Community for Advancing
Discovery Research in Education

Discovery Research K-12 (DR K-12): Descriptive Overview of Portfolio

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Executive Summary

The National Science Foundation's Discovery Research K-12 (DR K-12) program supports high-quality research and development on science, technology, engineering, and mathematics (STEM) learning and teaching. The DR K-12 program largely funds investigators with prior NSF funding; 71.8 percent of projects are led by principal investigators with prior NSF awards.

The portfolio of DR K-12 projects span what NSF has characterized as a *cycle of research and development*[1]—a dynamic, ongoing process through which knowledge and products are conceived, developed, disseminated and revised—although a majority of DR K-12 projects are developing, refining, testing, and validating materials, measurement tools, and methods for STEM education. While projects address multiple aspects of the cycle, the DR K-12 portfolio projects (63.7 percent) are largely developing, refining, testing, and validating materials, measurement tools, and methods for STEM education.

Projects primarily focus on elementary, middle, and high school settings, with only 5.7 percent of the projects involving the pre-kindergarten grades and just 4.4 percent other grade levels including postsecondary students. The majority of projects target students and teachers in K-12 classrooms (75.0 and 80.2 percent of projects, respectively), and far fewer (4.4 percent) include administrators or pre-service or alternative certification teachers (8.1 percent).

Most of the projects in the DR K-12 portfolio (85.1 percent) focus on *resources* that can be used directly in teaching, learning, or professional development; less than half (42.7 percent) focus on *technology* used to mediate teaching, learning, or professional development; and slightly more than a third (37.5 percent) are developing *models* to be used to guide educational activities, curriculum, policies, or frameworks.

The scope of the research, including the designs and methods utilized is diverse, reflecting the diversity of projects' goals and foci. For instance, many projects are designing or developing a resource, model or technology and they consequently incorporate design research approaches that involve small scale field tests, extensive iterative revisions, formative evaluation activities, and pilot studies. Other projects are studying the impacts of scaled-up interventions and thus tend to utilize research designs more appropriate for drawing causal conclusions such as randomized control trials.

Projects anticipate developing and disseminating a wide variety of products including, most commonly, products related to teacher professional development (54.8 percent), student learning (46.8 percent), and research findings (53.6 percent).

[1] NSF DR K-12 Solicitation, NSF09602.

1. Overview of Approach

1.1 Introduction

The Discovery Research K-12 (DR K-12) program, funded by the National Science Foundation (NSF) Division of Research on Learning in Formal and Informal Settings (DRL), supports high-quality research and development on science, technology, engineering, and mathematics (STEM) learning and teaching. The portfolio of DR K-12 projects span what NSF has characterized as a *cycle of research and development*[2]—a dynamic, ongoing process through which knowledge and products are conceived, developed, disseminated and revised.

The *Community for Advancing Discovery Research in Education* (CADRE) was established as the resource network that supports the DR K-12 community in advancing the state of research and evaluation in STEM education, and furthering the goals of the DR K-12 program. As part of its work, CADRE annually provides a descriptive overview of the DR K-12 portfolio, which includes the first four cohorts funded as of July 2011. The report characterizes the development and research in STEM education—on resources, models, and technologies—funded by the DR K-12 program.[3] The specific objectives of this portfolio overview are to:

1. Describe important characteristics of the projects in the DR K-12 portfolio;
2. Explain how grantees are working towards meeting the goals of the program;
3. Identify potential areas in which syntheses and targeted thematic studies can be conducted to deepen, broaden, or advance the field's understanding of specific aspects of STEM education;
4. Inform the support activities developed for grantees.

This overview is intended to describe the scope and depth of research and development DR K-12 has funded and to identify areas that could be advanced by further investigations by CADRE. The overview summarizes the 248 projects that met the criteria for inclusion and analysis.

1.2 Approach to Portfolio Review

In order to prepare this overview, CADRE collected materials from DR K-12 projects. These materials were reviewed and coded by a team of CADRE researchers using a protocol developed for systematically extracting specific pieces of information; data were then analyzed across the portfolio of projects.

1.2.1 Projects in the Portfolio

There were 272 projects eligible for inclusion in this portfolio overview. An initial set of 289 awards were nominated by NSF or identified as projects funded during one of the DR K-12 award cycles prior to winter 2010. Sixteen of these awards were linked because they funded a shared project. To avoid double-counting, only one project was retained in the analysis database for each linked set and the multiple awards were treated as a single project in this analysis. For purposes of this overview, the project principal investigator (PI) was the PI identified in the proposal, or the PI of the largest award, and the PIs of the linked awards were coded as co-PIs. The award supporting CADRE was also removed from the analytic database.

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2 NSF DR K-12 Solicitation, NSF09602.

3 Previous annual reviews were summarized in two reports completed in 2009 and 2010.

Additional projects were excluded because insufficient information was available for them. All of the materials used in project reviews were obtained from PIs or project staff or from publicly available materials.[4] PIs were asked to provide CADRE with their project's proposal, annual reports, project publications, and other information about the plans, activities, and achievements of the DR K-12 project; CADRE periodically asks PIs to update their materials.

In order to be included in the review, the project proposal at a minimum needed to be available to CADRE. Projects that did not meet this minimum standard were set aside from the analysis because reviewers did not have enough information to reliably code the project. Of the 272 eligible projects in the portfolio, 24 could not be included in the analysis because their PIs did not provide sufficient materials for review (9 percent). In all, 248 projects were included in the portfolio review (representing 262 awards in total when the linked awards are counted as well).

1.2.2 Projects Included in the Review Materials

The volume and detail of information available varied across projects. All 248 projects included in the analysis provided their initial project proposal narrative. Many projects also provided their responses to questions raised in the proposal process, and some projects made other materials available including annual reports, drafts of papers and presentations (published or in press), working papers and other documents.

The materials reviewed and coded for this analysis were created by investigators for purposes other than this review. Thus, the information CADRE sought was reported in diverse and unsystematic ways across projects. As a result, the level of detail that could reliably be extracted and coded was varied and at times limited. Specifically, detail concerning research designs and methods was especially limited, whereas there was more detail about the resources, models, and technologies being developed and/or studied. In addition, most of the materials reflected projects' plans or activities in the early stages of implementation. Consequently, the review was largely limited to projects' plans and goals rather than their accomplishments or their implemented activities.

1.2.3 Methodological Approach

Trained researchers coded project materials using a review protocol designed to capture information on project attributes and project characteristics as well as the DR K-12 program goals being addressed.[5] The data across projects were analyzed to provide a descriptive picture of the landscape of DR K-12 projects. The following research questions guided the analyses:

- What are the sizes of the projects DR K-12 is funding?
- Who is being funded?
- What types of projects is DR K-12 funding?
- Where is the program focusing its investment?
- What research is being conducted?
- Are projects evaluating their work?
- How do projects plan to disseminate their work?

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4 CADRE operates under a cooperative agreement with the NSF and does not have access to the data and materials maintained at NSF.

5 The team of reviewers was trained and had supervised practice coding projects on a set of detailed coding definitions and instructions. The team leader co-coded at least two projects with each of the reviewers to ensure a systematic approach and application of instructions and definitions across the team.

2. Overview of Portfolio

Projects included in this overview were distributed across four cohorts corresponding to annual funding cycles beginning in 2007—cohort 1 (75 projects, 30.2 percent), cohort 2 (51 projects, 20.6 percent), cohort 3 (51 projects, 20.6 percent), and cohort 4 (71 projects, 28.6 percent). The 229 projects for which there was information on length of the grant awards lasted for an average of 40.5 months, ranging from a single month (for producing conferences) to 5 years (Exhibit 2.1).

Exhibit 2.1: Duration of DR K-12 Projects

	Duration (months)
N	229
Mean	40.5
Standard deviation	16.4
Maximum	60
Median	36
Minimum	1

The DR K-12 program largely funds investigators with prior NSF funding. The majority of DR K-12 projects are led by PIs with prior NSF awards (178 projects, 71.8 percent). Of the remaining projects, new PIs led 41 projects (16.5 percent), and there was insufficient information to determine the prior award status for 29 projects (11.7 percent). When co-PIs are also considered, 195 of the projects (78.6) had at least one key investigator who has received NSF funding in the past.

The institutional locations of DR K-12 projects, identified by the home institutions of principal and co-principal investigators, are distributed across the country in 36 states and the District of Columbia. Individual projects were housed in as few as one and as many as four states. Exhibit 2.2 presents the number of projects located in each state, including 13 *Experimental Program to Stimulate Competitive Research* (EPSCoR) states.[6] The states hosting the largest number of projects are Massachusetts (44 projects), California (29 projects), New York (20 projects), Michigan (19 projects), and Pennsylvania (11 projects).

Exhibit 2.2: Geographical Distribution of Principal and Co-principal Investigators (n=204 projects)

Number of projects with at least one PI or co-PI in state	State
More than 20	California, Massachusetts
11 to 20	Michigan, New York, Pennsylvania
6 to 10	Arizona, Colorado, District of Columbia, Georgia, Illinois, Maryland, New Jersey, North Carolina, Texas, Utah, Washington
5 or fewer	Alabama, Alaska, Connecticut, Delaware, Florida, Hawaii, Indiana, Iowa, Kansas, Maine, Mississippi, Missouri, Montana, Nebraska, New Mexico, Ohio, Oregon, South Carolina, Tennessee, Virginia, Wisconsin

Exhibit reads: California and Massachusetts each have more than 20 projects located in their state when all of the PIs (and co-PIs) that are not missing this information are taken into account.

Notes: [a] Forty-four projects were missing information on the location of PIs and co-PIs. Besides these, this information was missing for another 50 PIs and co-PIs, but their projects are included here because at least some of the PIs in their projects did have available location information.

[6] Thirty states, Puerto Rico, and the Virgin Islands are designated as Experimental Program to Stimulate Competitive Research (EPSCoR) states.

2.1 Populations Targeted

2.1.1 Grade Levels

Projects primarily focus on elementary, middle, and high school settings (42.7, 56.4, and 45.6 percent respectively, Exhibit 2.3), with 37.5 percent involving multiple grade bands. Only 5.7 percent of the projects work with pre-kindergarten students or teachers, while 4.4 percent of them target other grade levels such as doctoral students in scholar programs, and students in early college levels.

Exhibit 2.3: Grade Levels in Projects (n=245 projects[a])

	Number	Percentage
Pre-kindergarten	14	5.7%
Elementary school	106	42.7%
Middle school	140	56.4%
High school	113	45.6%
Other	14	4.4%

Notes: [a] The grade level of three projects could not be determined (1.2%).

2.1.2 Populations Involved

The bulk of projects target students and teachers in K-12 classrooms[7] (75.0 and 80.2 percent of projects, respectively). Far fewer (4.4 percent) include K-12 school administrators in their focus (Exhibit 2.4), or pre-service or alternative certification teachers (8.1 percent of the 199 projects that include a focus on teachers). Only a small number of projects highlight specific subgroups of students or teachers who work with specific subgroups of students including English language learners, special education students, low-performing districts, or other targeted populations (e.g., urban and rural schools, students from specific racial/ethnic groups).

Exhibit 2.4: Populations Targeted by Projects (n=248 projects)

	Number	Percentage
Teachers	199	80.2%
Pre-service and alternative certification	20	8.1%
Targeted subgroups of students:		
Special education	5	2.0%
English language learners	23	9.3%
Low performing schools or districts	11	4.4%
Other	17	6.9%
Students	186	75.0%
Special education	3	1.2%
English language learners	23	9.3%
Low performing schools or districts	11	4.4%
Other	21	8.5%
School administrators	11	4.4%
Doctoral students in scholars' programs	9	3.6%
Higher education faculty	13	5.2%
Other	24	9.7%

Only a few projects stray outside the K-12 school setting, with 3.6 percent of the projects involving doctoral students in programs designed to develop scholars and researchers in particular substantive areas, 5.2 percent focusing on higher educational faculty, and 9.7 percent targeting other groups including

[7] Projects that specified age ranges rather than particular grade levels were classified as follows: Pre-K (ages 3-4); Kindergarten to 5th grade (ages 5-10); 6th to 8th grade (ages 11-13); 9th to 12th grade (ages 14-18).

parents and families, discipline coaches (e.g., math coaches), curriculum developers, and researchers, and policy makers.

2.2 Disciplines

Of the 248 projects in the portfolio, 41.1 percent are in science fields, 33.9 percent are in mathematics, 2.4 percent deal with engineering, and 0.8 percent cover computer and information science. Another 19 percent of the projects involve two or more of these disciplines. Exhibit 2.5 displays the distribution of these disciplines within the K-12 schooling levels as well.

Exhibit 2.5: Major Disciplines Addressed in Portfolio (n=248 projects)

	All grades	Elementary	Middle	High
Number of projects	**248**	**106**	**140**	**113**
Percentage of projects per grade addressing…				
Science	41.1%	29.3%	41.4%	41.6%
Mathematics	33.9%	40.6%	32.1%	30.1%
Multi-discipline [a]	19.0%	22.6%	29.3%	17.7%
Engineering	2.4%	2.8%	2.1%	5.3%
Computer and information science	0.8%	1.9%	1.4%	1.8%
Other disciplines [b]	2.8%	2.8%	3.6%	3.5%

Notes: [a] All projects that addressed more than one discipline were coded as: multi-discipline".
[b] Technology was coded as a major discipline if it was an academic subject of interest within the project. Projects that involved technology, but were only developing technologies as a tool through which teaching and learning occurs, but did not focus on technology as an academic discipline were not coded as having "technology" as a major discipline.

Among the 47 projects that address more than one topic area (Exhibit 2.6), a large majority involve science as well as another discipline (80.9 percent) or math and another discipline (76.6 percent). Not surprisingly, more than half of the multi-discipline projects include both science and mathematics (61.7 percent). The "other" category involved in the multi-discipline projects includes substantive areas not science, mathematics, or engineering specific (e.g., general STEM or technology concerns with no discipline focus, social sciences).

Exhibit 2.6: Percentage of Projects per Grade that Address More than One Discipline (n=47 projects)

	All grades	Elementary	Middle	High
Number of projects	**47**	**24**	**27**	**20**
Percentage of projects per grade addressing…				
Mathematics and science	44.7%	54.2%	40.7%	50.0%
Mathematics and other	10.6%	8.3%	14.8%	10.0%
Science and other	8.5%	12.5%	7.4%	10.0%
Mathematics, science, and engineering	10.6%	4.2%	11.1%	15.0%
All other combinations	25.5%	20.8%	25.9%	15.0%

Exhibit reads: 44.7 percent of the 47 projects in the portfolio that address multiple disciplines address topics in both mathematics and science fields (and no others). Considering each grade band separately, 54.2 percent of the 24 multi-discipline elementary school projects, 40.7 percent of the 27 middle school projects, and 50.0 percent of the 20 high school projects address both mathematics and science.

Exhibit 2.7 provides the percentages of projects that include a focus on each of the major STEM disciples either alone or in combination with other disciplines. Of the 248 projects in the portfolio, 56.5 percent address science topics (either exclusively or with other topic areas), 48.4 percent include a focus on mathematics either by itself or with another discipline, 6.5 percent address engineering, and 3.2 percent

address computer and information science. Exhibit 2.7 displays the distribution of these disciplines within the K-12 schooling levels as well.

Exhibit 2.7: Major Disciplines Addressed in Portfolio (n=248 projects)

	All grades	Elementary	Middle	High
Number of projects	**248**	**106**	**140**	**113**
Percentage of projects per grade addressing…				
Science	56.5%	49.1%	55.7%	56.6%
Mathematics	48.4%	58.5%	47.9%	44.2%
Engineering	6.5%	5.7%	6.4%	8.8%
Computer and information science	3.2%	3.8%	3.6%	3.5%
Other disciplines b	8.5%	8.5%	10.0%	8.8%

The 120 projects that address mathematics include a range of specific mathematics disciplines (Exhibit 2.8). The specific disciplines vary somewhat by grade. Almost a quarter of the elementary school projects deal with general math or with issues relevant across mathematics areas (24.5 percent). The most common specific topics are early algebra, rational numbers and proportional reasoning, and whole number arithmetic (each 8.5 percent). Among middle school projects, general math issues are addressed by 12.1 percent. The most common topics among these projects are rational numbers and proportional reasoning (10.7 percent), geometry, and fractions and decimals (7.9 percent each). High school projects address a narrower array of topics, with the most common topics elementary and intermediate algebra (11.5 percent) and higher algebra (8.0 percent).

Exhibit 2.8: Percentage of Projects per Grade Addressing Mathematics Topics (n=248 projects)

	All grades	Elementary	Middle	High
Number of projects per grade *(including those that are multi-discipline)*	***248***	***106***	***140***	***113***
Percentage of projects per grade addressing…				
General mathematics	13.7%	24.5%	12.1%	9.7%
Multiple mathematics topics	12.5%	12.3%	12.1%	12.4%
Geometry	8.5%	5.7%	7.9%	8.0%
Elementary and intermediate algebra	7.7%	1.9%	7.1%	11.5%
Rational numbers, proportional reasoning	6.5%	8.5%	10.7%	0.0%
Whole number arithmetic	5.2%	8.5%	6.4%	0.9%
Early algebra (elementary school)	3.6%	8.5%	2.9%	0.8%
Fractions and decimals	4.4%	7.6%	7.9%	0.0%
Measurement	4.0%	4.7%	3.6%	0.0%
Higher algebra	3.6%	0.9%	1.4%	8.0%
Problem solving, word problems, puzzles	3.2%	3.8%	2.1%	1.8%
Statistics	1.2%	0.0%	1.4%	1.8%
Pre-calculus	0.4%	0.0%	0.0%	0.9%
Calculus	0.4%	0.9%	0.7%	0.9%
Other mathematics topics	2.8%	0.9%	2.9%	4.4%

Exhibit reads: 13.7 percent of the 248 projects in the portfolio are in general mathematics. Considering each grade band separately, 24.5 percent of the 106 elementary school projects, 12.1 percent of the 140 middle school projects, and 9.7 percent of the 113 high school projects address general mathematics.

Of the 248 projects in the portfolio, (Exhibit 2.9), 18.6 percent involve biology, 11.7 percent geosciences (including environmental sciences), 8.9 percent physical science, 8.9 percent physics, 6.9 percent chemistry, 3.2 percent astronomy, and 3.6 percent address other science topics (e.g., science literacy or education in general, or the nature of science itself). Among elementary school projects, the common topics were general science (15.1 percent), physical science (10.4 percent), biology (9.4 percent), geosciences (7.6 percent), physics (5.7 percent), or multiple topics (11.3 percent). Common middle school science topics included biology (17.1 percent), multiple topics (15.7 percent) and geosciences (14.3 percent). High school projects infrequently address general science (3.5 percent) and more often cover biology (22.1 percent), multiple sciences (19.5 percent), geosciences (13.3 percent), physics (11.5 percent), and chemistry (10.6 percent).

Exhibit 2.9: Science Topics Covered in Projects by Grade (n=248 projects)

	All grades	Elementary	Middle	High
Number of projects per grade *(including those that are multi-discipline)*	***248***	***106***	***140***	***113***
Percentage of projects per grade addressing…				
Biology	18.6%	9.4%	17.1%	22.1%
Multiple science topics	16.5%	11.3%	15.7%	19.5%
Geosciences	11.7%	7.6%	14.3%	13.3%
General	9.7%	15.1%	7.1%	3.5%
Physical science	8.9%	10.4%	9.3%	4.4%
Physics	8.9%	5.7%	8.6%	11.5%
Chemistry	6.9%	2.8%	5.7%	10.6%
Astronomy	3.2%	2.8%	2.9%	4.4%
Other science topics	3.6%	2.8%	2.1%	2.7%

Exhibit reads: 18.6 percent of the 248 projects in the portfolio include a biology focus. Considering each grade band separately, 9.4 percent of the 106 elementary school projects, 17.1 percent of the 140 middle school projects, and 22.1 percent of the 113 high school projects address science.

2.3 Research and Development Cycle

The *cycle of research and development (*formerly called the *Cycle of Innovation and Learning)* was introduced in the DR K-12 program in the FY2008 program solicitation[8] and revised in the FY2010 program solicitation.[9] The cycle posits a dynamic, ongoing process through which knowledge and products are conceived, developed, disseminated and revised. The components of the cycle are:

- **Design**, develop, test, validate, and refine materials, measurement tools, and methods, in specific contexts;
- **Implement** innovations; study why interventions have the impacts they have with particular groups;
- **Evaluate** effectiveness; study complex phenomena, generalize;
- **Synthesize** lines of work; identify new insights and questions to inform new research and development; set research and development agendas; and
- **Hypothesize**, study and clarify phenomena of interest; frame issues; operationalize goals and constructs; develop and propose theory; conduct basic research on learning.

While all projects are expected to address multiple aspects of the cycle, most emphasize one or two components of the cycle over others. The aggregate representation of the DR K-12 projects across the stages provides a sense of the DR K-12 program's contribution to advancing the STEM education field overall. For this purpose, each project was classified according to the stage in the *Cycle of Research and Development* that it most emphasizes or that best characterizes its work (presented in Exhibit 2.10). Overall, the DR K-12 portfolio is heavily weighted toward developing, refining, testing, and validating materials, measurement tools, and methods for STEM education.

[8] NSF DR K-12 Solicitation, NSF08502.
[9] NSF DR K-12 Solicitation, NSF09602.

Exhibit 2.10: Projects' Placement on the Cycle of Research and Development (n=248 projects)

	Number	Percentage
Design, develop and test	158	63.7%
Implement, study efficacy, and improve	20	8.1%
Scale up and study effectiveness	12	4.8%
Synthesize and theorize	30	12.1%
Explore, hypothesize and clarify	28	11.3%

Within major STEM disciplines, most projects are in the "design, develop, and test" stage (Exhibit 2.11), although a larger proportion of science projects (77.5 percent) fall in this stage, compared to multi-discipline projects (67.4 percent) or math projects (51.2).

Exhibit 2.11: Percentage of Projects in Major Disciplines Developing or Researching Resources, Models, and Technologies (n=232 projects)

	Math only	Science only	Multi-discipline
Number of projects per discipline	***84***	***102***	***46***
Percentage of projects in each discipline per stage:			
Design, develop and test	51.2%	77.5%	67.4%
Implement, study efficacy, and improve	10.7%	6.9%	8.7%
Scale up and study effectiveness	9.5%	2.9%	0.0%
Synthesize and theorize	10.7%	6.9%	17.4%
Explore, hypothesize and clarify	17.9%	5.9%	6.5%

2.4 Resources, Models and Technology

Projects in the DR K-12 portfolio were also classified according to whether they emphasize (i.e., they are developing, revising, or studying) educational resources, models, or technologies (or a combination of these). For the purposes of this analysis **resources** were defined as instructional or related materials used directly in instruction, learning, or teachers' professional development. Projects that are studying or developing resources are those focusing on the materials or activities used most directly in teaching and learning or professional development.

Projects were classified as focusing on **technology** if they are developing or studying technologies through which teaching and/or learning occurs. Although most projects use some form of technology (i.e., computers), projects were classified as focusing on technology only if they use it in ways that directly shape or influence teaching and learning experiences (e.g., the use of contingent computer-based assessments, the creation of a virtual environment in which a topic can be explored and learned, or the development of an online space or support for virtual professional networking). Projects that use technology as a simple vehicle for communicating ideas and materials (e.g., online dictionaries, news sources, or worksheets available as PDF documents online) were not classified as technology projects.

Finally, **models** were defined as having a more indirect or distal influence on learning and instruction than resources or technologies. Projects that focus on models are developing or researching materials that provide support or guidance for teaching, educational materials, or curriculum. Models can be instructional guidelines, curriculum frameworks, topic area standards, or theoretical frameworks.

Most of the projects in the DR K-12 portfolio (85.1 percent) are focused on an educational resource—either alone or in combination with a technology or model (see Exhibit 2.12). Less than half of the projects (42.7 percent) are developing or studying a technology—alone or in combination with a resource or model—used to mediate teaching, learning, or professional development. Slightly more than a third of

the projects (37.5 percent) are developing models—alone or in combination—to be used to guide educational activities, curriculum, policies, or frameworks.

Exhibit 2.12: Proportion of Projects Developing or Studying Resources, Models, and Technologies (n=248 projects)

	Number	Percentage
All Resources	**211**	**85.1%**
Resources alone	71	28.6%
Resource and technology	77	31.1%
Resource and model	44	17.7%
Resource, model, and technology	19	7.7%
All Technologies	**106**	**42.7%**
Technology alone	7	2.8%
Resource and technology	77	31.1%
Model and technology	3	1.2%
Resource, model, and technology	19	7.7%
All Models	**93**	**37.5%**
Model alone	27	10.9%
Resource and model	44	17.7%
Model and technology	3	1.2%
Resource, model, and technology	19	7.7%

Resource projects (Exhibit 2.13) are commonly developing, revising, or studying professional development materials, activities, or professional networks (67.8 percent), or studying or developing student curriculum or learning materials (67.4 percent) or assessments (32.7 percent)[10].

Exhibit 2.13: Specific Types of Resources being Developed, Revised, or Studied in Projects with a Resource Focus (n=211 Projects)

	Percentage
Professional development activities, materials, or networks	67.8%
Curriculum, curriculum units, or courses	35.6%
Materials used by students in learning activities	31.8%
Assessment instruments	32.7%
Other	3.3%

Exhibit reads: Of the 211 projects developing, revising, or studying resources, 67.8 percent are working with professional development activities, materials, or networks for teachers.

Among projects studying or developing models (Exhibit 2.14), the most common types of models are learning progressions, which study and articulate the sequence traversed when learning a topic or a set of concepts, followed by models of educational practices, which are producing or studying examples of promising practices that can be used by teachers, programs, and others to guide their own practice (25.8 percent).

[10] The category of "materials used by students in learning activities" includes all activities, materials, and other types of resources for learning activities other than those included as part of a cull curriculum, a curriculum unit, or a course.

Exhibit 2.14: Types of Models being Developed, Revised, or Studied in Projects with a Model Focus (n=93 Projects)

	Percentage
Learning progression	27.9%
Model of ideal educational practice	25.8%
Curriculum frameworks	19.4%
Teacher professional development curriculum frameworks	17.2%
Theoretical framework	13.9%
Standards	6.5%
Guidelines	4.3%
Other	4.3%

Exhibit reads: Of the 93 projects developing, revising, or studying models, 27.9 percent are working with learning progressions.

Among the 106 projects that include a technology component (Exhibit 2.15), almost half are developing or studying a virtual or cyber learning experience— focusing on learning through interacting with a virtual environment, online laboratory, cyber game, or other interactive online experiences (46.2 percent). These are followed by those developing or studying an interactive resource—working with resources that are not as interactive as cyber games, but that encourage limited user interaction, such as interactive databases, online journals, and other information sources (37.7 percent), and those developing or studying online networking tools that allow students to communicate with each other or with STEM experts, or that support collaboration between teachers or the development of professional learning communities (31.1 percent). Twenty-one percent of the technology projects involve developing or researching technology-mediated student assessments. Other technologies include the use of diverse technologies such as using robotic platforms for learning, research on the use of laptops, specialized scientific equipment, or wireless devices in schools.

Exhibit 2.15: Specific Types of Technologies being Developed, Revised, or Studied in Projects with a Technology Focus (n=106 projects)

	Percentage
Cyberlearning (online gaming, interactive learning, or virtual environment)	46.2%
Interactive resource	37.7%
Online network/collaboration tool	31.1%
Assessment	20.8%
Other	12.3%

Exhibit reads: Of the 106 projects developing, revising, or studying technologies, 46.2 percent are working with online gaming, interactive learning, or virtual learning environments.

2.5 Distribution across Areas of Interest

The DR K-12 projects are distributed across the wide range of substantive areas presented above. Exhibit 2.16 displays the number of projects within each major discipline that are developing, revising, or studying a resource, model or technology by grade. Details about the specific types of resources, models and technologies are presented. The largest numbers of projects are developing, revising, or studying resources in mathematics or science.

Exhibit 2.16: Number of Projects in Major Discipline Areas that are Developing or Studying Resources, Models, and Technologies, by Grade (n=248)

	Mathematics			Science			Engineering			Other		
	Elem.	Middle	High	Elem.	Middle	High	Elem.	Middle	High	Elem.	Middle	High
Resources	**46**	**54**	**37**	**42**	**73**	**60**	**5**	**8**	**8**	**5**	**6**	**6**
Professional development activities, materials, networks	31	43	28	27	45	42	4	7	4	2	3	2
Curriculum	9	9	15	17	30	24	2	4	4	1	2	1
Student learning materials	1	4	10	17	31	24	1	3	2	2	3	2
Assessments	13	19	14	9	27	23	0	1	1	1	2	2
Other	2	3	3	1	2	2	1	1	1	0	0	0
Models	**34**	**32**	**20**	**20**	**23**	**21**	**4**	**3**	**3**	**1**	**2**	**2**
Learning progressions	7	6	1	5	8	5	0	0	0	0	0	1
Model of ideal practices	12	10	5	4	4	6	0	0	0	0	0	0
Theoretical frameworks	5	7	5	4	3	3	1	1	1	0	1	0
Professional development frameworks	4	4	3	3	7	7	1	0	0	0	0	0
Curriculum frameworks	5	4	3	3	2	2	2	1	1	1	1	1
Standards	3	3	2	0	0	1	1	1	1	0	0	0
Guidelines	1	2	2	0	0	0	1	1	1	0	0	0
Technology	**15**	**18**	**13**	**22**	**47**	**35**	**1**	**4**	**4**	**1**	**2**	**2**
Interactive resources	5	4	6	12	16	15	0	1	2	0	0	0
Interactive learning, gaming	4	6	5	10	28	21	0	1	0	1	1	1
Online networking, collaboration	4	4	3	8	13	14	1	1	1	0	0	0
Assessments	2	2	1	2	12	9	0	0	0	0	0	0
Software	3	4	2	3	10	5	0	0	2	0	0	0
Other	1	2	1	4	7	3	0	2	0	0	1	1

A companion document has been prepared that contains brief descriptions of each of the projects, grouped according to the four challenge areas presented in the latest grant solicitation (assessments; STEM learning and instruction; professional development and teacher practice; and the implementation, efficacy, impact, and cost effectiveness of specific interventions). Within each challenge section, projects are further grouped by subject and grade level. Where possible, the project descriptions were drawn directly (verbatim) from the thumbnail sketches developed by NSF for the NSF-generated content analysis of the DR K-12 portfolio, projects' abstracts, and project descriptions on the CADRE website.[11]

2.6 Research Conducted

Most of the projects in the DR K-12 portfolio incorporate plans to conduct research, but the scope of the work and the types of designs and methods are diverse in ways that reflect the diversity of projects' goals and foci. Many projects, for instance, are designing or developing a resource, model or technology and are consequently incorporating design research approaches that involve small-scale field tests, extensive iterative revisions, formative evaluation activities, and pilot studies. Other projects are studying the impacts of resources, models or technologies that are being scaled up and used in larger settings. These projects tend to utilize research designs more appropriate for drawing causal conclusions such as randomized control trials.

The diversity in the portfolio makes it difficult to succinctly characterize the research designs and methods in detail. In addition, most of the materials available for coding across projects were limited to those associated with projects' initial proposals or reports from their early years of work. Consequently, reviewers were restricted to coding projects' plans and goals (rather than implemented or completed designs) at whatever level of detail they found available in project materials.

Almost half of the projects use both qualitative and quantitative methods (49.6 percent); 15.3 percent use only qualitative methods and 14.1 percent use only quantitative methods. Overall, 63.7 of the projects have plans to conduct quantitative research and 64.9 percent are using qualitative approaches (Exhibit 2.17).

About one fifth of the projects in the portfolio (20.6 percent) are planning to incorporate experimental designs into their research (e.g., randomly assigning study participants to groups which are compared to one another after one or more of the groups receives an intervention and the others do not). Almost a quarter of the projects (22.9 percent) are planning to make pre-post comparisons without comparison groups. Nineteen percent of the projects are planning to use quasi-experimental designs in which groups are formed in order to make comparisons, but random assignment is not used. Nine percent of the projects are planning to use quantitative methods to develop descriptions of educational settings or groups, and 7.3 percent of projects are using correlational methods to explore trends or draw contrasts across subgroups.

[11] See http://cadrek12.org/.

Exhibit 2.17: Projects' Research Designs (n=248 projects)

	Number	Percentage
Quantitative	158	63.7%
Randomized control trial	*51*	*20.6%*
Quasi-experimental design (with comparison group)	*46*	*18.6%*
One group (pre/post)	*57*	*22.9%*
Correlational	*18*	*7.3%*
Descriptive	*21*	*8.5%*
Qualitative	161	64.9%
Synthesis	22	8.9%
Measurement/assessment development	58	23.4%
Design research	86	34.7%
Examination of research quality or progress	26	10.5%
Longitudinal research	25	10.1%
Insufficient information	13	5.2%

Some of the projects incorporate other more specialized research designs or methods into their plans. A third of the projects (34.7 percent) plan to use design-research methods (e.g., small-scale, often qualitative research methods that actively guide work designing resources or technologies). Almost a quarter of the projects have explicit plans to conduct extensive measurement development (23.4 percent). About 10 percent of the projects plan to conduct longitudinal research, collecting outcome data at three of more points in time (10.1 percent), and less than 10 percent are conducting meta-analyses, literature reviews, or syntheses of existing research and theories (8.9 percent).

Both student and teacher outcomes are being investigated in the research conducted across projects (Exhibit 2.18). Two thirds (66.1 percent) of the projects in the portfolio are researching student outcomes including achievement, performance, or content knowledge, and attitudes, beliefs, or behavior (e.g., engagement, usage of materials, etc.). Similarly, 64.9 percent of the projects are researching teacher outcomes including classroom practices or instruction, attitudes or beliefs, pedagogical content knowledge, and content knowledge. Fewer projects are investigating fidelity of implementation, administrator attitudes or beliefs, or the progress or quality of research being conducted as part of the project (13.7, 3.2, and 6.0 percent, respectively).

Exhibit 2.18: Selected Outcome Domains in Projects Collecting Data (n=248 projects)

	Number	Percentage
Students	164	66.1%
Achievement/performance	*153*	*61.7%*
Attitudes/beliefs	*80*	*32.3%*
Behavior	*45*	*18.2%*
Teachers	161	64.9%
Classroom practices	*121*	*48.8%*
Attitudes and beliefs	*85*	*34.3%*
Pedagogical content knowledge	*87*	*35.1%*
Content knowledge	*58*	*23.4%*
Administrators	13	5.2%
Knowledge	*3*	*1.2%*
Attitudes/beliefs	*8*	*3.2%*
Fidelity of implementation	34	13.7%
Quality/progress of research	15	6.0%
Other	13	5.2%
Insufficient information to classify	13	5.2%

2.7 Project Evaluations

More than two thirds of projects (66.9 percent) plan to seek guidance or review from an advisory group or experts. More than half of the projects (64.9 percent) included plans for conducting formative evaluations in the materials they provided for this review. Slightly fewer projects (62.5 percent) have plans for a summative evaluation (Exhibit 2.19).

Exhibit 2.19: Evaluation Designs among Projects Including Detailed Plans (n=248 projects)[a]

	Number	Percentage
Advisory group	166	66.9%
Formative	161	64.9%
Summative	155	62.5%

Notes: [a] A notable percentage of projects reported insufficient detail on evaluations to be classified into these categories (i.e., in the order of the table above: 7.7, 8.9, and 11.7 percent).

2.8 Dissemination Activities

DR K-12 solicitations require that projects include a dissemination plan as part of their project description, however 12.5 percent of the projects either did not include this information in the materials provided or there were too few details for reviewers to classify. In the plans provided, most of the projects identify the materials that they would disseminate (81.6 percent), and more than half specify the potential target audience or end users (66.4 percent), or identify their dissemination partners (57.6 percent). More than a third of the projects plan to incorporate input from their targeted users into their research or development plans (40.1 percent). Few projects, however, discuss their sustainability strategies, plans for developing a more formal dissemination plan, or the challenges anticipated (7.8, 2.3, and 1.4 percent, respectively).

Exhibit 2.20: Details Included in Dissemination Plan of Those Projects with Plans (n=217 projects)

	Number	Percentage
Identifies what will be disseminated	177	81.6%
Identifies potential adopter or end user	144	66.4%
Identifies dissemination partners	125	57.6%
Includes end-user input in design or development of research	87	40.1%
Addresses strategies for sustainability	17	7.8%
Intends to develop a formal dissemination plan	5	2.3%
Identifies dissemination challenges	3	1.4%

Projects reported plans for disseminating their work via a wide variety of vehicles (Exhibit 2.21). Projects most commonly plan to disseminate their work through presentations or poster sessions (74.6 percent of projects) and journal articles (70.6 percent). Many projects (60.5 percent) are also planning to disseminate their work or materials via existing or newly created websites. Less common dissemination strategies include professional networks (25 percent) workshops (19.4 percent), commercial publication or distribution of materials (15.7 percent), and books or chapters in books (9.3 percent). Projects also described a wide range of other were dissemination mechanisms including videotapes, briefings to Congress, meetings with school districts.

Exhibit 2.21: Anticipated Vehicles of Dissemination (n=248 projects)

	Number	Percentage
Presentations/poster sessions	185	74.6%
Journal articles	175	70.6%
Websites	150	60.5%
Professional networks	62	25.0%
Workshops	48	19.4%
Commercial product or publication	39	15.7%
Books or book chapters	23	9.3%
White papers	18	7.3%
Popular media	18	7.3%
Newsletter	14	5.6%
Webinars	10	4.0%
CDs/DVDs	9	3.6%
Other	70	28.2%
Insufficient information to classify	15	6.0%

2.9 Anticipated Products

In their proposals and reports, projects anticipated that they would develop and disseminate a wide variety of products including, most commonly, products related to teacher professional development (54.8 percent), student learning (46.8 percent), and research findings (53.6 percent, Exhibit 2.22). Products relating to teacher professional development include curriculum and/or materials, activities, and technologies. Products related to student learning included curriculum and/or materials, activities, technologies, and assessments.

Exhibit 2.22: Products Anticipated to be Produced by Projects (n=248)

	Number	Percentage
Teacher professional development	136	54.8%
Curriculum and/or materials	125	50.4%
Activities	46	18.5%
Technology	37	14.9%
Student learning	116	46.8%
Curriculum and/or materials	88	35.5%
Activities	43	17.3%
Technology	47	19.0%
Assessments	40	16.1%
Research findings	133	53.6%
Conference proceedings	30	12.1%
Syntheses	17	6.9%
Data collection instruments	16	6.5%
Database	6	2.4%
Standards	4	1.6%
Other	24	9.7%
Insufficient Information to classify	5	2.0%