Contributions of NSF's Discovery Research K-12 Projects to Research in Science and Mathematics Education with English Learners

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Introduction

There is an growing need for all students, particularly English Learners (ELs), to develop fundamental understanding of science, technology, engineering, and mathematics (STEM) and to fully participate in STEM because:

- While ELs are the fastest growing population in the nation's schools (National Center for Education Statistics [NCES], 2012), achievement gaps in mathematics and science have persisted between ELs and their non-EL peers (NCES, 2013);
- Recent educational policy reforms, including the Common Core State Standards (CCSS) for mathematics and the Next Generation Science Standards (NGSS), are language intensive and thus present both challenges and opportunities for language learning and content learning for ELs (Lee, Quinn, & Valdés, 2013).
- Today's technological and global society requires that all students learn challenging mathematics and science for personal and social reasons as well as for college and career readiness.

Both governmental and nongovernmental organizations are increasingly influential in education policy through grant funding (Ferris, Hentschke, & Harmssen, 2008; Hansen, 2008). Funding programs can play a critical role in shaping new research interests by prioritizing specific research topics and designs or by requiring particular specializations of researchers.

Traditionally, limited attention has been given to content area instruction for ELs, specifically in science and mathematics (August & Hakuta, 1997; Janzen, 2008). However, knowledge about science and mathematics instruction for ELs has been expanding in the last decade (Buxton & Lee, 2014).

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Goal of the Study

- To explore whether funding provided through the National Science Foundation's (NSF) Discovery Research in K–12 (DR K–12) program has made a unique contribution to the research in the fields of science and mathematics education for ELs.

- **NSF:** Federal agency created in 1950 that supports research and education in all fields of science and engineering (NSF, 2013)
- **DR K-12 Program:** The largest of NSF's six education research and development programs; focuses on the "development, testing, implementation effectiveness, and/or scale-up of innovative resources, models and tools" (NSF, 2011, p. 2).

Research Questions

- What are the research characteristics of the portfolio of DR K-12 projects and the literature of non DR K-12- projects in the field of EL science education? How do they compare?
- What are the research characteristics of the portfolio of DR K-12 projects and the literature of non DR K-12 projects in the field of EL mathematics education? How do they compare?
- What is the disciplinary expertise of the investigators (PIs and co-PIs) in the portfolio of DR K-12 EL science and mathematics projects?

Methods

Samples

- 34 DR K-12 projects that focused on ELs from the first five cohorts funded from 2007 – 2011 (12% of all projects funded). Of these projects, 15 focused on science, 16 on mathematics, and 3 on both science and mathematics.
  - — ANALYTIC SAMPLE => 18 science education; 19 mathematics education projects
- 77 projects identified through Lee (2005) review and additional literature searches. Of these projects, 32 focused on science education, 38 focused on mathematics education and 7 focused on both science and mathematics.
  - — ANALYTIC SAMPLE => 39 science education; 45 mathematics education projects
- 77 CVs of PIs and co-PIs of DR K-12 EL projects (96% of PIs)

Analysis Approach

- Content analyses of the portfolio of DR K-12 projects and the literature of non DR K-12 projects in the fields of EL science and mathematics education in terms of research topics, design, methods, scale, samples, outcomes.
- Content analyses of the curricula vitae (CVs) of the DR K–12 projects' PIs and co-PIs in terms of disciplinary expertise.

Results—Investigator Expertise

- All but one project had expertise in the content area focus of project (mathematics or science or both).
- A majority of science projects (but not math projects) had EL/ELA expertise among key investigators.
- The most common area of expertise added by advisory group members was EL/ELA expertise (7 of 9 additions), and this was more likely to be added to mathematics projects that lacked EL/ELA expertise in their key investigators.

Results—Research Characteristics

DR K-12 EL projects were distinct from non DR K-12 EL projects in three areas:

1) Use of mixed methods and experimental designs.

Table 1: Research Method, Design, and Scale

	Non DR K-12 EL science education projects through 2004 (n = 34)[a]	Non DR K-12 EL science education projects from 2005 to March 2013 (n = 39)	DR K–12 EL science education projects (n = 18)[b]	Non DR K-12 EL mathematics education projects since 1982 (n = 45)	DR K–12 EL mathematics education projects (n = 19)[b]
Research Methods					
Mixed methods	Rare	26%	89%	29%	84%
Quantitative methods only	Rare	44%	6%	47%	0%
Qualitative methods only	Most	31%	6%	24%	16%
Research Design					
Experimental design	Rare	8%	28%	2%	17%
Quasi-experimental design	Rare	44%	17%	38%	22%
Descriptive	Most	56%	56%	69%	61%
Research Scale					
Multiple sites[c]	Infrequent	36%	44%	40%	44%
Conducted by research team	Infrequent	79%	83%	69%	68%

Note: Totals do not necessarily sum to 100% due to rounding or to the fact that projects could include multiple research designs or outcomes.
[a] As described in Lee (2005).
[b] The three projects that focused on both science and mathematics were included in this total.
[c] Projects that collected data in at least two school districts were considered multi-site projects.

2) Focus on middle school students.

Table 2: Grade Levels Addressed

Grade levels researched	Non DR K-12 EL science education projects from 2005 to March 2013 (n = 39)	DR K–12 EL science education projects (n = 18)	Non DR K-12 EL mathematics education projects since 1982 (n = 45)	DR K-12 EL mathematics education projects (n = 19)
Pre-Kindergarten	0%	6%	0%	11%
Primary (grades K-5)	49%	56%	67%	39%
Middle (grades 6–8)	46%	72%	33%	56%
High (grades 9–12)	23%	11%	16%	22%

Note: Percentages add to over 100% because some projects focused on students and/or teachers of students across several grade levels, such as both the fifth and sixth grades, teachers of the secondary level (grades 7 to 12), or all grades (pre-K to 12).

3) Emphasis on instruction and teacher preparation.

Table 3: Topics Addressed

Research Topic	Non DR K-12 EL science education projects through 2004[a] (n = 34)	Non DR K-12 EL science projects from 2005 to March 2013 (n = 39)	DR K–12 EL science education projects (n = 18)	Non DR K-12 EL mathematics education projects since 1982 (n = 45)	DR K-12 EL mathematics education projects (n = 19)
Science learning	Emerging	44%	11%	42%	5%
Science curriculum	Limited	23%	44%	13%	16%
Science instruction	Emerging	41%	61%	29%	89%
Science assessment	Limited	21%	11%	29%	16%
Science teacher preparation (pre-service)	None	5%	22%	0%	21%

Note: Percentages sum to over 100% because projects could address more than one topic area.
[a] As described in Lee (2005).

Discussion

- The results of this study were shaped by the DR K-12 solicitation and the peer review process, both of which influence which projects were funded.
- The DR K-12 projects' greater use of mixed methods and experimental designs seems to reflect the increasing focus on intervention studies supported by federal funding agencies.
- DR K–12 projects, with their focus on instruction and teacher preparation, have already begun to contribute to the critical areas of preparing teachers to teach science and mathematics to the growing number of ELs.
- Although the DR K–12 researchers may not be representative of all investigators in conducting research in STEM education, the findings indicated that the DR K-12 program is building the capacity of a core group of EL science and mathematics education researchers.

Policy Implications

- Researchers applying for DR K–12 funding responded to grant criteria, including research designs and methods that test the effectiveness of interventions and a focus on language diversity, and thus moved the fields forward in important ways.
- Federal agencies should continue to provide funding to support this research as a necessary step to improving the quality of science and mathematics education for ELs, closing the achievement gap, and enabling them to be ready for college and careers by the end of high school.

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