Dynamic Data Software aimed to provide high school students with a background in data gathering, exploration, and analysis. The software was designed to be paired with Fathom Surveys, a product that streamlines the data collection process within the classroom. In addition to data analysis, the software was designed to allow students to gain experience with survey design and survey ethics.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

5. Geometry in Kindergarten through 12th Grade Settings

Geometry is the study of shapes and their properties, such as lines, points, planes, and solids. From kindergarten through 12th grade, students learn shapes and their attributes; draw and identify lines, angles, and other shapes; understand two- and three-dimensional figures; calculate area, surface area, and volume; and move onto geometric theorems in high school. Researchers have developed and tested various tools and interventions to help students learn geometry concepts and promote inquiry-based learning (Duatepe-Paksu and Ubuz 2009; Hannafin, Truxaw, Vermillion and Liu 2008). This chapter includes a project that sought to design and validate a geometry focused formative assessment designed to help teachers improve student learning.

Table Key

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The Diagnostic Geometry Assessment Project

Award # R305A080231 Michael Russell, Boston College

In this project, researchers designed and validated a computer-delivered diagnostic formative assessment of geometric conceptions in the middle grades and developed instructional resources meant to assist teachers in addressing flawed or underdeveloped conceptions identified by the assessment. The assessment targeted sources of difficulties and misconceptions in middle school geometry, specifically properties of shapes, transformations, and measurement.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

6. Fractions and Functions in Kindergarten through 12th Grade Settings

Fractions and functions describe the ways that numbers relate to one another. Researchers have found that fractions and functions are important early mathematical concepts that are associated with high school mathematics achievement (Siegler, Duncan, Davis-Kean, Duckworth et al. 2012; Good, Wood, Sabers, Olson et al. 2013). This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve elementary school student learning in adding, subtracting, multiplying, and dividing fractions; middle school student learning in defining, evaluating, and comparing functions; and high school student learning in linear, quadratic, exponential models, and trigonometric functions.

Table Key

Grade levels:

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Getting Fractions Right With Technology-Mediated Peer-Assisted Learning (TechPALS)

Award # R305K060011 Jeremy Roschelle, SRI International

In this project, researchers iteratively developed and tested TechPALS, an intervention for elementary school students developed to improve their mathematics achievement. The intervention used handheld computers to teach fractions in the context of peer-assisted learning. In TechPALS, a set of four mathematics-related activities covered a range of important concepts and skills related to rational numbers and fractions. The TechPALS software was driven by a database of mathematics tasks, each of which drew on and targeted well-known difficulties in learning fractions.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

The Role of External Representations in Learning and Transfer of Mathematical Knowledge

Award # R305B070407 Vladimir Sloutsky, Ohio State University

In this project, researchers iteratively developed and tested instructional principals to guide teachers' use of concrete representations to teach abstract concepts to kindergarten through sixth-grade students. The researchers posited that greater concreteness would hinder transfer of skills across problems as compared to more abstract, generic instantiations. Researchers taught children about fractions and examined effects of concreteness on transfer of this knowledge to novel instantiations and novel tasks involving fractions. They also examined the durability of learning by giving a delayed test after several weeks and proposed ways of optimizing both learning and transfer.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

An Online Intelligent Tutoring System to Advance Learning in Math Games

Award # EDIES09C0009 Snehal Patel, Sokikom

In this project, researchers iteratively developed and tested a functioning prototype of the Frachine learning game and performed tests on the usability and initial feasibility of the prototype. Researchers developed the web-based single player fraction learning game for elementary school students. The researchers produced an intelligent tutoring system that was integrated within the existing game and was intended to provide the individualized instructional support required to improve student math outcomes.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Developing and Evaluating a Technology-Based Fractions Intervention Program for Low-Achieving and At-Risk Students

Award # R305A100110 Ted Hasselbring, Vanderbilt University

In this project, researchers iteratively developed and tested the Helping At-Risk and Low-Achieving Students in Fractions (HALF) intervention for fifth- and sixth-grade students. The HALF system aimed to promote understanding of fractions by presenting learning problems in conjunction with virtual manipulatives and videos designed to anchor to-be-learned concepts within already-familiar topics. Researchers also created a professional development webinar intended to increase teachers' familiarity with and understanding of the software package.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

National Research and Development Center on Improving Mathematics Instruction for Students With Mathematics Difficulties

Award # R324C100004 Nancy Jordan, University of Delaware

In this project, researchers evaluated the impact of how children acquire or fail to acquire an understanding of rational numbers (i.e., fractions) and how children with math difficulties can be taught to understand and operate fluently with rational numbers. Researchers examined cognitive processes, such as working memory and inhibition, which impede understanding and operating with fractions. The interventions developed and tested during the project have focused on incorporating instructional strategies that emphasize a measurement interpretation of fractions.

Grade Levels:
ES, MS
Focal Populations:
SWD
Products Developed / Tested:

Combining Advantages of Collaborative and Individual Learning With an Intelligent Tutoring System for Fractions

Award # R305A120734 Vincent Aleven, Carnegie Mellon University

In this project, researchers iteratively adapted and tested an intelligent tutoring system for fourth- and fifth-grade students studying fractions. The system built on an existing version of a web-based intelligent tutoring system and integrated components that would allow for student collaboration and independent learning. To do so, researchers conducted small studies to test how best to combine these learning approaches. The researchers aimed to understand how these approaches complement each other by combining features of both into the web-based intelligent tutoring system that covered a comprehensive set of topics in fractions learning.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Use of Machine Learning to Adaptively Select Activity Types and Enhance Student Learning With an Intelligent Tutoring System

Award # R305A130215 Emma Brunskill, Carnegie Mellon University

In this project, researchers iteratively developed and tested web-based fraction learning tools for fourth- and fifth-grade students. The researchers extended their existing web-based intelligent tutoring system, the Fractions Tutor, to incorporate a broad set of activity types and to create a new method for automatically selecting individualized activities. The researchers aimed to increase student learning by developing new activities to promote sense-making and fluency-building and incorporated these into the Fractions Tutor.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Enhancing the Mathematical Problem Solving Performance of Sixth Grade Students Using Schema-Based Instruction

Award # R305K060002 Asha Jitendra, University of Minnesota

In this project, researchers iteratively developed and tested an instructional intervention for sixth-grade students that focused on critical mathematics concepts (e.g., ratios, proportions) and relations (e.g., multiplication and division). The researchers developed a set of lessons to promote students' understanding of problems involving multiplicative relations using schema-based instruction (SBI). The SBI intervention aimed to help students understand mathematics content and to solve a range of problems encountered in everyday life through teacher-led discussions to show students how to symbolically represent problems using schematic diagrams.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


AdaptErrEx: Exploring the Learning Benefits of Erroneous Examples and Their Dynamic Adaptations Within the Context of Middle School Mathematics

Award # R305A090460 Bruce McLaren, Carnegie Mellon University

In this project, researchers iteratively developed and tested AdaptErrEx, an intelligent tutoring system for middle school math students developed to help students learn decimals. The system presented students with worked examples of problems in which each step of a problem solution path was presented for the students, along with feedback and instruction. The intervention presented students with examples that contained errors and instructed them to find the error with help from the tutoring system.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System

Award # R305A110306 Pamela Buffington, Education Development Center, Inc.

In this project, researchers designed and validated the Eliciting Mathematics Misconceptions Project, a cognitive diagnostic assessment system for middle school students. The intervention aimed to enable teachers to quickly and effectively diagnose commonly held student misconceptions and overgeneralizations in the areas of fractions, decimals, and operations with fractions and decimals. The researchers developed and refined three valid and reliable sets of short, highly focused diagnostic measurement tools.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Learning of Ratio and Proportion Problem-Solving Using Schema-Based Instruction: Efficacy and Sustainability

Award # R305A110358 Asha Jitendra, University of Minnesota

In this project, researchers evaluated the impact of schema-based instruction (SBI) on seventh-grade students' mathematics problem solving and proportional reasoning. Researchers aimed to improve students' problem-solving performance by helping students more effectively categorize problems according to their structure and identify the underlying mathematical problem to be solved. The SBI intervention provided students with an understanding of proportions (including ratio, rate, and percent) and methods to enhance problem-solving performance.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Perceptual Learning Technology in Mathematics Education: Efficacy and Replication

Award # R305A120288 Philip Kellman, University of California, Los Angeles

In this project, researchers evaluated the impact of a web-based intervention on sixth-grade math students. Researchers aimed to accelerate students' abilities to recognize and discriminate key structures and relations in complex domains and to improve the effectiveness and efficiency of learning. The intervention consisted of perceptual learning modules (i.e., units that aim to develop students' ability to recognize and use structure, patterns, and relationships by having them interact with information) that integrated principles of perceptual learning to help support learning of fractions and measurement; and adaptive learning algorithms that used a constant stream of performance data, combined with principles of learning and memory, to adapt the learning process to each individual.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

7. Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings

Multi-unit and integrated mathematics curricula often blend or sequence topics so that they align with a developmental progression. This contrasts with single unit curricula, such as algebra or geometry, which focus strictly on one area. Multi-unit or integrated math curricula often blend more than one domain or discipline (e.g., math and science, reading, or another field) in order to help students form a more holistic or comprehensive understanding of mathematical concepts. These curricula can also span multiple grade levels, such as the Singapore math curriculum, which is an integrated mathematics curriculum developmentally aligned from kindergarten through grade 6 (Ginsburg, Leinwand, Anstrom, and Pollock 2005). Post and his colleagues (2012) found that integrated high school curricula, whether commercially-developed or researcher-developed, engage students in applications of mathematics and problem solving and are correlated with math achievement in college. This chapter includes math programs, instructional practices, curricula, technologies, and assessments that are multi-unit, sequential, or integrated in approach.

Table Key

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An Examination of the Impact of Big Math for Little Kids on Pre-K and Kindergarten Students' Learning of Math

Award # R305K040001 Margaret Clements, Education Development Center, Inc.

In this project, researchers evaluated the impact of the mathematics curriculum, Big Math for Little Kids, on prekindergarten and kindergarten students. Researchers aimed to determine if the curriculum provided young children who were at-risk for poor mathematics achievement with a stronger mathematics foundation. Big Math for Little Kids included a structured sequence of activities in both mathematics content and related verbal expression. Lessons were organized into six major content strands: number, shape, measurement, operations on numbers, patterns and logic, and space. The lessons included games, activities with manipulatives, explorations, stories, writing and reading mathematics, and various other activities.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Improving Children's Pure Numerical Estimation

Award # R305H050035 Robert Siegler, Carnegie Mellon University

In this project, researchers iteratively developed and tested a board game, called The Great Race, and a classroom activity, called the 150 Procedure, for preschool and elementary school children. The goal of these games was to help students acquire linear representations of numerical magnitudes. The Great Race focused on linear representations of numerical magnitude for numbers between 0-10, and the 150 Procedure focused on estimation skills on number lines from 0-1,000.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Improving Children's Numerical Understanding

Award # R305A080013 Robert Siegler, Carnegie Mellon University

In this project, researchers evaluated the impact of The Great Race, a board game based intervention for preschool and elementary school children, developed to teach children linear representations of numerical magnitude for numbers between 0-10 (for preschool students) and 0-100 (for second-grade students). The goals of this project were to test whether the intervention increased children's ability to learn arithmetic; whether Head Start personnel working with small groups of children effectively executed the intervention; and whether lengthening the intervention increased learning. Researchers also extended the intervention to middle school students to address their understanding of rational numbers (fractions, decimals, percentages).

Grade Levels:
EC, ES, MS
Focal Populations:

Products Developed / Tested:

Early Learning in Mathematics: A Prevention Approach

Award # R305K040081 Leanne Ketterlin Geller, University of Oregon

In this project, researchers iteratively developed and tested a mathematics instructional intervention and progress monitoring system for kindergarten students. Researchers aimed to develop a usable and effective approach to mathematics instruction in kindergarten by providing instructional strategies, curriculum materials, a computer software program for student practice, and assessment strategies for identifying students who were having trouble learning mathematics.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning

Award # R305H060070 Philip Kellman, University of California, Los Angeles

In this project, researchers iteratively developed and tested computer-based learning modules coordinated with other modes of instruction for students in the third through eighth grades. The intervention was designed to help students develop an integrated mathematical knowledge base in which measurement and fractions were meaningfully connected to each other and to core concepts of multiplication, division, ratio, and proportion. The intervention consisted of six units of computer-based instructional materials that combined perceptual learning modules (i.e., units that aim to develop students' ability to recognize and use structure, patterns, and relationships by having them interact with information), diagnostic assessments, benchmark lessons and investigations, and resources for teachers.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:


Evaluation of the First In Math Online Mathematics Program in New York City: A Randomized Control Trial

Award # R305B070048 John Flaherty, WestEd

In this project, researchers evaluated the impact of the First in Math online mathematics program on fourth- and fifth-grade student achievement. The First in Math program was a supplemental instructional tool developed to increase students' mathematics achievement using interactive online games. The study examined individual- and classroom-level conditions that influenced First in Math program use, the impact of First in Math on mathematics performance, and variation in impact across classrooms with high and low support of technology integration.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Teaching Fractions and Integers: The Development of a Research-Based Instructional Practice

Award # R305B070299 Geoffrey Saxe, University of California, Berkeley

In this project, researchers iteratively developed and tested a 16-lesson sequence aimed at improving fifth-grade students' understanding of integers and fractions. Key elements of the curriculum included a vector interpretation of the number line with translations to other representational contexts, lesson plans that provided teachers opportunities to build on student thinking while guiding students' conceptual grasp of mathematical ideas and definitions, and a sequence of lessons that enabled diverse students to build coherent and rich connections between integers and fractions.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Validating a Response to Intervention Multitiered Model for Primary Grade Students With Mathematics Difficulties

Award # R324B070164 Diane Bryant, University of Texas, Austin

In this project, researchers iteratively developed and tested two interventions, Early Mathematics Boosters Stage 2 and Stage 3, multi-unit math curricula to be used in a Response to Intervention mathematics model with first-grade students. The interventions aimed to reduce students' mathematics difficulties and improve long-term mathematics outcomes for all students, particularly for students with mathematics disabilities. Early Mathematics Boosters Stage 2 was intended for use with students with mathematics difficulties who were struggling with classroom-wide mathematics instruction. Early Mathematics Boosters Stage 3 was intended for use with students with severe mathematics disabilities. The interventions targeted number concept, operation, quantitative reasoning, and problem-solving skills.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Early Learning in Mathematics: Efficacy in Kindergarten Classrooms

Award # R305A080699 Benjamin Clarke, Pacific Institutes for Research

In this project, researchers evaluated the impact of the Early Learning in Mathematics (ELM) curriculum on kindergarten students' understanding of essential mathematics concepts like number operations, geometry, measurement, and mathematical vocabulary. The ELM curriculum aimed to help students develop the skills and strategies to understand mathematics concepts by providing explicit instruction and scaffolding the instruction for learners of different abilities. The evaluation took place in settings with a large percent of English-language learners.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"

Award # R305A090111 James Pellegrino, University of Illinois, Chicago

In this project, researchers validated embedded assessments within the Everyday Mathematics curriculum for students in grades 3 through 5. Researchers aimed to address three problems of assessment practice to improve the quality of mathematics learning and teaching: assessment scope and quality, coordination of multiple assessment functions, and support for teacher use of assessment information. Everyday Mathematics was a standards-based curricular that focused on number and numeration; operations and computation; and patterns, functions, and algebra.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Responsiveness-To-Instruction to Strengthen the Academic Performance of Students With Reading and Math Disabilities

Award # R324A090052 Douglas Fuchs, Vanderbilt University

In this project, researchers evaluated the impact of an intervention that integrates reading and math instruction and whether the intervention is more effective than an additive intervention for preventing or mitigating disability. The intervention focused on first-grade students with or at risk for disabilities in both reading and math. Students in the integrated approach received an intervention that combined both reading and math instruction. Students in the additive intervention participated in activities that focused on reading deficits alone or math deficits alone.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:


FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math

Award # EDIES10P0102 Gary Goldberger, Fablevision, Inc.

In this project, researchers iteratively developed and tested a prototype of FabLab Construction Station, a computer program designed to support second-grade teachers and students. FabLab allowed students to design two-dimensional and three-dimensional geometric shapes, bulletin boards, paper airplanes, pop-ups, and other materials. Researchers aligned the final product to outcomes in math and engineering and intended for the product to support the acquisition of knowledge in topics including shapes, geometry, pre-algebra, and measurement.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


National Randomized Control Trial of Everyday Mathematics

Award # R305A100116 Michael Vaden-Kiernan, Southwest Educational Development Corporation

In this project, researchers evaluated the impact of the Everyday Mathematics curriculum when used as the core mathematics curriculum in kindergarten through fifth-grade classrooms. The curriculum emphasized six strands of mathematics knowledge with learning targets identified for each strand by grade level. It included student materials, teacher manuals, assessment and practice guides, summer professional development, and home links to support parent involvement. Researchers examined teacher implementation and whether the intervention improved mathematics outcomes for elementary school students.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics

Award # R324A100068 Kavita Seeratan, SRI International

In this project, researchers designed and validated a formative and summative classroom online assessment system for elementary and early middle school students with mathematics learning disabilities (MLD). The instruments aimed to assess how students with MLD learned elementary fractions and constructs important to number sense and operations for whole numbers. The assessment was delivered via an online system designed to provide data logging, analysis, feedback, and reporting to users. The assessment system also incorporated universal design for learning principles (e.g., text to speech) to promote accessibility.

Grade Levels:
ES, MS
Focal Populations:
SWD
Products Developed / Tested:

Focused and Coherent Elementary Mathematics: Japanese Curriculum Resources for U.S. Teachers

Award # R305A110500 Catherine Lewis, Mills College

In this project, researchers iteratively developed and tested a widely used multiunit Japanese elementary mathematics curriculum for use in grades K through 2 in the United States. Researchers aimed to understand whether translated versions of the curriculum could be used effectively by teachers in U.S. mathematics classrooms. The selected mathematics topics in the revised curriculum aligned with the Common Core State Standards and included addition and subtraction, place value, and reasoning with shapes and their geometric attributes. Researchers also translated the K-5 teacher's manual and used lesson study as a professional development tool to build high-quality implementation of the Japanese curriculum.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Investigation of the Efficacy of the JUMP Program of Mathematics Instruction

Award # R305A120184 Rosemary Tannock, The Hospital for Sick Children (SickKids)

In this project, researchers evaluated the impact of Junior Undiscovered Math Prodigies (JUMP Math), a multiunit math curriculum for students in kindergarten through grade 8 developed to improve mathematics learning. The curriculum had a strong emphasis on symbolic math (e.g., numbers, letters, and mathematical symbols) and focused on the mental activity involved in constructing mathematical knowledge. An important hallmark of the JUMP Math curriculum was that math problems were reduced to increasingly smaller steps until students were able to achieve mastery, and then the problems were built back up incrementally to meet the curriculum demands.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Science4Us: Game-Based K-2 STEM Education for Teachers and Students

Award # EDIES13C0033 Catherine Christopher, Vkidz, Inc.

In this project, researchers iteratively developed and tested a prototype of a web-based gaming intervention for students in kindergarten through grade 2 developed to help them learn standard-based concepts in science, technology, engineering, and math. The games had engaging and interactive simulations, investigations, stories and videos, as well as individual pages that allowed students to access their own set of digital scientific tools such as a notebook, a glossary, and animations.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Efficacy of an Integrated Digital Elementary School Mathematics Curriculum

Award # R305A130400 Jeremy Roschelle, SRI International

In this project, researchers evaluated the impact of Reasoning Mind (RM), a fully developed digital mathematics curriculum, which can serve as a primary, full-year, grade 5 curriculum. The intervention aimed to give students and teachers instant feedback, provide supports for learning, and offer engaging activities. RM aimed to help develop students' understanding of key topics on the pathway to algebra, such as the place value system, fractions, rational numbers, geometric measurement, and graphing points in a coordinate plane.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments

Award # R305H040032 Brian Bottge, University of Wisconsin, Madison

In this project, researchers iteratively developed and tested Enhanced Anchored Instruction (EAI), a math intervention for average and low-achieving middle and high school students to improve their problem-solving and basic skills (e.g., computation of whole numbers and fractions) and to help them understand the importance and benefits of learning math. EAI used a mix of video-based problems delivered on CD-ROM and hands-on projects (e.g., building skateboard ramps, compost bins, or hovercrafts). Students defined and understood the EAI problem, located the relevant pieces of information for solving it, and then integrated this information into a logical solution.

Grade Levels:
MS, HS
Focal Populations:
SWD
Products Developed / Tested:

AnimalWatch: An Intelligent Tutoring System for Grade 6 Mathematics

Award # R305K050086 Carole Beal, University of Southern California

In this project, researchers iteratively developed and tested AnimalWatch, a supplemental mathematics intelligent tutoring software for grade 6 students. The software aimed to improve mathematics skill and achievement, particularly for students from groups that have been traditionally under-represented in science and engineering fields. The AnimalWatch software integrated mathematics problem solving and multimedia instruction with information about environmental science and endangered species. When students logged on to AnimalWatch, they adopted the role of a wildlife biologist charged with learning about and monitoring a particular endangered species.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

The Potential Efficacy of Math in a Cultural Context: Sixth Grade Math Modules

Award # R305A070218 Jerry Lipka, University of Alaska, Fairbanks

In this project, researchers iteratively developed and tested Math in a Cultural Context, a mathematics curriculum for native Alaskan sixth-grade students. The curriculum aimed to close the academic gap between native Alaskan and majority culture students by providing culturally based instruction that was accessible and interesting, thus motivating students to engage and learn. Math in a Cultural Context was a series of supplemental math modules that incorporated the knowledge of native Alaskan elders. Researchers developed the modules around everyday activities of native Alaskans and their subsistence-oriented lifestyle.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Bringing Cognitive Tutors to the Internet: A Website that Helps Middle-School Students Learn Math

Award # R305A080093 Vincent Aleven, Carnegie Mellon University

In this project, researchers iteratively developed and tested a website for students in grades 6 through 8 where they could practice and develop their mathematics skills with artificial-intelligent software called Cognitive Tutors. Researchers aimed to increase students' math achievement by providing step-by-step tutoring in the areas of numbers and operations, algebra, data analysis, geometry, and ratios and proportional reasoning. The website also included support materials such as interactive worksheets and quizzes and automated reporting of student progress and performance for tutors, teachers, and parents.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Closing the Achievement Gap in Middle School Mathematics Utilizing Stanford University's Education Program for Gifted Youth Differentiated Mathematics Program

Award # R305A080464 Patrick Suppes, Stanford University

In this project, researchers evaluated the impact of the EPGY program (Stanford University's Education Program for Gifted Youth) on middle school students' mathematics performance. Researchers aimed to determine the degree to which EPGY improved mathematics performance in middle schools with a large percentages of minority students, English language learners, and low-income students. The EPGY intervention was a computer-based program that was self-paced, individualized, and designed to detect and address gaps in student preparation. In addition, the EGPY program provided information on student progress ranging from summaries of performance measures to detailed reports showing student learning trends, areas of strengths and weaknesses, and forecasts of end-of-year performance.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

An Empirical Approach to Developing Web-based Math Learning Games to Improve Elementary School Student Outcomes

Award # EDIES10P0104 Snehal Patel, Virtual Learning Technologies

In this project, researchers iteratively developed and tested web-based math learning games and researched their usability, feasibility, and promise. Researchers developed a series of web-based math learning games that incorporated research-based pedagogy, communal learning, and adaptive, standards-based content. The games were designed to supplement elementary students' existing in-class curricular materials and addressed topics such as fractions, place value and estimation, numeric operations, algebra functions and operations, measurement geometry, and statistics data analysis and probability.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math

Award # R324A090179 Brian Bottge, University of Kentucky

In this project, researchers evaluated the impact of Enhanced Anchored Instruction (EAI), a mathematics pedagogical approach, on the math performance of middle school students with learning disabilities. EAI aimed to develop math skills, such as problem solving, by providing students with additional opportunities to practice their skills as they solved new but analogous math problems. The intervention integrated video-based problems, hands-on projects, and explicit instructional units.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities

Award # R324A090340 Lindy Crawford, Texas Christian University

In this project, researchers iteratively developed and tested the Math Learning Companion, a web-based mathematics intervention for sixth-grade students struggling with mathematics. The intervention aimed to improve student outcomes through four primary components: a supplemental sixth-grade mathematics curriculum with 48 standards-aligned multimedia lessons and additional self-paced content; support tools, including accommodations for students and reports for teachers; diagnostic math probes and assessments, as well as a progress monitoring system, designed to measure student growth; and an adaptive engine to capture student-program interactions, establish learner profiles and trajectories, and provide feedback to match student needs.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Planet First Energy World (PFEW)

Award # EDIES10P0103 George Newman, One Planet Education Network

In this project, researchers iteratively developed and tested a functioning prototype of three-dimensional (3D) virtual environment and performed tests on the usability and initial feasibility of the prototype. The project team developed a prototype of the Planet First Energy Worlds, a 3D virtual environment focused on energy-related topics that addressed sixth-grade mathematics and science standards. The intervention used inquiry scenarios and disciplinary content to address different situations using a video game format immersed in 3D technology. The intervention included teacher professional development and support.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

National Research & Development Center on Cognition and Mathematics Instruction

Award # R305C100024 Steve Schneider, WestEd

In this project, researchers iteratively adapted and tested components of a middle school mathematics curriculum, Connected Mathematics Project, and evaluated the impact of the redesigned curriculum materials. The researchers based their adaptations on cognitive research that focused on learning and information processing. To this end, researchers conducted an integrated series of design studies; developed and tested practical guidelines to enable mathematics teachers, curriculum developers, and publishers to apply the design guidelines; as well as conducted supplementary studies on important issues in mathematics teaching and learning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired

Award # EDIES11C0028 Marjorie Darrah, Information Research Corporation

In this project, researchers iteratively developed and tested Interactive Touch Science, an integrated software and hardware assistive technology platform, and researched its usability, feasibility, and promise. The product included a set of 20 applications that addressed standards-relevant content and aimed to support STEM (science, technology, engineering, and mathematics) learning among middle school students with (or without) visual impairments. The product also provided real-time tactile, visual, and audio feedback.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

8. Student Practice, Inquiry, and Reasoning in Mathematics in Kindergarten through 12th Grade Settings

Researchers have shown the importance of learning multiple strategies and building conceptual knowledge to help students with disabilities (Jitentra and Star 2011), struggling learners (Lynch and Star 2014), and learners in general excel in math (Rittle-Johnson, Star and Durkin 2012; Schneider, Rittle-Johnson and Star 2011). Research in this area focuses on how students engage subject matter as they develop and highlights the process of learning math, rather than memorizing specific facts or content. This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student learning and outcomes by strengthening student skills and practices, such as problem-solving, pattern recognition, abstract thinking and reasoning, and constructing viable arguments and critiquing the reasoning of others.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Using Cognitive Analyses to Improve Children's Math and Science Learning

Award # R305H020060 Robert Siegler, Carnegie Mellon University

In this project, researchers explored the relationship between differences in children's initial conceptual understandings of mathematics and science and children's later performance on mathematics and science tasks. The researchers also iteratively developed and tested a strategy for teaching children to overcome their misconceptions regarding numerical magnitudes.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Age-related Changes in Word Problem Solving and Working Memory

Award # R305H020055 H. Lee Swanson, University of California, Riverside

In this project, researchers evaluated the mechanisms by which working memory influenced word problem-solving accuracy for children in first through third grades who had normal mathematical abilities or who were at risk of math difficulties.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Increasing Learning by Promoting Early Abstract Thought

Award # R305H030031 Robert Pasnak, George Mason University

In this project, researchers evaluated the impact of an education intervention for kindergarten children on their acquisition of academic content knowledge in reading and math. The intervention aimed to enhance two particular forms of abstract thinking: figuring out which object in a group is unlike the others and knowing how to insert an appropriate object into a pre-given series of objects. The researchers compared student learning of the abstract thinking principles and their learning in mathematics and reading, to see which forms of instruction were more effective for attaining which learning outcomes.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Understanding Students' Mathematical Competencies: An Exploration of the Impact of Contextualizing Mathematical Problems

Award # R305H030282 Robert Sternberg, Tufts University

In this project, researchers explored the relationship between relating mathematical problems to the context of everyday life, fourth- and sixth-grade students' performance on those problems, and the students' mathematical knowledge of how to solve them. The researchers investigated whether the factors that made mathematical problems seem more practical also contributed to better student performance on those problems, as well as how to shape instruction to take advantage of those factors.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Optimizing Resistance to Forgetting

Award # R305H040108 Harold E. Pashler, University of California, San Diego

In this project, researchers iteratively developed and tested instructional procedures for fostering long-term retention of information and skills. The researchers in this project added a series of 10 cognitive experiments to another research program that examined factors that affected retention or forgetting of learned information. The researchers aimed to use information obtained from these studies to develop a computer-based intervention designed to teach English vocabulary and math knowledge to high school students preparing for the SAT.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

Math Pathways and Pitfalls Lessons for K-7 Students: Improving Mathematics Achievement for English Language Learners

Award # R305K050050 Carne Barnett-Clarke, WestEd

In this project, researchers evaluated the impact of the Math Pathways and Pitfalls (MPP) lessons on fourth- and fifth-grade English language learners' mathematical achievement and development of mathematics-related language. The MPP lessons aimed to help students strengthen their understanding of difficult mathematical concepts and to improve their capacity to use academic language to learn from demanding curricula. A component of the MPP lessons was the use of typical and atypical examples, including examples of pitfalls.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning

Award # R305H060070 Philip Kellman, University of California, Los Angeles

In this project, researchers iteratively developed and tested computer-based learning modules coordinated with other modes of instruction for students in the third through eighth grades. The intervention was designed to help students develop an integrated mathematical knowledge base in which measurement and fractions were meaningfully connected to each other and to core concepts of multiplication, division, ratio, and proportion. The intervention consisted of six units of computer-based instructional materials that combined perceptual learning modules (i.e., units that aim to develop students' ability to recognize and use structure, patterns, and relationships by having them interact with information), diagnostic assessments, benchmark lessons and investigations, and resources for teachers.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Validating a Response to Intervention Multitiered Model for Primary Grade Students With Mathematics Difficulties

Award # R324B070164 Diane Bryant, University of Texas, Austin

In this project, researchers iteratively developed and tested two interventions, Early Mathematics Boosters Stage 2 and Stage 3, multi-unit math curricula to be used in a Response to Intervention mathematics model with first-grade students. The interventions aimed to reduce students' mathematics difficulties and improve long-term mathematics outcomes for all students, particularly for students with mathematics disabilities. Early Mathematics Boosters Stage 2 was intended for use with students with mathematics difficulties who were struggling with classroom-wide mathematics instruction. Early Mathematics Boosters Stage 3 was intended for use with students with severe mathematics disabilities. The interventions targeted number concept, operation, quantitative reasoning, and problem-solving skills.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Focusing on the Efficacy of Teaching Advanced Forms of Patterning on First Graders' Improvements in Reading, Mathematics, and Reasoning Ability

Award # R305A090353 Robert Pasnak, George Mason University

In this project, researchers evaluated the impact of a fully developed patterning intervention on first-grade children's reading, mathematics, and reasoning performance. Researchers referred to "patterning" as the ability to recognize an ordering of numbers, letters, shapes, symbols, objects, or events according to some rule of progression. The researchers hypothesized that helping children develop the age-appropriate abstract thinking involved in recognizing patterns would lead to significant academic progress in numeracy and knowledge of letter sounds.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Spatial Temporal Mathematics at Scale: An Innovative and Fully Developed Paradigm to Boost Math Achievement Among All Learners

Award # R305A090527 George Farkas, University of California, Irvine

In this project, researchers evaluated the impact of Spatial-Temporal Math, a fully developed math curriculum that used a non-language-based approach to grade-level math concepts using animated instructional software. In this intervention, elementary school students experienced math concepts and solved mathematics problems through language- and symbol-minimized representations. The goal was to assess the precise benefits of approaching math through spatial temporal reasoning. The project studied program effects on K-5 schools that served a diverse demographic, including economically disadvantaged students and English learners.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

Strategy Training, Problem Solving, and Working Memory in Children With Math Disabilities

Award # R324A090002 H. Lee Swanson, University of California, Riverside

In this project, researchers iteratively developed and tested two interventions for upper elementary students with math disabilities. The intervention was developed to help students compensate for working memory limitations to improve students' performance on math word problems. The researchers designed two interventions to help third- through fifth-grade students with problem-solving accuracy, comprehension, and math calculation and memory. The researchers also examined whether training students with math disabilities to use a rehearsal strategy improved word problem-solving performance.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Language in Math

Award # R305A100862 Walter Secada, University of Miami

In this project, researchers iteratively developed and tested Language in Math, an intervention for upper elementary and middle school English language learners developed to increase students' knowledge of academic language used in math. The intervention focused students' attention on the mathematical problem to be solved, the relevant textual information, procedural and conceptual aspects of the problem, and justification of the solution. In addition, the researchers developed professional development to promote pedagogical practices that support students' math-literacy development.

Grade Levels:
ES, MS
Focal Populations:
EL
Products Developed / Tested:

A Longitudinal Study of 3-D Spatial Skills and Mathematics Development in Elementary School Children

Award # R305A110920 Martha Carr, University of Georgia

In this project, researchers explored the relationship between the development of spatial skills and the development of mathematics number sense and competency. The researchers aimed to examine how spatial skills develop and change over the elementary school years. The work included an experiment to determine whether a 5-week training program can improve second- and fourth-grade students' spatial skills. The training program was implemented during students' afterschool program and included exercises to improve students' spatial skills through use of isometric drawings, orthographic drawings, flat patterns, rotation of objects about single and multiple axes, and cutting planes.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Spatial Ability as a Malleable Factor for Math Learning

Award # R305A120416 Kelly Mix, Michigan State University

In this project, researchers explored the relationship between spatial ability and aspects of math performance of kindergarten, second-, and fourth-grade students. The researchers also gathered evidence regarding whether training to improve spatial ability also improved math performance.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

The Solutions Project: Teaching Students With Moderate/Severe Intellectual Disability to Solve Mathematical Problems

Award # R324A130001 Diane Browder, University of North Carolina, Charlotte

In this project, researchers iteratively developed and tested materials for teaching mathematical problem solving to students in fourth through eighth grades with moderate to severe intellectual disabilities. Researchers combined methods used to teach problem solving to students with high-incidence disabilities and research-based practices for teaching mathematics to students with moderate/severe intellectual disabilities. The intervention included scripted teacher read alouds; adapting schema-based instruction; and methods of teaching students to generalize the problem solving across problems, real life activities, and education settings. The intervention also included a peer-tutoring component implemented in general education math classrooms.

Grade Levels:
ES, MS
Focal Populations:
SWD
Products Developed / Tested:

Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments

Award # R305H040032 Brian Bottge, University of Wisconsin, Madison

In this project, researchers iteratively developed and tested Enhanced Anchored Instruction (EAI), a math intervention for average and low-achieving middle and high school students to improve their problem-solving and basic skills (e.g., computation of whole numbers and fractions) and to help them understand the importance and benefits of learning math. EAI used a mix of video-based problems delivered on CD-ROM and hands-on projects (e.g., building skateboard ramps, compost bins, or hovercrafts). Students defined and understood the EAI problem, located the relevant pieces of information for solving it, and then integrated this information into a logical solution.

Grade Levels:
MS, HS
Focal Populations:
SWD
Products Developed / Tested:

Guided Cognition for Unsupervised Learning

Award # R305H050062 William Whitten, Fordham University

In this project, researchers iteratively developed and tested an instructional method for structuring homework assignments for middle and high school English and math students. The researchers aimed to identify ways to increase the likelihood that homework would involve productive study of new material. The method, called guided cognition, structured study tasks to guide the learner to engage in specific, observable cognitive events (e.g., drawing a diagram, listing multiple approaches to solving a problem, listing specific evidence that support conclusions). The researchers hypothesized that these cognitive events elicit underlying cognitive processes that may facilitate learning.

Grade Levels:
MS, HS
Focal Populations:
EL
Products Developed / Tested:

Artificial Intelligence Software for Individualized Math Tutoring for Students Who are Blind and Visually Impaired

Award # ED06PO0919 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively a prototype of artificial intelligence (AI) tutor software program developed and tested artificial intelligence software for individualized math tutoring for students who are blind or visually impaired. The software aimed to provide full accessibility to the blind and individuals with reading disabilities, using Internet screen reader technology.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Enhancing the Mathematical Problem Solving Performance of Sixth Grade Students Using Schema-Based Instruction

Award # R305K060002 Asha Jitendra, University of Minnesota

In this project, researchers iteratively developed and tested an instructional intervention for sixth-grade students that focused on critical mathematics concepts (e.g., ratios, proportions) and relations (e.g., multiplication and division). The researchers developed a set of lessons to promote students' understanding of problems involving multiplicative relations using schema-based instruction (SBI). The SBI intervention aimed to help students understand mathematics content and to solve a range of problems encountered in everyday life through teacher-led discussions to show students how to symbolically represent problems using schematic diagrams.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Improving Mathematics Performance of At-Risk Students and Students With Learning Disabilities in Urban Middle Schools (MSM Project)

Award # R324A070206 Marjorie Montague, University of Miami

In this project, researchers evaluated the impact of Solve It!, an intervention for middle school students with learning disabilities to help them understand, analyze, solve, and evaluate mathematical problems by developing the processes and strategies that effective problem solvers use. Solve It! was based on explicit instruction and was characterized by structured lessons, appropriate cues and prompts, guided and distributed practice, immediate feedback, positive reinforcement, overlearning, and mastery. Solve It! embedded other research-based instructional strategies such as active student participation, verbal rehearsal, and cognitive modeling.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Guided Cognition for Unsupervised Learning of Mathematics

Award # R305A080134 William Whitten, Fordham University

In this project, researchers iteratively adapted and tested an instructional method that guided learner to engage in specific, observable cognitive events (e.g. drawing a diagram, listing multiple approaches to solving a problem). The researchers used this method, called "guided cognition", which is more commonly used in English literature classes, to restructure homework assignments for middle school mathematics students. The researchers also aimed to understand whether it was possible to enrich the learning value of middle school students' mathematics homework by selectively incorporating cognitive events that occur frequently in supervised group learning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math

Award # R324A090179 Brian Bottge, University of Kentucky

In this project, researchers evaluated the impact of Enhanced Anchored Instruction (EAI), a mathematics pedagogical approach, on the math performance of middle school students with learning disabilities. EAI aimed to develop math skills, such as problem solving, by providing students with additional opportunities to practice their skills as they solved new but analogous math problems. The intervention integrated video-based problems, hands-on projects, and explicit instructional units.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

A Theory-Driven Search for the Optimal Conditions of Instructional Guidance in Algebra Tutor

Award # R305A100109 John Anderson, Carnegie Mellon University

In this project, researchers explored the cognitive processes of seventh- through ninth-grade students as they solved algebra problems in the context of the Carnegie Learning's Algebra Tutor software. The researchers used computer simulations of individual students (synthetic student models) to find the optimal conditions of instructional guidance a student needs to master an algebra problem.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Math Messenger

Award # ED06PO0912 Hsinchao Liao, Creava, Inc.

In this project, researchers iteratively developed a prototype of Math Messenger, an online mathematics communication tool that combined instant messaging and texting technologies with the ability to write and edit formulas. Math Messenger was designed for use in online high school mathematics courses to facilitate collaboration of mathematical problems and to allow users to visualize graphical problems.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

The Organization of Mathematical Knowledge

Award # R305A080341 Lance Rips, Northwestern University

In this project, researchers explored the relationship between two different ways of organizing mathematical information and high school students' understanding of and memory for the text. The researchers aimed to understand which cognitive components (e.g., rehearsal of and memory for important information) might be affected by the format of the text and to offer research-based suggestions for curriculum presentation. The formats examined were the object-based format that organized the content around mathematical objects, sub-objects, and the properties of objects and the deduction-based format that organized the content using deductive relations that exist between concepts.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts

Award # R305A100074 Julie Booth, Temple University

In this project, researchers iteratively developed and tested a computer program for Algebra I high school students to help them overcome misconceptions in algebra through the use of incorrect examples and self-explanation exercises. The intervention provided high school students with different types of self-explanation exercises: typical self-explanation (designed to help them discover and strengthen correct strategies) and corrective self-explanation (designed to help them understand why ineffective strategies were incorrect).

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Coordinating Multiple Representations: A Comparison of Eye Gaze Patterns of High School Students Who Do and Do Not Enroll in Calculus

Award # R305A120471 Jennifer Cromley, Temple University

In this project, researchers explored the relationship between coordinating multiple representations and 12th-grade students' scores on practice Advanced Placement calculus questions. The researchers also examined whether experience in a calculus class was related to students' ability to coordinate multiple representations and whether minor text manipulations could increase the extent to which students coordinate multiple representations. The researchers aimed to determine how high school seniors engage in coordinating multiple representations skills with graphical, symbolic, and tabular representations during mathematical problem solving.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

Optimizing Resistance to Forgetting

Award # R305H020061 Harold E. Pashler, University of California, San Diego

In this project, researchers explored how to extend basic research on memory beyond the laboratory setting to evaluate effective strategies to optimize the use of study time and improve students' ability to retain information, including mathematics knowledge. In particular, they looked at how approaches such as spaced practice and interleaving affect learning.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

9. Student Perceptions, Motivations, Attitudes, and Anxiety about Mathematics in Kindergarten through 12th Grade Settings

Students who are motivated and engaged in mathematics have high math self-efficacy and self-concept in math (Gunderson et al. 2012) and subsequently have high math achievement (Parker et al. 2014). Students with lower self-efficacy in math exhibit less help-seeking behavior (Beal, Qu and Lee 2008; Zusho and Barnett 2011; Ryan, Patrick and Shim 2005), less engagement or "press" to understand math (Nosek and Smyth 2011), and experience more anxiety related to math (Ramirez, Gunderson, Levine and Beilock 2013). Anxiety in math is particularly salient for students of color (Cheema and Galluzo 2013) and students with disabilities (Prevatt, Welles, Li, and Proctor 2010). This chapter includes projects that strive to promote math achievement by understanding student perceptions and attitudes towards math, including math anxiety, motivation, self-regulation, and metacognitive strategies used to learn math.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

A Longitudinal Study of Gender and Mathematics Using ECLS-K Data

Award # R305A080147 Sarah Lubienski, University of Illinois, Urbana-Champaign

In this project, researchers explored the relationship between gender and elementary school students' mathematics performance. Researchers aimed to shed light on ways in which boys' and girls' early experiences differ at both school and home and determine which of those differences related to gender disparities in K-5 mathematics achievement. This study provided an examination of factors that predict gender differences in elementary school mathematics performance.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Teaching Every Student: Using Intelligent Tutoring and Universal Design to Customize the Mathematics Curriculum

Award # R305A080664 Beverly Woolf, University of Massachusetts, Amherst

In this project, researchers iteratively developed and tested two web-based mathematics tutors for elementary, middle, and high school math students—Wayang Outpost and 4mality. Researchers aimed to minimize student disengagement and create a supportive and fruitful learning environment through the enhancement of three major components: affect detection software that estimated the emotional state of the user to determine the appropriate difficulty level for ensuing math problems, a suite of interventions to re-engage disengaged students, and assessment tools that informed teachers about each student's progress and affect.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

An Exploration of Malleable Social and Cognitive Factors Associated With Early Elementary School Students' Mathematics Achievement

Award # R305A110682 Sian Beilock, University of Chicago

In this project, researchers explored how first and second grade students' mathematics anxiety and attitudes relate to their mathematics achievement. The researchers also explored the relationship between teachers' math anxiety and students' math achievement. The researchers gathered student and teacher data at the beginning and end of the school year and observed teachers who were identified as having low or high math anxiety while they taught their students mathematics and reading. The project also explored how different types of teacher practices affected students' math and reading anxiety, stereotypes, and performance.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

The Potential Efficacy of Math in a Cultural Context: Sixth Grade Math Modules

Award # R305A070218 Jerry Lipka, University of Alaska, Fairbanks

In this project, researchers iteratively developed and tested Math in a Cultural Context, a mathematics curriculum for native Alaskan sixth-grade students. The curriculum aimed to close the academic gap between native Alaskan and majority culture students by providing culturally based instruction that was accessible and interesting, thus motivating students to engage and learn. Math in a Cultural Context was a series of supplemental math modules that incorporated the knowledge of native Alaskan elders. Researchers developed the modules around everyday activities of native Alaskans and their subsistence-oriented lifestyle.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

A Randomized Trial of Reducing Stereotype Threat Among Minority and Economically Disadvantaged Students

Award # R305A090162 Thomas Dee, National Bureau of Economic Research (NBER)

In this project, researchers evaluated the impact of a 15-minute, written, in-class exercise for middle school students. The intervention aimed to negate stereotype threat by affirming students' self-integrity through their reflection on personally important core values. By doing so, the intervention was to reduce gaps in academic performance between students of different backgrounds (e.g., socioeconomic, gender, race).

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Academic Achievement in Limited English Proficient Students: A Multivariate Latent Growth Modeling Analysis of Predictors, Mediators, and Moderators

Award # R305A090288 Sergio Guglielmi, Lake Forest College

In this project, researchers explored the relationship between native language proficiency and mathematics and science achievement growth of English language learners (EL) in grades 8, 10, and 12. Researchers aimed to identify mechanisms through which native language proficiency related to the achievement growth of EL students. The research focused on a bilingual education model in which proficiency in students' native language and exposure to their heritage culture promoted academic achievement by facilitating the development of English language skills and bolstering students' self-esteem. Researchers used data from the National Education Longitudinal Study to conduct the research.

Grade Levels:
MS, HS
Focal Populations:
EL
Products Developed / Tested:

Empires: The First Socially-Networked Story-Based Math Game

Award # EDIES13C0043 Scott Laidlaw, Imagine Education

In this project, researchers iteratively developed and tested Empires, a web-based game for seventh-grade students to engage and motivate them in mathematics learning. The prototype of this game was developed under a previous IES award. The game included a narrative-based story that applied learning of content and skills aligned to the Common Core State Standards in mathematics. As students played the game, they were highly engaged in math-focused activities to drive the action, such as taxing citizens to learn ratios and proportions, allocating resources to learn percentages, and measuring the distance and time to a neighboring empire by applying the principles of the Pythagorean Theorem.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Impact of Theories of Intelligence on Self-Regulated Learning Strategies and Performance Improvement

Award # R305A130699 Joyce Ehrlinger, Washington State University

In this project, researchers explored whether a belief that a person could improve his or her own intelligence could lead students to use self-regulated learning strategies more often and in more effective ways. The intervention targeted freshmen and sophomore high school students and focused on whether adopting self-regulated learning strategies had consequences for metacognitive accuracy and sustained learning in mathematics.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

10. Mathematics in Postsecondary and Adult Education Settings

After high school graduation, math continues to be an important component of student development and an area that proves difficult for many students. Colleges and universities require credits in mathematics regardless of student major, and math skills continue to be essential as postsecondary institutions prepare students for employment (Hodara 2013). However, math continues to serve as an obstacle for many students outside of the K-12 system. For example, many students need remediation in math in community colleges and other institutions of higher education (Sparks and Malkus 2013; ACT 2011), and the math anxieties (Prevatt, Welles, Huijun, and Proctor 2010), expectations and interests (Yeager et al. 2014), and self-efficacy of adult learners may affect their math learning (Parker, Marsh, Ciarrochi, Marshall et al. 2014). This chapter includes research related to postsecondary and adult education, specifically remedial or gateway math courses, as well as courses needed to complete a bachelor's degree.

Table Key

Grade levels:

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Promoting Discriminative and Generative Learning: Transfer in Arithmetic Problem Solving

Award # R305A130082 Charles Kalish, University of Wisconsin, Madison

In this project, researchers explored the relationships between malleable factors of instructional practice and fluent, transferable learning. Researchers explored a set of malleable factors linking forms of arithmetic practice to specific memory models to identify a range of outcomes of mathematics instruction by testing second grade students in classroom studies and undergraduate students in lab experiments. Researchers wanted to highlight distinct goals for mathematics education and provide a set of design principles for achieving those outcomes and goals.

Grade Levels:
ES, PA
Focal Populations:

Products Developed / Tested:

Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation

Award # R305A110060 David Landy, University of Richmond

In this project, researchers iteratively developed and tested Pushing Symbols, an intervention for middle, high school, and remedial college students developed to enhance students' understanding of algebraic notations. The intervention used a set of verbal, physical, and computer-based visualizations to allow students to interact physically and dynamically with expression elements.

Grade Levels:
MS, HS, PA
Focal Populations:

Products Developed / Tested:

Ready or Not? California's Early Assessment Program and the Transition to College

Award # R305A100971 Michal Kurlaender, University of California, Davis

In this project, researchers evaluated the impact of California's Early Assessment Program (EAP), a program designed to help high school students assess whether they are academically prepared for college. The primary component of the EAP is an assessment of English and math skills among California 11th graders. The EAP assessment supplements California Standards Test and the California State University (CSU) placement standards with a set of multiple-choice questions and an essay. The researchers used data from the California Department of Education, CSU, and the community college system to determine student participation in the EAP assessment during 11th grade, their subsequent course taking during 12th grade, their rates of application to California state universities and community colleges, their rates of placement in non-remedial college courses, their college GPAs, and their persistence from semester to semester.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:
✓

Improving the Assessment Capability of Standardized Tests: How High-Stakes Testing Environments Compromise Performance

Award # R305H050004 Sian Beilock, University of Chicago

In this project, researchers iteratively developed and tested assessment tools that reduce the negative effects of stereotype threat that undermine undergraduate women's expression of math skills. The project aimed to provide new guidance on how standardized assessments can be developed that accurately reflect all students' abilities and potential.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:
✓

National Center for Postsecondary Research

Award # R305A060010 Thomas Bailey, Columbia University, Teachers College

In this project, researchers evaluated the impact of policies and programs designed to help students successfully transition to postsecondary education and training and to graduate with a college degree. This center included a cluster of coordinated research projects that addressed different components of the overall goal. These projects pursued research on the effectiveness of dual enrollment programs, postsecondary remediation in math and English, and financial aid and higher education information systems.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Enhancing Self-Reflection and Mathematics Achievement of At-Risk Students at an Urban Technical College: A Self-Regulated Learning Intervention

Award # R305H060018 Barry Zimmerman, City University of New York (CUNY)

In this project, researchers iteratively developed and tested an intervention for students in remedial and college-level mathematics courses. The intervention aimed to help at-risk students in an urban technical college improve their mathematics performance by improving their self-regulation, with particular attention to self-reflection processes. The intervention included teacher demonstrations of coping techniques and exercises designed to encourage self-efficacy, self-evaluation, and self-reflection processes. Students receiving the intervention were given opportunities to improve their math quiz scores by engaging in a self-regulation revision process that allowed them to correct wrong answers.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Evaluating the Effects of Basic Skills Mathematics Placement on Academic Outcomes of Community College Students

Award # R305A100381 Tatiana Melguizo, University of Southern California

In this project, researchers evaluated the impact of postsecondary math placement policies on the course-taking patterns of community college transfer students who were placed in basic-skills mathematics courses. Researchers aimed to provide insights for district and state decisionmakers that could result in significant cost savings based on the effect of remedial placement on successful course sequences. Researchers used secondary analysis of student transcript data to evaluate the effects of assignment to a higher or lower level of basic skills math courses on students' college progress and success.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Math Education for Adult Learners and College Remediation Using Artificial Intelligence

Award # EDIES11C0041 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively developed and tested a web-based artificial intelligence tutor and researched its usability, feasibility, and promise. The prototype of this tutor was developed under a previous IES award. The project aimed to extend artificial intelligence methodologies to an on-demand tutor focused on developmental mathematics for adult learners and underprepared college students requiring remediation. The project team programmed the web-based artificial intelligence tutor with an automated assessment feature to check responses and offer immediate tutoring on any mistakes.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Award # R305A130125 Mary Visher, MDRC

In this project, researchers evaluated the impact of a developmental math curriculum and placement policies for Texas community college students in need of remediation. The placement policy included using students' scores on placement exams to determine whether students could enter directly into credit-bearing courses or if they would be encouraged to take a developmental math course or, if the student scored particularly low, more basic-level courses. The developmental math curriculum studied in this project divided the math content into discrete modules, allowing students to learn at their own pace.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

11. Teacher Instruction, Pedagogy, and Professional Development in Mathematics

Research has found that a teachers' math knowledge correlates with student learning gains in mathematics (Hill et al. 2005; Santagata et al. 2011) and that effective teacher instruction in and knowledge of math are both associated with increased student learning in math (Hill, Rowan, and Ball 2005; Newman et al. 2012). However, research also suggests that some teachers are insufficiently knowledgeable beyond basic arithmetic (Garet et al. 2011) and that this lack of mathematics knowledge is more pronounced among teachers in low-income schools (Hill 2007, 2010). Research on teachers' pedagogy and instruction has focused on various professional development, training, and coaching models to help teachers improve their pedagogical efficacy (Borko 2004; Yoon et al. 2007). This chapter focuses exclusively on projects designed to help teachers develop their instructional skills and content knowledge to improve student outcomes in math.

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Understanding and Facilitating Symbolic Learning

Award # R305H050059 David Uttal, Northwestern University

In this project, researchers iteratively developed and tested two math interventions for parents and elementary school teachers designed to help them use symbolic objects, such as manipulatives, more effectively. The first intervention facilitated 4-year-olds' understanding of the symbolic properties of letters and numbers through simple games using magnetic letters and numbers that parents could use while playing with their child. The second intervention took place in second- and fourth-grade classrooms, where teachers implemented instructional methods designed to help children link what they learned with mathematics manipulatives to written versions of the same kind of problems.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation

Award # R305M060057 Nicole Kersting, University of Arizona

In this project, researchers designed and validated video-analysis assessments for three pre-algebra topic areas (fractions, ratio and proportion, and equations) in order to measure elementary and middle school teachers' knowledge of teaching mathematics. Each video-analysis assessment (administered online) consisted of a set of video clips and an analysis task. Teachers analyzed each clip and recorded their responses in text fields.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

The Efficacy of the Responsive Classroom Approach for Improving Teacher Quality and Children's Academic Performance

Award # R305A070063 Sara Rimm-Kaufman, University of Virginia

In this project, researchers evaluated the impact of the Responsive Classroom approach in third through fifth grade classrooms. The intervention aimed to integrate social and academic learning and create optimal classroom learning environments that enhanced children's ability to learn. Responsive Classroom featured regular structured class meetings; an established approach to handling rules and consequences for behavior; procedures that offered academic choice to children; specific recommendations for teachers that focus children's attention on the process of learning, problem solving, and reflecting on their work; and methods for introducing new academic material to students.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Improving the Mathematical Content Base of Lesson Study: Design and Test of Two Research-Based Toolkits

Award # R305A070237 Catherine Lewis, Mills College

In this project, researchers iteratively developed and tested a research-based toolkit to help teachers. In this professional development approach, teachers worked in lesson study groups to learn together how to access and use content knowledge effectively. The toolkit designed for these groups focused on mathematical representations and included resources designed to help the study group participants learn about the teaching and learning of the topic (e.g., mathematical tasks, examples of student work, classroom videos, and assessments). The project gathered preliminary data comparing three forms of professional development: lesson study with the developed toolkits, lesson study without the toolkit resources, and professional development in elementary mathematics.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Evaluating Math Recovery With Student Outcomes

Award # R305B070554 Paul Cobb, Vanderbilt University

In this project, researchers evaluated the impact of the Math Recovery program on mathematics achievement among low-performing first graders. The Math Recovery program aimed to enable first graders whose performance was below the 25th percentile nationally to achieve at the level of their higher performing peers, thus changing the longitudinal trajectory of their mathematics development. The program consisted of three components: screening low-performing students in mathematics and conducting interviews to develop a detailed profile of each child's knowledge of arithmetic, providing one-to-one tutoring, and training teachers in new practices for clinical assessment and diagnostic tutoring.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Instructional Effects on Achievement Growth of Children With Learning Difficulties in Mathematics

Award # R324A070270 Paul Morgan, Pennsylvania State University

In this project, researchers explored the relationship between specific types of mathematics instructional practices for children in grades K through 5 with or at risk for mathematics disabilities and the children's academic outcomes. Researchers aimed to identify potentially effective interventions for improving student achievement by analyzing data from the Early Childhood Longitudinal Study-Kindergarten Cohort to determine which instructional practices were associated with better student achievement. This information could then be used to develop interventions that incorporated those practices that were most likely to contribute to better student outcomes.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities

Award # R324A080014 Diane Browder, University of North Carolina, Charlotte

In this project, researchers iteratively developed and tested a framework for creating math and science learning targets and model lesson plans for students in grades 3 through 10 with significant cognitive disabilities. The intervention aimed to develop high-quality mathematics and science instruction for students who participated in alternate assessments and who were judged against alternate achievement standards. The intervention also included an instructional alignment evaluation checklist, sample learning targets in six strands of science, and model lesson plans.

Grade Levels:
ES, MS, HS
Focal Populations:
SWD
Products Developed / Tested:

The National Center for Research on Rural Education

Award # R305C090022 Susan Sheridan, University of Nebraska, Lincoln

In this project, researchers evaluated the impact of professional development practices designed to improve instruction in rural schools and improve rural students' acquisition of knowledge and skills in reading, science, and mathematics. The project had three primary goals: investigating variations in existing rural professional development practices, differences in professional development practices between rural and non-rural settings, and the potential influence of various characteristics of professional development on rural teachers' knowledge, perceptions, and instructional practices.

Grade Levels:
ES, MS, HS
Focal Populations:
Products Developed / Tested:

National Center for Teacher Effectiveness: Validating Measures of Effective Math Teaching

Award # R305C090023 Thomas Kane, Harvard University, Graduate School of Education

In this project, researchers evaluated the impact of practices and characteristics that distinguished between more and less effective math teachers in grades 4 and 5. Researchers aimed to use this information to develop a suite of empirically validated and practical instruments that school districts could use to select, deploy, and retain more effective teachers. The project had four goals: to unify the strands of research for teacher effectiveness, to develop empirically validated instruments for measuring teacher effectiveness, to operationalize the measures and ensure that they are usable, and to validate the measure of teacher effectiveness against student achievement.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Making Room for Student Thinking: Using Automated Feedback, Video-Based Professional Development, and Evidence-Based Practice Recommendations to Improve Mathematical Discussion

Award # R305A100178 Kevin Miller, University of Michigan

In this project, researchers iteratively developed and tested methods to help teachers monitor and improve classroom discussions on mathematics. The researchers conducted small-scale studies testing some of the underlying assumptions of the intervention to be developed, adapted an automated technique for giving teachers daily feedback on the extent of classroom talk, and used video-based online professional development to provide teachers with methods for leading mathematical discussions. The researchers targeted experienced and beginning elementary teachers and fifth- and sixth-grade students to measure changes in the distribution and quality of classroom discussion.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:


Improving Mathematics Achievement through Active Student Participation in Mathematics Classrooms

Award # R305A100181 Noreen Webb, University of California, Los Angeles

In this project, researchers explored the relationships among the kinds of student participation that are productive for learning, the teacher practices that promote high-quality student participation, and high levels of student achievement in mathematics in grades K through 6. Researchers posited that engaging students as active participants in mathematics classrooms was central to the development of their mathematical skills and understanding. Researchers conducted secondary data analysis of video- and audio-taped classroom observation data of mathematics lessons focusing on number relations and operations.

Grade Levels:
ES, MS
Focal Populations:
Products Developed / Tested:

Using Data to Inform Decisions: How Teachers Use Data to Inform Practice and Improve Student Performance in Mathematics

Award # R305A100445 Linda Cavalluzzo, CNA Corporation

In this project, researchers evaluated the impact of the Using Data (UD) intervention in elementary schools. The researchers examined whether a professional development program designed to help teachers make better use of assessment and other data could translate into improved student performance in mathematics. In this intervention, a data coach, a group of teachers, and an administrator received training on using high-capacity data strategies.

Grade Levels:
ES
Focal Populations:
EL, SWD
Products Developed / Tested:

Developing Mathematics Teaching through Focused Collaborative Assessment of Practice

Award # R305A100623 Pamela Moss, University of Michigan

In this project, researchers iteratively developed and tested a professional development program for mathematics teachers in grades 1 through 5. The proposed program initiated and sustained learning communities in schools in which practicing classroom teachers collaborated with university instructors and novice teachers to assess teaching practice. Researchers developed and used a common language to analyze and guide each practice, enacted practices in their own teaching, and analyzed and provided feedback on their colleagues' practice.

Grade Levels:
ES
Focal Populations:
Products Developed / Tested:

Prime Online: Teacher Pedagogical Content Knowledge and Research-based Practice in Inclusive Elementary Mathematics Classrooms

Award # R324A100196 Cynthia Griffin, University of Florida

In this project, researchers iteratively developed and tested PRIME Online, an online professional development intervention for in-service regular and special education teachers of mathematics in grades 3 through 5. The intervention aimed to improve teachers' content and pedagogical knowledge through modules that addressed four elements: mathematics content, pedagogical content knowledge for teaching elementary mathematics grounded in explicit strategy instruction emphasizing self-regulated learning, the needs of students with learning disabilities included in general education math classrooms, and the use of progress monitoring assessments.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

Japanese Structured Problem-Solving as a Resource for U.S. Elementary Mathematics Teachers: Program Development and Testing

Award # R305A110491 Catherine Lewis, Mills College

In this project, researchers iteratively developed and tested elementary math teacher resources for structured problem solving (SPS), a teaching strategy common in Japan. The SPS approach focused on providing students with systematic ways of approaching problem-solving (e.g., identifying, defining, and describing the problem). The teacher resources aimed to provide teachers with fundamental SPS guides, support their use of the approach in their classrooms, and develop a national community of SPS implementers through summer institutes and webinars.

Grade Levels:
ES
Focal Populations:
Products Developed / Tested:

Scientific Validation of a Set of Instruments Measuring Fidelity of Implementation (FOI) of Reform-Based Science and Mathematics Instructional Materials

Award # R305A110621 Dae Kim, University of Chicago

In this project, researchers designed and validated a suite of fidelity of implementation (FOI) instruments to enable rigorous, specific, and systematic analysis of reform-based K-5 mathematics and science interventions. Researchers designed three classroom-level FOI instruments (Teacher Instructional Questionnaire, Teacher Instructional Logs, and Teacher Instructional Observation) and a student questionnaire to measure student engagement.

Grade Levels:
ES, MS
Focal Populations:
Products Developed / Tested:

Longitudinal Study of a Successful Scaling-Up Project: Extending TRIAD

Award # R305A120813 Douglas Clements, University of Denver

In this project, researchers evaluated the impact of the Technology-enhanced, Research-based, Instruction, Assessment, and professional Development (TRIAD) program on the mathematics achievement of students in grades 2 through 5. Researchers followed the original sample of prekindergarten to grade 1 students who had been in one of two treatment groups: the general TRIAD intervention, which included the use of the Building Blocks prekindergarten mathematics curriculum, teacher professional development, and used the Building Blocks software and Building Blocks Learning Trajectory web application; or TRIAD plus Follow-Through, which included the same components as the general TRIAD intervention, plus teachers were informed about students' prior mathematical accomplishments and competences and were provided tools to support the students' learning in mathematics.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Improving Teachers' Monitoring of Learning

Award # R305A120265 Keith Thiede, Boise State University

In this project, researchers iteratively developed and tested a professional development program for K through 6 teachers called Monitoring Professional Development. This program aimed to improve teachers' accuracy of monitoring student mathematics learning by supporting teacher use of formative assessments. The intervention consisted of a summer institute and professional development activities during the school year. During the summer institute, teachers learned about the importance of accurate assessment of student learning. Professional development during the school year included working in groups, receiving individual coaching, and learning from classroom observations focused on teachers' creation and use of formative assessments.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Replicating the CGI Experiment in Diverse Environments

Award # R305A120781 Robert Schoen, Florida State University

In this project, researchers evaluated the impact of Cognitively Guided Instruction (CGI), a widely used professional development program. Researchers proposed to replicate a previous efficacy study to examine the impact of this intervention on student achievement in mathematics when implemented with a larger and more diverse sample of elementary school students. The study also aimed to identify the principal, teacher, and student characteristics that moderate intervention impact and to explore the mechanisms through which the intervention affects student mathematics achievement.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

A Multidisciplinary Study of Analogical Transfer in Children's Mathematical Learning

Award # R305H030141 Keith Holyoak, University of California, Los Angeles

In this project, researchers evaluated the impact of ways to improve children's learning of mathematics through teachers' use of analogy in instruction. As a first step, the research team analyzed videotapes of eighth-grade mathematics lessons about dividing fractions to examine how teachers used analogies in their teaching and how students relied on analogies in their learning. Based on those analyses, the researchers carried out four experiments in which middle school students were randomly assigned to view videotaped mathematics lessons reflecting various aspects of the use of analogy in instruction.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams

Award # R305K030140 Kenneth Koedinger, Carnegie Mellon University

In this project, researchers iteratively developed and tested a web-based cognitive assessment system. Researchers integrated assistance and assessment by using a web-based system, ASSISTment, which offered instruction to middle school students while providing a more detailed evaluation of their abilities to the teacher than was possible under current approaches. When students worked on the website, the system "learned" more about the students' abilities and provided teachers with increasingly accurate predictions of how the students would do on a standardized mathematics test. Teachers then used the system's detailed feedback to tailor their instruction to focus on the particular difficulties identified by the system.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Algebra Learning for All (ALFA)

Award # R305M030154 James Stigler, LessonLab, Inc.

In this project, researchers iteratively developed and tested a video- and internet-based professional development program to improve sixth-grade pre-algebra teachers' mathematics instruction. The intervention instructed teachers how to identify, design, and present problems in challenging forms as part of their regular classroom teaching. The researchers evaluated the impact of the two training programs on teachers' knowledge of mathematical content for classroom use, teachers' ability to present rich problems in their lessons, and students' mathematics achievement.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet

Award # R305H040099 Michael Russell, Boston College

In this project, researchers designed and validated a set of computer-based algebra short tests—or testlets—for eighth- and ninth-grade algebra teachers. These testlets were to provide information about students' misconceptions of specific algebraic concepts to enable teachers to use that information to guide their instruction. Researchers instructed teachers on how to use the testlets and examined whether teachers could use them to identify students' misconceptions and to respond appropriately.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Algebra Connections: Teacher Education in Clear Instruction and Responsive Assessment of Algebra Patterns and Problem Solving

Award # R305M040127 Barbara Radner, DePaul University

In this project, researchers iteratively developed and tested a professional development program for middle school algebra teachers to improve their practice and student learning, particularly for African-American or Latino students from low-income communities. In-service teachers completed three graduate courses in algebra and one course in responsive assessment of mathematics learning and received weekly in-school support.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Relationship Between Mathematics Teachers' Content Knowledge and Students' Mathematics Achievement: Exploring the Predictive Validity of the Praxis Series Middle School Mathematics Test

Award # R305M040156 Richard Tannenbaum, Educational Testing Service (ETS)

In this project, researchers validated the Praxis Series® middle school mathematics test, an existing measure of teachers' middle school mathematics content and pedagogical knowledge. The researchers aimed to explore the explicit connection between scores on tests of teacher content knowledge and student achievement by examining associations between the Praxis Series® measure and student mathematics achievement.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Classroom Connectivity in Promoting Mathematics and Science Achievement

Award # R305K050045 Douglas Owens, Ohio State University

In this project, researchers evaluated the impact of connected classroom technology with interactive pedagogy and professional development on the mathematics and science achievement of students in grades 7 through 10. Researchers aimed to provide teachers with immediate information that could be used to adjust instruction. This information included displays of student work that were instantly aggregated and available on the teacher's computer as soon as student work was submitted. The intervention consisted of six parts: provision of connected classroom technology (TI-Navigator), professional development, teacher experiential learning in their own classrooms, online web-based training, online discussion forum for the teacher community, and follow-up professional development at an annual conference.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Investigating the Efficacy of a Professional Development Program in Classroom Assessment for Middle School Reading and Mathematics

Award # R305M050270 Christina Schneider, South Carolina Department of Education

In this project, researchers evaluated the impact of a professional development program to determine how best to implement and deliver standardized professional development that focused on teachers' use of classroom assessments in math and reading. Reading and mathematics teachers in selected middle schools received 12 weeks of intensive professional development on classroom assessment as well follow-up support from trained coaches. The professional development program itself used video-presentation of material, collaborative small group work, presentation of a performance task related to a specific aspect of classroom assessment, and submission of parallel performance tasks for feedback

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Does Visual Scaffolding Facilitate Students' Mathematics Learning? Evidence From Early Algebra

Award # R305H060097 Martha Alibali, University of Wisconsin, Madison

In this project, researchers explored the relationship between visual scaffolding (e.g., pointing, representational gestures, diagrams, and other methods of highlighting visual information) and learning in the context of middle school mathematics learning in early algebra. The researchers aimed to document how teachers used visual scaffolding in naturalistic instructional communication; to investigate whether visual scaffolding promoted students' comprehension of instructional language and, therefore, their learning; and to investigate a possible mechanism by which visual scaffolding may promote learning—namely, by facilitating students' encoding of visual information.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning

Award # R305A070440 Neil Heffernan III, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested the ASSISTments system, a computer-based assessment and tutoring system developed to track and support mastery learning in mathematics among sixth- and seventh-grade students. The system provided tutoring on the mathematics questions that students got wrong. Teachers also received instantaneous feedback on their students' progress, and parents received weekly reports detailing what their children learned as well as what specific skills were a struggle for students.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

An On-Line Professional Development Program for FluidMath

Award # EDIES09C0012 Donald Carney, Fluidity Software, Inc.

In this project, researchers iteratively developed and tested an online professional development platform for the FluidMath software and researched its usability, feasibility, and promise. Researchers designed FluidMath to recognize handwritten math formulas and sketches drawn on the screen of a pen-enabled computer. In this project, researchers aimed to create a platform for training teachers to integrate FluidMath into basic algebra practice. The project also examined teacher use of the technology and its promise in increasing student understanding of algebra.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Linear Functions for Teaching: An Efficacy Study of Learning and Teaching Linear Functions

Award # R305A100047 Steve Schneider, WestEd

In this project, researchers evaluated the impact of professional development in algebra to improve teachers' mathematics understanding and to improve mathematics teaching practices. The professional development also aimed to increase students' algebra proficiency, learning, and achievement. The project targeted middle schools serving high numbers of traditionally underrepresented students, including English learners, African American students, Latino students, and socioeconomically challenged students.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Making Middle School Mathematics Accessible for All Students

Award # R305A100454 Shandy Hauk, WestEd

In this project, researchers iteratively developed and tested a professional development course and facilitator guide to support middle school mathematics teachers, paraprofessionals, and teacher-leaders. The project emphasized applying cognitive science and research-based professional development best practices to support teachers as they learned to plan, instruct, and reflect on lessons that incorporated mathematical language, responded to student thinking, and scaffolded instructional conversation with and within small groups of students.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Mathematics Coaching Supporting English Language Learners

Award # R305A110076 Mark Driscoll, Education Development Center, Inc.

In this project, researchers iteratively developed and tested two math coaching handbooks—a seminar handbook and a coaching cycle handbook—for middle school math teachers. Combined, these handbooks formed Mathematics Coaching Supporting English Learners (MCSEL), which included mathematics coaching and professional development for teachers whose classrooms included English language learners (ELs). Coaches used the seminar handbook to develop teachers' understanding of mathematics, language, and the principles of EL-focused mathematics instruction. The coaching cycle handbook guided coaches in using a model for mathematics coaching and presented best ways to influence the instructional practices of EL teachers.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)

Award # R305A110392 Tedra Clark, Mid-continent Research for Education and Learning (McREL)

In this project, researchers iteratively developed and tested a professional development program for implementing formative assessments in middle school mathematics. The project aimed to increase students' math achievement by using the Assessment Work Sample Method (AWSM), which had the following features: centering professional development on authentic mathematics assessment work, providing a facilitator to support teacher development from novice to expert users of mathematics formative assessment, and supporting teachers in a collaborative peer-review setting to facilitate peer learning around effective practices of formative assessment.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

Learning and Teaching Algebra (LTA)

Award # R305A110451 Albert Cuoco, Education Development Center, Inc.

In this project, researchers iteratively developed and tested Learning and Teaching Algebra (LTA), an intervention for middle school teachers developed to help them build the mathematical understanding and practices needed to model and help build mathematical thinking. LTA had two components: a professional development program for teachers, including a detailed implementation guide, model lessons, pacing guides, and assessments; and a professional development program for coaches, including mathematical background for coaches, strategies for setting up teacher discussion groups, and essays by existing coaches.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning

Award # R305A110913 Sara Dexter, University of Virginia

In this project, researchers iteratively developed and tested CANLEAD (Cognitive Assistance Network, Learning Environment, and Database), a year-long leadership institute and web-based learning environment for leadership in middle schools. CANLEAD aimed to train leadership teams (principals, teacher-leaders, and technology specialists) to recognize what strong instruction in math and science looked like when it integrated technology and carry out the instructional leadership practices needed to foster integration of technology into math and science instruction. The CANLEAD web-based software created an online learning environment that included curricula, math and science technology resources, planning tools, video-conferencing, and social networking tools.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Updating Middle School Mathematics Diagnostics Teacher Assessments in Mathematics & Science (DTAMS)

Award # R305A120553 William S. Bush, University of Louisville

In this project, researchers validated items from the Diagnostics Teacher Assessments in Mathematics and Science (DTAMS) and designed new items to align the Middle School Mathematics portion of the DTAMS with the Common Core State Standards in Mathematics and the Standards for Mathematical Practice. Researchers aimed to assess teacher knowledge of mathematical content, teacher implementation of mathematical practices, and mathematics knowledge for teaching. The measure assessed four content areas of middle school mathematics: number and computation, geometry and measurement, probability and statistics, and algebraic ideas.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Professional Development for Algebra Progress Monitoring

Award # R324A090295 Anne Foegen, Iowa State University

In this project, researchers iteratively developed and tested Professional Development for Algebra Progress Monitoring, a professional development system for algebra teachers to help them better monitor the algebra learning of students with disabilities. The intervention included online instructional modules that trained teachers to use algebra progress monitoring measures. The system also included online tools for scoring and data management to support teachers' scoring of the measures.

Grade Levels:
HS
Focal Populations:
SWD
Products Developed / Tested:

PlatinuMath: An Online Formative Assessment Math Game for Preservice Elementary Teachers

Award # EDIES11C0045 Scott Brewster, Triad Digital Media

In this project, researchers iteratively developed and tested PlatinuMath, a web-based mathematics game for preservice teachers, and researched its usability, feasibility, and promise. The intervention aimed to strengthen preservice teachers' knowledge of mathematics and provide college instructors with accurate assessments of their students' mathematical understanding. PlatinuMath included a series of narrative-based mini-games that covered 24 standards-relevant topics and supplemented any preservice curriculum or training course.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

12. Mathematics Assessment

Student assessments, both formative and summative, are important tools for schools to ensure that data-based decisions are being made (Newton et al. 2009; Newton and Llosa 2010; Popham 2008). Assessments help teachers screen students to receive an intervention (Fuchs et al. 2007; Jenkins, Hudson, and Johnson 2007), monitor student learning and achievement (Ardoin et al. 2005; Callender 2007), and align standards with valid assessments (Brown and Conley 2007; Spooner et al. 2008). However, assessments must be developed, validated, and used appropriately in order to be fully effective. This chapter includes projects that focus on student screening and progress monitoring assessments and standards-based assessments.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Development of Assessment Technologies for Early Childhood: Phase I

Award # ED06PO0895 Christopher Camacho, Children's Progress, Inc.

In this project, researchers iteratively developed a prototype of a "response error analysis" software component to work with the Children's Progress Academic Assessment (CPAA), a dynamic computer assessment that measured language arts and math abilities in pre-kindergarten to second-grade students. The real-time response error analysis component for CPAA was designed to monitor all student errors during the assessment while targeting two specific error types: errors associated with content (e.g., arithmetic errors) and errors associated with response behavior (e.g., response times). It was also designed for at-home or school use and to provide feedback reports for parents.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:


Early Childhood Assessment and Intervention to Improve Grade School Students' Math and Reading

Award # ED07CO0039 Christopher Camacho, Children's Progress, Inc.

In this project, researchers iteratively developed and tested a dynamic, web-delivered assessment tool and researched its usability, feasibility, and promise. Researchers developed the tool for prekindergarten through third-grade students so that children could independently complete assessments and instruction on their classroom or home computer. The tool also provided teacher and parent reports and web-report videos that gave information on students' learning. Researchers assessed feasibility and usability by randomly assigning classrooms to receive the intervention or "business as usual" and analyzing student performance on standardized assessments.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:


Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood

Award #EDIES11C0044 Eugene Galanter, Children's Progress, Inc.

In this project, researchers developed and tested the Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood, an additional assessment that was to supplement an existing assessment in order to identify "gifted" students in pre-kindergarten through second grade. The prototype of this additional assessment was developed under an earlier IES award. The existing assessment, Children's Progress Academic Assessment, measured language arts and math abilities in pre-kindergarten to second-grade students. The new software aimed to identify "gifted" children through computer adaptive methods that measured children's ability profiles in analytic, practical, and creative domains.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:


Developing and Using Diagnostic Items in Mathematics and Science

Award # R305K040051 Caroline Wylie, Educational Testing Service (ETS)

In this project, researchers iteratively developed and tested a set of diagnostic questions to help elementary and middle school teachers better understand student misconceptions that impeded their academic progress in science and mathematics. The goal of the project was to improve students' achievement by developing questions teachers could use to identify student misconceptions that may occur in the process of mastering science and mathematics material. Researchers also examined the effects on student learning of having teachers integrate the use of these questions into their teaching.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:


Early Learning in Mathematics: A Prevention Approach

Award # R305K040081 Leanne Ketterlin Geller, University of Oregon

In this project, researchers iteratively developed and tested a mathematics instructional intervention and progress monitoring system for kindergarten students. Researchers aimed to develop a usable and effective approach to mathematics instruction in kindergarten by providing instructional strategies, curriculum materials, a computer software program for student practice, and assessment strategies for identifying students who were having trouble learning mathematics.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Assessing Data Modeling and Statistical Reasoning

Award # R305K060091 Richard Lehrer, Vanderbilt University

In this project, researchers designed and validated a formative and summative assessment system to evaluate elementary and middle school students' skills and understandings related to data modeling and statistical reasoning. The researchers used the Berkeley Evaluation and Assessment Research model to develop construct maps for each of four strands of data modeling: measurement, representation, data structures, and statistical inference. The construct maps guided the selection of assessment items based on progress variables, hypothetical developmental trajectories of learning based on current knowledge about how students in this age band typically reason about these concepts.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:


mCLASS:Math: Development and Analysis of an Integrated Screening, Progress Monitoring, and Cognitive Assessment System for K-3 Mathematics

Award # R305B070325 Herbert Ginsburg, Columbia University, Teachers College

In this project, researchers designed and validated a comprehensive handheld computer assessment system (mCLASS®:Math), which aimed to help kindergarten through third-grade teachers monitor student progress in mathematics and develop an understanding of those cognitive processes that impede student performance. The system guided teachers in conducting the assessment and recording the results. The assessment included screening and progress monitoring measures and diagnostic cognitive interviews. Once the collected data were uploaded to a server, the system prepared reports for teachers and for administrators. The system also provided information about informal strategies and concepts that teachers could use to improve student mathematics performance.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Assessments Aligned With Grade Level Content Standards and Scaled to Reflect Growth for Students With Disabilities (SWD) and Persistent Learning Problems (PLP)

Award # R324A070188 Gerald Tindal, University of Oregon

In this project, researchers designed and validated reading and math assessments for students who needed special education services and were behind their grade-level peers. Researchers aimed to address the challenges related to modified academic achievement standards by developing and validating reading and math assessments based on modified academic achievement standards.

Grade Levels: ES, MS
Focal Populations: SWD
Products Developed / Tested:

Math Monster Mystery: A Formative Assessment in Game Format for Grade 4 Mathematics

Award # EDIES09C0015 Robert Brown, Triad Digital Media

In this project, researchers iteratively developed and tested a math computer game and researched its usability, feasibility, and promise. The project team developed an online computer game, Monster Mystery (M3), to serve as a formative assessment tool to measure fourth graders' mathematical understanding and provide immediate feedback on instructional practice. Researchers developed the M3 game using narratives, graphics, and mathematical concepts aligned with the National Council of Mathematics Teachers' standards.

Grade Levels: ES
Focal Populations:
Products Developed / Tested:

The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"

Award # R305A090111 James Pellegrino, University of Illinois, Chicago

In this project, researchers validated embedded assessments within the Everyday Mathematics curriculum for students in grades 3 through 5. Researchers aimed to address three problems of assessment practice to improve the quality of mathematics learning and teaching: assessment scope and quality, coordination of multiple assessment functions, and support for teacher use of assessment information. Everyday Mathematics was a standards-based curricular that focused on number and numeration; operations and computation; and patterns, functions, and algebra.

Grade Levels: ES
Focal Populations:
Products Developed / Tested:

A Proposal to Measure the Impact of Indiana's System of Diagnostic Assessments on Student Achievement Outcomes

Award # R305E090005 Shazia Miller, Learning Point Associates

In this project, researchers evaluated the impact of Indiana's statewide diagnostic assessment intervention on changes in math teachers' instructional behaviors and on K-8 student performance on state accountability math tests. The researchers aimed to provide evidence regarding the value of using interim assessments to monitor student progress to guide instruction and increase student achievement. The project also examined whether variation in implementation of the diagnostic assessment intervention was associated with differences in impacts and whether school, teacher, or student characteristics modified the effects of the intervention on student test scores.

Grade Levels: ES, MS
Focal Populations:
Products Developed / Tested: ✓

Dynamic Assessment to Predict First Graders' Mathematics Development

Award # R324A090039 Lynn Fuchs, Vanderbilt University

In this project, researchers designed and validated the Dynamic Assessment, a screening tool for early mathematics developed to assess first-grade students' capacity to learn. The researchers first developed the tool to work with English-speaking students and then developed a Spanish-language version. Researchers also determined the tool's usefulness for forecasting students' math performance in first grade to identify students at risk of poor outcomes so that they could receive early intervention.

Grade Levels: ES
Focal Populations: EL, SWD
Products Developed / Tested: ✓

Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics

Award # R324A100068 Kavita Seeratan, SRI International

In this project, researchers designed and validated a formative and summative classroom online assessment system for elementary and early middle school students with mathematics learning disabilities (MLD). The instruments aimed to assess how students with MLD learned elementary fractions and constructs important to number sense and operations for whole numbers. The assessment was delivered via an online system designed to provide data logging, analysis, feedback, and reporting to users. The assessment system also incorporated universal design for learning principles (e.g., text to speech) to promote accessibility.

Grade Levels: ES, MS
Focal Populations: SWD
Products Developed / Tested: ✓

Methods to Improve Accessibility of Tests for Persistently Low-Performing Students With Disabilities

Award # R324A100344 Louis Danielson, Ohio Department of Education

In this project, researchers designed and validated grade-level reading and mathematics state assessments by identifying specific cognitive barriers that may impede the performances of persistently low-performing fifth-grade students with disabilities. The researchers aimed to make tests more accessible to low-performing students with disabilities and to provide reliable and valid information about students' achievement by producing a set of modified reading and mathematics assessment items based on grade-level achievement standards.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:


Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams

Award # R305K030140 Kenneth Koedinger, Carnegie Mellon University

In this project, researchers iteratively developed and tested a web-based cognitive assessment system. Researchers integrated assistance and assessment by using a web-based system, ASSISTment, which offered instruction to middle school students while providing a more detailed evaluation of their abilities to the teacher than was possible under current approaches. When students worked on the website, the system "learned" more about the students' abilities and provided teachers with increasingly accurate predictions of how the students would do on a standardized mathematics test. Teachers then used the system's detailed feedback to tailor their instruction to focus on the particular difficulties identified by the system.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:


Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning

Award # R305A070440 Neil Heffernan III, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested the ASSISTments system, a computer-based assessment and tutoring system developed to track and support mastery learning in mathematics among sixth- and seventh-grade students. The system provided tutoring on the mathematics questions that students got wrong. Teachers also received instantaneous feedback on their students' progress, and parents received weekly reports detailing what their children learned as well as what specific skills were a struggle for students.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:


The Diagnostic Geometry Assessment Project

Award # R305A080231 Michael Russell, Boston College

In this project, researchers designed and validated a computer-delivered diagnostic formative assessment of geometric conceptions in the middle grades and developed instructional resources meant to assist teachers in addressing flawed or underdeveloped conceptions identified by the assessment. The assessment targeted sources of difficulties and misconceptions in middle school geometry, specifically properties of shapes, transformations, and measurement.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Applications of Intelligent Tutoring Systems (ITS) to Improve the Skill Levels of Students With Deficiencies in Mathematics

Award # R305A090528 Xiangen Hu, University of Memphis

In this project, researchers evaluated the impact of using the Assessment and Learning in Knowledge Spaces (ALEKS) system as a method of strategic intervention in after-school settings to improve the mathematical skills of struggling sixth-grade students. ALEKS, a web-based artificial intelligence assessment and learning system, used adaptive questioning to quickly and accurately determine what a student did and did not know.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities

Award # R324A090340 Lindy Crawford, Texas Christian University

In this project, researchers iteratively developed and tested the Math Learning Companion, a web-based mathematics intervention for sixth-grade students struggling with mathematics. The intervention aimed to improve student outcomes through four primary components: a supplemental sixth-grade mathematics curriculum with 48 standards-aligned multimedia lessons and additional self-paced content; support tools, including accommodations for students and reports for teachers; diagnostic math probes and assessments, as well as a progress monitoring system designed to measure student growth; and an adaptive engine to capture student-program interactions, establish learner profiles and trajectories, and provide feedback to match student needs.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

An Adaptive Testing System for Diagnosing Sources of Mathematics Difficulties

Award # R305A100234 Susan Embretson, Georgia Institute of Technology

In this project, researchers designed and validated an online assessment system to diagnose the sources of middle school students' mathematics deficits and to provide information to teachers to guide instruction. The assessment system consisted of seven components: a diagnostic system, item bank, diagnostic item response theory model calibrations, adaptive item selection modules, an interactive online test delivery module, a score report module, and a validity module.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Creating Cross-Grade Assessments of the Development of Core Algebraic Constructs

Award # R305A100518 Malcolm Bauer, Educational Testing Service (ETS)

In this project, researchers designed and validated two types of assessments for middle school math teachers: periodic locator assessments to provide profiles of groups of students who require different instructional approaches and incremental assessments to inform ongoing instructional decisionmaking. Researchers aimed to improve student learning and instruction by providing teachers with assessments that they could readily incorporate into their existing curricula. The curriculum focused on three key concepts in algebra: equality, notion of a variable, and multiplicative reasoning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Intended and Unintended Consequences of State High-Stakes Testing: Evidence From Standards-Based Reform in Massachusetts

Award # R305E100013 Richard Murnane, Harvard University, Graduate School of Education

In this project, researchers evaluated the impact of high-stakes testing on middle and high school students in Massachusetts. The project examined the effect of introducing exit examinations, the effect of failing the exit exam, the effect of labeling 8th-grade students based on their scores, and the effect of performance on state tests on students' educational aspirations, and whether the effect of failing the 10th-grade mathematics examination depended on students' prior educational aspirations.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Developing Middle School Mathematics Progress Monitoring Measures

Award # R324A100026 Gerald Tindal, University of Oregon

In this project, researchers designed and validated comprehensive mathematics screening and progress monitoring measures for middle school special education students. Researchers aimed to design sensitive progress measures that could assist with the early identification of struggling students. The system included measures of numbers and operations, geometry, algebraic relations, measurement, and analysis. The design of the assessment allowed users to interpret student growth between grade levels.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:


Feedback-and-Revision on Alternate Assessment Based on Modified Achievement Standards in Mathematics

Award # R324A100065 Cara Cahalan Laitusis, Educational Testing Service (ETS)

In this project, researchers designed and validated a new test administration format for alternative math assessment based on modified achievement standards in mathematics. The alternative assessment allowed eighth-grade special education students with persistent learning problems in math to receive immediate feedback on their answers to test items related to numeric operation and geometry and to revise their answers for partial credit. The researchers examined whether providing the students immediate feedback and an opportunity to revise their responses to test items improved the quality of the assessment.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:


Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System

Award # R305A110306 Pamela Buffington, Education Development Center, Inc.

In this project, researchers designed and validated the Eliciting Mathematics Misconceptions Project, a cognitive diagnostic assessment system for middle school students. The intervention aimed to enable teachers to quickly and effectively diagnose commonly held student misconceptions and overgeneralizations in the areas of fractions, decimals, and operations with fractions and decimals. The researchers developed and refined three valid and reliable sets of short, highly focused diagnostic measurement tools.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:


Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)

Award # R305A110392 Tedra Clark, Mid-continent Research for Education and Learning (McREL)

In this project, researchers iteratively developed and tested a professional development program for implementing formative assessments in middle school mathematics. The project aimed to increase students' math achievement by using the Assessment Work Sample Method (AWSM), which had the following features: centering professional development on authentic mathematics assessment work, providing a facilitator to support teacher development from novice to expert users of mathematics formative assessment, and supporting teachers in a collaborative peer-review setting to facilitate peer learning around effective practices of formative assessment.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

An Efficacy Study of Online Mathematics Homework Support: An Evaluation of the ASSISTments Formative Assessment and Tutoring Platform

Award # R305A120125 Jeremy Roschelle, SRI International

In this project, researchers evaluated the impact of ASSISTments, an online formative assessment and mathematics tutoring platform for middle school students, including relative effectiveness with English learners and students with disabilities. The intervention aimed to support students' mathematics homework completion and facilitate differentiated instruction. Students completed their homework on laptop computers and received immediate feedback on their answers, individualized tutoring and hint messages on difficult problems, mastery problem sets that adjusted to knowledge level, and automatic reassessment of a subset of skills to help improve students' retention of previously mastered skills. Teachers were able to receive reports of students' progress and adapt their instruction accordingly.

Grade Levels:
MS
Focal Populations:
EL, SWD
Products Developed / Tested:

Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System

Award # R305A120217 Mark Wilson, University of California, Berkeley

In this project, researchers designed and validated a computerized formative assessment system around the topics of statistics and modeling to provide teachers with diagnostic information about middle school students' learning. The researchers designed assessments for six constructs from the Assessing Data Modeling and Statistical Reasoning curriculum, including data display, meta-representational competence, conceptions of statistics, chance, modeling variability, and informal inference. The online assessment considered students' learning progressions, incorporated complex item formats that evaluated constructed responses, and included sophisticated item response modeling techniques.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Comprehensive Research-Based Computer Assessment and Accommodation System for ELL Students

Award # R305A130223 Jamal Abedi, University of California

In this project, researchers designed and validated a computer-based system to measure the accessibility of middle school math assessments and provide accommodations for English language learner (EL) students. The project targeted Spanish-speaking and native English-speaking students in eighth grade. Researchers examined the effectiveness of language-based accommodations commonly used for Spanish-speaking EL students by focusing on the validity of different accommodations for students who differ on variables such as language proficiency (both in their first language and in English), length of time in the U.S., and instructional program.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Professional Development for Algebra Progress Monitoring

Award # R324A090295 Anne Foegen, Iowa State University

In this project, researchers iteratively developed and tested Professional Development for Algebra Progress Monitoring, a professional development system for algebra teachers to help them better monitor the algebra learning of students with disabilities. The intervention included online instructional modules that trained teachers to use algebra progress monitoring measures. The system also included online tools for scoring and data management to support teachers' scoring of the measures.

Grade Levels:
HS
Focal Populations:
SWD
Products Developed / Tested:

Ready or Not? California's Early Assessment Program and the Transition to College

Award # R305A100971 Michal Kurlaender, University of California, Davis

In this project, researchers evaluated the impact of California's Early Assessment Program (EAP), a program designed to help high school students assess whether they are academically prepared for college. The primary component of the EAP is an assessment of English and math skills among California 11th graders. The EAP assessment supplements California Standards Test and the California State University (CSU) placement standards with a set of multiple-choice questions and an essay. The researchers used data from the California Department of Education, CSU, and the community college system to determine student participation in the EAP assessment during 11th grade, their subsequent course taking during 12th grade, their rates of application to California state universities and community colleges, their rates of placement in non-remedial college courses, their college GPAs, and their persistence from semester to semester.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:


Algebra Screening and Progress Monitoring

Award # R324A110262 Anne Foegen, Iowa State University

In this project, researchers designed and validated a series of algebra screening and progress monitoring measures developed to enable teachers of high school students with disabilities to better monitor students' learning in algebra. The assessment system included six algebra progress monitoring measures with three measures focusing on traditional algebra instruction (e.g., symbolic manipulation) and three reformist measures targeting conceptual understanding and problem solving.

Grade Levels:
HS
Focal Populations:
SWD
Products Developed / Tested:


Improving the Assessment Capability of Standardized Tests: How High-Stakes Testing Environments Compromise Performance

Award # R305H050004 Sian Beilock, University of Chicago

In this project, researchers iteratively developed and tested assessment tools that reduce the negative effects of stereotype threat that undermine undergraduate women's expression of math skills. The project aimed to provide new guidance on how standardized assessments can be developed that accurately reflect all students' abilities and potential.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:


13. Mathematics Policy

Although education practitioners and researchers primarily focus on improving classroom practices and environments, education policy often has an equally important role in building the conditions necessary to ensure positive student outcomes. For example, Newman and his colleagues found that the state-driven policy, the Alabama Math Science and Technology Initiative, improved student math outcomes and had a positive effect on classroom practices in math after one year (2012). This chapter includes additional research projects and evaluations of prekindergarten through adult education mathematics-related policies, including projects designed to improve and inform policy, as well as studies of the impacts of current policies.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Evaluating the Effectiveness of Tennessee's Voluntary Pre-K Program

Award # R305E090009 Mark Lipsey, Vanderbilt University

In this project, researchers evaluated the impact of the Tennessee Voluntary Pre-K Program, a state-wide policy initiative to help at-risk prekindergarten students. The program's primary objective was to enhance the school readiness of economically disadvantaged children and improve their academic performance. The researchers also examined the relationship between student outcomes and selected policy-relevant characteristics of teachers, classrooms, and schools to provide guidance for program improvement.

Grade Levels: EC, ES
Focal Populations: EL, SWD
Products Developed / Tested:

Comprehensive Evaluation of the Effects of District-Wide High School Curriculum Reform on Academic Achievement and Attainment in Chicago

Award # R305R060059 Elaine Allensworth, University of Chicago

In this project, researchers evaluated the impact of "constrained curriculum" policies that required all students to take a strong reading and math college preparatory program in high school, such as Advanced Placement and International Baccalaureate programs. The researchers aimed to understand if students in diverse high schools who take more rigorous coursework have higher achievement and educational attainment. Researchers examined data on students moving through the school system across time, from elementary through high school.

Grade Levels: ES, MS, HS
Focal Populations:
Products Developed / Tested:

The Effects of School Climate and Supports on Mathematics Achievements for Students With Visual Impairments

Award # R324K060009 Brenda Cavenaugh, Mississippi State University

In this project, researchers explored the relationship between school climate (e.g., policies and practices related to teacher, student, and family involvement supports) and mathematics achievement for elementary and middle school students with visual impairments. Researchers aimed to determine what school-related variables affected the achievement of students with visual impairments. Researchers analyzed data from the Special Education Elementary Longitudinal Study, a nationally representative longitudinal study of elementary and middle school students with disabilities conducted between 2000 and 2005.

Grade Levels: ES, MS
Focal Populations: SWD
Products Developed / Tested:

Do Professional Communities Improve K-16 Curricula Mastery and Augment Mathematics Achievement?

Award # R305A100822 Stephanie Moller, University of North Carolina, Charlotte

In this project, researchers explored the relationship among mathematics curricula, instruction, and school organizational structure on students' mathematics achievement during elementary, middle, and high school. The researchers also examined whether mathematics curricula, instruction, and school organizational structure moderated gaps in mathematics achievement trajectories by student demographics. Researchers aimed to carry out a comprehensive national analysis of students' mathematics achievement between kindergarten and 12th grade. The researchers conducted secondary data analyses using the Early Childhood Longitudinal Study, the National Education Longitudinal Study, and the Education Longitudinal Study.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

Do Lower Barriers to Entry Affect Student Achievement and Teacher Retention: The Case of Math Immersion

Award # R305E060025 James Wyckoff, State University of New York (SUNY), Albany

In this project, researchers explored the relationship between student test-score gains in mathematics and teacher certification pathways, teacher characteristics, and other explanatory variables. The researchers examined the student test-score gains of teachers in New York City public schools with the following certification pathways: Math Immersion teachers who were not math majors but who demonstrated a background in math, mathematics teachers who completed traditional preparation programs, teachers who completed alternative certification programs or other certification routes, and uncertified teachers.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Intended and Unintended Consequences of State High-Stakes Testing: Evidence From Standards-Based Reform in Massachusetts

Award # R305E100013 Richard Murnane, Harvard University, Graduate School of Education

In this project, researchers evaluated the impact of high-stakes testing on middle and high school students in Massachusetts. The project examined the effect of introducing exit examinations, the effect of failing the exit exam, the effect of labeling 8th-grade students based on their scores, and the effect of performance on state tests on students' educational aspirations, and whether the effect of failing the 10th-grade mathematics examination depended on students' prior educational aspirations.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:
✓

The Impact of the Michigan Merit Curriculum and Michigan Promise Scholarship on Student Outcomes

Award # R305E100008 Brian A. Jacob, University of Michigan

In this project, researchers evaluated the impact of two reforms designed to promote college attendance and success: the Michigan Merit Curriculum, which required a more rigorous high school curriculum, and the Michigan Promise Scholarship, which provided funding for college to students who met academic criteria. The Michigan Merit Curriculum required all high school students to pass a set of 16 rigorous academic courses, including Algebra I, Geometry, Algebra II, Biology, and Chemistry or Physics. The Michigan Promise Scholarship provided students who met certain academic standards with up to $4,000 for college.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Doubling Up? The Impact of Remedial Algebra on Students' Long-Run Outcomes

Award # R305A120466 Joshua Goodman, Harvard College

In this project, researchers evaluated the impact of the double-dose algebra policy on high school students' long-term outcomes such as advanced math coursework and performance, ACT scores, high school graduation rates, and college enrollment. Double-dose algebra was a scheduling mechanism in which students in need of math remediation were required to take two periods of algebra per day instead of one.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

National Center for Postsecondary Research

Award # R305A060010 Thomas Bailey, Columbia University, Teachers College

In this project, researchers evaluated the impact of policies and programs designed to help students successfully transition to postsecondary education and training and to graduate with a college degree. This center included a cluster of coordinated research projects that addressed different components of the overall goal. These projects pursued research on the effectiveness of dual enrollment programs, postsecondary remediation in math and English, and financial aid and higher education information systems.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Evaluating the Effects of Basic Skills Mathematics Placement on Academic Outcomes of Community College Students

Award # R305A100381 Tatiana Melguizo, University of Southern California

In this project, researchers evaluated the impact of postsecondary math placement policies on the course-taking patterns of community college transfer students who were placed in basic-skills mathematics courses. Researchers aimed to provide insights for district and state decisionmakers that could result in significant cost savings based on the effect of remedial placement on successful course sequences. Researchers used secondary analysis of student transcript data to evaluate the effects of assignment to a higher or lower level of basic skills math courses on students' college progress and success.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Award # R305A130125 Mary Visher, MDRC

In this project, researchers evaluated the impact of a developmental math curriculum and placement policies for Texas community college students in need of remediation. The placement policy included using students' scores on placement exams to determine whether students could enter directly into credit-bearing courses or if they would be encouraged to take a developmental math course or, if the student scored particularly low, more basic-level courses. The developmental math curriculum studied in this project divided the math content into discrete modules, allowing students to learn at their own pace.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

Section II: Science

As a result of the growing push to ensure that all students are college- and career-ready, science education has recently undergone major shifts in terms of both content and teaching methodology (Abell and Lederman 2007; Pruitt 2014). The four major domains of science featured in this section include the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science. These four domains align with domains highlighted college- and career-readiness standards, such as the Next Generation Science Standards (NGSS), a set of standards developed by 26 states along with field experts that outline what students should be able to do at various points within their K-12 educations (NGSS Lead States 2013; Pruitt 2014). College- and career-readiness standards often include reference not only to specific content areas but also to other skills and abilities students should develop, such as student scientific inquiry and reasoning across grade levels.

This section features 139 projects focused on science. Each chapter within this section introduces a major research focus, such as physical sciences or student inquiry in science and displays relevant projects in table format. The tables provide the project title and award number; the principal investigator and affiliation and a short project description with and tags to indicate the grade level(s) on which the project focused; the project's focal population, i.e., English language learners or students with disabilities; and the types of products developed or tested through the project. Some of the projects in this section occur in multiple chapters.

1. Science in Prekindergarten Settings

Early childhood science education focuses on skills (e.g., inquiry, communication, problem-solving), natural world experiences, and experiential learning (Enger and Yager 2006; Gelman and Brenneman 2004; Peterson and French 2008). Prekindergarten science education serves as a foundation for future science learning and also helps to build and support academic and life skills (Campbell and Jobling 2012; Eshach 2006). This chapter includes research on and evaluations of programs and curricula designed to improve the early science learning of children five years old and younger, prior to kindergarten.

Table Key

Grade levels:

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Early Childhood Hands-On Science Curriculum Development and Demonstration

Award # R305K060036 Judy Brown, Miami Museum of Science

In this project, researchers iteratively developed and tested Early Childhood Hands-On Science (ECHOS), an early childhood science readiness curriculum and professional development program for Head Start teachers and their students. The ECHOS curriculum aimed to improve early childhood educators' capacity to guide science inquiry, supporting young children's overall cognitive development and school readiness, in general, and enhanced science learning, in particular.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality

Award # R305A070068 Mable Kinzie, University of Virginia

In this project, researchers iteratively developed and tested My Teaching Partner, an integrated science and math curriculum for preschool children at risk for early school failure. The intervention aimed to improve students' academic achievement in math and science through detailed lesson plans that linked to demonstration videos of high-quality implementation, along with a range of teaching resources. My Teaching Partner provided teachers with instructional sequencing, required weekly activities, and opportunities to choose from weekly menus those activities best suited to their students' needs.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children

Award # R305A090502 Daryl Greenfield, University of Miami

In this project, researchers iteratively developed and tested Lens on Science, a computer adaptive test of preschoolers' science knowledge. The researchers aimed to create an appropriate, reliable, and valid direct assessment of children's science knowledge and process skills. The test assessed three broad early childhood science content areas (life science, earth/space science, and physical/energy science) and science processing skills (observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating).

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

ECHOS: Early Childhood Hands on Science

Award # R305A100275 Judy Brown, Miami Museum of Science

In this project, researchers evaluated the impact of the Early Childhood Hands-On Science (ECHOS) curriculum, a comprehensive early childhood science curriculum and professional development program. ECHOS aimed to promote young children's understanding of basic science concepts through nine units focused on life science, earth science, and the physical sciences. The curriculum combined direct instruction with guided inquiry-based science experiences and exploration.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Award # R305A120631 Mable Kinzie, University of Virginia

In this project, researchers evaluated the impact of MyTeachingPartner-Mathematics and Science (MTP-M/S) curricula and professional development supports on Head Start teachers' instructional practices and children's early mathematics and science knowledge and skills. The curriculum aimed to strengthen children's inquiry skills and knowledge of key concepts in science and mathematics through two mathematics and two science activities that teachers implemented every week across the school year. The MTP-M/S implementation support system for teachers included video of high-quality, high-fidelity implementation; video-based challenges; teaching tips; instructional adaptations; and curricular extensions.

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

2. Physical Sciences in Kindergarten through 12th Grade Settings

The physical sciences, which include physics and chemistry, focus on the interactions, motion, stability, and energy inherent to matter and applications of these. Research shows a positive association between test scores and student interest and motivation associated with scientific inquiry and problem solving in physics (Hong and Lin-Siegler 2012). Process-oriented, guided inquiry in the physical sciences has also improved outcomes, particularly for girls and students of color (Barthlow and Watson 2014). This chapter includes programs and curricula designed to improve student learning in the physical sciences by developing and testing physical science-related assessments, curricula, instructional materials, online learning environments, and tutorials.

Table Key

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The Universally Designed Science Notebook: An Intervention to Support Science Learning for Students With Disabilities

Award # R324A070130 Gabrielle Rappolt-Schlichtmann, CAST, Inc.

In this project, researchers iteratively developed and tested a universally designed, web-based science notebook on the topic of magnetism and electricity devised to improve the science achievement of fourth- and fifth-grade students with high-incidence disabilities. To support classroom use of the notebook, researchers also developed a teacher training module and a teacher guide.

Grade Levels:
ES
Focal Populations:
SWD
Products Developed / Tested:

The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School

Award # R305A120138 Cari Herrmann Abell, American Association for the Advancement of Science (AAAS)

In this project, researchers designed and validated a set of three assessment instruments (for elementary, middle, and high school students, respectively) that aimed to monitor how students progress in their understanding of important ideas about energy. The instruments covered an extensive and coherent set of important energy concepts, tested for the correct scientific understanding, probed for common student misconceptions, and tested learning progressions. Researchers made the instrument available in both paper-based and online formats and provided teacher materials to guide the interpretation of assessment results.

Grade Levels:
ES, MS, HS
Focal Populations:
EL
Products Developed / Tested:

Transmedia: Augmented Reality Game for Essential Transfer of Science

Award # EDIES13C0037 Victoria Van Voorhis, Second Avenue Software

In this project, researchers developed a prototype of a web-based game designed to teach fourth- through sixth-grade science concepts, including an introduction to chemistry. The intervention used the illustrations of chemical elements and science terms created by Simon Basher in his three books, *The Periodic Table: Elements with Style!*, *Chemistry: Getting a Big Reaction!*, and *Physics: Why Matter Matters!* The game also included curriculum support materials.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Dynamically Modifying the Learning Trajectories of Novices With Pedagogical Agents

Award # R305H050052 Carole Beal, University of Southern California

In this project, researchers iteratively adapted and tested the IMMEX (Interactive Multi-Media Exercises) program for middle and high school chemistry students to help them revise their chemistry problem solving strategies. IMMEX was a web-based problem-solving simulation program through which students learned to frame a problem from a scenario, judge what information was relevant, plan a strategy, gather information, and reach a decision that demonstrated understanding. The researchers modified the intervention to integrate a pedagogical model into the system that provided neutral feedback (general encouragement) or individualized feedback that explicitly addressed how the student was approaching the problem.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

An Implementation of Vicarious Learning With Deep-Level Reasoning Questions in Middle School and High School Classrooms

Award # R305H050169 Barry Gholson, University of Memphis

In this project, researchers iteratively developed and tested AutoTutor, an intelligent tutoring system for middle and high school students developed to support their computer literacy and knowledge of Newtonian physics. The researchers compared different versions of AutoTutor to examine how best to support students' learning of course content. Deep-level reasoning questions were embedded in the intelligent tutoring system. The tutor served as a conversational partner with the learner and encouraged students to provide answers to questions until they mastered each concept. The researchers also developed guidelines for teachers to support the use of AutoTutor during classroom instruction.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Cinematic Sciences: An Online Simulation Platform With Real Physics and Behavioral Programming for Physical Sciences

Award # ED06C00039 Daniel Savage, Whimsica Toys

In this project, researchers iteratively developed and tested Cinematic Sciences, a web-based, multimedia simulation platform designed to facilitate eighth-grade student learning in the physical sciences. Researchers designed Cinematic Sciences to include 20 simulations aligned with the National Physical Sciences Standards as well as a web-based tool for teachers and students to create their own simulations. As part of the development process, researchers tested the intervention's usability, feasibility, and promise for improving student outcomes.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Technology Enhanced Science Education

Award # ED06PO0907 Peter Solomon, Advanced Fuel Research, Inc.

In this project, researchers iteratively developed a prototype of a web-based science curriculum focused on the atomic behavior underlying real world physical and chemical phenomena. The aim of the web-based curriculum was to improve science lessons, to help teachers feel more comfortable teaching science, and to increase science comprehension in middle school students.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Technology Enhanced Science Education in Middle School

Award # ED07CO0037 Peter Solomon, Advanced Fuel Research, Inc.

In this project, researchers iteratively developed and tested web-delivered science units focused on force and motion, position, energy, and gravity. These units were designed to replace or supplement middle school physical science curricula. Each unit included daily activity outlines, computer simulations with worksheets, instructions for hands-on experiments with worksheets, teacher instructions for each activity, animated tutorials, concept organizers, and pre- and post-tests. Researchers also developed a web-based teacher professional development course. As part of the development process, researchers tested the intervention's usability, feasibility, and promise for improving student outcomes.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Establishing the Validity and Diagnostic Capacity of Facet-Based Science Assessments

Award # R305A100475 Angela DeBarger, SRI International

In this project, researchers designed and validated facet-based science assessments for middle and high school students. Students' thinking can be organized into hypothetical facet clusters around a key idea or event. The assessments focused on providing information to teachers about whether their students understood key concepts in force and motion (description of motion, nature of forces, and forces to explain motion), and if not, what partial understandings were present instead.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Learning Progressions in Middle School Science Instruction and Assessment

Award # R305A100692 Mark Wilson, University of California, Berkeley

In this project, researchers designed and validated learning progression assessments for use with middle school science students. Researchers developed these assessments—Structure of Matter and Scientific Reasoning—to focus on learning progression in physical science and eighth graders' scientific reasoning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


STEM Solar Explorations

Award # EDIES11C0022 David Marley, Diversified Construction, Inc.

In this project, researchers iteratively developed and tested the STEM Solar Explorations platform, a multidisciplinary solar energy field laboratory for middle school students developed to help students apply learning in the area of energy science. The researchers designed curricular materials, multi-media video clips, lesson plans, student activities, assessments, and a back-end system to house data generated by the activities.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Explanation and Prediction Increasing Gains and Metacognition (EPIGAME)

Award # R305A110782 Douglas Clark, Vanderbilt University

In this project, researchers iteratively developed and tested Cup Racer, a game environment to scaffold middle school students' understanding of formal physics concepts. Cup Racer incorporated different approaches to integrating prediction and explanation into the fabric of a digital game. Researchers aimed to provide a platform both for students learning core science ideas and for researchers studying design principles for games. The design of the game environment randomized assignment of players to multiple configurations of parameters within the game and embedded computer adaptive assessment and data log analysis functionality to support sophisticated analytics and data collection.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining

Award # R305A120778 Janice Gobert, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested a pedagogical agent (an animated character used in the online learning), designed to assist middle school students in learning inquiry in new physical science topics. Researchers integrated the pedagogical agent into 12 previously developed physical science microworlds (small scale interactive simulations), in which students conducted inquiry by generating hypotheses, collecting data to test their hypotheses, interpreting the data, warranting claims, and communicating findings. The pedagogical agent guided students through each step of the inquiry process and provided real-time scaffolding through validated assessments.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Integrated Software for Artificial Intelligence Tutoring and Assessment in Science

Award # R305K040008 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively developed and tested a computer-based tutoring and assessment system for high school chemistry students. The system aimed to improve student learning and achievement by providing detailed comments to students if they made mistakes while trying to solve chemistry problems and by generating reports for teachers and students that analyzed student learning as reflected by their performance on a given set of chemistry problems.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Molecules and Minds: Optimizing Simulations for Chemistry Education

Award # R305K050140 Jan Plass, New York University

In this project, researchers iteratively developed and tested instructional computer simulations and curriculum for high school students to improve their learning and achievement in chemistry. The computer simulations imitated real-world chemistry processes (e.g., gas laws and the kinetic theory of heat) and were based on three principles of learning: active engagement of the learner, optimization of visual cognitive load, and consideration of the impact of learner characteristics (e.g.., prior knowledge, spatial ability, and metacognitive skills) on the learning process.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Intelligent Molecular Model Kit and Software Suite for Improving High School Chemistry Instruction and Student Achievement

Award # ED07CO0044 Keith Donaldson, MolySym, Inc.

In this project, researchers iteratively developed and tested an intelligent molecular modeling kit and software suite for advanced placement chemistry classes. The project team designed the suite to include real-time communication between student-built hand-held physical models and virtual software models, which enable users to view changes in properties as they manipulate the molecular model in their hands. Researchers assessed the usability and feasibility of the product in eight advanced placement chemistry classrooms.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Integrated Software for Artificial Intelligence Tutoring and Assessment in Science

Award # R305A070067 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively developed and tested three new units for a previously developed computer-based tutoring and assessment system for a first-year high school chemistry course. The system aimed to improve student learning and achievement in chemistry by providing feedback to students while they tried to solve chemistry problems. In addition, the system generated reports for teachers and students that analyzed student learning and performance.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Conceptual Analysis and Student Learning in Physics

Award # R305B070085 Brian Ross, University of Illinois

In this project, researchers iteratively developed and tested an easy-to-implement intervention for physics instruction to improve high school and college students' conceptual understanding and problem solving. The intervention had students focus on conceptual aspects of problem solving by training them to write strategies for solving problems prior to using the strategies to solve physics equations.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

Online Learning System to Advance Teaching of Hyper Molecular Modeling

Award # ED08CO0044 Keith Donaldson, MolySym, Inc.

In this project, researchers iteratively developed and tested a teaching and training interface for the MolySym Hypermodeling System and researched its usability, feasibility, and promise. The incorporation of electronics and robotics technologies into ball-and-stick models to communicate in real-time with a software simulation system is called hypermodeling. The MolySym Hypermodeling System is intended to improve students' understanding of important chemical principles relating to three dimensional molecular structures. In order to successfully deploy this tool in classrooms, researchers developed a teaching and training interface for MolySym, called the Online Learning System (OLS).

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Electronic Chemistry Laboratory Workbook (ECLW)

Award # ED08CO0051 Christina Gilpin, Select-O-Sep, LLC

In this project, researchers iteratively developed and tested a simulation-based chemistry laboratory tool and researched its usability, feasibility, and promise. The prototype of this product was developed under an earlier IES award. Researchers developed the Electronic Chemistry Laboratory Workbook (ECLW), a hardware interface with tactile controls used to carry out experimental computer simulations. The researchers aimed to offer a realistic hands-on feeling for simulated lab experiments, including the incorporation of systematic and random errors, as well as visual and tactile feedback. The team designed ECLW to affect student tactile skills, cognitive skills, and interest in chemistry.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

A Randomized Controlled Study of the Effects of Intelligent Online Chemistry Tutors in Urban California School Districts

Award # R305A080063 Steve Schneider, WestEd

In this project, researchers evaluated the impact of Quantum Chemistry Tutors, a suite of computer-based cognitive tutors, on high school chemistry students' performance. Researchers aimed to understand not only the efficacy of the intervention but also the general effects of intelligent tutoring software on student learning, when used in conjunction with a range of commercially available science curricula. Quantum Chemistry Tutors provided individual tutoring to high school students using natural language to scaffold student thinking and performance through questioning, modeling, illustration, and explanation of issues within the context of the student's work.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Testing the Effectiveness of CALM for High School Chemistry Students

Award # R305A090195 Jonathan Plucker, Indiana University

In this project, researchers evaluated the impact of the Computer Assisted Learning Method (CALM)—a fully developed chemistry program widely used in the state of Indiana—on high school students' science achievement. CALM consisted of two components: the CALM online learning tool and the CALM teacher professional development workshop. The CALM online learning tool allowed students to practice solving chemistry problems on topics such as balancing chemical reactions and kinetics. Teachers received a professional development workshop to learn about the underlying philosophy of CALM and the mechanics of its use.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Molecules & Minds: Developing Bridging Scaffolds to Improve Chemistry Learning

Award # R305A090203 Catherine Milne, New York University

In this project, researchers iteratively developed and tested four types of instructional supports ("scaffolds") to assist high school chemistry students. The intervention used these scaffolds in four existing chemistry simulations: kinetic theory, diffusion, gas laws, and phase change. Three types of visual scaffolds were integrated into each simulation to help students make specific connections between observable, explanatory, and symbolic molecular representations. The fourth scaffold was a narrative that placed students in the role of helping the protagonist understand the conceptual area of the simulation or explaining the protagonist's understanding to a broader audience. Additionally, researchers developed curricular materials to integrate each simulation and scaffold into existing chemistry curricula.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Embedded Assessments Using the ChemCollective Virtual Lab

Award # R305A100069 Jodi Davenport, WestEd

In this project, researchers iteratively developed and tested new activities with embedded assessments for the previously developed ChemCollective Virtual Lab. Researchers aimed to improve high school students' science achievement through a deeper understanding of chemical principles and their ability to plan and conduct laboratory investigations. The intervention consisted of two online modules with ChemCollective Virtual Lab activities and embedded assessments focused on stoichiometry and thermochemistry in which researchers provided students with authentic chemistry investigations and personalized coaching. Researchers also provided high school teachers with information about individual students that they could use to monitor student progress and guide instruction.

Grade Levels:
HS
Focal Populations:
EL
Products Developed / Tested:

Improving a Natural-Language Tutoring System that Engages Students in Deep Reasoning Dialogues About Physics

Award # R305A100163 Sandra Katz, University of Pittsburgh

In this project, researchers iteratively developed and tested an enhanced version of a natural-language dialog system meant to engage high school physics students by engaging them in conversations. The dialog system helped students reason deeply about and reflect on problems they solved in Andes, a separate intelligent, web-based tutoring system for physics. During the dialog system's "turn," it would reuse parts of the student's previous response. It also used the student's responses to determine whether he or she was missing important concepts or overgeneralizing by analyzing the level of abstraction in the student's response.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

DeepTutor: An Intelligent Tutoring System Based on Deep Language and Discourse Processing and Advanced Tutoring Strategies

Award # R305A100875 Vasile Rus, University of Memphis

In this project, researchers iteratively developed and tested DeepTutor, an intelligent, dialog-based tutoring system for high school students, which aimed to improve students' outcomes in physics relative to a tutoring system called AutoTutor, an alternative, interactive automated tutoring software program. DeepTutor provided accurate assessment, better communication, and advanced tutoring and instructional strategies to improve tutoring quality and learning.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

The Connected Chemistry Curriculum

Award # R305A100992 Mike Stieff, University of Illinois, Chicago

In this project, researchers iteratively developed and tested Connected Chemistry, a curriculum for high school chemistry students meant to improve their understanding of and achievement in science through computer-based activities. The curriculum linked reactions students saw at the sub micro-level to their everyday experience at the macro-level through computer-based visualization tools. Each curriculum unit consisted of three modules: Laboratory/Demonstration, in which students performed an experiment; Simulation, in which students explored a simulation; and Discussion, in which the teacher led students through a synthesis of their observations.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Virtual Labs for High School Physics

Award # EDIES11C0029 Jeanne Finstein, Polyhedron Learning Media, Inc.

In this project, researchers iteratively developed and tested a virtual physics lab and researched its usability, feasibility, and promise. The prototype of this product was developed under an earlier IES award. Researchers developed a set of cost-effective and maintenance-free web-based virtual labs on topics such as displacement, velocity, acceleration of gravity, kinematics, and Newton's second law that could fully replace or supplement hands-on labs in a typical high school physics course. The online virtual physics labs were designed to be used when equipment was not available or as a supplement before or after using real equipment. Researchers also developed support professional development materials.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:


Exploring Studies to Derive Policies for Adaptive Natural-language Tutoring in Physics

Award # R305A130441 Sandra Katz, University of Pittsburgh

In this project, researchers explored the relationships between decision rules—used to design effective intelligent tutoring systems—and the improvement of student outcomes in physics. The intervention targeted high school physics students in urban, suburban, and parochial school districts. The researchers aimed to identify effective malleable factors of tutoring to inform the development of a future intelligent tutoring systems intervention and, more broadly, to inform one-on-one tutoring and classroom instructional practices.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

3. Life Sciences in Kindergarten through 12th Grade Settings

The life sciences involve the scientific study of living organisms, such as microorganisms, fungi, plants, and animals (including the study of human beings). Researchers have shown that hands-on experiential learning contributed to interest, motivation, inquiry skills, and achievement in the life sciences (Wyss et al. 2013; Kremer, Spect, Urhahne and Mayer 2014; Lightburn and Fraser 2007). This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student learning in the life sciences.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms

Award # R305H060089 Gautam Biswas, Vanderbilt University

In this project, researchers iteratively developed and tested Teachable Agents (TAs), a software intervention for middle school students to develop their metacognition (i.e., their awareness of their cognitive processes) and ability to learn through a learn-by-teaching approach. TAs were interactive computer-based learning environments in which students taught virtual students, called agents, how to understand various concepts. Students used three primary components to teach the agents: teaching an agent using a concept map, querying to see how much the agent understood, and quizzing the agent with a provided test to see how well it did on questions the student may not have considered.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice

Award # R305A110285 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested a teacher professional development program designed to build the content and pedagogical knowledge of elementary and middle school teachers. The researchers developed two courses and materials (teacher book, workbook, and facilitator guide) on life science content for professional development facilitators and teachers as part of the Making Sense of SCIENCE professional development program for teacher learning across earth, life, and physical science domains. The main components were approaches that had previous evidence of being effective with English learners, namely hands-on science investigations that allowed teachers to explore core science concepts; literacy investigations, in which teachers strengthened their ability to write, read, and talk about science; and teaching investigations that led teachers to examine teaching practices and student thinking.

Grade Levels:
ES, MS
Focal Populations:
EL
Products Developed / Tested:

Advancing Ecosystems Science Education via Situated Collaborative Learning in Multi-User Virtual Environments

Award # R305A080141 Christopher Dede, Harvard University, Graduate School of Education

In this project, researchers iteratively developed and tested a multi-user virtual environment ecosystem science curriculum for grade 6 and 7 students in which students use graphical representations (avatars) to interact with other students and with computer-based agents to facilitate collaborative learning. The curriculum aimed to offer opportunities for student learning, engagement, and assessment through illustrating the situated geospatial relationships in an ecosystem; providing interactive, immersive depictions of plant and animal behavior; and generating student performance data. The intervention also included a workshop for teachers, a guide and accompanying curricular materials, and assessment instruments.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Systems and Cycles: Using Structure-Behavior-Function Thinking as a Conceptual Tool for Understanding Complex Natural Systems in Middle School Science

Award # R305A090210 Cindy Hmelo-Silver, Rutgers University

In this project, researchers iteratively developed and tested three middle school science curriculum units on ecosystems using structure-behavior-function thinking as a conceptual tool for promoting students' understanding of ecosystems. Structure-behavior-function models of systems explicitly represent the configuration of components and connections (structure), the visible output (functions), and the internal causal processes (behaviors) of the system. For each of three curriculum units on aquarium, local, and distal aquatic systems, researchers developed a suite of tools including a structure-behavior-function modeling environment, hypermedia, computer simulations, and a notebook for students to record observations and information gathered during physical data collection.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Game-Based Interactive Life Science for Students With Learning Disabilities

Award # EDIES10C0023 Dan White, Filament Games

In this project, researchers iteratively developed and tested life science games and researched the usability, feasibility, and promise of the suite. Researchers created these games using universal design principles to facilitate deeper conceptual understanding of the scientific inquiry process among middle school students—especially among struggling learners. The games provided tutorials and scaffolding where necessary to support student learning.

Grade Levels:
MS
Focal Populations:
EL, SWD
Products Developed / Tested:

Voyage to Galapagos: Development of a Differentiated Assistance Model in an Inquiry Learning Environment

Award # R305A110021 Michael Timms, WestEd

In this project, researchers evaluated the impact of combining SimScientists, a web-based learning management system, with Voyage to Galapagos (VTG), an inquiry-driven instructional module that provided middle and high school biology students with the opportunity to simulate science field work in the Galapagos. Researchers created three versions of the VTG module, with each one providing different types of assistance (e.g., feedback after completing a level or feedback while working on a problem) within the SimScientists' web based platform. Researchers then explored how students learn when receiving tutoring at different points in the simulation process and when the tutoring that they receive is contingent on their ability level.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

An Examination of the Qualities of Interactive Science Learning Environments That Promote Optimal Motivation and Learning

Award # R305A110810 Steven McGee, The Learning Partnership

In this project, researchers explored the relationship between the strategies for increasing cognitive development and the strategies for increasing interest in science that underlie Journey to El Yunque, a web-based ecology curriculum for middle school students. Journey to El Yunque aimed to promote both learning and interest in science. The researchers posited that variables that promote interest may be detrimental to learning whereas variables that advance learning may be detrimental to interest. The researchers examined both variables together in the context of Journey to El Yunque.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

SimScientists Assessment System

Award # R305A120390 Edys Quellmalz, WestEd

In this project, researchers designed and validated a set of middle school simulation-based assessments for the life science strand of the SimScientists Assessment System. The researchers aimed to measure complex learning that could be useful to instruction through simulation-based assessments that encompassed three units taught in middle school: cells, human body systems, and ecosystems.

Grade Levels:
MS
Focal Populations:
EL, SWD
Products Developed / Tested:

SimScientists Model Progressions

Award # R305A130160 Edys Quellmalz, WestEd

In this project, researchers iteratively developed and tested additional life science instructional suites for SimScientists, a simulation-based science learning environment for middle school students. Researchers also developed and validated the learning progressions, trajectories, and connections between multiple life science systems advocated in the Next Generation Science Standards and professional development that included a summer workshop and webinars. For this study, researchers focused on outcomes of students from a range of socioeconomic levels as well as disadvantaged students and English language learners.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Mentoring Teachers through Pedagogical Content Knowledge Development

Award # R305M050064 Luanne Hall-Stoodley, Allegheny Singer Research Institute

In this project, researchers iteratively developed and tested a professional development program for high school life science teachers to increase teachers' in-depth knowledge in specialized topics of life science. The professional development program covered life science instruction in three different domains: genomics and bioethics, biotechnology and bio-informatics, and microbiology/infectious diseases. The emphasis of the program was on teachers' content knowledge, pedagogical knowledge, and application of pedagogies.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

V-Frog: Applying Virtual Surgery Principles to Dissection Simulation

Award # R305S050019 Kevin Chugh, Tactus Technologies, Inc.

In this project, researchers iteratively developed and tested a functioning prototype of V-Frog and performed tests on the usability and initial feasibility of the prototype. The researchers developed V-Frog, virtual-reality frog-dissection software, designed to be used as a substitute or supplement to physical dissection in high school-level biology. The project included an evaluation that compared students' learning and mastery of anatomy with V-Frog to that of students performing actual physical dissections.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Effect of the SUN Teacher Workshop on Student Achievement

Award # R305B070443 Ann Batiza, Milwaukee School of Engineering

In this project, researchers iteratively developed and tested an in-service training workshop for high school teachers (called Students Understanding eNergy) that aimed to help teachers build a deeper understanding of potentially difficult concepts, like energy transfer in biological systems and the impact of these processes on the flow of matter and energy in biology. In the workshop, high school teachers learned to use interactive physical models that provided multisensory experiences. In addition to the physical models, teachers were provided with interactive and hyperlinked computer visualizations, animations, pen and paper exercises, schematics, and other materials to help them teach high school biology.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Guru: A Computer Tutor that Models Expert Human Tutors

Award # R305A080594 Andrew Olney, University of Memphis

In this project, researchers iteratively developed and tested Guru, a computer-based intelligent tutoring system for high school students developed to promote educational attainment by targeting biology content that students must master in order to graduate. Students interacted with the Guru animated agent by having a conversation with the tutor. During the course of the conversation, Guru and the student worked through biology topics and problems through a multimedia panel that presented movies, interactive diagrams, and other instructional media.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Education Research - BioBridge Teacher Quality

Award # R305A080692 Loren Thompson, University of California, San Diego

In this project, researchers iteratively developed and tested laboratory activities and materials for high school science curricula, focusing on introducing emerging research and technology directly into classrooms. The researchers and teachers created and evaluated a professional development program with four components: a hands-on training where teachers play the role of a student as they learn the lab, its related content, and pedagogy; a practice session where teachers conduct the lab with a small group of their students while supported by a training team (the "BioBridge team"); a consultation with the BioBridge team that takes place at their school a day before the first implementation of the lab; and support during the lab's initial implementation. In addition, the intervention contained a student leader component, in which students were trained to take leadership positions and help teachers implement the lab with a full classroom of students.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Agile Mind Visualizations to Increase High School Biology Learning

Award # EDIES09C0017 Linda Chaput, Agile Mind, Inc.

In this project, researchers iteratively developed and tested interactive, animated visualizations of key science concepts to increase student engagement in learning. Visualizations can be designed to encourage exploration and the testing of ideas to facilitate understanding. The project team designed several visualizations and then embedded them within Agile Minds' existing online high school biology course services. The product also included online, real-time teacher support to enable successful integration of the technology within classroom practice.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Promoting Robust Understanding of Genetics With a Cognitive Tutor that Integrates Conceptual Learning With Problem Solving

Award # R305A090549 Albert Corbett, Carnegie Mellon University

In this project, researchers iteratively developed and tested new modules for the Carnegie Mellon Genetics Cognitive Tutor (GCT), an intelligent tutoring system for learning genetics. The new GCT modules used conceptually grounded problem solving to help students understand genetics processes more fully and to help students learn how to form hypotheses based on observations. Researchers integrated the new GCT modules with existing GCT modules to form a new Conceptually Grounded Genetics Problem Solving environment.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:


Cyber-enabled Tangible Molecular Models for High School

Award # R305A120047 Jodi Davenport, WestEd

In this project, researchers iteratively developed and tested cyber-enabled tangible molecular models and companion activities for high school biology students. The intervention aimed to enhance the instruction of core concepts of molecular biology taught in high school (protein structure, enzymes, DNA, and viruses) through physical, flexible models of molecules. The models were cyber-enabled, as users manipulated the models in front of a computer's webcam, the software tracked the motion of the physics models in real-time. Researchers posited that the physical manipulation could promote students' understanding of how proteins interact and illustrate how secondary and tertiary structures emerge during the movement.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:


4. Earth and Space Sciences in Kindergarten through 12th Grade Settings

Earth and space sciences encompass the study of the Earth (e.g., Earth's climate, makeup, human activity, and its place in the solar system) and the universe. Researchers have developed and tested curricula that use hands-on activities infused with educational technology to promote student motivation and learning in earth science (Wu, Hwang and Tasai 2013; Isik-Ercan, Inan, Nowak and Kim 2014). This chapter includes a project that focused on evaluating approaches to teacher professional development designed to improve Earth science teaching.

Table Key

Grade levels:

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Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation

Award # R305M050226 William R. Penuel, SRI International

In this project, researchers evaluated the impact of Investigating Earth Systems and Earth Science by Design, two earth science programs developed to enhance middle school science education. Researchers assessed three approaches to professional development: providing teachers with high-quality curriculum units and with professional development and follow-up; providing teachers with training in how to develop high-quality curriculum units and give them time to develop these units, along with follow-up mentoring; and providing teachers with training in how to develop high-quality curriculum units and give them high-quality materials to revise and adapt in developing units.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

5. Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings

Multi-unit or integrated science curricula often blend or sequence topics (e.g., chemistry and physics) so that they align with a developmental progression or incorporate skills from different domains (e.g., math, reading, and writing). This contrasts with a single unit curriculum for biology or chemistry. Researchers have found that an integrated approach to science, such as integrating science learning with reading comprehension, has positive impacts on student science and literacy outcomes (Romance and Vitale 2012; Tong, Irby, Lara-Alecio, Guerrero et al. 2014). This chapter includes programs and curricula that are multi-unit, sequential, or integrated in approach designed to improve student learning and outcomes in science. These projects feature programs, curriculum design, learning and instructional activities, assessments, and online and software-based learning systems designed to offer integrated science instruction.

Table Key

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The Scientific Literacy Project: Enhancing Young Children's Scientific Literacy Through Reading and Inquiry-Centered Adult-Child Dialogue

Award # R305K050038 Panayota Mantzicopoulos, Purdue University

In this project, researchers iteratively developed and tested Scientific Literacy Project, a comprehensive, multiunit instructional program for kindergarten children developed to enhance their early scientific literacy. The intervention involved six units that addressed major themes in early science learning (i.e., the five senses, animals, insects, plants, the environment, and weather and seasons). Each unit consisted of a 5-week inquiry cycle comprising three phases (pre-inquiry, inquiry, post-inquiry). Each inquiry cycle was structured to relate the science learning from the specific unit to the overarching curricular themes through multiple related inquiry and literacy activities.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Diagnostic Embedded Classroom Assessment-An Efficacy Study

Award # R305B070354 Steve Schneider, WestEd

In this project, researchers evaluated the impact of the Assessing Science Knowledge diagnostic formative assessment system, which aimed to enable grade 4 teachers to monitor student learning, provide immediate feedback to students at key junctures, and adjust instruction accordingly. The embedded assessments were incorporated into instruction and provided continuous information about students' learning to both teachers and students. The benchmark assessments were summative measures of students' accumulated knowledge and understanding of science. The assessment system was developed to be an integral part of the Full Option Science System (FOSS) elementary science modules. Assessing Science Knowledge comprised two kinds of assessments: embedded and benchmark.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Mindful Instruction of Nonmainstream Children

Award # R305A080347 Richard Anderson, University of Illinois, Urbana-Champaign

In this project, researchers evaluated the impact of Collaborative Reasoning, an intervention created to boost students' conceptual understanding, thinking skills, language, and motivation through classroom discussion. The researchers deployed this intervention as part of the Wolf Management Unit, a curriculum about wolf ecology for fifth-grade students. Through Collaborative Reasoning, students had opportunities to reason and deliberate with one another about the multi-faceted issues raised in the text(s) they read, thereby improving their skills in multiple domains including reading comprehension and science.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums

Award # EDIES10C0020 George Newman, One Planet Education Network

In this project, researchers iteratively developed and tested a virtual learning environment for science and social studies and researched its usability, feasibility, and promise. The project team developed a three-dimensional (3D) virtual replica of Machu Picchu national park and the ancient Incan ruins in Peru. The online environment was designed for classroom use and was intended to foster engagement in learning and enhance gains in a set of multidisciplinary student outcomes. Researchers planned to test the virtual environment in social studies classrooms.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

The Effects of Arts-Integration on Retention of Content and Student Engagement

Award # R305A120451 Mariale Hardiman, Johns Hopkins University

In this project, researchers iteratively developed and tested an arts-integrated science curriculum for fifth-grade students. The curricular units addressed astronomy, ecology, and the physical and life sciences domains. Researchers aimed to enhance student engagement and retention of instructional content through arts integration, a pedagogical technique for delivering content in core subjects through visual and performing arts activities with the explicit goal of making instruction engaging. The arts integration curriculum was intended to replace traditional classroom activities with artistic activities into which the same academic content was embedded.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Videogame-Based Inquiry Learning Module for Science Literacy

Award # ED06PO0899 Jeremiah Dibley, South Dakota Health Technology

In this project, researchers iteratively developed a prototype of Creature Control: Earth Day, a videogame designed to teach middle school science concepts that align with the National Science Education Standards. In Creature Control: Earth Day, earth science concepts were embedded into a virtual world where students learned about an ecosystem and how it could be disrupted by human impact.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Test-Enhanced Learning in the Classroom

Award # R305H060080 Henry Roediger III, Washington University, St. Louis

In this project, researchers evaluated the impact of the Test-Enhanced Learning Program on a sample of sixth- through eighth-grade science and social studies students. The project built on earlier work on test-enhanced learning that used frequent quizzes as learning events. Specifically, researchers examined four concepts: whether testing enhanced learning, whether production tests produced better retention at delays than did recognition tests, whether multiple tests were better than single tests for enhancing learning, and whether immediate feedback improved the effect of testing, especially for facts missed on the tests.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

The Tactus Immersive Learning Environment (TILE) for Enhancing Learning in High School Science Classrooms

Award # ED07CO0038 Kevin Chugh, Tactus Technologies, Inc.

In this project, researchers iteratively developed and tested a virtual reality simulation platform and researched its usability, feasibility, and promise. The project team developed the Tactus Immersive Learning Environment (TILE) to facilitate student learning of core National Science Education Standards. Researchers intended TILE for use as a supplement to middle and high school science curricula, for primary instruction of concepts, for review of concepts, or for individual or small-group practice.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Understanding Science: Improving Achievement of Middle School Students in Science

Award # R305B070233 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested three middle school teacher professional development courses that aimed to improve teachers' understanding of challenging physical science and earth science topics and, thus, help close the achievement gap especially for English learners. The three topic areas were heat and energy, plate tectonics, and climate and weather. The courses also helped teachers to examine how children make sense of those concepts and to analyze and improve their teaching. The first two courses had a pedagogical focus on supporting students' writing in science and the last one had a pedagogical focus on supporting students' reading in science.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

The Digital Earth Explorations Project to Enrich the Middle School Sciences

Award # ED08CO0050 George Newman, One Planet Education Network

In this project, researchers iteratively developed and tested a three-dimensional (3D) web-based virtual reality game and researched its usability, feasibility, and promise. The game was designed to act as a supplement to middle school life science, social studies, and persuasive writing curricula. The project team aligned the game to standards in the life sciences. In the game, students perform inquiry-based activities or quests to understand and solve problems that arise. Each adventure was designed to connect to specific academic standards and disciplinary content to help students better understand and value cultural and natural heritage.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight

Award # R305A080422 Janet Carlson, Biological Sciences Curriculum Study (BSCS)

In this project, researchers iteratively developed and tested an inquiry-based, multidisciplinary, science curriculum for eighth-grade students designed to improve their interest and proficiency in science. The curriculum contained five units: science as inquiry, physical science, life science, earth and space, and science in a personal and social perspective. The curriculum used inquiry as the dominant theme by weaving concepts of energy and systems throughout each curriculum unit. Within each unit, the curriculum included formative and summative assessments to offer teachers an opportunity to improve teaching and classroom practices, plan appropriate activities, develop self-directed learners, and report student progress.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

National Research & Development Center on Cognition and Science Instruction

Award # R305C080009 F. Joseph Merlino, 21st Century Partnership for STEM Education

In this project, researchers iteratively adapted and tested life science, physical science, and earth science units of two widely used middle school curricula, Holt and Full Option Science System (FOSS). The adaptations integrated three theoretical principles of cognitive science: analogical reasoning, spatial reasoning, and student prior knowledge. Additionally, the researchers created professional development materials and evaluated the impact of the modified curricula and the support materials.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

ASSISTment Meets Science Learning (AMSL)

Award # R305A090170 Janice Gobert, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested a computer-based intelligent tutoring system, ASSISTment, which aimed to tutor middle school students in science inquiry and process skills. Materials in the modules addressed the following science strands: earth in the solar system, classification of organisms, structures and functions of cells, and systems of living things. The modules used microworlds to tutor students on science process skills needed to conduct inquiry. In the microworld, students were presented with a scenario and then asked to make predictions and answer questions about that scenario. The ASSISTment tutoring system provided support and feedback to students.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Planet First Energy World (PFEW)

Award # EDIES10P0103 George Newman, One Planet Education Network

In this project, researchers iteratively developed and tested a functioning prototype of three-dimensional (3D) virtual environment and performed tests on the usability and initial feasibility of the prototype. The project team developed a prototype of the Planet First Energy Worlds, a 3D virtual environment focused on energy-related topics that addressed sixth-grade mathematics and science standards. The intervention used inquiry scenarios and disciplinary content to address different situations using a video game format immersed in 3D technology. The intervention included teacher professional development and support.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Accessible Professional Development for Teaching Aquatic Science Inquiry

Award # R305A100091 Kanesa Duncan, University of Hawaii

In this project, researchers iteratively developed and tested an intervention for teachers of heterogeneous groups of students in middle and high schools in both rural and urban settings. Researchers developed a series of professional development modules consisting of in-person trainings coupled with online learning support. The four modules focused on: introductory, physical, biological, and ecological aquatic science. Researchers planned to assess teacher outcomes as well as student outcomes.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Toward High School Biology: Helping Middle School Students Make Sense of Chemical Reactions

Award # R305A100714 Jo Ellen Roseman, American Association for the Advancement of Science (AAAS)

In this project, researchers iteratively developed and tested an intervention for a diverse group of middle school classrooms. Researchers developed two new replacement units for teaching middle school chemistry and biochemistry. Each 2-week unit addressed significant and persistent problems that many students have in understanding key ideas related to chemical reactions and their application to living and non-living systems. For the pilot, researchers measured curriculum quality, teacher knowledge, classroom feasibility, and promise in promoting student understanding.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired

Award # EDIES11C0028 Marjorie Darrah, Information Research Corporation

In this project, researchers iteratively developed and tested Interactive Touch Science, an integrated software and hardware assistive technology platform, and researched its usability, feasibility, and promise. The product included a set of 20 applications that addressed standards-relevant content and aimed to support STEM (science, technology, engineering, and mathematics) learning among middle school students with (or without) visual impairments. The product also provided real-time tactile, visual, and audio feedback.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Readorium Software for Improved Reading Comprehension of Non-fiction Science Text

Award # EDIES11C0042 Harriet Isicke, Mtelegence Corporation

In this project, researchers iteratively developed and tested Readorium, web-based software to support struggling middle school readers' understanding of nonfiction science texts. The prototype of this software was developed under an earlier IES award. Readorium was designed to supplement middle school science curricula and included an avatar that explained all functions and guided student learning. As part of the project, the project team also researched Readorium's usability, feasibility, and promise.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Developing a Manual for Test-Enhanced Learning in the Classroom

Award # R305A110550 Henry Roediger III, Washington University, St. Louis

In this project, researchers iteratively developed and tested a manual for science teachers to use in adapting the Test-Enhanced Learning (TEL) approach for middle school and high school students in the content areas of history, biology, and chemistry. TEL aimed to improve students' retention of knowledge in many different subject matters. The TEL approach was grounded in three theoretical processes that augment learning and retention: active retrieval of information from memory, learning from feedback, and improvement in metacognition (i.e., the ability to think about one's cognitive processes). Researchers created a TEL teacher manual for middle and high school teachers to help them integrate TEL into their classroom practices.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

GlobalEd 2

Award # R305A130195 Scott Brown, University of Connecticut

In this project, researchers evaluated the impact of Global2 Ed, a set of online problem-based learning simulations for middle school students. The intervention focused on the multidisciplinary nature of social studies as an expanded curricular space for students to learn and apply scientific literacies and concepts in an international context. The researchers evaluated eighth-grade students' STEM literacies, knowledge, and attitudes to determine whether results varied across diverse groups from both urban and suburban environments.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Measuring the Efficacy and Student Achievement of Research-based Instructional Materials in High School Multidisciplinary Science

Award # R305K060142 Joseph A. Taylor, Biological Sciences Curriculum Study (BSCS)

In this project, researchers evaluated the impact of Biological Sciences Curriculum Study (BSCS) Science: An Inquiry Approach, a multidisciplinary science curriculum for high school students. The study aimed to understand whether students who used this curriculum learned more than students who used the existing commercially produced science curriculum.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Cosmic Chemistry: Engaging Summer Learning for High School Students

Award # R305A090344 Dawn Mackety, Mid-continent Research for Education and Learning (McREL)

In this project, researchers iteratively developed and tested an intervention for disadvantaged students at risk of low achievement in science who wish to take chemistry in high school. Researchers created a summer science curriculum that served as a fully developed intervention—Cosmic Chemistry. This summer curriculum included curriculum sequences and a storyline, museum exhibits, a sense-making strategies document, and websites for both students and facilitators.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

6. Engineering, Technology, and Applications of Science in Kindergarten through 12th Grade Settings

Some scholars contend that a focus on just scientific facts and a singular scientific method misrepresents the full range of what science can encompass and does a disservice to the areas of science where theory meets design and application, in particular engineering (National Research Council 2012). Education researchers have found that engineering skills, such as spatial reasoning, are related to science achievement and may also mediate gender differences in middle school students' science performance (Ganley, Vasilyeva, and Dulaney 2014; Uttal, Miller, and Newcombe 2013). This chapter focuses on student learning within domains where science and application meet and, in particular, on engineering, including defining an engineering problem, developing possible solutions, and optimizing design solutions. The projects included here developed and evaluated simulations and learning environments that apply science in interactive learning settings.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums

Award # EDIES10C0020 George Newman, One Planet Education Network

In this project, researchers iteratively developed and tested a virtual learning environment for science and social studies and researched its usability, feasibility, and promise. The project team developed a three-dimensional (3D) virtual replica of Machu Picchu national park and the ancient Incan ruins in Peru. The online environment was designed for classroom use and was intended to foster engagement in learning and enhance gains in a set of multidisciplinary student outcomes. Researchers planned to test the virtual environment in social studies classrooms.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:


FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math

Award # EDIES10P0102 Gary Goldberger, Fablevision, Inc.

In this project, researchers iteratively developed and tested a prototype of FabLab Construction Station, a computer program designed to support second-grade teachers and students. FabLab allowed students to design two-dimensional and three-dimensional geometric shapes, bulletin boards, paper airplanes, pop-ups, and other materials. Researchers aligned the final product to outcomes in math and engineering and intended for the product to support the acquisition of knowledge in topics including shapes, geometry, pre-algebra, and measurement.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


Science4Us: Game-Based K-2 STEM Education for Teachers and Students

Award # EDIES13C0033 Catherine Christopher, Vkidz, Inc.

In this project, researchers iteratively developed and tested a prototype of a web-based gaming intervention for students in kindergarten through second grade developed to help them learn standard-based concepts in science, technology, engineering, and math. The games had engaging and interactive simulations, investigations, stories and videos, as well as individual pages that allowed students to access their own set of digital scientific tools such as a notebook, a glossary, and animations.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


7. Student Practice, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings

Researchers have found that scientific discourse and argumentation (Shemwell and Furtak 2010), guided inquiry (Bunterm, Lee, Kong, Srikoon et al. 2014), and hands-on learning (Wyss, Dolence, Kong and Tai 2013) are associated with higher levels of conceptual knowledge, rigorous course taking, and science learning and achievement. These findings suggest that student scientific practices—how they ask questions and define problems, plan and carry out investigations, and evaluate and communicate information—are important to overall science learning and skill. This chapter includes programs, instructional practices, curricula, technologies, and assessments designed to improve student practices, their understanding of scientific inquiry, and their ability to reason using scientific processes.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Using Cognitive Analyses to Improve Children's Math and Science Learning

Award # R305H020060 Robert Siegler, Carnegie Mellon University

In this project, researchers explored the relationship between differences in children's initial conceptual understandings of mathematics and science and children's later performance on mathematics and science tasks. The researchers also iteratively developed and tested a strategy for teaching children to overcome their misconceptions regarding numerical magnitudes.

Grade Levels:
EC, ES
Focal Populations:

Products Developed / Tested:

The Scientific Literacy Project: Enhancing Young Children's Scientific Literacy Through Reading and Inquiry-Centered Adult-Child Dialogue

Award # R305K050038 Panayota Mantzicopoulos, Purdue University

In this project, researchers iteratively developed and tested Scientific Literacy Project, a comprehensive, multiunit instructional program for kindergarten children developed to enhance their early scientific literacy. The intervention involved six units that addressed major themes in early science learning (i.e., the five senses, animals, insects, plants, the environment, and weather and seasons). Each unit consisted of a 5-week inquiry cycle comprising three phases (pre-inquiry, inquiry, post-inquiry). Each inquiry cycle was structured to relate the science learning from the specific unit to the overarching curricular themes through multiple related inquiry and literacy activities.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Training in Experimental Design: Developing Scalable and Adaptive Computer-based Science Instruction

Award # R305H060034 David Klahr, Carnegie Mellon University

In this project, researchers iteratively developed and tested a computer-based intelligent tutoring system developed to improve elementary and middle school students' learning of scientific thinking. The intervention included computerized instructional modules with simulations, tracking of students' performance, and adaptive algorithms that provided feedback based on students' current actions and knowledge. Students who did not reach mastery in a particular module received one-on-one instruction.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms

Award # R305H060089 Gautam Biswas, Vanderbilt University

In this project, researchers iteratively developed and tested Teachable Agents (TAs), a software intervention for middle school students to develop their metacognition (i.e., their awareness of their cognitive processes) and ability to learn through a learn-by-teaching approach. TAs were interactive computer-based learning environments in which students taught virtual students, called agents, how to understand various concepts. Students used three primary components to teach the agents: teaching an agent using a concept map, querying to see how much the agent understood, and quizzing the agent with a provided test to see how well it did on questions the student may not have considered.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Teaching the Logic of the Scientific Method in the Fourth Grade

Award # R305H060150 Elizabeth Lorch, University of Kentucky

In this project, researchers iteratively developed and tested an intervention for teaching the core logic of the scientific method to fourth-grade students. The researchers aimed to understand the efficacy of direct instruction versus discovery learning on fourth-grade students' learning of the scientific method. Two levels of intervention were used: the first involved explicit instruction combined with extensive student participation throughout the lessons; the second involved explicit instruction, but the student participation activities were replaced with teacher-provided demonstrations and examples.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Improving Science Learning Through Tutorial Dialogs

Award # R305B070434 Wayne Ward, Boulder Language Technologies, Inc.

In this project, researchers evaluated the impact of a dialog interaction system called Questioning the Author (QTA) designed to help elementary science students learn and integrate new concepts with what they already know to deepen and expand knowledge presented in class. The researchers also evaluated the use of a virtual tutor that acted like a human tutor in conducting the dialogs. The researchers examined the potential of tutorial dialogs to improve children's science learning and practices in schools that had previously performed poorly with the Full Option Science System (FOSS), a structured science program that had been shown to work with many but not all students.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning

Award # R305A080316 Katherine Rawson, Kent State University

In this project, researchers iteratively developed and tested the Retrieval-Monitoring-Feedback method, an intervention for fifth- through seventh-grade students and undergraduates developed to support durable and efficient student learning of key science concepts from course content. The intervention was a computer-assisted study process that combined advances in techniques used to improve metacognitive monitoring with spaced retrieval practice and restudy.

Grade Levels:
ES, MS, PA
Focal Populations:

Products Developed / Tested:

Mindful Instruction of Nonmainstream Children

Award # R305A080347 Richard Anderson, University of Illinois, Urbana-Champaign

In this project, researchers evaluated the impact of Collaborative Reasoning, an intervention created to boost students' conceptual understanding, thinking skills, language, and motivation through classroom discussion. The researchers deployed this intervention as part of the Wolf Management Unit, a curriculum about wolf ecology for fifth-grade students. Through Collaborative Reasoning, students had opportunities to reason and deliberate with one another about the multi-faceted issues raised in the text(s) they read, thereby improving their skills in multiple domains including reading comprehension and science.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Efficacy of the Science Writing Heuristic Approach

Award # R305A090094 Brian Hand, University of Iowa

In this project, researchers evaluated the impact of the Science Writing Heuristic (SWH) approach on the science achievement of students in grades 4 through 6. SWH was an inquiry approach developed to help build elementary school students' science content knowledge, argumentation skills, and interest. The approach embedded instruction about building scientific arguments within typical science inquiry lessons. When using the SWH approach, students set their own investigative agenda for laboratory work by framing questions, proposing methods to address those questions, and carrying out appropriate investigations.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Promoting Science among English Language Learners (P-SELL): Efficacy and Sustainability

Award # R305A090281 Okhee Lee, University of Miami

In this project, researchers evaluated the impact of the Promoting Science among English Language Learners (P-SELL) on English language learners in fifth grade. The curriculum aimed to promote standards-based, inquiry-driven science learning by focusing on instruction to enhance students' understanding of science and acquisition of English language and literacy. The P-SELL curriculum incorporated the following strategies into the curriculum: literacy development of all students, language support, linguistic scaffolding during classroom discourse, and drawing on students' home language as instructional support. The P-SELL curriculum included a student book, teachers' guide, science supplies, and trade books related to science topics.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

Promoting Transfer of the Control of Variables Strategy in Elementary and Middle School Children via Contextual Framing and Abstraction

Award # R305A100404 David Klahr, Carnegie Mellon University

In this project, researchers iteratively developed and tested TED2, a web-based computer tutor for elementary and middle school students developed to support their conceptual understanding and procedural skills in designing and interpreting scientific experiments. The researchers conducted studies to explore the effects on student learning of varying instructional methods used by the online tutor.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Habitat Tracker: Learning About Scientific Inquiry Through Digital Journaling at Wildlife Centers

Award # R305A100782 Paul Marty, Florida State University

In this project, researchers iteratively developed and tested the Habitat Tracker Digital Journal and the Habitat Tracker Community Website, which aimed to foster fourth- and fifth-grade students' understanding of scientific inquiry and the nature of science through student-led data collection and analysis, before, during, and after visits to a local wildlife center. The journal was an application for a handheld device through which students recorded observations, answered questions, and accessed multimedia content. The website was an interactive forum where students could read and edit their digital journal entries and contribute data about natural habitats they observed. The intervention also included a 3-day professional development workshop.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Retrieval-Oriented Learning Strategies

Award # R305A110903 Jeffrey Karpicke, Purdue University

In this project, researchers explored the relationship between concept mapping and its usefulness as a retrieval-oriented learning strategy in science classes and the relationship between retrieval cues and free recall of learned material. Researchers aimed to identify the best practices for implementing retrieval-oriented learning strategies to promote students' learning in grade 3 to 5 science courses.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Teaching Perceptual and Conceptual Processes in Graph Interpretation

Award # R305A120531 Steven Franconeri, Northwestern University

In this project, researchers explored the relationship between learning specific visual routines for extracting relational information from graphs (e.g., through a serial inspection of one object or value at a time) and acquiring scientific knowledge. The researchers aimed to produce preliminary evidence of the role of dynamic visual routines in extracting information from graphs. The research sample included high school juniors and seniors, third-grade students, and students in the summer immediately after completing fourth grade.

Grade Levels:
ES, HS
Focal Populations:

Products Developed / Tested:

My Science Tutor: Improving Science Learning through Tutorial Dialogs (MyST)

Award # R305A130206 Wayne Ward, Boulder Language Technologies, Inc.

In this project, researchers evaluated the impact of a computer-based intelligent tutoring system called My Science Tutor (MyST) for third- through fifth-grade students. The team designed MyST to supplement classroom instruction using the Full Option Science System (FOSS) curriculum. FOSS was a non-textbook based science curriculum focused on allowing students the opportunity to actively construct ideas through inquiry, experimentation, and analysis. Researchers evaluated the project by randomly assigning students to the one-on-one MyST tutoring or the control conditions (small-group human tutoring or business as usual) and measuring student science outcomes.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Introducing Desirable Difficulties for Educational Applications in Science

Award # R305H020113 Robert Bjork, University of California, Los Angeles

In this project, researchers evaluated the impact of interventions that appear to make learning more difficult and slow the rate of learning to determine whether they can be effective in enhancing long-term retention of information. The researchers aimed to determine whether these "desirable difficulties" could be generalized to realistic educational materials and contexts involving middle school and college students using the Web-based Inquiry Science Environment program.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Supporting Efficient and Durable Student Learning

Award # R305H050038 John Dunlosky, Kent State University

In this project, researchers iteratively developed and tested a new method of learning and study called retrieval-feedback-monitoring. Retrieval-feedback-monitoring was designed to support students' learning for long-term retention of key concepts in academic content areas. The project team planned to complete laboratory research to optimize the process then implement it with undergraduate psychology students and middle school science students.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Dynamically Modifying the Learning Trajectories of Novices with Pedagogical Agents

Award # R305H050052 Carole Beal, University of Southern California

In this project, researchers iteratively adapted and tested the IMMEX (Interactive Multi-Media Exercises) program for middle and high school chemistry students to help them revise their chemistry problem solving strategies. IMMEX was a web-based problem-solving simulation program through which students learned to frame a problem from a scenario, judge what information was relevant, plan a strategy, gather information, and reach a decision that demonstrated understanding. The researchers modified the intervention to integrate a pedagogical model into the system that provided neutral feedback (general encouragement) or individualized feedback that explicitly addressed how the student was approaching the problem.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations

Award # R305H050116 Robert Goldstone, Indiana University

In this project, researchers iteratively developed and tested perceptually based and interactive computer simulations and curricula for teaching complex systems developed to support K-12 and college students as they mastered abstract scientific principles.

Grade Levels:
MS, HS, PA
Focal Populations:

Products Developed / Tested:

Scientific Misconceptions: From Cognitive Underpinning to Educational Treatment

Award # R305H050125 Andrew Heckler, Ohio State University

In this project, researchers iteratively developed and tested empirically supported and theoretically-driven instructional approaches for sixth-grade science courses and for a university-level physics course developed to help students correct physical science misconceptions. In order to identify the underlying cognitive processes that lead to the creation of misconceptions in scientific reasoning, researchers artificially created and studied misconception-like phenomena. Researchers designed a set of instructional approaches used to revise the cognitive processes, overcome these misconceptions, and improve science learning. Researchers then tested these techniques both in laboratory contexts and during physics instruction in elementary school and university instructional settings.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Test-Enhanced Learning in the Classroom

Award # R305H060080 Henry Roediger III, Washington University, St. Louis

In this project, researchers evaluated the impact of the Test-Enhanced Learning Program on a sample of sixth- through eighth-grade science and social studies students. The project built on earlier work on test-enhanced learning that used frequent quizzes as learning events. Specifically, researchers examined four concepts: whether testing enhanced learning, whether production tests produced better retention at delays than did recognition tests, whether multiple tests were better than single tests for enhancing learning, and whether immediate feedback improved the effect of testing, especially for facts missed on the tests.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Improving Metacomprehension and Self-Regulated Learning From Scientific Texts

Award # R305B070460 Keith Thiede, Boise State University

In this project, researchers iteratively developed and tested an intervention for college students and students in seventh grade. The intervention aimed to improve students' reading comprehension and their ability to learn effectively from scientific text by improving the effectiveness of self-regulated learning and metacognitive self-monitoring accuracy (i.e., their awareness of their own cognitive processes and the ability to track this awareness). Researchers explored whether indicating the kind of test that would be given to students through explicit instruction or practice tests affected metamemory and metacomprehension accuracy, and explored whether improvements in monitoring accuracy produced better selection of texts for restudy.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight

Award # R305A080422 Janet Carlson, Biological Sciences Curriculum Study (BSCS)

In this project, researchers iteratively developed and tested an inquiry-based, multidisciplinary, science curriculum for eighth-grade students designed to improve their interest and proficiency in science. The curriculum contained five units: science as inquiry, physical science, life science, earth and space, and science in a personal and social perspective. The curriculum used inquiry as the dominant theme by weaving concepts of energy and systems throughout each curriculum unit. Within each unit, the curriculum included formative and summative assessments to offer teachers an opportunity to improve teaching and classroom practices, plan appropriate activities, develop self-directed learners, and report student progress.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Scaffolding Students' Use of Multiple Representations for Science Learning

Award # R305A080507 Sadhana Puntambekar, University of Wisconsin

In this project, researchers iteratively developed and tested an approach to science instruction that engaged multiple modalities—text, hands-on experimentation, and interactive computer simulations that incorporated scaffolding both by the teacher and the computer—to immerse middle school students in science practices. The researchers hypothesized that a careful integration of multiple representations within an instructional unit and the design of scaffolding that enabled translation between representations would lead to a deeper conceptual understanding and improved student outcomes. Researchers tested the intervention on a racially and socioeconomically diverse group of middle school students, preservice teachers, and college students.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Virtual Performance Assessments for Measuring Student Achievement in Science

Award # R305A080514 Christopher Dede, Harvard University, Graduate School of Education

In this project, researchers validated the use of computer-based virtual performance assessments to assess middle school students' science inquiry skills in a standardized testing setting. Researchers designed three single-user immersive three-dimensional environments to assess sixth- and seventh-grade students' science inquiry process learning in the context of life science. In the space, students took on the identity of a virtual persona that could move around, interact with the environment, and complete a science inquiry problem.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

SimScientists: Interactive Simulation-Based Science Learning Environments

Award # R305A080614 Edys Quellmalz, WestEd

In this project, researchers iteratively developed and tested SimScientists, an intervention for middle school science students developed to promote complex science learning, particularly for underperforming students. SimScientists supplemented and extended existing middle school science instructional materials and offered problem-driven curriculum inquiry activities that presented students with problems to be solved by using science inquiry processes. The intervention also included embedded formative assessments, reflection activities, and teacher professional development.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Expanding the Science and Literacy Curricular Space: The GlobalEd 2 Project

Award # R305A080622 Scott Brown, University of Connecticut

In this project, researchers iteratively developed and tested GlobalEd 2, an intervention for eighth-grade students developed to facilitate their abilities to construct sophisticated persuasive text and understand important scientific principles. The intervention was a communication-intensive, technology-based instructional environment in which classrooms were assigned to represent particular countries in an online simulation-based scenario and students worked collaboratively to resolve real-world international problems through scientific arguments in oral and written presentations. The pilot test of the full version of the intervention included a professional development component.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

National Research & Development Center on Instructional Technology: Possible Worlds

Award # R305C080022 Cornelia Brunner, Education Development Center, Inc.

In this project, researchers iteratively developed and tested Super Sleuths, a portable multimedia-enhanced curriculum developed to support science and literacy learning among seventh-grade students. SuperSleuths used the Nintendo Dual-Screen portable gaming environment and included three integrated supports: a motivating story context that unfolded over time in which students had a competitive role and were challenged to act as scientists, communication capacities between teacher and multi-player students to enhance classroom problem solving and teamwork, and mini-games that built specific science knowledge and concrete literacy skills. As part of this project, the researchers created professional development materials and evaluated the impact of SuperSleuths on students' science and reading outcomes.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

ASSISTment Meets Science Learning (AMSL)

Award # R305A090170 Janice Gobert, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested a computer-based intelligent tutoring system, ASSISTment, which aimed to tutor middle school students in science inquiry and process skills. Materials in the modules addressed the following science strands: earth in the solar system, classification of organisms, structures and functions of cells, and systems of living things. The modules used microworlds to tutor students on science process skills needed to conduct inquiry. In the microworld, students were presented with a scenario and then asked to make predictions and answer questions about that scenario. The ASSISTment tutoring system provided support and feedback to students.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Learning Progressions in Middle School Science Instruction and Assessment

Award # R305A100692 Mark Wilson, University of California, Berkeley

In this project, researchers designed and validated learning progression assessments for use with middle school science students. Researchers developed these assessments—Structure of Matter and Scientific Reasoning—to focus on learning progression in physical science and eighth graders' scientific reasoning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Argument-Driven Inquiry in the Middle and High School Laboratory-The Refinement and Further Development of a New Instructional Model

Award # R305A100909 Victor Sampson, Florida State University

In this project, researchers iteratively developed and tested the Argument-Driven Inquiry instructional model, an intervention used by middle and high school teachers to change the nature of laboratory experiences inside science classrooms to better support and promote the development of students' scientific proficiency. The model included students making observations and generating data, articulating an argument about the phenomenon under investigation, writing an investigation report, and reflecting on the investigation and the nature of science.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Improving the Science Performance of Students With Learning Disabilities Through Strategic Note-taking

Award # R324A120409 Joseph Boyle, Temple University

In this project, researchers iteratively developed and tested an intervention for eighth-grade students with high-incidence disabilities designed to improve students' note-taking skills and retention of science content in general education or inclusive science classes. The intervention drew on research on working memory during writing and note-taking tasks to teach students with learning disabilities how to improve their note-taking skills during science lectures and helped students improve their understanding of science content. The researchers developed a teacher training manual with student materials, videotaped and scripted science lectures, and a teacher training video on how to train students to use strategic note-taking.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Possible Worlds: Explorer Series

Award # EDIES12C0040 Tobi Saulnier, 1st Playable Productions

In this project, researchers iteratively developed and tested a prototype of a platform to host web-based interactive games and performed tests on the usability and initial feasibility of the prototype. The project team developed the platform to help middle grade students overcome scientific misconceptions. In this project, researchers aimed to convert and enhance the games and materials for use on tablet-based devices with touch-screen capabilities to enable more in-depth and interactive gameplay. Researchers designed the games to supplement classroom lessons for topics such as genetics, photosynthesis, electricity, and energy.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

Enhancing Learning and Transfer of Science Principles via Category Construction

Award # R305A120554 Kenneth Kurtz, State University of New York (SUNY), Binghamton

In this project, researchers iteratively developed and tested a set of tasks in which middle school students who were learning evolution concepts classified relevant science text passages written on note cards by organizing them according to common characteristics. The intervention aimed to guide students in scientific thinking in much the same way that natural object categories (e.g., dog, chair) guide learners in making sense of everyday experiences.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining

Award # R305A120778 Janice Gobert, Worcester Polytechnic Institute

In this project, researchers iteratively developed and tested a pedagogical agent (an animated character used in the online learning), designed to assist middle school students in learning inquiry in new physical science topics. Researchers integrated the pedagogical agent into 12 previously developed physical science microworlds (small scale interactive simulations), in which students conducted inquiry by generating hypotheses, collecting data to test their hypotheses, interpreting the data, warranting claims, and communicating findings. The pedagogical agent guided students through each step of the inquiry process and provided real-time scaffolding through validated assessments.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Comprehension SEEDING: Comprehension Through Self-Explanation, Enhanced Discussion and Inquiry Generation

Award # R305A120808 Rodney Nielsen, Boulder Language Technologies, Inc.

In this project, researchers iteratively developed and tested a computer-based system and instructional method for sixth-grade students. The intervention aimed to simultaneously engage all students in self-explanation of science concepts through three primary components: inquiry generation—in which the teacher poses deep questions to students, self-explanation—in which students submit their constructed responses via tablet computers, and enhanced discussion— in which the computer system displays an answer prototypical of the group for the teacher and students to discuss.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

SciSkillQuest: A Standards-Based Game to Develop Students' Scientific Skills, Academic Mindsets, and Learning Strategies in Science

Award # EDIES13C0028 Lisa Sorich Blackwell, Mindset Works, LLC

In this project, researchers iteratively developed and tested SciSkillQuest, an intervention for sixth through eighth grade students. SciSkillQuest was a web-based multiplayer game that aimed to teach students key scientific inquiry skills, along with the academic mindsets and learning strategies to facilitate engagement and effective science learning. The game included different paths to a solution, role playing elements, immersive narratives, challenge-based progressions, and peer collaboration to engage players. Embedded in-game characters introduced and reinforced the growth mindset (i.e., the belief that one can improve his or her intelligence through effort and practice) message that ability and skill are developed through effort and learning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Measuring the Efficacy and Student Achievement of Research-based Instructional Materials in High School Multidisciplinary Science

Award # R305K060142 Joseph A. Taylor, Biological Sciences Curriculum Study (BSCS)

In this project, researchers evaluated the impact of Biological Sciences Curriculum Study (BSCS) Science: An Inquiry Approach, a multidisciplinary science curriculum for high school students. The study aimed to understand whether students who used this curriculum learned more than students who used the existing commercially produced science curriculum.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

A Cognitive Approach to Implementing Tree Thinking in High School and College Biology Curricula

Award # R305A080621 Laura Novick, Vanderbilt University

In this project, researchers iteratively developed and tested curricula for undergraduate and high school students to help them understand and reason in biology. The curricula integrated cladgrams, a type of hierarchical diagram used by contemporary scientists to depict evolutionary histories among species or groups of species. Being able to use cladgrams, which have tree-like shapes, is called "tree thinking". Researchers aimed to facilitate tree-thinking by designing a curriculum based on the results of cognitive experiments that focused on the cognitive and perceptual factors that influence students' reasoning.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

8. Student Perceptions, Motivations, Attitudes, and Anxiety about Science in Kindergarten through 12th Grade Settings

Student perceptions, attitudes, and experiences related to science have proven to be associated with student success (Aronson et al. 2009; Halpern et al. 2007; Kerpelman, Eryigit, and Stephens 2008), such as student achievement, interest and motivation, and educational and career aspirations. This chapter includes projects that promote science achievement by understanding self-esteem, motivation, and student perceptions and attitudes towards science.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Academic Achievement in Limited English Proficient Students: A Multivariate Latent Growth Modeling Analysis of Predictors, Mediators, and Moderators

Award # R305A090288 Sergio Guglielmi, Lake Forest College

In this project, researchers explored the relationship between native language proficiency and mathematics and science achievement growth of English language learners (EL) in grades 8, 10, and 12. Researchers aimed to identify mechanisms through which native language proficiency related to the achievement growth of EL students. The research focused on a bilingual education model in which proficiency in students' native language and exposure to their heritage culture promoted academic achievement by facilitating the development of English language skills and bolstering students' self-esteem. Researchers used data from the National Education Longitudinal Study to conduct the research.

Grade Levels:
MS, HS
Focal Populations:
EL
Products Developed / Tested:

An Examination of the Qualities of Interactive Science Learning Environments That Promote Optimal Motivation and Learning

Award # R305A110810 Steven McGee, The Learning Partnership

In this project, researchers explored the relationship between the strategies for increasing cognitive development and the strategies for increasing motivation and interest in science that underlie Journey to El Yunque, a web-based ecology curriculum for middle school students. Journey to El Yunque aimed to promote both learning and interest in science. The researchers posited that variables that promote interest may be detrimental to learning whereas variables that advance learning may be detrimental to interest. The researchers examined both variables together in the context of Journey to El Yunque.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

SimSelf: A Simulation Environment Designed to Model and Scaffold Learners' Self-Regulation Skills to Optimize Complex Science Learning

Award # R305A120186 Gautam Biswas, Vanderbilt University

In this project, researchers iteratively developed and tested SimSelf, a computer-based learning environment for seventh and eighth grade students. SimSelf aimed to strengthen students' cognitive, metacognitive, motivational, and self-regulated learning processes to enhance students' ability to solve complex science problems. SimSelf had a suite of adaptive pedagogical agents and supporting services that monitored and provided supports to build student self-regulated learning skills and knowledge of science content necessary to engage in learning tasks or to solve complex science problems.

Grade Levels:
MS
Focal Populations:
Products Developed / Tested:

9. Science in Postsecondary and Adult Education Settings

The number of college graduates with science-related degrees in general—and minority and female science-degree graduates specifically—continue to be inadequate to meet the nation's growing needs (National Science Board 2014; National Science Foundation, National Center for Science and Engineering Statistics 2013). Researchers have noted the importance of identity development, values, and motivation in the retention of college students majoring in STEM (Perez, Cromley, and Kaplan 2014). This chapter includes projects that addressed adult science learning, remedial and gateway science courses, and science courses required for a college degree.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
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The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning

Award # R305A080316 Katherine Rawson, Kent State University

In this project, researchers iteratively developed and tested the Retrieval-Monitoring-Feedback method, an intervention for fifth- through seventh-grade students and undergraduates developed to support durable and efficient student learning of key science concepts from course content. The intervention was a computer-assisted study process that combined advances in techniques used to improve metacognitive monitoring with spaced retrieval practice and restudy.

Grade Levels:
ES, MS, PA
Focal Populations:

Products Developed / Tested:

Introducing Desirable Difficulties for Educational Applications in Science

Award # R305H020113 Robert Bjork, University of California, Los Angeles

In this project, researchers evaluated the impact of interventions that appear to make learning more difficult and slow the rate of learning to determine whether they can be effective in enhancing long-term retention of information. The researchers aimed to determine whether these "desirable difficulties" could be generalized to realistic educational materials and contexts involving middle school and college students using the Web-Based Inquiry Science Environment program.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations

Award # R305H050116 Robert Goldstone, Indiana University

In this project, researchers iteratively developed and tested perceptually based and interactive computer simulations and curricula for teaching complex systems developed to support K-12 and college students as they mastered abstract scientific principles.

Grade Levels:
MS, HS, PA
Focal Populations:

Products Developed / Tested:

Scientific Misconceptions: From Cognitive Underpinning to Educational Treatment

Award # R305H050125 Andrew Heckler, Ohio State University

In this project, researchers iteratively developed and tested empirically supported and theoretically-driven instructional approaches for sixth-grade science courses and for a university-level physics course developed to help students correct physical science misconceptions. In order to identify the underlying cognitive processes that lead to the creation of misconceptions in scientific reasoning, researchers artificially created and studied misconception-like phenomena. Researchers designed a set of instructional approaches used to revise the cognitive processes, overcome these misconceptions, and improve science learning. Researchers then tested these techniques both in laboratory contexts and during physics instruction in elementary school and university instructional settings.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Improving Metacomprehension and Self-Regulated Learning From Scientific Texts

Award # R305B070460 Keith Thiede, Boise State University

In this project, researchers iteratively developed and tested an intervention for college students and students in seventh grade. The intervention aimed to improve students' reading comprehension and their ability to learn effectively from scientific text by improving the effectiveness of self-regulated learning and metacognitive self-monitoring accuracy (i.e., their awareness of their own cognitive processes and the ability to track this awareness). Researchers explored whether indicating the kind of test that would be given to students through explicit instruction or practice tests affected metamemory and metacomprehension accuracy, and explored whether improvements in monitoring accuracy produced better selection of texts for restudy.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Scaffolding Students' Use of Multiple Representations for Science Learning

Award # R305A080507 Sadhana Puntambekar, University of Wisconsin

In this project, researchers iteratively developed and tested an approach to science instruction that engaged multiple modalities—text, hands-on experimentation, and interactive computer simulations that incorporated scaffolding both by the teacher and the computer—to immerse middle school students in science practices. The researchers hypothesized that a careful integration of multiple representations within an instructional unit and the design of scaffolding that enabled translation between representations would lead to a deeper conceptual understanding and improved student outcomes. Researchers tested the intervention on a racially and socioeconomically diverse group of middle school students, preservice teachers, and college students.

Grade Levels:
MS, PA
Focal Populations:

Products Developed / Tested:

Conceptual Analysis and Student Learning in Physics

Award # R305B070085 Brian Ross, University of Illinois

In this project, researchers iteratively developed and tested an easy-to-implement intervention for physics instruction to improve high school and college students' conceptual understanding and problem solving. The intervention had students focus on conceptual aspects of problem solving by training them to write strategies for solving problems prior to using the strategies to solve physics equations.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

A Cognitive Approach to Implementing Tree Thinking in High School and College Biology Curricula

Award # R305A080621 Laura Novick, Vanderbilt University

In this project, researchers iteratively developed and tested curricula for undergraduate and high school students to help them understand and reason in biology. The curricula integrated cladgrams, a type of hierarchical diagram used by contemporary scientists to depict evolutionary histories among species or groups of species. Being able to use cladgrams, which have tree-like shapes, is called "tree thinking". Researchers aimed to facilitate tree-thinking by designing a curriculum based on the results of cognitive experiments that focused on the cognitive and perceptual factors that influence students' reasoning.

Grade Levels:
HS, PA
Focal Populations:

Products Developed / Tested:

A Virtual Launchpad for Learning at Higher Speeds

Award # ED06PO0900 PL Senger, Current Concepts

In this project, researchers iteratively developed a prototype of Virtual Learning LaunchPad, a virtual learning platform designed to enable students to learn health-related biological information at a faster rate than students who view traditional video lectures on the same subject matter.
Virtual Learning LaunchPad combined non-traditional instructional delivery methods, such as the use of 3-dimensonal anatomical reconstructions, step-by-step animations, streaming-animations, voice-overs, and instant replay of important components. The first topic covered by the prototype was reproductive science.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:


Virtual Physics Laboratory

Award # ED07CO0040 Jeanne Finstein, Polyhedron Learning Media, Inc.

In this project, researchers iteratively developed and tested a virtual physics lab and researched its usability, feasibility, and promise. The prototype of this product was developed under a previous IES award. Researchers developed a set of web-based virtual labs on topics such as vector addition of forces, uniform motion, kinematics, Newton's Second Law, and conservation of energy. These labs were intended to either fully replace or serve as a supplement to hands-on labs in a typical introductory college physics course.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:


Acquiring Research Investigative and Evaluative Skills (ARIES) for Scientific Inquiry

Award # R305B070349 Keith Millis, Northern Illinois University

In this project, researchers iteratively developed and tested ARIES (Acquiring Research Investigative and Evaluative Skills), an interactive intelligent tutor for college students developed to teach students scientific inquiry skills. Students read an online text describing and explaining key concepts in scientific inquiry. To promote deep learning, students taught an animated "other-agent" (a learner like the student) while the "guide-agent" (the tutor) looked on and made suggestions. Later, students applied the learned concepts to problems that required the critical evaluation of studies and causal claims.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:


Higher Learning @ Higher Speeds in Biosciences using Time Compressed Animated Delivery (TCAD)

Award # ED008CO0050 Phillip L. Senger, Current Conceptions, Inc.

In this project, researchers iteratively developed and tested the Time Compressed Animated Delivery (TCAD) system consisting of short (10 to 15 minutes) animated units to teach the reproductive sciences. The content was designed to be delivered in approximately half the time required by traditional lecture methods. The TCAD was designed to educate college students about core biologic principles with a focus on how these principles affect personal reproductive health.

Grade Levels:
PA
Focal Populations:

Products Developed / Tested:

10. Teacher Instruction, Pedagogy, and Professional Development in Science

Research on science teacher preparation in the United States has found that multiple pathways to teacher certification and variations between state science teacher certification systems have resulted in less than optimal levels of teacher preparation and identified the need for further research (Olson et al. 2015). Adoption of the Next Generation Science Standards (NGSS) requires that the teaching of science evolve to meet the challenges presented by new standards. This includes professional development in teaching methods required to effectively meet these standards (Krajcik et al. 2014; Lee, Miller, and Januszyk 2014; Osborne 2014; Pruitt 2014). Projects in this chapter focus on teacher development, instructional improvement, teacher learning about science (e.g., hands-on, inquiry-based, or experiential learning), and improvements in teacher pedagogy and practice.

Table Key

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Assessing the Potential Impact of a Professional Development Program in Science on Head Start Teachers and Children

Award # R305M050060 Nancy Clark-Chiarelli, Education Development Center, Inc.

In this project, researchers iteratively developed and tested a professional development program in science, Foundations of Science Literacy, for Head Start teachers. The program was designed to build teachers' pedagogical content knowledge in the physical and life sciences and had two main components that were given over a 6-month period: face-to-face instructional sessions that built teachers' knowledge, and mentoring sessions that supported teachers as they mastered science content and inquiry-based methods. The mentoring included coaching, reflective documentation (videotaping teacher instruction), and teacher study groups.

Grade Levels:
EC
Focal Populations:
EL
Products Developed / Tested:

Assessing the Efficacy of a Comprehensive Intervention in Physical Science on Head Start Teachers and Children

Award # R305A090114 Nancy Clark-Chiarelli, Education Development Center, Inc.

In this project, researchers evaluated the impact of the Foundations of Science Literacy (FSL) intervention, a professional development program for Head Start teachers. The intervention aimed to address the achievement gap in early science education by providing a framework for teachers to learn and implement preschool science instructional practices in classrooms serving children from low-income backgrounds. Researchers examined the impact of the FSL program on teachers' attitudes toward and knowledge of physical science content, teachers' classroom instructional practices, and children's understanding of physical science content.

Grade Levels:
EC
Focal Populations:
Products Developed / Tested:

Cultivating Young Scientists: Expanding Foundations of Science Literacy

Award # R305A120193 Nancy Clark-Chiarelli, Education Development Center, Inc.

In this project, researchers iteratively developed and tested Cultivating Young Scientists, an intervention for preschool teachers designed to build their pedagogical science knowledge and support their ability to teach science to young children in the domains of earth, life, physical science, and engineering. The intervention included three components: professional development sessions for preschool teachers that introduced key concepts, skills, and strategies; content-specific modules that provided a complete course in science topics (water, structures, and nature); and supports for teachers to implement the inquiry-based science concepts including a set of formative assessment tools and an online website to provide support and resources to teachers.

Grade Levels:
EC
Focal Populations:
Products Developed / Tested:

Replication and Outcomes of the Teaching SMART® Program in Elementary Science Classrooms

Award # R305M050023 Kathryn Borman, University of South Florida

In this project, researchers evaluated the impact of Teaching SMART, a professional development program for elementary school science teachers. The intervention aimed to improve third-, fourth-, and fifth-grade teacher performance and student learning and attitudes in science, particularly those of girls and minority students. Teacher training sessions included effective teaching strategies that incorporated gender and minority equity, inquiry-based instruction, cooperative learning, coaching, real world connections, and career awareness. The researchers examined instructional methodologies and strategies that were effective in improving teacher performance and, in turn, student achievement.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

Evolving Inquiry: An Experimental Test of a Science Instruction Model for Teachers in Rural, Culturally Diverse Schools

Award # R305M050109 Elizabeth Doll, University of Nebraska

In this project, researchers iteratively developed and tested a technology-supported professional development program for rural fifth- through eighth-grade science teachers. The program aimed to improve their knowledge and application of biological sciences content and inquiry-based science pedagogy. Teachers participated in a three-phase professional development sequence. Phase 1 was a graduate seminar; Phase 2 was a field- and observation-based summer school; and Phase 3 was a teacher-designed action research project in inquiry learning.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Integrating Science and Diversity Education: A Model of Pre-Service Elementary Teacher Preparation

Award # R305M060065 Roland Tharp, University of California, Berkeley

In this project, researchers iteratively developed and tested an experimental model of preservice elementary science teacher education based on the Five Standards for Effective Pedagogy program. This program was designed to prepare elementary school teachers to teach science to an increasingly diverse student body and had three main components: a Five Standards-based science teaching methods course, coaching in the Five Standards Pedagogy in the student teaching practicum, and practicum placement in an elementary classroom that modeled the Five Standards Pedagogy.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities

Award # R324A080014 Diane Browder, University of North Carolina, Charlotte

In this project, researchers iteratively developed and tested a framework for creating math and science learning targets and model lesson plans for students in grades 3 through 10 with significant cognitive disabilities. The intervention aimed to develop high-quality mathematics and science instruction for students who participated in alternate assessments and who were judged against alternate achievement standards. The intervention also included an instructional alignment evaluation checklist, sample learning targets in six strands of science, and model lesson plans.

Grade Levels:
ES, MS, HS
Focal Populations:
SWD
Products Developed / Tested:

INSPIRE: Urban Teaching Fellows Program

Award # R305A090145 Carla Johnson, University of Cincinnati

In this project, researchers iteratively developed and tested a whole-school, sustained, collaborative, and technology-enhanced science professional development program for elementary and middle school teachers (grades 4 through 6). The intervention aimed to build teacher content knowledge and strategies to teach science. The modified program incorporated the following elements: school-level leadership-building activities and the establishment of professional learning communities, a specific focus on elementary school science teachers, the use of technology to bring more resources into the classroom and to streamline the intervention, and teacher participation in two graduate-level science courses in physics and biodiversity.

Grade Levels:
ES, MS
Focal Populations:
EL
Products Developed / Tested:

The National Center for Research on Rural Education

Award # R305C090022 Susan Sheridan, University of Nebraska, Lincoln

In this project, researchers evaluated the impact of professional development practices designed to improve instruction in rural schools and improve rural students' acquisition of knowledge and skills in reading, science, and mathematics. The project had three primary goals: investigating variations in existing rural professional development practices, differences in professional development practices between rural and non-rural settings, and the potential influence of various characteristics of professional development on rural teachers' knowledge, perceptions, and instructional practices.

Grade Levels:
ES, MS, HS
Focal Populations:

Products Developed / Tested:

A Practice-Based Approach to Professional Development in Science in Urban Elementary and Middle Schools

Award # R305A100176 Ann Rosebery, Technical Education Research Centers, Inc. (TERC)

In this project, researchers iteratively developed and tested an intervention for new K-8 teachers in large urban school systems who have been teaching fewer than 5 years and who teach students historically placed at risk in school and society (e.g., from low-income households, of African descent, or who speak a first language other than English at home). The researchers designed, developed, and evaluated a practice-based inquiry approach to professional development to prepare new teachers in urban districts to move K-8 science teaching toward more rigorous, engaged, and equitable learning for their students.

Grade Levels:
ES, MS
Focal Populations:
EL
Products Developed / Tested:

Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice

Award # R305A110285 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested a teacher professional development program designed to build the content and pedagogical knowledge of elementary and middle school teachers. The researchers developed two courses and materials (teacher book, workbook, and facilitator guide) on life science content for professional development facilitators and teachers as part of the Making Sense of SCIENCE professional development program for teacher learning across earth, life, and physical science domains. The main components were approaches that had previous evidence of being effective with English learners, namely hands-on science investigations that allowed teachers to explore core science concepts; literacy investigations, in which teachers strengthened their ability to write, read, and talk about science; and teaching investigations that led teachers to examine teaching practices and student thinking.

Grade Levels:
ES, MS
Focal Populations:
EL
Products Developed / Tested:

Scientific Validation of a Set of Instruments Measuring Fidelity of Implementation (FOI) of Reform-Based Science and Mathematics Instructional Materials

Award # R305A110621 Dae Kim, University of Chicago

In this project, researchers designed and validated a suite of fidelity of implementation (FOI) instruments to enable rigorous, specific, and systematic analysis of reform-based K-5 mathematics and science interventions. Researchers designed three classroom-level FOI instruments (Teacher Instructional Questionnaire, Teacher Instructional Logs, and Teacher Instructional Observation) and a student questionnaire to measure student engagement.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:


From Cognitive Models of Reasoning to Lesson Plans for Inquiry

Award # R305H030229 David Klahr, Carnegie Mellon University

In this project, researchers iteratively developed and tested cognitively grounded lesson-planning methods for middle school science teachers developed to implement sustainable changes in teacher instructional practices and affect student science achievement. The researchers carried out a three-phase design experiment: the researchers studied how science education was currently being delivered; they developed lesson-planning methods with science teachers; and they used a professional development process to help regular teachers learn to apply the new lesson- planning methods.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Classroom Connectivity in Promoting Mathematics and Science Achievement

Award # R305K050045 Douglas Owens, Ohio State University

In this project, researchers evaluated the impact of connected classroom technology with interactive pedagogy and professional development on the mathematics and science achievement of students in grades 7 through 10. Researchers aimed to provide teachers with immediate information that could be used to adjust instruction. This information included displays of student work that were instantly aggregated and available on the teacher's computer as soon as student work was submitted. The intervention consisted of six parts: provision of connected classroom technology (TI-Navigator), professional development, teacher experiential learning in their own classrooms, online web-based training, online discussion forum for the teacher community, and follow-up professional development at an annual conference.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Utah's Improving Science Teacher Quality Initiative

Award # R305M050005 Carla Johnson, University of Cincinnati

In this project, researchers iteratively developed and tested a professional development program for middle school science teachers designed to improve the science achievement of Latino students. The intervention, a modified version of the Ohio-based Model Schools Initiative, immersed teachers in standards-based science instruction through a sustained experience, allowing them to develop skills of teaching inquiry-based, student-centered, real-world science. The summer experiences and ongoing instruction and support from university faculty were also intended to increase teacher knowledge of Latino culture and language as they gained basic communication-level Spanish.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation

Award # R305M050226 William R. Penuel, SRI International

In this project, researchers evaluated the impact of Investigating Earth Systems and Earth Science by Design, two earth science programs developed to enhance middle school science education. Researchers assessed three approaches to professional development: providing teachers with high-quality curriculum units and with professional development and follow-up; providing teachers with training in how to develop high-quality curriculum units and give them time to develop these units, along with follow-up mentoring; and providing teachers with training in how to develop high-quality curriculum units and give them high-quality materials to revise and adapt in developing units.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Understanding Science: Improving Achievement of Middle School Students in Science

Award # R305B070233 Steve Schneider, WestEd

In this project, researchers iteratively developed and tested three middle school teacher professional development courses, which aimed to improve teachers' understanding of challenging physical science and earth science topics and, thus, help close the achievement gap especially for English learners. The three topic areas were heat and energy, plate tectonics, and climate and weather. The courses also helped teachers to examine how children make sense of those concepts and to analyze and improve their teaching. The first two courses had a pedagogical focus on supporting students' writing in science, and the last one had a pedagogical focus on supporting students' reading in science.

Grade Levels:
MS
Focal Populations:
EL
Products Developed / Tested:

Leadership for Integrated Middle-School Science (LIMSS)

Award # R305A080078 Robert Potter, University of South Florida

In this project, researchers iteratively developed and tested a professional development program, Leadership for Integrated Middle School Science (LIMSS). LIMSS aimed to develop teacher leadership in middle schools and teachers' ability to deliver student-centered, engaging science instruction. Major themes of the professional development included developing teacher leadership skills, enhancing teacher understanding of how students learn, and helping teachers understand how science processes can be incorporated across all content areas of science instruction. The program includes 2-week summer institutes, job-embedded school-year activities and web-supported professional development.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

National Research & Development Center on Cognition and Science Instruction

Award # R305C080009 F. Joseph Merlino, 21st Century Partnership for STEM Education

In this project, researchers iteratively adapted and tested life science, physical science, and earth science units of two widely used middle school curricula, Holt and Full Option Science System (FOSS). The adaptations integrated three theoretical principles of cognitive science: analogical reasoning, spatial reasoning, and student prior knowledge. Additionally, the researchers created professional development materials and evaluated the impact of the modified curricula and the support materials.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Visualizing Science With Adapted Curriculum Enhancements (ACE)

Award # R324A080096 Sheila Arens, Mid-continent Research for Education and Learning (McREL)

In this project, researchers iteratively developed and tested a professional development program for middle and high school special education and science teachers. The intervention was designed to train teachers in visualization techniques that were intended to improve access to the general education science curriculum for students with visual impairments. The intervention had three components: a set of resources to assist the teachers in learning about the spectrum of visual impairments, tools to assess the individual needs of students with visual impairments, and training in the implementation of specially designed Adapted Curriculum Enhancements science visualization techniques.

Grade Levels:
MS, HS
Focal Populations:
SWD
Products Developed / Tested:

Online Application to Support Inquiry-based Science Teaching

Award # EDIES09C0014 Robbin Chapman, G8four Consulting

In this project, researchers iteratively developed and tested an online application and researched its usability, feasibility, and promise. The project team developed the Online Application to Support Inquiry-based Science (OASIS) to facilitate teachers' inquiry-based teaching strategies in their classrooms. Specifically, the OASIS website was developed to support the integration of social networking, media rich videos, activities, materials, and sensors into teaching middle school science concepts. Researchers collected data to assess the OASIS systems' ability to improve teacher lesson planning, integration into classroom practice, and self-efficacy, as well as student science learning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Accessible Professional Development for Teaching Aquatic Science Inquiry

Award # R305A100091 Kanesa Duncan, University of Hawaii

In this project, researchers iteratively developed and tested an intervention for teachers of heterogeneous groups of students in middle and high schools in both rural and urban settings. Researchers developed a series of professional development modules consisting of in-person trainings coupled with online learning support. The four modules focused on: introductory, physical, biological, and ecological aquatic science. Researchers planned to assess teacher outcomes as well as student outcomes.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Developing and Evaluating Measures of Formative Assessment Practices

Award # R305A100571 Maria Ruiz-Primo, University of Colorado, Denver

In this project, researchers designed and validated instruments to measure the quality of middle school teachers' formative assessment practices in science classrooms. Researchers constructed benchmark measures of formative assessment practices and resources and social processes to support those practices. They developed surrogate measures, which included a classroom observation protocol by a third-party, a self-report teacher log protocol, and student and teacher self-report questionnaires. The researchers then created technical reports on the measures and a manual detailing how to use and implement the surrogate measures.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


An Alternative Statewide Assessment Strategy that Uses Test Results to Support Learning and Includes Measures of Problem Solving

Award # R305A110121 Faranak Rohani, Florida State University

In this project, researchers designed and validated an assessment strategy for seventh-grade science students and their teachers designed to measure complex cognitive competencies, such as problem solving, and facilitate formative use of summative assessments at the classroom level. The assessment strategy had three components: a series of performance assessments of problem solving and other cognitively complex competencies that measured selected state-level benchmarks; performance assessment "specifications" that defined comparable measures to be developed by teachers, linking teachers' assessments to those administered statewide; and information about the use of these performance assessments to generate both summative and formative data.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Making Sense of SCIENCE: Efficacy Study of a Professional Development Series for Middle School Science Teachers

Award # R305A110515 Steve Schneider, WestEd

In this project, researchers evaluated the impact of the Making Sense of SCIENCE professional development program for middle school physical science teachers. The intervention aimed to help teachers learn major concepts in science; examine how children make sense of those concepts; analyze and improve teaching practice; and support student reading, writing, and discussion in science. The intervention consisted of three physical science courses for teachers and used Science Investigations and hands-on explorations designed to engage adult learners.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Developing a Manual for Test-Enhanced Learning in the Classroom

Award # R305A110550 Henry Roediger III, Washington University, St. Louis

In this project, researchers iteratively developed and tested a manual for science teachers to use in adapting the Test-Enhanced Learning (TEL) approach for middle school and high school students in the content areas of history, biology, and chemistry. TEL aimed to improve students' retention of knowledge in many different subject matters. The TEL approach was grounded in three theoretical processes that augment learning and retention: active retrieval of information from memory, learning from feedback, and improvement in metacognition (i.e., the ability to think about one's cognitive processes). Researchers created a TEL teacher manual for middle and high school teachers to help them integrate TEL into their classroom practices.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:

Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning

Award # R305A110913 Sara Dexter, University of Virginia

In this project, researchers iteratively developed and tested CANLEAD (Cognitive Assistance Network, Learning Environment, and Database), a year-long leadership institute and web-based learning environment for leadership in middle schools. CANLEAD aimed to train leadership teams (principals, teacher-leaders, and technology specialists) to recognize what strong instruction in math and science looked like when it integrated technology and carry out the instructional leadership practices needed to foster integration of technology into math and science instruction. The CANLEAD web-based software created an online learning environment that included curricula, math and science technology resources, planning tools, video-conferencing, and social networking tools.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:

Mentoring Teachers through Pedagogical Content Knowledge Development

Award # R305M050064 Luanne Hall-Stoodley, Allegheny Singer Research Institute

In this project, researchers iteratively developed and tested a professional development program for high school life science teachers to increase teachers' in-depth knowledge in specialized topics of life science. The professional development program covered life science instruction in three different domains: genomics and bioethics, biotechnology and bio-informatics, and microbiology/infectious diseases. The emphasis of the program was on teachers' content knowledge, pedagogical knowledge, and application of pedagogies.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Effect of the SUN Teacher Workshop on Student Achievement

Award # R305B070443 Ann Batiza, Milwaukee School of Engineering

In this project, researchers iteratively developed and tested an in-service training workshop for high school teachers (called Students Understanding eNergy) that aimed to help teachers build a deeper understanding of potentially difficult concepts, like energy transfer in biological systems and the impact of these processes on the flow of matter and energy in biology. In the workshop, high school teachers learned to use interactive physical models that provided multisensory experiences. In addition to the physical models, teachers were provided with interactive and hyperlinked computer visualizations, animations, pen and paper exercises, schematics, and other materials to help them teach high school biology.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Online Learning System to Advance Teaching of Hyper Molecular Modeling

Award # ED08CO0044 Keith Donaldson, MolySym, Inc.

In this project, researchers iteratively developed and tested a teaching and training interface for the MolySym Hypermodeling System and researched its usability, feasibility, and promise. The incorporation of electronics and robotics technologies into ball-and-stick models to communicate in real-time with a software simulation system is called hypermodeling. The MolySym Hypermodeling System is intended to improve students' understanding of important chemical principles relating to three dimensional molecular structures. In order to successfully deploy this tool in classrooms, researchers developed a teaching and training interface for MolySym, called the Online Learning System (OLS).

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Education Research - BioBridge Teacher Quality

Award # R305A080692 Loren Thompson, University of California, San Diego

In this project, researchers iteratively developed and tested laboratory activities and materials for high school science curricula, focusing on introducing emerging research and technology directly into classrooms. The researchers and teachers created and evaluated a professional development program with four components: a hands-on training where teachers play the role of a student as they learn the lab, its related content, and pedagogy; a practice session where teachers conduct the lab with a small group of their students while supported by a training team (the "BioBridge team"); a consultation with the BioBridge team that takes place at their school a day before the first implementation of the lab; and support during the lab's initial implementation. In addition, the intervention contained a student leader component, in which students were trained to take leadership positions and help teachers implement the lab with a full classroom of students.

Grade Levels:
HS

Focal Populations:

Products Developed / Tested:

11. Science Assessment

Student assessments, both formative and summative, are important tools used to ensure that data-based decisions are being made at both the classroom and school level (Newton et al. 2009; Newton and Llosa 2010; Popham 2008). Researchers have shown that science assessments can help teachers differentiate instruction and address student motivation (Yin, Shavelson, Ayala, Ruiz-Primo et al. 2008), monitor student learning and achievement (Vannest, Soares, Smith and Williams 2012), and align student science knowledge to standardized tests (Liu, Lee and Linn 2010). Projects in this chapter focus on student screening and progress monitoring assessments and standards-based assessments.

Table Key

Grade levels:

EC	Early Childhood	HS	High School
ES	Elementary School	PA	Postsecondary and Adult Education
MS	Middle School		

Focal populations:

EL	English Language Learners
SWD	Students With Disabilities

Products developed or tested:


The book icon denotes **instructional interventions** developed or tested.


The apple icon denotes **professional development** developed or tested.


The computer icon denotes **educational technology** developed or tested.


The checkmark icon denotes **assessments** developed or validated.

For more information about a project and publications stemming from them, please follow the hyperlinked award number to the online abstract on the IES website.

Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children

Award # R305A090502 Daryl Greenfield, University of Miami

In this project, researchers iteratively developed and tested Lens on Science, a computer adaptive test of preschoolers' science knowledge. The researchers aimed to create an appropriate, reliable, and valid direct assessment of children's science knowledge and process skills. The test assessed three broad early childhood science content areas (life science, earth/space science, and physical/energy science) and science processing skills (observing, describing, comparing, questioning, predicting, experimenting, reflecting, and cooperating).

Grade Levels:
EC
Focal Populations:

Products Developed / Tested:

Developing and Using Diagnostic Items in Mathematics and Science

Award # R305K040051 Caroline Wylie, Educational Testing Service (ETS)

In this project, researchers iteratively developed and tested a set of diagnostic questions developed to help elementary and middle school teachers better understand student misconceptions that impeded their academic progress in science and mathematics. The goal of the project was to improve students' achievement by developing questions teachers could use to identify student misconceptions that may occur in the process of mastering science and mathematics material. Researchers also examined the effects on student learning of having teachers integrate the use of these questions into their teaching.

Grade Levels:
ES, MS
Focal Populations:

Products Developed / Tested:

Diagnostic Embedded Classroom Assessment-An Efficacy Study

Award # R305B070354 Steve Schneider, WestEd

In this project, researchers evaluated the impact of the Assessing Science Knowledge diagnostic formative assessment system, which aimed to enable grade 4 teachers to monitor student learning, provide immediate feedback to students at key junctures, and adjust instruction accordingly. The embedded assessments were incorporated into instruction and provided continuous information about students' learning to both teachers and students. The benchmark assessments were summative measures of students' accumulated knowledge and understanding of science. The assessment system was developed to be an integral part of the Full Option Science System (FOSS) elementary science modules. Assessing Science Knowledge comprised two kinds of assessments: embedded and benchmark.

Grade Levels:
ES
Focal Populations:

Products Developed / Tested:

English Learners and Science Tests

Award # R305A110122 Tracy Noble, Technical Education Research Centers, Inc. (TERC)

In this project, researchers designed and validated test items for a fifth-grade science assessment developed to avoid linguistic structures that impeded English language learners' (ELs) performance. The researchers identified linguistic aspects of test items that interfered with the valid measurement of science knowledge among ELs.

Grade Levels:
ES
Focal Populations:
EL
Products Developed / Tested:

The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School

Award # R305A120138 Cari Herrmann Abell, American Association for the Advancement of Science (AAAS)

In this project, researchers designed and validated a set of three assessment instruments (for elementary, middle, and high school students respectively) that aimed to monitor how students progress in their understanding of important ideas about energy. The instruments covered an extensive and coherent set of important energy concepts, tested for the correct scientific understanding, probed for common student misconceptions, and tested learning progressions. Researchers made the instrument available in both paper-based and online formats and provided teacher materials to guide the interpretation of assessment results.

Grade Levels:
ES, MS, HS
Focal Populations:
EL
Products Developed / Tested:

Principled Science Assessment Designs for Students With Disabilities

Award # R324A070035 Geneva Haertel, SRI International

In this project, researchers designed and validated universal test design paired with an approach termed "evidence-centered design" to develop or redesign test items that can more accurately evaluate the knowledge and skills of all students on statewide assessments. The study focused on middle school science, but researchers also planned to apply the approach to other topics and age ranges. Specifically, the researchers aimed to evaluate the validity of inferences from existing state science assessments for students with and without disabilities, redesign assessment items, study the validity of inferences generated from the redesigned items, and develop research-based guidelines.

Grade Levels:
MS
Focal Populations:
SWD
Products Developed / Tested:

Multilevel Assessments of Science Standards (MASS)

Award # R305A080225 Edys Quellmalz, WestEd

In this project, researchers designed and validated technology-enhanced formative assessments to test eighth-grade students' science learning. The Multilevel Assessment of Science Standards (MASS) project aimed to bring best formative assessment practices into classrooms to transform what, how, when, and where science learning was assessed. MASS featured simulation-based tasks with immediate, individualized feedback and a hint system, and gathered, documented, and promoted grade 8 students' learning of connected science knowledge and extended inquiry not measured by large-scale tests.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Virtual Performance Assessments for Measuring Student Achievement in Science

Award # R305A080514 Christopher Dede, Harvard University, Graduate School of Education

In this project, researchers validated the use of computer-based virtual performance assessments to assess middle school students' science inquiry skills in a standardized testing setting. Researchers designed three single-user immersive three-dimensional environments to assess sixth- and seventh-grade students' science inquiry process learning in the context of life science. In the space, students took on the identity of a virtual persona that could move around, interact with the environment, and complete a science inquiry problem.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


Establishing the Validity and Diagnostic Capacity of Facet-Based Science Assessments

Award # R305A100475 Angela DeBarger, SRI International

In this project, researchers designed and validated facet-based science assessments for middle and high school students. Students' thinking can be organized into hypothetical facet clusters around a key idea or event. The assessments focused on providing information to teachers about whether their students understood key concepts in force and motion (description of motion, nature of forces, and forces to explain motion), and if not, what partial understandings were present instead.

Grade Levels:
MS, HS
Focal Populations:

Products Developed / Tested:


Learning Progressions in Middle School Science Instruction and Assessment

Award # R305A100692 Mark Wilson, University of California, Berkeley

In this project, researchers designed and validated learning progression assessments for use with middle school science students. Researchers developed these assessments—Structure of Matter and Scientific Reasoning—to focus on learning progression in physical science and eighth graders' scientific reasoning.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


An Alternative Statewide Assessment Strategy that Uses Test Results to Support Learning and Includes Measures of Problem Solving

Award # R305A110121 Faranak Rohani, Florida State University

In this project, researchers designed and validated an assessment strategy for seventh-grade science students and their teachers designed to measure complex cognitive competencies, such as problem solving, and facilitate formative use of summative assessments at the classroom level. The assessment strategy had three components: a series of performance assessments of problem solving and other cognitively complex competencies that measured selected state-level benchmarks; performance assessment "specifications" that defined comparable measures to be developed by teachers, linking teachers' assessments to those administered statewide; and information about the use of these performance assessments to generate both summative and formative data.

Grade Levels:
MS
Focal Populations:

Products Developed / Tested:


SimScientists Assessment System

Award # R305A120390 Edys Quellmalz, WestEd

In this project, researchers designed and validated a set of middle school simulation-based assessments for the life science strand of the SimScientists Assessment System. The researchers aimed to measure complex learning that could be useful to instruction through simulation-based assessments that encompassed three units taught in middle school: cells, human body systems, and ecosystems.

Grade Levels:
MS
Focal Populations:
EL, SWD
Products Developed / Tested:


Integrated Software for Artificial Intelligence Tutoring and Assessment in Science

Award # R305K040008 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively developed and tested a computer-based tutoring and assessment system for high school chemistry students. The system aimed to improve student learning and achievement by providing detailed comments to students if they made mistakes while trying to solve chemistry problems and generating reports for teachers and students that analyzed student learning as reflected by their performance on a given set of chemistry problems.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Integrated Software for Artificial Intelligence Tutoring and Assessment in Science

Award # R305A070067 Benny Johnson, Quantum Simulations, Inc.

In this project, researchers iteratively developed and tested three new units for a previously developed computer-based tutoring and assessment system for a first-year high school chemistry course. The system aimed to improve student learning and achievement in chemistry by providing feedback to students while they tried to solve chemistry problems. In addition, the system generated reports for teachers and students that analyzed student learning and performance.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

Embedded Assessments Using the ChemCollective Virtual Lab

Award # R305A100069 Jodi Davenport, WestEd

In this project, researchers iteratively developed and tested new activities with embedded assessments for the previously developed ChemCollective Virtual Lab. Researchers aimed to improve high school students' science achievement through a deeper understanding of chemical principles and their ability to plan and conduct laboratory investigations. The intervention consisted of two online modules with ChemCollective Virtual Lab activities and embedded assessments focused on stoichiometry and thermochemistry in which researchers provided students with authentic chemistry investigations and personalized coaching. Researchers also provided high school teachers with information about individual students that they could use to monitor student progress and guide instruction.

Grade Levels:
HS
Focal Populations:
EL
Products Developed / Tested:

12. Science Policy

In addition to developing and implementing college and career-readiness standards, such as the Next Generation Science Standards (NGSS), some states have focused on promoting science achievement by changing policies related to science learning. For example, states have changed school accountability policies to include science outcomes, and, in these states, teachers may spend significantly more time (as many as four additional hours per week) on science instruction (Blank 2013; Judson 2013). This chapter includes projects focused on the evaluation of policies related to prekindergarten through adult science education.

Table Key

Grade levels:

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Evaluating the Effectiveness of Tennessee's Voluntary Pre-K Program

Award # R305E090009 Mark Lipsey, Vanderbilt University

In this project, researchers evaluated the impact of the Tennessee Voluntary Pre-K Program, a state-wide policy initiative to help at-risk prekindergarten students. The program's primary objective was to enhance the school readiness of economically disadvantaged children and improve their academic performance. The researchers also examined the relationship between student outcomes and selected policy-relevant characteristics of teachers, classrooms, and schools to provide guidance for program improvement.

Grade Levels:
EC, ES
Focal Populations:
EL, SWD
Products Developed / Tested:

The Impact of the Michigan Merit Curriculum and Michigan Promise Scholarship on Student Outcomes

Award # R305E100008 Brian A. Jacob, University of Michigan

In this project, researchers evaluated the impact of two reforms designed to promote college attendance and success: the Michigan Merit Curriculum, which required a more rigorous high school curriculum, and the Michigan Promise Scholarship, which provided funding for college to students who met academic criteria. The Michigan Merit Curriculum required all high school students to pass a set of 16 rigorous academic courses, including Algebra I, Geometry, Algebra II, Biology, and Chemistry or Physics. The Michigan Promise Scholarship provided students who met certain academic standards with up to $4,000 for college.

Grade Levels:
HS
Focal Populations:

Products Developed / Tested:

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Index

Appendix A: Compendium Process

The Institute identified 319 projects, spanning 11 years (2002 – 2013), to be included in this compendium. These projects included NCER and NCSER research grants, evaluation contracts, and other awards. The compendium process was highly collaborative, with multiple rounds of feedback from the Institute and content advisors with expertise in math, Dr. Douglas Clements, and science, Dr. Stephanie Wilkerson. The contractor led the writing of the project descriptions and the development of the structure of the compendium. Dr. Clements, Dr. Wilkerson, and the Institute provided feedback on the proposed structure, and the Institute provided additional feedback on the writing conventions. The Institute also provided all project information, including the full abstracts, a list of publications and products, and other award information.

Project Descriptions

The contractor developed a project description template that included prescriptive guidelines on verb tense, verb usage, description length, and sentence stems. For each project, the contractor wrote a short project description using the project abstract provided by the Institute.[4] To ensure consistency across the project descriptions, the contractors used the past tense and active voice for all projects.

Project descriptions are typically 100 words or fewer and highlight key areas of the project abstract including the following:

- the theory or motivation behind the project;
- the type of research project;
- the population of students/project focus; and
- the level of intervention (e.g., student, class, school).

NCER and NCSER fund research that align with the following research goals: exploration, development, and innovation of interventions (e.g., curricula, policies), evaluation, and development and validation of assessments.[5] To help orient readers categorize projects appropriately, the contractor developed a set of common verbs and sentence stems associated with each research goal, as shown below:

[4] Copies of the full abstracts, which served as the source documents for this compendium, are available online at http://ies.ed.gov/funding/grantsearch.

[5] These research types reflect the Research Goals described in NCER's Request for Applications for Education Research and NCSER's Request for Applications for Special Education Research. These two requests, however, identify five research goals: Exploration, Development and Innovation, Efficacy and Replication, Effectiveness, and Measurement. For the purposes of this compendium, we combine Efficacy and Replication and Effectiveness under the term *evaluation*.

Research Goal	Sentence Stems	Recurring Verbs
Exploration	"In this project, researchers explored the relationship between" "In this project, researchers explored how"	Explored
Development and Innovation of Policies and Practices	"In this project, researchers iteratively developed and tested" "In this project, researchers iteratively adapted and tested"	Developed Adapted Tested
Evaluation	"In this project, researchers evaluated the impact of"	Evaluated
Development and Validation of Assessments	"In this project, researchers designed and validated" "In this project, researchers validated"	Designed Validated

Compendium Categorization

The categorization process included tagging each project for domains such as settings, grade level, focal population, products, and outcomes. The contractor categorized each project into compendium sections and chapters. The contractor developed a categorization scheme in partnership with the Institute and the external content advisors. The categorization scheme, shown in the text boxes that follow, includes section headers (i.e., Mathematics or Science), chapter headers (e.g., Mathematics in Prekindergarten Settings), section and chapter descriptions, and key words.

After developing the definitions for and perimeters of each section and chapter, the contractor reviewed each project description to determine the section and chapter in which each project would best fit. Per Institute guidance, the contractor categorized projects for this compendium into multiple sections and chapters. The contractor followed the guidelines set forth by the Institute, wherein projects could be categorized into multiple sections (i.e., Mathematics and Science) and multiple setting-specific chapters (e.g., Prekindergarten Setting, Kindergarten through 12th Grade Setting, Postsecondary and Adult Education Setting, Teacher Instruction, Assessment, and Policy).

The guidelines included the following:

1. If a project focused on both math and science content, it was listed in both sections.
2. Within a section, a project was listed only once according to its primary focus. There were some exceptions to this rule:
    a. If a project included a focus on an element inside the K-12 system (e.g., kindergarteners' instruction; high school students' college preparation) and on an element in the preschool, postsecondary, or adult education system, it was listed in the chapters that align with each of the students' grade levels.
    b. If a project had one of the content area focus areas along with one of the other research focus areas (defined below), it could appear in two chapters.

c. If a project had equal, or near equal, focus on more than one of the other research foci, it could be listed under the two other research foci chapters that account for the majority of the work.

3. If a project had more than one content focus area within the same domain (i.e., math or science), it was included in the Multi-Unit and Integrated chapter for that section.

Section	Content Area Foci	Other Research Foci
Math	number and quantity; algebraic thinking, equations, and Algebra; measurement, data, statistics, and probability; geometry; and fractions and functions *Note: if a project contained more than one of these content area foci, it was labeled "multi-unit/integrated"*	prekindergarten settings; student practices, inquiry, and reasoning; student perceptions, motivations, attitudes, and anxiety; postsecondary and adult education settings ; teacher instruction and development; assessment; policy
Science	physical science; life science; Earth and space; engineering, technology, and applications of science *Note: if a project contained more than one of these content area foci, it was labeled "multi-unit/integrated"*	prekindergarten settings; student practices, inquiry, and reasoning; student perceptions, motivations, attitudes, and anxiety; postsecondary and adult education settings ; teacher instruction and development; assessment; policy

To illustrate, a project to evaluate an early childhood algebra curriculum that targets prekindergarten and kindergarten students would appear in two chapters in the mathematics section: Mathematics in Prekindergarten Settings and Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings. Another example is a project designed to help teach elementary school children concepts of algebra and geometry, this project would appear in one chapter: the Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings. Following these guidelines led to 16 projects occurring in both the Math and Science sections, and 44 occurring in two Math chapters, 1 in three Math chapters, 39 in two Science chapters, and 1 in three Science chapters. No project occurred more than three times in either section.

Per Institute guidance, the contractor did not consult additional information sources or review publications from projects for more information about the projects. Thus, the Institute was the sole source of project information.

Institute staff verified all project information presented in this compendium. Two contract staff categorized each of the projects, comparing 100 percent of categorzations. In instances where the two coders did not agree, a third contract staff member was brought in for reconciliation. For any

project in which the contract staff could not reach agreement based on the abstracts provided by the Institute, Institute staff provided further assistance or documentation to determine the best chapter for each project. Upon completion of all categorization, Institute staff reviewed the categorization(s) of each project to ensure content accuracy and agreement.

In addition to determining the section and chapter in which a project should be placed, the contractor also coded projects for the student population (i.e., grade level, English learners, and students with disabilities) based on the Institute-provided abstract. The grade level reflects the student sample noted in the abstracts, and, when this information was not available in the abstracts, Institute staff provided additional documentation. Projects that received the abbreviation EL, to note the inclusion of English language learners (ELLs), included ELLs as a primary focus population or the project abstract noted them as a significant component of the sample group. All projects funded through NCSER necessarily had students with or at risk for disabilities as part of their samples and, thus, received the abbreviation SWD. NCER projects in which students with or at risk for disabilities were a noted subgroup in the research plan also received a SWD abbreviation. The coding process followed was similar to that of the categorization process. Two contract staff coded each project for 100 percent reconciliation. A third contract staff member was brought in if necessary, and for any instance in which contract staff could not reach agreement based on the abstracts provided by the Institute, Institute staff provided further assistance or documentation. Finally, Institute staff verified all codes (icons) for grade-level and focal population.

The contractor also identified what types of products were developed or tested by a project, using the Institute-provided abstract. The book icon was used to denote instructional interventions that inform instructional practices or school programs. In particular, the book icon denotes packaged curricula, intervention frameworks, and instructional approaches. The apple icon denotes professional development projects. The computer icon denotes education technology, such as online assessment tools, computer-based games, or software programs. The checkmark icon denotes formative and summative assessments as well as observation tools that teachers or researchers may use while working with students or teachers.

Products developed or tested:

The book icon denotes **instructional interventions** (i.e., packaged curricula, intervention frameworks, and instructional approaches) developed or tested.

The apple icon denotes **professional development** developed or tested.

The computer icon denotes **educational technology** developed or tested.

The checkmark icon denotes **assessments** developed or validated.

To determine whether or not a project should be labeled with an icon, the contractor reviewed the entire Institute-provided abstract. All projects that focused on development or evaluation received at

least one icon. All projects that focused on measurement also received at least one icon. No exploration project received an icon, even if it was, for example, exploring the relationships among components of an existing curriculum. The book icon was reserved for interventions that were for students, not teachers. The icons were used exclusively to highlight the development or evaluation of products or interventions.

Some projects received multiple icons. For instance, if a project was developing a classroom curriculum and this curriculum included a professional development handbook, it would receive both a book (instructional intervention) and an apple (professional development) icon. As with the coding for grade level and focal population, two contract staff coded each project in relation to products developed and testsed for 100 percent reconciliation. A third contract staff member was brought in if necessary, and for any instance in which contract staff could not reach agreement based on the abstracts provided by the Institute, Institute staff provided further assistance or documentation. After the contractor completed the coding of projects to include these icons, Institute staff reviewed the icons and provided additional documentation, if necessary, to accurately reflect the items developed or tested in a project.

Categorization Scheme for Mathematics		
Chapter Headers	**Definition**	**Key Words**
1. Mathematics in Prekindergarten Settings	This chapter focuses on projects associated with prekindergarten or early childhood settings in math, including students. Learning counting and cardinality, number names, the counting sequence, and basic math concepts.	Early math skills, school readiness in math, counting, number sequence, number order, number names, cardinality
2. Number and Quantity in Kindergarten through 12th Grade Settings	This chapter focuses on projects to teach number and quantity to K-12 students. *Number system*: Students understand the number system, including base 10, place value, multi-digit numbers, rational numbers, irrational numbers, and complex number systems (polynomials, vectors, matrices). *Quantity*: Students reason quantitatively and use units to solve problems.	Place value, Base 10, counting sequence, digits, whole numbers, multi-digit numbers, decimals, rational numbers, irrational numbers, complex number system, polynomials, vectors, matrices

Categorization Scheme for Mathematics		
Chapter Headers	**Definition**	**Key Words**
3. **Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings**	This chapter focuses on projects to teach algebra or pre-algebra concepts to K-12 students. Students learn expressions (record of a computation with numbers and symbols) and equations and inequalities (statement of equality between two expressions). Students start with learning addition and subtraction, multiplication and division (factors and multiples), and solving linear equations.	Subtraction, addition, multiplication, division, arithmetic, equations, properties of operations (i.e., PEMDAS), radicals, integer exponents, proportional relationships, linear equations
4. Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings	This chapter focuses on projects to teach measurement, data, statistics, and probability to K-12 students. *Measurement and data:* Students learn various ways to measure and compare. In measurement, students learn time, money, measuring things in standard units (volume, area, perimeter, and mass). *Statistics and probability:* Students learn statistical variability and distributions, random sampling to draw inferences about population (or inferences about two populations), probability and conditional probability, and patterns of association in bivariate data.	Time, money, liquid volumes, mass of objects, area and perimeter, inferences, sampling, bivariate data, conditional probability
5. Geometry in Kindergarten through 12th Grade Settings	This chapter focuses on projects to teach geometry to K-12 students. Students learn shapes and their attributes; draw and identify lines, angles, and other shapes, two- and three-dimensional figures; calculate area, surface area and volume; and geometric theorems.	Geometry, shapes, angles, planes lines, two-dimensional figures, area, surface area, volume, Pythagorean Theorem, cylinders cones, spheres, arcs
6. Fractions and Functions in Kindergarten through 12th Grade Settings	This chapter focuses on projects to teach fractions or functions to K-12 students. *Fractions:* Students learn fractions, decimals, and ratios. *Functions:* Students learn how to describe situations where one quantity determines another (e.g., time it takes to drive 100 miles is a function of a car's speed in miles per hour).	Fractions, decimal notation, decimal fractions, ratio, functions, linear, quadratic, and exponential models, trigonometric functions

Categorization Scheme for Mathematics		
Chapter Headers	**Definition**	**Key Words**
7. Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings	This chapter focuses on projects that use integrated math curriculum, sequential multi-year or multi-unit math curriculum, or projects that focus on multiple math concepts (e.g. algebra and geometry).	Integrated math curriculum, multi-year math curriculum, multiple math concepts
8. Student Mathematics Practices, Inquiry, and Reasoning in Kindergarten through 12th Grade Settings	This chapter focuses on what students should know about mathematics, "how to think like a mathematician". The emphasis is not on domains or specific subjects in mathematics. Mathematical practices include thinking abstractly and quantitatively, seeing patterns, and making sense of problems in order to solve them.	Problem solving, abstract thinking, quantitative thinking
9. Student Perceptions, Motivations, Attitudes, and Anxiety about Mathematics in Kindergarten through 12th Grade Settings	This chapter focuses on student outcomes related to mindset, stereotype threat, motivation, attitudes, and perceptions regarding mathematics. The focus is on the student (not teachers).	Attitudes, motivation, engagement, stereotype threat, self-regulation, meta-cognition, growth mindset, perceptions of math
10. Mathematics in Postsecondary and Adult Education Settings	This chapter focuses on projects associated with postsecondary and adult education, and includes topics such as remedial/gateway math (e.g., access, completion, gateway math courses), courses needed for a math or any other degree (e.g., math courses needed for a liberal arts degree versus a mathematics degree), or career readiness in math (e.g., job-specific skills related to math).	Remedial math, gateway math, college-level math courses
11. Teacher Instruction, Pedagogy, and Professional Development in Mathematics	This chapter focuses on teacher instruction and pedagogy in mathematics. The focus is on teachers, teacher learning about math, improvements in pedagogy and practice.	Pedagogy, instruction, scaffolding, teacher practice, teacher professional development, teacher learning, coaching and practice

Categorization Scheme for Mathematics		
Chapter Headers	**Definition**	**Key Words**
12. Mathematics Assessment	This chapter is focuses on developing and testing/validating math assessments, monitoring tools, and formative assessments for use with students.	Validation, assessment, progress monitoring, psychometric, screening, formative assessments
13. Mathematics Policy	This chapter focuses on math policy projects, such as those addressing common core, NCLB, or state policies. This can include policies to improve math student outcomes for college readiness (e.g. double-dose algebra), school readiness in math, and math course credits in secondary or postsecondary education.	Math policy, federal policy in math, state policy in math, standards

Categorization Scheme for Science		
Chapter Headers	**Definition**	**Key Words**
1. Science in Prekindergarten Settings	This chapter focuses on projects associated with prekindergarten or early childhood learning in science. Students learn basic science concepts.	Early science skills, school readiness in science
2. Physical Sciences in Kindergarten through 12th Grade Settings	This chapter focuses on projects that sought to improve the teaching of physical science to K-12 students. Physical science is the study of physics and chemistry in nature. Topics include forces and interactions of force (e.g., push/pull, slope, and motion), waves (e.g., light and sound), matter, chemical reaction, and energy.	Force and motion, push/pull, energy and forces, wave properties, electromagnetic radiation, properties of matter, chemical reactions
3. Life Sciences in Kindergarten through 12th Grade Settings	This chapter focuses on projects that sought to improve the teaching of life science to K-12 students. Life sciences comprise the fields of science involving the scientific study of living organisms such as microorganisms, plants, animals, and human beings. Topics include the interdependent relationships of ecosystems, and growth and development of an organism. Disciplines include biology (including marine biology, bioethics, biochemistry, etc.), medical sciences, pharmacology, and neuroscience.	Natural resources, human impacts on earth systems, matter and energy flow in organisms, structure and function of organisms, growth and development of organisms, inheritance/ variation of traits, biodiversity, adaptation, natural selection, reproduction of organisms

Categorization Scheme for Science		
Chapter Headers	**Definition**	**Key Words**
4. Earth and Space Sciences in Kindergarten through 12th Grade Settings	This chapter focuses on projects that sought to improve the teaching of earth and space science to K-12 students. Earth and space science is the study of the earth's weather/climate, earth materials, solar system, universe and stars, and processes that shape the earth (e.g., history of earth, materials, plate tectonics, role of water).	Weather and climate, conservation of energy and energy transfer, natural hazards, seasonal patterns, motion of the sun, moon and stars, plate tectonics, human impact on earth, global climate
5. Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings	This chapter focuses on projects that use integrated science curriculum, sequential multi-year or multi-unit science curriculum, or projects that focus on multiple science subjects (e.g., physics and chemistry).	Integrated science curriculum, multi-year science curriculum, multiple science concepts
6. Engineering, Technology, and Applications of Science in Kindergarten through 12th Grade Settings	This chapter focuses on students defining engineering problems, developing solutions, and optimizing the design solution. The focus is not on educational technology or learning technologies, but rather a student's application of science and engineering principles.	Engineering, usability, design and test
7. Student Practice, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings	This chapter focuses on what students should know about the process of scientific inquiry, or "how to think like a scientist". The emphasis is not on domains or specific subjects in science. Scientific inquiry includes creating a hypothesis, testing the hypothesis, and refining the hypothesis.	Hypothesis testing, inquiry-based science, question and explore, create experiments, develop questioning strategies, scientific investigations, interpret and analyze data, draw conclusions, thinking critically and logically, defending results
8. Student Perceptions, Motivations, Attitudes, and Anxiety about Science in Kindergarten through 12th Grade Settings	This chapter focuses on student outcomes related to mindset, stereotype threat, motivation, and perceptions regarding science. The focus (and outcomes of interest) is on students (not teachers).	Attitudes, motivation, engagement, stereotype threat, self-regulation, meta-cognition, growth mindset, perceptions of science

Categorization Scheme for Science		
Chapter Headers	**Definition**	**Key Words**
9. Science in Postsecondary and Adult Education Settings	This chapter focuses on projects associated with postsecondary and adult education, and includes topics such as remedial/gateway science (e.g., access, completion, gateway science courses), courses needed for a science or any other degree (e.g., science courses needed for a liberal arts degree versus a science degree), or career readiness in science (e.g. job-specific skills related to science).	Remedial science, gateway science, college-level science courses
10. Teacher Instruction, Pedagogy, and Professional Development in Science	This chapter focuses on teacher instruction and pedagogy in science. The focus is on teacher development, instructional improvement, teacher learning about science, teachers learning about hands-on or inquiry-based science, improvements in pedagogy and practice.	Hands-on learning instruction, inquiry-based science instruction, science pedagogy, instruction, teacher practice, teacher professional development, teacher learning, coaching and practice
11. Science Assessment	This chapter is focuses on developing and testing/validating science assessments, monitoring tools, and formative assessments for use with students.	Validation, assessment, progress monitoring, psychometric, screening, formative assessments
12. Science Policy	This chapter focuses on science policy projects, such as those addressing Next Generation Science Standards, NCLB, state policies. This can include policies to improve science student outcomes for college readiness, school readiness in science, and science course credits in secondary or postsecondary education.	Science policy, federal policy in science, state policy in science, science standards

Appendix B: Instructional Interventions by Chapter

Mathematics in Pre-Kindergarten Settings

Award Number	**Instructional Interventions by Chapter**
R305H020060	Using Cognitive Analyses to Improve Children's Math and Science Learning
R305K040001	An Examination of the Impact of Big Math for Little Kids on Pre-K and Kindergarten Students' Learning of Math
R305H050035	Improving Children's Pure Numerical Estimation
R305K050082	Developing an Intervention to Foster Early Number Sense and Skill
R305K050157	Scaling Up TRIAD: Teaching Early Mathematics for Understanding With Trajectories and Technologies
R305K050186	Scaling Up the Implementation of a Prekindergarten Mathematics Curriculum in Public Preschool Programs
R305K060089	Numbers Plus: A Comprehensive Approach to Early Mathematics Education
R305A070068	Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality
R305B070542	An Economical Improvement In Literacy and Numeracy
R305A080013	Improving Children's Numerical Understanding
R305A080697	Closing the SES Related Gap in Young Children's Mathematical Knowledge
R305A080700	Increasing the Efficacy of An Early Mathematics Curriculum With Scaffolding Designed to Promote Self-Regulation
R324A090145	Building Math Readiness in Young Deaf/Hard-of-Hearing Children: Parents as Partners
R305A100267	MathemAntics Preschool --> 3: Development and Evaluation of Mathematics Software for Children From Preschool to Grade 3
R305A110483	Numbers Plus Efficacy Study
R324A120410	A Randomized Trial of a Tutor-Based Mathematics and Attention Intervention for Low-Performing Preschoolers at Risk for Mathematical Difficulties in School
R305A120262	A Randomized Study of the Efficacy of a 2-Year Mathematics Intervention for At-Risk Prekindergarten and Kindergarten Students
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System
R324A120059	Recognition and Response: Addressing Early Learning Difficulties in Math through an RtI Model for Pre-K

Number and Quantity in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305K050082	Developing an Intervention to Foster Early Number Sense and Skill
R305A100267	MathemAntics Preschool --> 3: Development and Evaluation of Mathematics Software for Children From Preschool to Grade 3
R305A080287	Making Sense of Concrete Models for Mathematics
R305A080479	Fostering Fluency With Basic Addition and Subtraction
R324A090341	Foundations of Mathematical Understanding: Developing a Strategic Intervention on Whole Number Concepts
EDIES11C0026	Project NumberShire: A Game-Based Integrated Learning and Assessment System to Target Whole Number Concepts
R324A110286	KinderTEK: Teaching Early Knowledge of Whole Number Concepts Through Technology
R324A120071	Development of a Game-based Integrated Learning and Assessment System to Target Whole Number Concepts (Project NumberShire)
R324A120304	A Randomized Control Trial of a Tier 2 Kindergarten Mathematics Intervention
EDIES13C0044	Teachley: Math Facts - Design and Development of Intervention Software Promoting Single-Digit Operational Fluency

Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305H050179	Using Contrasting Examples to Support Procedural Flexibility and Conceptual Understanding in Mathematics
R305B070297	Arithmetic Practice that Promotes Conceptual Understanding and Computational Fluency
R305A110198	Improving Children's Understanding of Mathematical Equivalence
EDIES13C0032	WebFluidMath
EDIES13C0045	NumberShire II: Development of a Second Grade Game-Based Integrated Learning System to Target Whole Numbers and Operations in Base Ten and Operations and Operations and Algebraic Thinking
R305K040003	Algebraic Interventions for Measured Achievement
R305A070185	Effectiveness of Cognitive Tutor Algebra I Implemented at Scale
R305B070487	Bridging the Bridge to Algebra: Measuring and Optimizing the Influence of Prerequisite Skills on a Pre-Algebra Curriculum
R305A090197	Efficacy Study of AnimalWatch: An Intelligent Tutoring System for Pre-Algebra

Award Number	Instructional Interventions by Chapter
R305A090519	Learning by Teaching Synthetic Student: Using SimStudent to Study the Effect of Tutor Learning
EDIES10C0024	Perceptual and Adaptive Learning Technologies: Developing Products to Improve Algebra Learning
R305A100150	Transforming Algebra Assignments
R305A110060	Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation
R305A110451	Learning and Teaching Algebra (LTA)
R305A120045	Efficacy Study of a Pre-Algebra Supplemental Program in Rural Mississippi Schools
R324A120006	AnimalWatch-VI Suite: A Comprehensive Program to Increase Access to Mathematics for Students With Visual Impairments
R324A120115	Promoting Algebra Readiness: Developing a Strategic Intervention On Rational Number Concepts (Project PAR)
R324A120364	Project AIM: Algebra-readiness Intervention Modules for At-Risk Students
R305H030016	The Neural Markers of Effective Learning
R305A070105	Algebra Intervention for Measured Achievement-Full Year Curriculum
R305B070430	Democratizing Access to Core Mathematics Grades 9-12
R305B070508	Successful Transitions to Algebra I: A Randomized Control Trial of Two Theories of Ninth Grade Algebra Instruction
R305C080015	National Research & Development Center on Instructional Technology: Center for Advanced Technology in Schools
R305A100074	Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts
R305A110149	Assessing the Efficacy of Online Credit Recovery in Algebra I for At-Risk Ninth Graders
R305A110517	Interleaved Mathematics Practice

Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305A110685	Data Modeling Supports the Development of Statistical Reasoning
ED06PO0930	Fathom Dynamic Data Software

Fractions and Functions in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305K060011	Getting Fractions Right With Technology-Mediated Peer-Assisted Learning (TechPALS)
R305B070407	The Role of External Representations in Learning and Transfer of Mathematical Knowledge
EDIES09C0009	An Online Intelligent Tutoring System to Advance Learning in Math Games
R305A100110	Developing and Evaluating a Technology-Based Fractions Intervention Program for Low-Achieving and At-Risk Students
R324C100004	National Research and Development Center on Improving Mathematics Instruction for Students With Mathematics Difficulties
R305A120734	Combining Advantages of Collaborative and Individual Learning With an Intelligent Tutoring System for Fractions
R305A130215	Use of Machine Learning to Adaptively Select Activity Types and Enhance Student Learning With an Intelligent Tutoring System
R305K060002	Enhancing the Mathematical Problem Solving Performance of Sixth Grade Students Using Schema-Based Instruction
R305A090460	AdaptErrEx: Exploring the Learning Benefits of Erroneous Examples and Their Dynamic Adaptations Within the Context of Middle School Mathematics
R305A110358	Learning of Ratio and Proportion Problem-Solving Using Schema-Based Instruction: Efficacy and Sustainability
R305A120288	Perceptual Learning Technology in Mathematics Education: Efficacy and Replication

Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305K040001	An Examination of the Impact of Big Math for Little Kids on Pre-K and Kindergarten Students' Learning of Math
R305H050035	Improving Children's Pure Numerical Estimation
R305A080013	Improving Children's Numerical Understanding
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305H060070	Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning
R305B070048	Evaluation of the First In Math Online Mathematics Program in New York City: A Randomized Control Trial
R305B070299	Teaching Fractions and Integers: The Development of a Research-Based Instructional Practice

Award Number	Instructional Interventions by Chapter
R324B070164	Validating a Response to Intervention Multitiered Model for Primary Grade Students With Mathematics Difficulties
R305A080699	Early Learning in Mathematics: Efficacy in Kindergarten Classrooms
R305A090111	The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"
R324A090052	Responsiveness-To-Instruction to Strengthen the Academic Performance of Students With Reading and Math Disabilities
EDIES10P0102	FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math
R305A100116	National Randomized Control Trial of Everyday Mathematics
R305A110500	Focused and Coherent Elementary Mathematics: Japanese Curriculum Resources for U.S. Teachers
R305A120184	Investigation of the Efficacy of the JUMP Program of Mathematics Instruction
EDIES13C0033	Science4Us: Game-Based K-2 STEM Education for Teachers and Students
R305A130400	Efficacy of an Integrated Digital Elementary School Mathematics Curriculum
R305H040032	Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments
R305K050086	AnimalWatch: An Intelligent Tutoring System for Grade 6 Mathematics
R305A070218	The Potential Efficacy of Math in a Cultural Context: Sixth Grade Math Modules
R305A080093	Bringing Cognitive Tutors to the Internet: A Website that Helps Middle-School Students Learn Math
R305A080464	Closing the Achievement Gap in Middle School Mathematics Utilizing Stanford University's Education Program for Gifted Youth Differentiated Mathematics Program
EDIES10P0104	An Empirical Approach to Developing Web-based Math Learning Games to Improve Elementary School Student Outcomes
R324A090179	Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities
EDIES10P0103	Planet First Energy World (PFEW)
R305C100024	National Research & Development Center on Cognition and Mathematics Instruction
EDIES11C0028	Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired

Student Mathematics Practices, Inquiry, and Reasoning in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305H020060	Using Cognitive Analyses to Improve Children's Math and Science Learning
R305H030031	Increasing Learning by Promoting Early Abstract Thought
R305H040108	Optimizing Resistance to Forgetting
R305K050050	Math Pathways and Pitfalls Lessons for K-7 Students: Improving Mathematics Achievement for English Language Learners
R305H060070	Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning
R324B070164	Validating a Response to Intervention Multitiered Model for Primary Grade Students With Mathematics Difficulties
R305A090353	Focusing on the Efficacy of Teaching Advanced Forms of Patterning on First Graders' Improvements in Reading, Mathematics, and Reasoning Ability
R305A090527	Spatial Temporal Mathematics at Scale: An Innovative and Fully Developed Paradigm to Boost Math Achievement Among All Learners
R324A090002	Strategy Training, Problem Solving, and Working Memory in Children With Math Disabilities
R305A100862	Language in Math
R324A130001	The Solutions Project: Teaching Students With Moderate/Severe Intellectual Disability to Solve Mathematical Problems
R305H040032	Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments
R305H050062	Guided Cognition for Unsupervised Learning
ED06PO0919	Artificial Intelligence Software for Individualized Math Tutoring for Students Who are Blind and Visually Impaired
R305K060002	Enhancing the Mathematical Problem Solving Performance of Sixth Grade Students Using Schema-Based Instruction
R324A070206	Improving Mathematics Performance of At-Risk Students and Students With Learning Disabilities in Urban Middle Schools (MSM Project)
R305A080134	Guided Cognition for Unsupervised Learning of Mathematics
R324A090179	Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math
R305A100074	Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts

Student Perceptions, Motivations, Attitudes, and Anxiety about Mathematics in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305A080664	Teaching Every Student: Using Intelligent Tutoring and Universal Design to Customize the Mathematics Curriculum
R305A070218	The Potential Efficacy of Math in a Cultural Context: Sixth Grade Math Modules
R305A090162	A Randomized Trial of Reducing Stereotype Threat Among Minority and Economically Disadvantaged Students
EDIES13C0043	Empires: The First Socially-Networked Story-Based Math Game

Mathematics in Postsecondary and Adult Education Settings

Award Number	Instructional Interventions by Chapter
R305A110060	Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation
R305A060010	National Center for Postsecondary Research
R305H060018	Enhancing Self-Reflection and Mathematics Achievement of At-Risk Students at an Urban Technical College: A Self-Regulated Learning Intervention
EDIES11C0041	Math Education for Adult Learners and College Remediation Using Artificial Intelligence
R305A130125	Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Teacher Instruction, Pedagogy, and Professional Development in Mathematics

Award Number	Instructional Interventions by Chapter
R305H050059	Understanding and Facilitating Symbolic Learning
R305A070237	Improving the Mathematical Content Base of Lesson Study: Design and Test of Two Research-Based Toolkits
R305B070554	Evaluating Math Recovery With Student Outcomes
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities
R305A100445	Using Data to Inform Decisions: How Teachers Use Data to Inform Practice and Improve Student Performance in Mathematics
R305A120813	Longitudinal Study of a Successful Scaling-Up Project: Extending TRIAD

Award Number	Instructional Interventions by Chapter
R305A120781	Replicating the CGI Experiment in Diverse Environments
R305H030141	A Multidisciplinary Study of Analogical Transfer in Children's Mathematical Learning
R305A110451	Learning and Teaching Algebra (LTA)
R305A110913	Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning
EDIES11C0045	PlatinuMath: An Online Formative Assessment Math Game for Preservice Elementary Teachers

Mathematics Assessment

Award Number	Instructional Interventions by Chapter
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305A090111	The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"
R305A090528	Applications of Intelligent Tutoring Systems (ITS) to Improve the Skill Levels of Students With Deficiencies in Mathematics
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities
R305A120125	An Efficacy Study of Online Mathematics Homework Support: An Evaluation of the ASSISTments Formative Assessment and Tutoring Platform

Mathematics Policy

Award Number	Instructional Interventions by Chapter
R305E090009	Evaluating the Effectiveness of Tennessee's Voluntary Pre-K Program
R305R060059	Comprehensive Evaluation of the Effects of District-Wide High School Curriculum Reform on Academic Achievement and Attainment in Chicago
R305A060010	National Center for Postsecondary Research
R305A130125	Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Science in Prekindergarten Settings

Award Number	Instructional Interventions by Chapter
R305K060036	Early Childhood Hands-On Science Curriculum Development and Demonstration
R305A070068	Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality
R305A100275	ECHOS: Early Childhood Hands on Science
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Physical Sciences in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R324A070130	The Universally Designed Science Notebook: An Intervention to Support Science Learning for Students With Disabilities
EDIES13C0037	Transmedia: Augmented Reality Game for Essential Transfer of Science
R305H050052	Dynamically Modifying the Learning Trajectories of Novices With Pedagogical Agents
R305H050169	An Implementation of Vicarious Learning With Deep-Level Reasoning Questions in Middle School and High School Classrooms
ED06C00039	Cinematic Sciences: An Online Simulation Platform With Real Physics and Behavioral Programming for Physical Sciences
ED06PO0907	Technology Enhanced Science Education
ED07CO0037	Technology Enhanced Science Education in Middle School
EDIES11C0022	STEM Solar Explorations
R305A110782	Explanation and Prediction Increasing Gains and Metacognition (EPIGAME)
R305A120778	The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining
R305K050140	Molecules and Minds: Optimizing Simulations for Chemistry Education
ED07CO0044	Intelligent Molecular Model Kit and Software Suite for Improving High School Chemistry Instruction and Student Achievement
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305B070085	Conceptual Analysis and Student Learning in Physics
ED08CO0051	Electronic Chemistry Laboratory Workbook (ECLW)
R305A080063	A Randomized Controlled Study of the Effects of Intelligent Online Chemistry Tutors in Urban California School Districts
R305A090195	Testing the Effectiveness of CALM for High School Chemistry Students

Award Number	Instructional Interventions by Chapter
R305A090203	Molecules & Minds: Developing Bridging Scaffolds to Improve Chemistry Learning
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab
R305A100163	Improving a Natural-Language Tutoring System that Engages Students in Deep Reasoning Dialogues About Physics
R305A100875	DeepTutor: An Intelligent Tutoring System Based on Deep Language and Discourse Processing and Advanced Tutoring Strategies
R305A100992	The Connected Chemistry Curriculum
EDIES11C0029	Virtual Labs for High School Physics

Life Sciences in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305H060089	A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms
R305A110285	Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice
R305A080141	Advancing Ecosystems Science Education via Situated Collaborative Learning in Multi-User Virtual Environments
R305A090210	Systems and Cycles: Using Structure-Behavior-Function Thinking as a Conceptual Tool for Understanding Complex Natural Systems in Middle School Science
EDIES10C0023	Game-Based Interactive Life Science for Students With Learning Disabilities
R305A120390	SimScientists Assessment System
R305A130160	SimScientists Model Progressions
R305S050019	V-Frog: Applying Virtual Surgery Principles to Dissection Simulation
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
R305A080594	Guru: A Computer Tutor that Models Expert Human Tutors
R305A080692	Education Research - BioBridge Teacher Quality
EDIES09C0017	Agile Mind Visualizations to Increase High School Biology Learning
R305A090549	Promoting Robust Understanding of Genetics With a Cognitive Tutor that Integrates Conceptual Learning With Problem Solving
R305A120047	Cyber-enabled Tangible Molecular Models for High School

Earth and Space Sciences in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305M050226	Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation

Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305K050038	The Scientific Literacy Project: Enhancing Young Children's Scientific Literacy Through Reading and Inquiry-Centered Adult-Child Dialogue
R305B070354	Diagnostic Embedded Classroom Assessment-An Efficacy Study
R305A080347	Mindful Instruction of Nonmainstream Children
EDIES10C0020	OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums
R305A120451	The Effects of Arts-Integration on Retention of Content and Student Engagement
R305H060080	Test-Enhanced Learning in the Classroom
ED07CO0038	The Tactus Immersive Learning Environment (TILE) for Enhancing Learning in High School Science Classrooms
R305B070233	Understanding Science: Improving Achievement of Middle School Students in Science
ED08CO0050	The Digital Earth Explorations Project to Enrich the Middle School Sciences
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305C080009	National Research & Development Center on Cognition and Science Instruction
EDIES10P0103	Planet First Energy World (PFEW)
R305A100714	Toward High School Biology: Helping Middle School Students Make Sense of Chemical Reactions
EDIES11C0028	Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired
EDIES11C0042	Readorium Software for Improved Reading Comprehension of Non-fiction Science Text
R305A110550	Developing a Manual for Test-Enhanced Learning in the Classroom
R305A130195	GlobalEd 2
R305K060142	Measuring the Efficacy and Student Achievement of Research-based Instructional Materials in High School Multidisciplinary Science

Award Number	Instructional Interventions by Chapter
R305A090344	Cosmic Chemistry: Engaging Summer Learning for High School Students

Engineering, Technology, and Applications of Science in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
EDIES10C0020	OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums
EDIES10P0102	FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math
EDIES13C0033	Science4Us: Game-Based K-2 STEM Education for Teachers and Students

Student Practices, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305H020060	Using Cognitive Analyses to Improve Children's Math and Science Learning
R305K050038	The Scientific Literacy Project: Enhancing Young Children's Scientific Literacy Through Reading and Inquiry-Centered Adult-Child Dialogue
R305H060034	Training in Experimental Design: Developing Scalable and Adaptive Computer-based Science Instruction
R305H060089	A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms
R305H060150	Teaching the Logic of the Scientific Method in the Fourth Grade
R305B070434	Improving Science Learning Through Tutorial Dialogs
R305A080316	Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning
R305A080347	Mindful Instruction of Nonmainstream Children
R305A090094	Efficacy of the Science Writing Heuristic Approach
R305A090281	Promoting Science among English Language Learners (P-SELL): Efficacy and Sustainability
R305A100404	Promoting Transfer of the Control of Variables Strategy in Elementary and Middle School Children via Contextual Framing and Abstraction
R305A100782	Habitat Tracker: Learning About Scientific Inquiry Through Digital Journaling at Wildlife Centers
R305A130206	My Science Tutor: Improving Science Learning through Tutorial Dialogs (MyST)

Award Number	Instructional Interventions by Chapter
R305H020113	Introducing Desirable Difficulties for Educational Applications in Science
R305H050038	Supporting Efficient and Durable Student Learning
R305H050052	Dynamically Modifying the Learning Trajectories of Novices with Pedagogical Agents
R305H050116	Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations
R305H050125	Scientific Misconceptions: From Cognitive Underpinning to Educational Treatment
R305H060080	Test-Enhanced Learning in the Classroom
R305B070460	Improving Metacomprehension and Self-Regulated Learning From Scientific Texts
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305A080507	Scaffolding Students' Use of Multiple Representations for Science Learning
R305A080614	SimScientists: Interactive Simulation-Based Science Learning Environments
R305A080622	Expanding the Science and Literacy Curricular Space: The GlobalEd 2 Project
R305C080022	National Research & Development Center on Instructional Technology: Possible Worlds
R305A100909	Argument-Driven Inquiry in the Middle and High School Laboratory-The Refinement and Further Development of a New Instructional Model
R324A120409	Improving the Science Performance of Students With Learning Disabilities Through Strategic Note-taking
EDIES12C0040	Possible Worlds: Explorer Series
R305A120554	Enhancing Learning and Transfer of Science Principles via Category Construction
R305A120778	The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining
R305A120808	Comprehension SEEDING: Comprehension Through Self-Explanation, Enhanced Discussion and Inquiry Generation
EDIES13C0028	SciSkillQuest: A Standards-Based Game to Develop Students' Scientific Skills, Academic Mindsets, and Learning Strategies in Science
R305K060142	Measuring the Efficacy and Student Achievement of Research-based Instructional Materials in High School Multidisciplinary Science
R305A080621	A Cognitive Approach to Implementing Tree Thinking in High School and College Biology Curricula

Student Perceptions, Motivations, Attitudes, and Anxiety About Science in Kindergarten through 12th Grade Settings

Award Number	Instructional Interventions by Chapter
R305A120186	SimSelf: A Simulation Environment Designed to Model and Scaffold Learners' Self-Regulation Skills to Optimize Complex Science Learning

Science in Postsecondary and Adult Education Settings

Award Number	Instructional Interventions by Chapter
R305A080316	Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning
R305H020113	Introducing Desirable Difficulties for Educational Applications in Science
R305H050116	Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations
R305H050125	Scientific Misconceptions: From Cognitive Underpinning to Educational Treatment
R305B070460	Improving Metacomprehension and Self-Regulated Learning From Scientific Texts
R305A080507	Scaffolding Students' Use of Multiple Representations for Science Learning
R305B070085	Conceptual Analysis and Student Learning in Physics
R305A080621	A Cognitive Approach to Implementing Tree Thinking in High School and College Biology Curricula
ED07CO0040	Virtual Physics Laboratory
R305B070349	Acquiring Research Investigative and Evaluative Skills (ARIES) for Scientific Inquiry
ED008CO0050	Higher Learning @ Higher Speeds in Biosciences using Time Compressed Animated Delivery (TCAD)

Teacher Instruction, Pedagogy, and Professional Development in Science

Award Number	Instructional Interventions by Chapter
R305A090114	Assessing the Efficacy of a Comprehensive Intervention in Physical Science on Head Start Teachers and Children
R305A120193	Cultivating Young Scientists: Expanding Foundations of Science Literacy
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities

Award Number	Instructional Interventions by Chapter
R305A090145	INSPIRE: Urban Teaching Fellows Program
R305A110285	Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice
R305M050226	Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation
R305B070233	Understanding Science: Improving Achievement of Middle School Students in Science
R305C080009	National Research & Development Center on Cognition and Science Instruction
R324A080096	Visualizing Science With Adapted Curriculum Enhancements (ACE)
R305A110515	Making Sense of SCIENCE: Efficacy Study of a Professional Development Series for Middle School Science Teachers
R305A110550	Developing a Manual for Test-Enhanced Learning in the Classroom
R305A110913	Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
R305A080692	Education Research - BioBridge Teacher Quality

Science Assessment

Award Number	Instructional Interventions by Chapter
R305B070354	Diagnostic Embedded Classroom Assessment-An Efficacy Study
R305A120390	SimScientists Assessment System
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab

Science Policy

Award Number	Instructional Interventions by Chapter
R305E090009	Evaluating the Effectiveness of Tennessee's Voluntary Pre-K Program

Appendix C: Professional Development by Chapter

Mathematics in Pre-Kindergarten Settings

Award Number	**Professional Development by Chapter**
R305K050157	Scaling Up TRIAD: Teaching Early Mathematics for Understanding With Trajectories and Technologies
R305K050186	Scaling Up the Implementation of a Prekindergarten Mathematics Curriculum in Public Preschool Programs
R305K060089	Numbers Plus: A Comprehensive Approach to Early Mathematics Education
R305A070068	Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System
R32A120059	R305A120631 Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Number and Quantity in Kindergarten through 12th Grade Settings

Award Number	**Professional Development by Chapter**
EDIES13C0044	Teachley: Math Facts – Design and Development of Intervention Software Promoting Single-Digit Operational Fluency

Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings

Award Number	**Professional Development by Chapter**
R305M030154	Algebra Learning for All (ALFA)
R305K040003	Algebraic Interventions for Measured Achievement
R305M040127	Algebra Connections: Teacher Education in Clear Instruction and Responsive Assessment of Algebra Patterns and Problem Solving
EDIES09C0012	An On-Line Professional Development Program for FluidMath
R305A100047	Linear Functions for Teaching: An Efficacy Study of Learning and Teaching Linear Functions
R305A100150	Transforming Algebra Assignments
R305A110451	Learning and Teaching Algebra (LTA)
R324A120006	AnimalWatch-VI Suite: A Comprehensive Program to Increase Access to Mathematics for Students With Visual Impairments

Award Number	Professional Development by Chapter
R305A080667	Agent and Library Augmented Shared Knowledge Areas (ALASKA)
R324A090295	Professional Development for Algebra Progress Monitoring

Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A110685	Data Modeling Supports the Development of Statistical Reasoning

Fractions and Functions in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A100110	Developing and Evaluating a Technology-Based Fractions Intervention Program for Low-Achieving and At-Risk Students

Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A080699	Early Learning in Mathematics: Efficacy in Kindergarten Classrooms
R305A100116	National Randomized Control Trial of Everyday Mathematics
R305A110500	Focused and Coherent Elementary Mathematics: Japanese Curriculum Resources for U.S. Teachers
EDIES10P0103	Planet First Energy World (PFEW)

Student Mathematics Practices, Inquiry, and Reasoning in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A100862	Language in Math

Teacher Instruction, Pedagogy, and Professional Development in Mathematics

Award Number	Professional Development by Chapter
R305A070063	The Efficacy of the Responsive Classroom Approach for Improving Teacher Quality and Children's Academic Performance
R305A070237	Improving the Mathematical Content Base of Lesson Study: Design and Test of Two Research-Based Toolkits
R305B070554	Evaluating Math Recovery With Student Outcomes
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities
R305C090022	The National Center for Research on Rural Education
R305A100178	Making Room for Student Thinking: Using Automated Feedback, Video-Based Professional Development, and Evidence-Based Practice Recommendations to Improve Mathematical Discussion
R305A100445	Using Data to Inform Decisions: How Teachers Use Data to Inform Practice and Improve Student Performance in Mathematics
R305A100623	Developing Mathematics Teaching through Focused Collaborative Assessment of Practice
R324A100196	Prime Online: Teacher Pedagogical Content Knowledge and Research-based Practice in Inclusive Elementary Mathematics Classrooms
R305A110491	Japanese Structured Problem-Solving as a Resource for U.S. Elementary Mathematics Teachers: Program Development and Testing
R305A120813	Longitudinal Study of a Successful Scaling-Up Project: Extending TRIAD
R305A120265	Improving Teachers' Monitoring of Learning
R305A120781	Replicating the CGI Experiment in Diverse Environments
R305M030154	Algebra Learning for All (ALFA)
R305M040127	Algebra Connections: Teacher Education in Clear Instruction and Responsive Assessment of Algebra Patterns and Problem Solving
R305K050045	Classroom Connectivity in Promoting Mathematics and Science Achievement
R305M050270	Investigating the Efficacy of a Professional Development Program in Classroom Assessment for Middle School Reading and Mathematics
EDIES09C0012	An On-Line Professional Development Program for FluidMath
R305A100047	Linear Functions for Teaching: An Efficacy Study of Learning and Teaching Linear Functions
R305A100454	Making Middle School Mathematics Accessible for All Students
R305A110076	Mathematics Coaching Supporting English Language Learners
R305A110392	Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)

Award Number	Professional Development by Chapter
R305A110451	Learning and Teaching Algebra (LTA)
R324A090295	Professional Development for Algebra Progress Monitoring
EDIES11C0045	PlatinuMath: An Online Formative Assessment Math Game for Preservice Elementary Teachers

Mathematics Assessment

Award Number	Professional Development by Chapter
R305A110392	Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)
R324A090295	Professional Development for Algebra Progress Monitoring

Science in Prekindergarten Settings

Award Number	Professional Development by Chapter
R305K060036	Early Childhood Hands-On Science Curriculum Development and Demonstration
R305A070068	Prekindergarten Mathematics and Science for At-Risk Children: Outcomes-Focused Curricula and Support for Teaching Quality
R305A100275	ECHOS: Early Childhood Hands on Science
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Physical Sciences in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R324A070130	The Universally Designed Science Notebook: An Intervention to Support Science Learning for Students With Disabilities
R305A120138	The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School
ED07CO0037	Technology Enhanced Science Education in Middle School
ED08CO0044	Online Learning System to Advance Teaching of Hyper Molecular Modeling
R305A090195	Testing the Effectiveness of CALM for High School Chemistry Students
EDIES11C0029	Virtual Labs for High School Physics

Life Sciences in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A110285	Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice
R305A130160	SimScientists Model Progressions
R305M050064	Mentoring Teachers through Pedagogical Content Knowledge Development
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
R305A080692	Education Research - BioBridge Teacher Quality

Earth and Space Sciences in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305M050226	Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation

Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305B070233	Understanding Science: Improving Achievement of Middle School Students in Science
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305C080009	National Research & Development Center on Cognition and Science Instruction
EDIES10P0103	Planet First Energy World (PFEW)
R305A100091	Accessible Professional Development for Teaching Aquatic Science Inquiry
R305A100714	Toward High School Biology: Helping Middle School Students Make Sense of Chemical Reactions
R305A110550	Developing a Manual for Test-Enhanced Learning in the Classroom

Student Practice, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings

Award Number	Professional Development by Chapter
R305A100782	Habitat Tracker: Learning About Scientific Inquiry Through Digital Journaling at Wildlife Centers
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305A080614	SimScientists: Interactive Simulation-Based Science Learning Environments
R305A080622	Expanding the Science and Literacy Curricular Space: The GlobalEd 2 Project
R305C080022	National Research & Development Center on Instructional Technology: Possible Worlds
R324A120409	Improving the Science Performance of Students With Learning Disabilities Through Strategic Note-Taking

Teacher Instruction, Pedagogy, and Professional Development in Science

Award Number	Professional Development by Chapter
R305M050060	Assessing the Potential Impact of a Professional Development Program in Science on Head Start Teachers and Children
R305A090114	Assessing the Efficacy of a Comprehensive Intervention in Physical Science on Head Start Teachers and Children
R305A120193	Cultivating Young Scientists: Expanding Foundations of Science Literacy
R305M050023	Replication and Outcomes of the Teaching SMART® Program in Elementary Science Classrooms
R305M050109	Evolving Inquiry: An Experimental Test of a Science Instruction Model for Teachers in Rural, Culturally Diverse Schools
R305M060065	Integrating Science and Diversity Education: A Model of Pre-Service Elementary Teacher Preparation
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities
R305A090145	INSPIRE: Urban Teaching Fellows Program
R305C090022	The National Center for Research on Rural Education
R305A100176	A Practice-Based Approach to Professional Development in Science in Urban Elementary and Middle Schools
R305A110285	Understanding Life Science: Improving Student Achievement by Deepening Teacher Content and Pedagogical Content Knowledge in Ways That Transform Instructional Practice
R305H030229	From Cognitive Models of Reasoning to Lesson Plans for Inquiry

Award Number	Professional Development by Chapter
R305K050045	Classroom Connectivity in Promoting Mathematics and Science Achievement
R305M050005	Utah's Improving Science Teacher Quality Initiative
R305M050226	Comparing the Efficacy of Three Approaches to Improving Teaching Quality in Science Education: Curriculum Implementation, Design, and Adaptation
R305B070233	Understanding Science: Improving Achievement of Middle School Students in Science
R305A080078	Leadership for Integrated Middle-School Science (LIMSS)
R305C080009	National Research & Development Center on Cognition and Science Instruction
R324A080096	Visualizing Science With Adapted Curriculum Enhancements (ACE)
EDIES09C0014	Online Application to Support Inquiry-based Science Teaching
R305A100091	Accessible Professional Development for Teaching Aquatic Science Inquiry
R305A110515	Making Sense of SCIENCE: Efficacy Study of a Professional Development Series for Middle School Science Teachers
R305A110550	Developing a Manual for Test-Enhanced Learning in the Classroom
R305M050064	Mentoring Teachers through Pedagogical Content Knowledge Development
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
ED08CO0044	Online Learning System to Advance Teaching of Hyper Molecular Modeling
R305A080692	Education Research - BioBridge Teacher Quality

Science Assessment

Award Number	Professional Development by Chapter
R305A120138	The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School

Appendix D: Educational Technology by Chapter

Mathematics in Pre-Kindergarten Settings

Award Number	**Educational Technology by Chapter**
R305K050082	Developing an Intervention to Foster Early Number Sense and Skill
R305K050157	Scaling Up TRIAD: Teaching Early Mathematics for Understanding With Trajectories and Technologies
R305K050186	Scaling Up the Implementation of a Prekindergarten Mathematics Curriculum in Public Preschool Programs
ED06PO0895	Development of Assessment Technologies for Early Childhood: Phase I
R305A080697	Closing the SES Related Gap in Young Children's Mathematical Knowledge
R324A090145	Building Math Readiness in Young Deaf/Hard-of-Hearing Children: Parents as Partners
R305A100267	MathemAntics Preschool --> 3: Development and Evaluation of Mathematics Software for Children From Preschool to Grade 3
EDIES11C0044	Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Number and Quantity in Kindergarten through 12th Grade Settings

Award Number	**Educational Technology by Chapter**
R305K050082	Developing an Intervention to Foster Early Number Sense and Skill
R305A100267	MathemAntics Preschool --> 3: Development and Evaluation of Mathematics Software for Children From Preschool to Grade 3
R305A080479	Fostering Fluency With Basic Addition and Subtraction
EDIES11C0026	Project NumberShire: A Game-Based Integrated Learning and Assessment System to Target Whole Number Concepts
R324A110286	KinderTEK: Teaching Early Knowledge of Whole Number Concepts Through Technology
R324A120071	Development of a Game-based Integrated Learning and Assessment System to Target Whole Number Concepts (Project NumberShire)
EDIES13C0044	Teachley: Math Facts - Design and Development of Intervention Software Promoting Single-Digit Operational Fluency

Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
ED06PO0921	Natural Math: An Empirically Derived Software for Mathematics Education
R305M060057	Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation
EDIES13C0032	WebFluidMath
EDIES13C0045	NumberShire II: Development of a Second Grade Game-Based Integrated Learning System to Target Whole Numbers and Operations in Base Ten and Operations and Operations and Algebraic Thinking
R305M030154	Algebra Learning for All (ALFA)
R305H040099	Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet
R305A070185	Effectiveness of Cognitive Tutor Algebra I Implemented at Scale
R305B070487	Bridging the Bridge to Algebra: Measuring and Optimizing the Influence of Prerequisite Skills on a Pre-Algebra Curriculum
EDIES09C0012	An On-Line Professional Development Program for FluidMath
R305A090197	Efficacy Study of AnimalWatch: An Intelligent Tutoring System for Pre-Algebra
R305A090519	Learning by Teaching Synthetic Student: Using SimStudent to Study the Effect of Tutor Learning
EDIES10C0024	Perceptual and Adaptive Learning Technologies: Developing Products to Improve Algebra Learning
R305A110060	Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation
R324A110355	Expanding Audio Access to Mathematics Expressions by Students With Visual Impairments via MathML
R324A120006	AnimalWatch-VI Suite: A Comprehensive Program to Increase Access to Mathematics for Students With Visual Impairments
R305H030016	The Neural Markers of Effective Learning
ED06PO0931	Venture Map
R305B070430	Democratizing Access to Core Mathematics Grades 9-12
R305A080667	Agent and Library Augmented Shared Knowledge Areas (ALASKA)
R305C080015	National Research & Development Center on Instructional Technology: Center for Advanced Technology in Schools
R305A100074	Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts

Award Number	Educational Technology by Chapter
R305A110149	Assessing the Efficacy of Online Credit Recovery in Algebra I for At-Risk Ninth Graders
R324A110262	Algebra Screening and Progress Monitoring

Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305A120217	Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System
ED06PO0930	Fathom Dynamic Data Software

Geometry in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305A080231	The Diagnostic Geometry Assessment Project

Fractions and Functions in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305K060011	Getting Fractions Right With Technology-Mediated Peer-Assisted Learning (TechPALS)
EDIES09C0009	An Online Intelligent Tutoring System to Advance Learning in Math Games
R305A100110	Developing and Evaluating a Technology-Based Fractions Intervention Program for Low-Achieving and At-Risk Students
R305A120734	Combining Advantages of Collaborative and Individual Learning With an Intelligent Tutoring System for Fractions
R305A130215	Use of Machine Learning to Adaptively Select Activity Types and Enhance Student Learning With an Intelligent Tutoring System
R305A090460	AdaptErrEx: Exploring the Learning Benefits of Erroneous Examples and Their Dynamic Adaptations Within the Context of Middle School Mathematics
R305A110306	Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System
R305A120288	Perceptual Learning Technology in Mathematics Education: Efficacy and Replication

Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305H060070	Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning
R305B070048	Evaluation of the First In Math Online Mathematics Program in New York City: A Randomized Control Trial
EDIES10P0102	FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math
R324A100068	Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics
EDIES13C0033	Science4Us: Game-Based K-2 STEM Education for Teachers and Students
R305A130400	Efficacy of an Integrated Digital Elementary School Mathematics Curriculum
R305H040032	Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments
R305K050086	AnimalWatch: An Intelligent Tutoring System for Grade 6 Mathematics
R305A080093	Bringing Cognitive Tutors to the Internet: A Website that Helps Middle-School Students Learn Math
R305A080464	Closing the Achievement Gap in Middle School Mathematics Utilizing Stanford University's Education Program for Gifted Youth Differentiated Mathematics Program
EDIES10P0104	An Empirical Approach to Developing Web-based Math Learning Games to Improve Elementary School Student Outcomes
R324A090179	Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities
EDIES10P0103	Planet First Energy World (PFEW)
EDIES11C0028	Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired

Student Mathematics Practices, Inquiry, and Reasoning in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305H040108	Optimizing Resistance to Forgetting
R305H060070	Integrating Conceptual Foundations in Mathematics through the Application of Principles of Perceptual Learning
R305A090527	Spatial Temporal Mathematics at Scale: An Innovative and Fully Developed Paradigm to Boost Math Achievement Among All Learners
R305H040032	Advancing the Math Skills of Low-Achieving Adolescents in Technology-Rich Learning Environments
ED06PO0919	Artificial Intelligence Software for Individualized Math Tutoring for Students Who are Blind and Visually Impaired
R324A090179	Evaluating the Efficacy of Enhanced Anchored Instruction for Middle School Students With Learning Disabilities in Math
ED06PO0912	Math Messenger
R305A100074	Improving Students' Skill at Solving Equations Through Better Encoding of Algebraic Concepts

Student Perceptions, Motivations, Attitudes, and Anxiety about Mathematics in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305A080664	Teaching Every Student: Using Intelligent Tutoring and Universal Design to Customize the Mathematics Curriculum
EDIES13C0043	Empires: The First Socially-Networked Story-Based Math Game

Mathematics in Postsecondary and Adult Education Settings

Award Number	Educational Technology by Chapter
R305A110060	Learning the Visual Structure of Algebra Through Dynamic Interactions With Notation
EDIES11C0041	Math Education for Adult Learners and College Remediation Using Artificial Intelligence
R305A130125	Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Teacher Instruction, Pedagogy, and Professional Development in Mathematics

Award Number	Educational Technology by Chapter
R305M060057	Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation
R305A100178	Making Room for Student Thinking: Using Automated Feedback, Video-Based Professional Development, and Evidence-Based Practice Recommendations to Improve Mathematical Discussion
R324A100196	Prime Online: Teacher Pedagogical Content Knowledge and Research-based Practice in Inclusive Elementary Mathematics Classrooms
R305A120813	Longitudinal Study of a Successful Scaling-Up Project: Extending TRIAD
R305K030140	Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams
R305M030154	Algebra Learning for All (ALFA)
R305H040099	Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet
R305K050045	Classroom Connectivity in Promoting Mathematics and Science Achievement
R305A070440	Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning
EDIES09C0012	An On-Line Professional Development Program for FluidMath
R305A110913	Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning
EDIES11C0045	PlatinuMath: An Online Formative Assessment Math Game for Preservice Elementary Teachers

Mathematics Assessment

Award Number	Educational Technology by Chapter
ED06PO0895	Development of Assessment Technologies for Early Childhood: Phase I
ED07CO0039	Early Childhood Assessment and Intervention to Improve Grade School Students' Math and Reading
EDIES11C0044	Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305B070325	mCLASS:Math: Development and Analysis of an Integrated Screening, Progress Monitoring, and Cognitive Assessment System for K-3 Mathematics

Award Number	Educational Technology by Chapter
EDIES09C0015	Math Monster Mystery: A Formative Assessment in Game Format for Grade 4 Mathematics
R324A100068	Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics
R305K030140	Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams
R305A070440	Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning
R305A080231	The Diagnostic Geometry Assessment Project
R305A090528	Applications of Intelligent Tutoring Systems (ITS) to Improve the Skill Levels of Students With Deficiencies in Mathematics
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities
R305A100234	An Adaptive Testing System for Diagnosing Sources of Mathematics Difficulties
R305A110306	Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System
R305A120125	An Efficacy Study of Online Mathematics Homework Support: An Evaluation of the ASSISTments Formative Assessment and Tutoring Platform
R305A120217	Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System
R305A130223	Comprehensive Research-Based Computer Assessment and Accommodation System for ELL Students
R324A110262	Algebra Screening and Progress Monitoring

Mathematics Policy

Award Number	Educational Technology by Chapter
R305A130125	Using Computer-Assisted Instruction to Accelerate Students through Developmental Math: An Impact Study of Modularization and Compression

Science in Pre-Kindergarten Settings

Award Number	Educational Technology by Chapter
R305A090502	Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children
R305A120631	Efficacy Trial of MyTeachingPartner-Mathematics and Science Curricula and Implementation Support System

Physical Sciences in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R324A070130	The Universally Designed Science Notebook: An Intervention to Support Science Learning for Students With Disabilities
EDIES13C0037	Transmedia: Augmented Reality Game for Essential Transfer of Science
R305H050052	Dynamically Modifying the Learning Trajectories of Novices With Pedagogical Agents
R305H050169	An Implementation of Vicarious Learning With Deep-Level Reasoning Questions in Middle School and High School Classrooms
ED06C00039	Cinematic Sciences: An Online Simulation Platform With Real Physics and Behavioral Programming for Physical Sciences
ED06PO0907	Technology Enhanced Science Education
ED07CO0037	Technology Enhanced Science Education in Middle School
EDIES11C0022	STEM Solar Explorations
R305A110782	Explanation and Prediction Increasing Gains and Metacognition (EPIGAME)
R305A120778	The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining
R305K040008	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305K050140	Molecules and Minds: Optimizing Simulations for Chemistry Education
ED07CO0044	Intelligent Molecular Model Kit and Software Suite for Improving High School Chemistry Instruction and Student Achievement
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
ED08CO0044	Online Learning System to Advance Teaching of Hyper Molecular Modeling
ED08CO0051	Electronic Chemistry Laboratory Workbook (ECLW)
R305A080063	A Randomized Controlled Study of the Effects of Intelligent Online Chemistry Tutors in Urban California School Districts
R305A090195	Testing the Effectiveness of CALM for High School Chemistry Students

Award Number	Educational Technology by Chapter
R305A090203	Molecules & Minds: Developing Bridging Scaffolds to Improve Chemistry Learning
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab
R305A100163	Improving a Natural-Language Tutoring System that Engages Students in Deep Reasoning Dialogues About Physics
R305A100875	DeepTutor: An Intelligent Tutoring System Based on Deep Language and Discourse Processing and Advanced Tutoring Strategies
R305A100992	The Connected Chemistry Curriculum
EDIES11C0029	Virtual Labs for High School Physics

Life Sciences in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305H060089	A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms
R305A080141	Advancing Ecosystems Science Education via Situated Collaborative Learning in Multi-User Virtual Environments
R305A090210	Systems and Cycles: Using Structure-Behavior-Function Thinking as a Conceptual Tool for Understanding Complex Natural Systems in Middle School Science
EDIES10C0023	Game-Based Interactive Life Science for Students With Learning Disabilities
R305A110021	Voyage to Galapagos: Development of a Differentiated Assistance Model in an Inquiry Learning Environment
R305A120390	SimScientists Assessment System
R305A130160	SimScientists Model Progressions
R305S050019	V-Frog: Applying Virtual Surgery Principles to Dissection Simulation
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
R305A080594	Guru: A Computer Tutor that Models Expert Human Tutors
EDIES09C0017	Agile Mind Visualizations to Increase High School Biology Learning
R305A090549	Promoting Robust Understanding of Genetics With a Cognitive Tutor that Integrates Conceptual Learning With Problem Solving
R305A120047	Cyber-enabled Tangible Molecular Models for High School

Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
EDIES10C0020	OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums
ED06PO0899	Videogame-Based Inquiry Learning Module for Science Literacy
ED07CO0038	The Tactus Immersive Learning Environment (TILE) for Enhancing Learning in High School Science Classrooms
ED08CO0050	The Digital Earth Explorations Project to Enrich the Middle School Sciences
R305A090170	ASSISTment Meets Science Learning (AMSL)
EDIES10P0103	Planet First Energy World (PFEW)
R305A100091	Accessible Professional Development for Teaching Aquatic Science Inquiry
EDIES11C0028	Haptic Immersion Platform to Improve STEM Learning for the Visually Impaired
EDIES11C0042	Readorium Software for Improved Reading Comprehension of Non-fiction Science Text
R305A130195	GlobalEd 2
R305A090344	Cosmic Chemistry: Engaging Summer Learning for High School Students

Engineering, Technology, and Applications of Science in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
EDIES10C0020	OPEN's Virtual National Parks 3D Learning Environment for Science and Social Studies: Low-Cost and Easy to Implement Curriculums
EDIES10P0102	FabLab Construction Station: Engaging Teacher and Students in Technology, Engineering, and Math
EDIES13C0033	Science4Us: Game-Based K-2 STEM Education for Teachers and Students

Student Practice, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305H060034	Training in Experimental Design: Developing Scalable and Adaptive Computer-based Science Instruction
R305H060089	A Learning by Teaching Approach to Help Students Develop Self-Regulatory Skills in Middle School Science Classrooms

Award Number	Educational Technology by Chapter
R305B070434	Improving Science Learning Through Tutorial Dialogs
R305A080316	Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning
R305A100404	Promoting Transfer of the Control of Variables Strategy in Elementary and Middle School Children via Contextual Framing and Abstraction
R305A100782	Habitat Tracker: Learning About Scientific Inquiry Through Digital Journaling at Wildlife Centers
R305A130206	My Science Tutor: Improving Science Learning through Tutorial Dialogs (MyST)
R305H020113	Introducing Desirable Difficulties for Educational Applications in Science
R305H050038	Supporting Efficient and Durable Student Learning
R305H050052	Dynamically Modifying the Learning Trajectories of Novices with Pedagogical Agents
R305H050116	Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations
R305A080507	Scaffolding Students' Use of Multiple Representations for Science Learning
R305A080514	Virtual Performance Assessments for Measuring Student Achievement in Science
R305A080614	SimScientists: Interactive Simulation-Based Science Learning Environments
R305A080622	Expanding the Science and Literacy Curricular Space: The GlobalEd 2 Project
R305C080022	National Research & Development Center on Instructional Technology: Possible Worlds
R305A090170	ASSISTment Meets Science Learning (AMSL)
EDIES12C0040	Possible Worlds: Explorer Series
R305A120778	The Development of an Intelligent Pedagogical Agent for Physical Science Inquiry Driven by Educational Data Mining
R305A120808	Comprehension SEEDING: Comprehension Through Self-Explanation, Enhanced Discussion and Inquiry Generation
EDIES13C0028	SciSkillQuest: A Standards-Based Game to Develop Students' Scientific Skills, Academic Mindsets, and Learning Strategies in Science

Student Perceptions, Motivations, Attitudes, and Anxiety About Science in Kindergarten through 12th Grade Settings

Award Number	Educational Technology by Chapter
R305A120186	SimSelf: A Simulation Environment Designed to Model and Scaffold Learners' Self-Regulation Skills to Optimize Complex Science Learning

Science in Postsecondary and Adult Education Settings

Award Number	Educational Technology by Chapter
R305A080316	Developing the Retrieval-Monitoring-Feedback (RMF) Method for Improving the Durability and Efficiency of Student Learning
R305H020113	Introducing Desirable Difficulties for Educational Applications in Science
R305H050116	Grounded and Transferable Knowledge of Complex Systems Using Computer Simulations
R305A080507	Scaffolding Students' Use of Multiple Representations for Science Learning
ED06PO0900	A Virtual Lanuchpad for Learning at Higher Speeds
ED07CO0040	Virtual Physics Laboratory
R305B070349	Acquiring Research Investigative and Evaluative Skills (ARIES) for Scientific Inquiry
ED008CO0050	Higher Learning @ Higher Speeds in Biosciences using Time Compressed Animated Delivery (TCAD)

Teacher Instruction, Pedagogy, and Professional Development in Science

Award Number	Educational Technology by Chapter
R305A120193	Cultivating Young Scientists: Expanding Foundations of Science Literacy
R305M050109	Evolving Inquiry: An Experimental Test of a Science Instruction Model for Teachers in Rural, Culturally Diverse Schools
R305A090145	INSPIRE: Urban Teaching Fellows Program
R305K050045	Classroom Connectivity in Promoting Mathematics and Science Achievement
R305A080078	Leadership for Integrated Middle-School Science (LIMSS)
R324A080096	Visualizing Science With Adapted Curriculum Enhancements (ACE)
EDIES09C0014	Online Application to Support Inquiry-based Science Teaching
R305A100091	Accessible Professional Development for Teaching Aquatic Science Inquiry
R305A110913	Strengthening School Leaders' Instructional Leadership Practice Through Developing Teachers' Abilities to Integrate Technology in Support of Student Learning
R305B070443	Effect of the SUN Teacher Workshop on Student Achievement
ED08CO0044	Online Learning System to Advance Teaching of Hyper Molecular Modeling

Science Assessment

Award Number	Educational Technology by Chapter
R305A090502	Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children
R324A070035	Principled Science Assessment Designs for Students With Disabilities
R305A080225	Multilevel Assessments of Science Standards (MASS)
R305A080514	Virtual Performance Assessments for Measuring Student Achievement in Science
R305A120390	SimScientists Assessment System
R305K040008	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab

Appendix E: Assessment by Chapter

Mathematics in Pre-Kindergarten Settings

Award Number	**Assessment by Chapter**
R305K050186	Scaling Up the Implementation of a Prekindergarten Mathematics Curriculum in Public Preschool Programs
ED06PO0895	Development of Assessment Technologies for Early Childhood: Phase I
R305K060089	Numbers Plus: A Comprehensive Approach to Early Mathematics Education
EDIES11C0044	Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood
R324A120059	Recognition and Response: Addressing Early Learning Difficulties in Math through an RtI Model for Pre-K

Number and Quantity in Kindergarten through 12th Grade Settings

Award Number	**Assessment by Chapter**
EDIES11C0026	Project NumberShire: A Game-Based Integrated Learning and Assessment System to Target Whole Number Concepts

Algebraic Thinking, Equations, and Algebra in Kindergarten through 12th Grade Settings

Award Number	**Assessment by Chapter**
R305M060057	Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation
R305H040099	Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet
R305A100150	Transforming Algebra Assignments
R305A100518	Creating Cross-Grade Assessments of the Development of Core Algebraic Constructs
R305A110451	Learning and Teaching Algebra (LTA)
ED06PO0931	Venture Map
R324A090295	Professional Development for Algebra Progress Monitoring
R324A110262	Algebra Screening and Progress Monitoring

Measurement, Data, Statistics, and Probability in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305K060091	Assessing Data Modeling and Statistical Reasoning
R305A120217	Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System

Geometry in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A080231	The Diagnostic Geometry Assessment Project

Fractions and Functions in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A110306	Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System

Multi-Unit and Integrated Mathematics in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305A090111	The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"
R324A100068	Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities

Student Perceptions, Motivations, Attitudes, and Anxiety about Mathematics in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A080664	Teaching Every Student: Using Intelligent Tutoring and Universal Design to Customize the Mathematics Curriculum

Mathematics in Postsecondary and Adult Education Settings

Award Number	Assessment by Chapter
R305A100971	Ready or Not? California's Early Assessment Program and the Transition to College
R305H050004	Improving the Assessment Capability of Standardized Tests: How High-Stakes Testing Environments Compromise Performance

Teacher Instruction, Pedagogy, and Professional Development in Mathematics

Award Number	Assessment by Chapter
R305M060057	Using Video Clips of Classroom Instruction as Item Prompts to Measure Teacher Knowledge of Teaching Mathematics: Instrument Development and Validation
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities
R305C090023	National Center for Teacher Effectiveness: Validating Measures of Effective Math Teaching
R305A110621	Scientific Validation of a Set of Instruments Measuring Fidelity of Implementation (FOI) of Reform-Based Science and Mathematics Instructional Materials
R305K030140	Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams
R305H040099	Bridging the Gap: Applying Algebra Cognition Research to Develop and Validate Diagnostic Classroom Algebra Testlet
R305M040156	The Relationship Between Mathematics Teachers' Content Knowledge and Students' Mathematics Achievement: Exploring the Predictive Validity of the Praxis Series Middle School Mathematics Test
R305A070440	Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning

Award Number	Assessment by Chapter
R305A110392	Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)
R305A110451	Learning and Teaching Algebra (LTA)
R305A120553	Updating Middle School Mathematics Diagnostics Teacher Assessments in Mathematics & Science (DTAMS)
R324A090295	Professional Development for Algebra Progress Monitoring

Mathematics Assessment

Award Number	Assessment by Chapter
ED06PO0895	Development of Assessment Technologies for Early Childhood: Phase I
ED07CO0039	Early Childhood Assessment and Intervention to Improve Grade School Students' Math and Reading
EDIES11C0044	Computer Adaptive Triarchic Assessment and Instructional Activities for Early Childhood
R305K040051	Developing and Using Diagnostic Items in Mathematics and Science
R305K040081	Early Learning in Mathematics: A Prevention Approach
R305K060091	Assessing Data Modeling and Statistical Reasoning
R305B070325	mCLASS:Math: Development and Analysis of an Integrated Screening, Progress Monitoring, and Cognitive Assessment System for K-3 Mathematics
R324A070188	Assessments Aligned With Grade Level Content Standards and Scaled to Reflect Growth for Students With Disabilities (SWD) and Persistent Learning Problems (PLP)
EDIES09C0015	Math Monster Mystery: A Formative Assessment in Game Format for Grade 4 Mathematics
R305A090111	The Cognitive, Psychometric, and Instructional Validity of Curriculum-Embedded Assessments: In-Depth Analyses of the Resources Available to Teachers Within "Everyday Mathematics"
R305E090005	A Proposal to Measure the Impact of Indiana's System of Diagnostic Assessments on Student Achievement Outcomes
R324A090039	Dynamic Assessment to Predict First Graders' Mathematics Development
R324A100068	Learning Progressions: Developing an Embedded Formative and Summative Assessment System to Assess and Improve Learning Outcomes for Elementary and Middle School Students With Learning Disabilities in Mathematics
R324A100344	Methods to Improve Accessibility of Tests for Persistently Low-Performing Students With Disabilities
R305K030140	Using Web-Based Cognitive Assessment Systems for Predicting Student Performance on State Exams

Award Number	Assessment by Chapter
R305A070440	Making Longitudinal Web-Based Assessments Give Cognitively Diagnostic Reports to Teachers, Parents, and Students While Employing Mastery Learning
R305A080231	The Diagnostic Geometry Assessment Project
R305A090528	Applications of Intelligent Tutoring Systems (ITS) to Improve the Skill Levels of Students With Deficiencies in Mathematics
R324A090340	The Math Learning Companion: An Individualized Intervention for Students With Math Learning Disabilities
R305A100234	An Adaptive Testing System for Diagnosing Sources of Mathematics Difficulties
R305A100518	Creating Cross-Grade Assessments of the Development of Core Algebraic Constructs
R305E100013	Intended and Unintended Consequences of State High-Stakes Testing: Evidence From Standards-Based Reform in Massachusetts
R324A100026	Developing Middle School Mathematics Progress Monitoring Measures
R324A100065	Feedback-and-Revision on Alternate Assessment Based on Modified Achievement Standards in Mathematics
R305A110306	Eliciting Mathematics Misconceptions (EM2): A Cognitive Diagnostic Assessment System
R305A110392	Learning to Use Formative Assessment in Mathematics With the Assessment Work Sample Method (AWSM)
R305A120125	An Efficacy Study of Online Mathematics Homework Support: An Evaluation of The ASSISTments Formative Assessment and Tutoring Platform
R305A120217	Innovative Computer-Based Formative Assessment via a Development, Delivery, Scoring, and Report-Generative System
R305A130223	Comprehensive Research-Based Computer Assessment and Accommodation System for ELL Students
R324A090295	Professional Development for Algebra Progress Monitoring
R305A100971	Ready or Not? California's Early Assessment Program and the Transition to College
R324A110262	Algebra Screening and Progress Monitoring
R305H050004	Improving the Assessment Capability of Standardized Tests: How High-Stakes Testing Environments Compromise Performance

Mathematics Policy

Award Number	Educational Technology by Chapter
R305E100013	Intended and Unintended Consequences of State High-Stakes Testing: Evidence From Standards-Based Reform in Massachusetts

Science in Prekindergarten Settings

Award Number	Assessment by Chapter
R305A090502	Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children

Physical Sciences in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A120138	The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School
R305A100475	Establishing the Validity and Diagnostic Capacity of Facet-Based Science Assessments
R305A100692	Learning Progressions in Middle School Science Instruction and Assessment
R305A110782	Explanation and Prediction Increasing Gains and Metacognition (EPIGAME)
R305K040008	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab

Life Sciences in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A080141	Advancing Ecosystems Science Education via Situated Collaborative Learning in Multi-User Virtual Environments
R305A120390	SimScientists Assessment System

Multi-Unit and Integrated Science in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305B070354	Diagnostic Embedded Classroom Assessment-An Efficacy Study
ED08CO0050	The Digital Earth Explorations Project to Enrich the Middle School Sciences
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305A090170	ASSISTment Meets Science Learning (AMSL)

Student Practices, Inquiry, and Reasoning in Science in Kindergarten through 12th Grade Settings

Award Number	Assessment by Chapter
R305A080422	BSCS Science: An Inquiry Approach-Development of a Conceptually Coherent, Multidisciplinary Science Program for Grade Eight
R305A080514	Virtual Performance Assessments for Measuring Student Achievement in Science
R305A090170	ASSISTment Meets Science Learning (AMSL)
R305A100692	Learning Progressions in Middle School Science Instruction and Assessment

Teacher Instruction, Pedagogy, and Professional Development in Science

Award Number	Assessment by Chapter
R305A120193	Cultivating Young Scientists: Expanding Foundations of Science Literacy
R324A080014	Math and Science Teaching that Promotes Clear Expectations and Real Learning across Years for Students With Significant Cognitive Disabilities
R305A110621	Scientific Validation of a Set of Instruments Measuring Fidelity of Implementation (FOI) of Reform-Based Science and Mathematics Instructional Materials
R324A080096	Visualizing Science With Adapted Curriculum Enhancements (ACE)
R305A100571	Developing and Evaluating Measures of Formative Assessment Practices
R305A110121	An Alternative Statewide Assessment Strategy that Uses Test Results to Support Learning and Includes Measures of Problem Solving

Science Assessment

Award Number	Assessment by Chapter
R305A090502	Lens on Science: Development and Validation of a Computer-Administered, Adaptive, IRT-Based Science Assessment for Preschool Children
R305K040051	Developing and Using Diagnostic Items in Mathematics and Science
R305B070354	Diagnostic Embedded Classroom Assessment-An Efficacy Study
R305A110122	English Learners and Science Tests
R305A120138	The Development and Validation of an Assessment Instrument to Study the Progression of Understanding of Ideas About Energy From Elementary School Through High School
R324A070035	Principled Science Assessment Designs for Students With Disabilities
R305A080225	Multilevel Assessments of Science Standards (MASS)
R305A080514	Virtual Performance Assessments for Measuring Student Achievement in Science
R305A100475	Establishing the Validity and Diagnostic Capacity of Facet-Based Science Assessments
R305A100692	Learning Progressions in Middle School Science Instruction and Assessment
R305A110121	An Alternative Statewide Assessment Strategy that Uses Test Results to Support Learning and Includes Measures of Problem Solving
R305A120390	SimScientists Assessment System
R305K040008	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A070067	Integrated Software for Artificial Intelligence Tutoring and Assessment in Science
R305A100069	Embedded Assessments Using the ChemCollective Virtual Lab