Federal Support for Education Innovation Through the Small Business Innovation Research Program

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Executive Summary

The federal Small Business Innovation Research (SBIR) program offers the potential to be an important catalyst for enhancing U.S. education by prompting technology start-ups to invent products that facilitate and improve education, and to become commercially viable small businesses. This study's research team conducted a first-ever extensive analysis of publicly available data on SBIR efforts specific to education. This report discusses patterns among education-related SBIR awards by subject area, types of products and their educational users, awardees' location, and other factors.

To augment the findings from the analyses of public data, this study included input from a panel of SBIR experts who suggested enhancements for the SBIR system that might help education entrepreneurs. The panelists offered potential strategies for drawing larger numbers of small businesses into the enterprise and urged the field to strengthen supports for moving SBIR awardees to even greater accomplishments.

Patterns Among Education-Related SBIR Awards

The SBIR program, administered by 11 federal agencies and coordinated by the Small Business Administration, is currently a federal investment of over $2 billion and supports technology start-ups striving to address the nation's needs in numerous high-priority areas, including education.

This report presents research funded by the Kauffman Foundation to examine SBIR funding that supports innovation and entrepreneurship in education. It describes the SBIR program and shows SBIR funding over time and across agencies, then moves on to examine the characteristics of SBIR education–related awards by the U.S. Department of Education (ED) and the National Science Foundation (NSF).

- ***Number of federal SBIR awards***. Over the span of more than two decades, federal contracts awarded nationwide that address education needs have ranged from 2 awarded by the Department of Commerce to nearly 1,200 awarded by NSF and ED.
- Characteristics of education-focused SBIR projects funded by NSF and ED.
    - ***Product type.*** SBIR projects for NSF and ED during the past decade (the focus of this research) have involved research and development on education apps, games, software, robotics, and tools (categorized as "product type" in this research); most involved software projects (58 percent), followed by those that developed tools (22 percent).
    - ***Subject area***. In terms of subject matter, these SBIR projects funded by NSF and ED have addressed assessments; English language arts; needs of special populations (particularly English language learners and students with disabilities); science, technology, engineering, and math

(STEM); and teacher development (of the teacher development projects, 36 percent addressed STEM and 31 percent addressed the needs of special populations).

- ***Educational user***. Most projects in ED and NSF have targeted student needs (as opposed to the needs of teachers or administrators and researchers) in grades K–12.

Catalyzing More SBIR Awards and Greater Successes

The SBIR program awards small, short initial grants in Phase I: $150K for six months. Firms can go on to apply for more substantial, longer Phase II awards of $900K for two years. Of the Phase I awards we examined (from the past decade), 30 percent of those funded by NSF secured Phase II funding and 51 percent of those funded by ED secured Phase II funding. We also found the following about Phase II awards:

- Product type, subject matter, and targeted grade span did not appear to be related to success in obtaining Phase II funding. However, in the ED pool, when the targeted user was represented by administrators or researchers, advancement to Phase II funding was found to be negatively correlated.
- Roughly half of each agency's Phase II grantees were found to still exist and be selling services or products five years after they had received the funding, a conclusion meriting further examination into publicly available data.

Panelist recommendations

Panelists offered many suggestions for increasing the number of firms applying for Phase I, helping them to succeed and apply for Phase II, and aiding them to be successful in Phase II and beyond (i.e., becoming a readily available product or service). The following are examples of over 20 recommendations presented in this portion of the report.

- Federal agencies and other parties, as possible, should increase collaboration with intermediaries such as accelerators and venture capitalists to increase awareness of the multiple SBIR solicitations by federal agencies and their differing timetables.
- Potential applicants should be encouraged to seek preliminary feedback from federal program officers before a competition period begins, after which time those officials are no longer permitted to give advice.
- Higher education institutions should explore how to more strongly empower faculty to pursue SBIR awards by balancing standard tenure and promotion requirements for academic publications with recognition for successful pursuit of SBIR awards.
- No later than by the time of a Phase II application, applicants should partner as needed with other individuals and organizations to bring the full range of required expertise (e.g., address any lack of expertise in business

planning, formal knowledge of K-12 schooling, and formal knowledge of product testing and evaluation in educational settings).

- Phase I applicants must be encouraged to stay on a quick timetable so that start-ups can reduce the risk of running out of capital between carrying out their Phase I award and applying for a Phase II award.
- Phase II awardees need to immediately seek funding other than their SBIR award to capitalize the eventual product; early in the final year, this strategy can include pursing a Phase II supplemental award (NSF grantees).

While this study was successful in identifying and describing the strategic weak points in the SBIR pipeline and ideas for addressing them, the expert panel recommended additional future research that would capture detailed examples of successes and pitfalls among a sample of grantees.

Further, the authors encourage formal augmentation to the anecdotal information currently available about the commercial existence and success of SBIR grantees after Phase II. Through a small exploratory study of extant online information, the researchers found that about half of grantees still existed and were selling services or products five years after their Phase II award. However, it was often not possible to find specifics about a given product tied to their SBIR award. This knowledge gap about SBIR program outcomes suggests a need for future research designed to help locate former SBIR grantees, identify hurdles they faced and how they overcome those hurdles, and identify other supports that would have been helpful to former SBIR grantees.

Introduction

About This Study

This research study investigated, from publicly available data, the types of projects funded by the Small Business Innovation Research program in the U.S. Department of Education and the National Science Foundation. Specifically, the research addressed three major questions:

- What has been funded over time, and at what levels, by the Small Business Innovation Research (SBIR) program — and, if relevant, the Small Business Technology Transfer program — to support innovation and entrepreneurship in education?
- What appear to be patterns from the data regarding types of educational innovation and entrepreneurship projects supported, and have these patterns changed over time?
- What organizations have been funded, how have they used the funds, and — where possible — to what degree has the funding led to their commercial sustainability?

To address these questions, we used the database at sbir.gov, initially examining the award data for all 11 participating federal agencies since the inception of the program in each of those agencies (usually 1983). We first identified the agencies with the highest number of education projects (the U.S. Department of Education and the National Science Foundation) and then, within their funding histories, the years with the most clearly stated themes and strands. These exploratory analyses led us to focus this research project on award data for the U.S. Department of Education and the National Science Foundation for the most recent 10 years (2005–2015).

About This Report

The report first describes the SBIR program (touching briefly on the Small Business Technology Transfer program) and displays SBIR funding over time and across agencies. Next, the report discusses characteristics of SBIR education–related awards by the U.S. Department of Education and the National Science Foundation. We display characteristics of projects that secure later SBIR funding, contrasted with those that do not, and we determine, as possible, which projects continue after federal funding has ended. Experts in educational innovation and the SBIR program in particular offer suggestions for increasing the numbers of successful grantees as well as further research that could help explain supports needed by small entrepreneurial firms attempting to develop and market products and services to assist learners and teachers.

About the Kauffman Foundation

Founded in the mid-1960s and advancing the principles and ideals of its founder Ewing Marion Kauffman, the Kauffman Foundation supports efforts to foster "a society of economically independent individuals who are engaged citizens, contributing to the improvement of their communities." Its research, grants, and information dissemination establish it as the largest American foundation to focus on entrepreneurship.

The Small Business Innovation Research Program

The largest federal investments in innovation toward commercialization are the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs organized centrally by the Small Business Administration (SBA) and operated government-wide by individual agencies. They were established by law in 1982 through Public Law 97-219, the Small Business Innovation Development Act, and reauthorized and revised periodically until the current version, which was reauthorized in December 2011. "By including qualified small businesses in the nation's R&D (research and development) effort, SBIR and STTR grants are intended to stimulate innovative new technologies to help agencies meet the specific research and development needs of the nation in many areas, including health, the environment, and national defense" (Wessner, 2008, p. xiii).

Agencies operate either the SBIR program alone or jointly with the STTR program, depending on the size of their R&D budgets (as explained further below). Both are highly competitive programs that encourage domestic small businesses to engage in research that has the potential for commercialization (SBIR & STTR, 2016). They are considered the main sources of federal funding for early-stage technology development in the United States. For the small businesses receiving such grants, the awards bring not only financial support, but also coaching, contacts, visibility, and a type of "certification" (Audretsch, Link, & Scott, 2013; Lerner, 1999; Link & Scott, 2013; Wessner, 2008).

The Value of U.S. Innovation Policy and SBIR

The SBIR program is viewed globally as a national best practice in affecting innovation and innovation policy. Many nations are actively seeking to replicate what they see as successful U.S. policies and programs that drive domestic growth and employment. Examples include Innovation Awards, 21st Century Universities, consortia, regional clusters, and directed research (Wessner, 2016). These efforts are undertaken to increase standing in the competitive environment and respond to global challenges that require innovation. The competitive environment includes individual nations that continue to increase their talent and research and development opportunities, innovative regions around the world, and off-shore research centers seeking to invent and market products for the global marketplace. Global challenges include developing new sources of energy and commercializing renewable alternatives to oil and coal, growing a green economy, improving security, and improving and personalizing health care and education (Wessner, 2016). More nations continue to increase funding for research, support innovative small

businesses, attract innovative industries, and establish and strengthen government-industry partnerships to bring new products to market.

SBIR is a key driver of innovation

The United States has established pillars, mindsets, and policies that have helped it maintain its leadership role in innovation. Generally, there is an openness to science and innovation and a trust for scientific institutions. Social norms throughout the nation are such that there is a high value on achieving commercial success and attitudes exist that support individuals and organizations in multiple attempts at achieving success. Specifically, there are entrepreneur-friendly policies, with markets open to competition, bankruptcy laws that permit rapid recovery, and a flexible and improving labor market (Wessner, 2016).

Research and development and funding opportunities are key pillars in the U.S. system, encompassing more than 200 research universities, a federal investment of more than $150 billion per year in research and development, and private investments of more than $300 billion per year. Capital available to innovators is broad, deep, and efficient with significant angel ($22.5 billion) and venture funding ($28.4 billion) (Sohl, 2012). Further, the United States maintains a large share of global research and development funding, comprising 26.4 percent of the global total, compared to China's 20.4 percent (R&D Magazine, 2016).

Coupled with these research and development efforts is a broad-based federal effort to support science and innovation. Several well-developed, mission-driven institutions exist and help drive innovation. For example, the National Science Foundation supports basic research and the National Institutes of Health provide funding for research that underpins modern pharmaceutical and biotechnology industries. These institutions are instrumental to supporting the innovation pursued by small businesses.

SBIR combats many market pitfalls

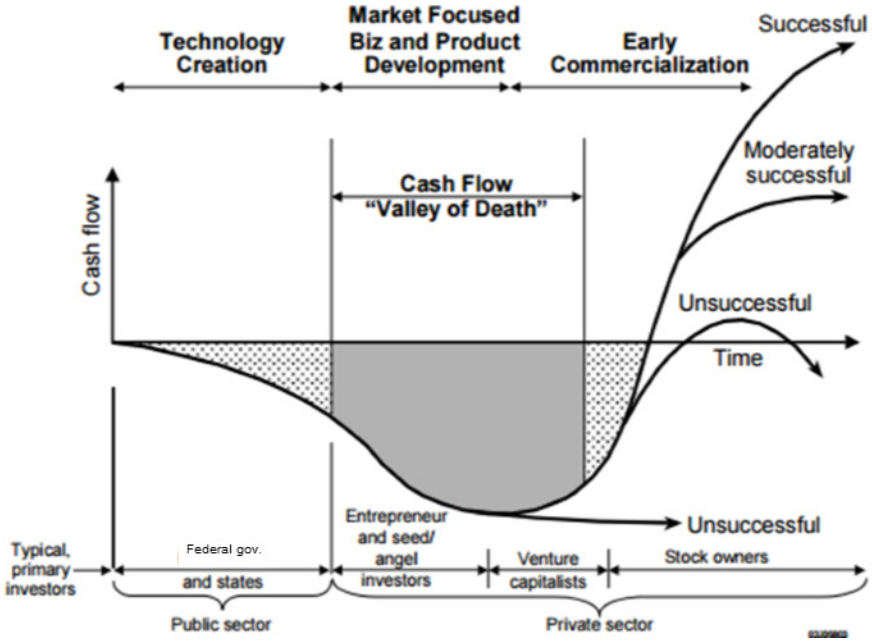
Small businesses in the United States are major sources of high-technology innovation and are key to bringing new technologies to market. The SBIR program serves to fund these small businesses and ensure they and their innovative technologies are less vulnerable to market financial and other hurdles (Wessner, 2016). A common myth is that the market will fund good ideas and avoid bad ideas. However, the reality is that potential investors have less than perfect knowledge, especially about innovative ideas. When investments are made, asymmetric information can lead to suboptimal decisions (Stiglitz, 2002). Additionally, public investment often guides or directs private sector investment to areas of the public good (Murphy & Edwards, 2003). There is also a myth about the capacity of venture capital markets. Venture capitalists have limited information on new firms; are prone to herding tendencies; have moved their investments toward later, less

risky stages of technology development; and have shown declining investments in the seed stage of investment (Wessner, 2016). Yet, many companies live and grow with venture funding, even though many fail completely or are only able to simply return invested funds (Cochrane, 2005).

SBIR helps small firms navigate the "valley of death"

Early-stage innovation ideas, however promising, may still be too high risk for private investors. These innovative ideas and small companies need capital to transform the ideas into tangible innovations, develop the product, and grow commercially. The vast majority of entrepreneurial ventures that do not attract venture capital will fail within their first three years (Gompers & Lerner, 2002). The lack of this capital is referred to as the "cash flow valley of death" (Murphy & Edwards, 2003). This valley of death refers to a time period where entrepreneurs have high cash demands and low ability to raise it. This term is also used to describe the general difficulties in reaching commercialization (Wessner, 2016). Figure 1 illustrates this concept schematically as a function of development state with typical investors shown for the various stages of development: technology creation, product development, and early commercialization. Several trajectories, indicating different levels of success for the venture, are also indicated. In the early technology creation phase, the public sector (e.g., SBIR) can provide a significant portion of the financing needed in combination with the entrepreneurs who frequently contribute a significant amount of bootstrapping (Murphy & Edwards, 2003).

Figure 1. The Cash Flow Valley of Death as a function of development state, with typical investors shown for the various stages



Source: Adapted from Murphy & Edwards (2003).

Once the technology has been created, the development of products based on the technology and a business that will take the product to marketplace become the focus (Murphy & Edwards, 2003). Later-stage public sector funding (e.g., SBIR Phase II) can address the funding needed to help entrepreneurs shift their focus to key business development issues for the venture to be successful. Additionally, early-stage SBIR funding helps to attract attention and funding from the private sector that can help companies successfully avoid the valley of death.

SBIR success

SBIR has had measurable effects on firm formation, growth, and ongoing development. One study found that almost one quarter of examined companies were founded as a direct result of a prospective SBIR award. Almost 70 percent of examined companies stated that SBIR awards played a key role in their decision to pursue a research project aimed at innovation and served as a catalyst to a firm partnering with academic consultants (Wessner, 2016). SBIR has helped new start-ups grow and has led to new products, patents, licenses, and publications. These companies and products have been used in both the public and private sectors. For example, NASA has used SBIR-funded lithium-ion batteries to power the Mars Rover and has used SBIR-funded laser technologies to guide the docking of space vehicles to satellites. This later technology is now used in Lasik eye surgeries. In the private sector, SBIR investments have contributed to the success of companies like Qualcomm and Luna (Wessner, 2016).

The SBIR program has been popular with universities, entrepreneurs, and government agencies. Universities have used SBIR awards to help researchers create new firms that are low risk in that they do not require the professor to give up his or her university position. The work from these firms helps to grow the local economy and provides returns on research and development investments. Entrepreneurs benefit from SBIR funds in that they are able to augment their research budgets, not dilute their ownership of the company in seeking additional funds; are not required to repay the funds or pay royalties; can retain the rights to intellectual property developed using SBIR funds; and attract private investments through the publicity and recognition afforded them by being part of the SBIR program. Government agencies are able to use the SBIR program as a low-cost exploration of ideas that may hold promise and to do so cheaply and quickly. The program is cost effective because it identifies failed ideas or companies before substantial investments are made in them. SBIR funding also enhances competition by diversifying the government supplier base and by bringing in low-cost solutions and new approaches to address agency mission needs (Wessner, 2016).

The successes of SBIR have led other nations to try to replicate and implement it. Almost a dozen countries around the world have implemented programs similar to SBIR in their structure and mission, including the Czech Republic, Finland, India, Japan, Korea, the

Netherlands, Russia, Singapore, Sweden, Taiwan, and the United Kingdom; SBIR has also been added as a program by the European Commission (Wessner, 2016). SBIR has provided the structure to fund new ideas to meet societal challenges. The next section details that structure.

Size and Structure of SBIR

By law, agencies with R&D budgets that exceed $100 million are required to set aside at least 3 percent of their extramural budgets for awards to small businesses. (The requirement will rise to 3.2 percent in fiscal year 2017.) At present, this includes 11 federal agencies: Department of Defense, Department of Energy, Department of Health and Human Services, National Aeronautics and Space Administration, National Science Foundation, Department of Agriculture, Department of Commerce, Department of Education, Department of Homeland Security, Department of Transportation, and Environmental Protection Agency.

In addition, those with extramural R&D budgets exceeding $1 billion (the first five in the list above) must set aside nearly 0.5 percent (one half of 1 percent) for awards to small businesses under the STTR program to support research institutions in the development of commercially viable innovative technologies. (As described further below, our analyses uncovered education-related projects mostly in agencies with smaller R&D budgets, which therefore did not need to set aside STTR funds; thus, our research ended up examining only SBIR program awards, not those in STTR programs.)

Three phases of SBIR funding

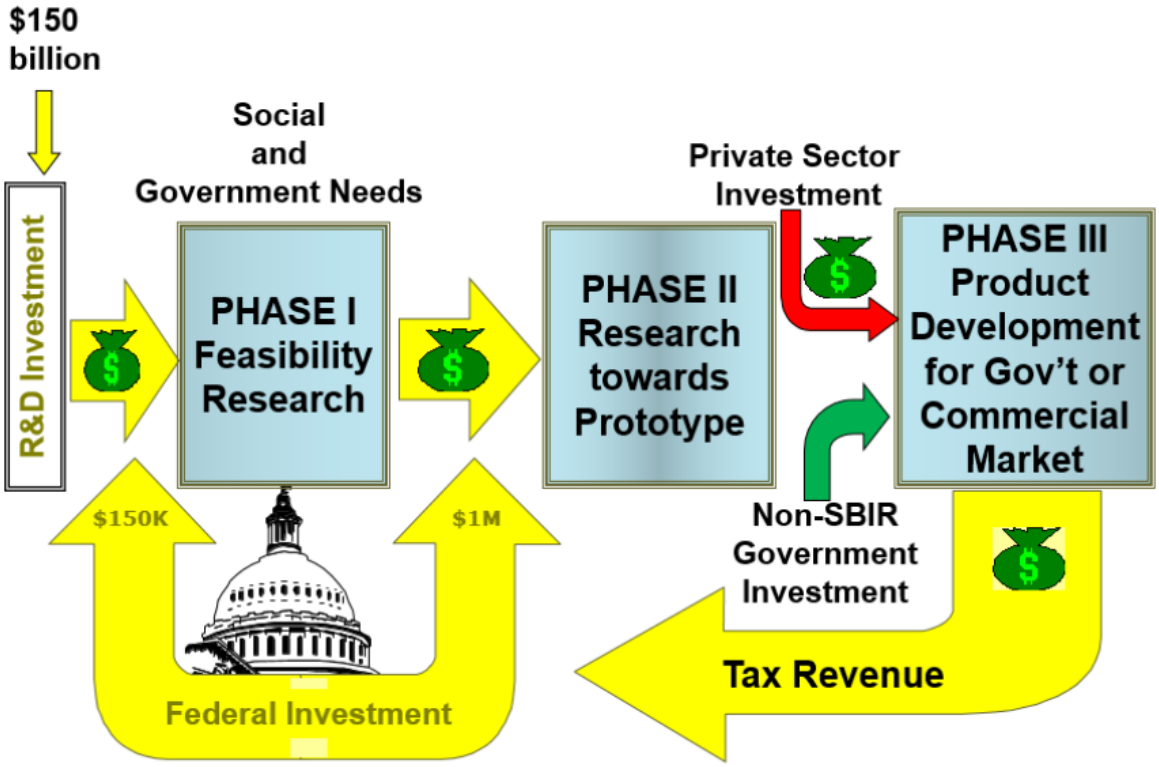
In the SBIR (and STTR) program, there are three phases of funding (Figure 2). Applicants compete for support for Phase I work, "to establish the technical merit, feasibility, and commercial potential of the proposed R&D efforts and to determine the quality of performance of the small business awardee" (SBIR/STTR Interagency Policy Committee, 2014, p. 7), typically for no more than $150,000 and for less than one year in duration. If their Phase I research succeeds, those small businesses can compete for Phase II support (typically for no more than $1.5 million and not exceeding two years in duration) so they can scale up enough to demonstrate the scientific and technical merit and commercial potential of their product. Legislation and program documents speak also of a Phase III, which is the period when the businesses need to secure non-government support.

Figure 2. Three phases of SBIR funding

Source: SBIR/STTR Interagency Policy Committee (2014).

Awards in both programs are intended to stimulate technological innovation aligned with individual agency missions; meet federal R&D needs while strengthening the role of small businesses; foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons; and increase private-sector commercialization of innovations derived from federal research and development funding. Figure 3 below further details these three phases of funding, how Phase I and Phase II funds support entrepreneurs prior to other forms of investment from the private and public sector, and how supporting these companies in the SBIR program leads to taxable revenue from salaries generated by successful companies.

Figure 3. The SBIR "Open Innovation" Model



Source: Wessner (2016).

Distribution of SBIR Awards by Participating Federal Agencies

To address these purposes, each agency organizes competitions for the funds, selects grantees, and oversees their work to ensure program goals are met. (The goals for the five agencies' STTR programs are similar; SBA, 2014). Across the participating agencies, the programs' funding levels and number of awards vary substantially commensurate with the size of the R&D budgets. Table 1 below displays the budgets and number of awards for both Phases I and II across the 11 participating federal agencies for fiscal year 2013 (SBA, 2015).

Table 1. SBIR funding and awards, by participating federal agency (for fiscal year 2013)

Federal agency	Budget ($)	Number of Phase I awards	Number of Phase II awards
Department of Agriculture	18,256	60	28
Department of Commerce	5,356	19	10
Department of Defense	977,669	1303	824
Department of Education	10,534	24	8
Department of Energy	158,637	284	96
Department of Health and Human Services	630,108	653	290
Department of Homeland Security	19,575	29	19
Department of Transportation	8,573	21	10
Environmental Protection Agency	4,534	25	7
National Aeronautics and Space Administration	148,200	258	88
National Science Foundation	132,800	223	130
Government-wide	2,104,278	3011	1474

Source: SBA (2015).

For fiscal year 2013, more than $2 billion was distributed for 3,011 Phase I awards and 1,474 Phase II awards — representing 15 percent and 55 percent of the proposals received that year, respectively. Figure 4 below shows the number of SBIR awards government-wide historically and the proportion of proposals funded ("success rate") for the SBIR Phase I and Phase II solicitations.

Figure 4. Number of SBIR awards annually and proportion of proposals funded, government-wide (1990–2013)

Source: SBIR Annual Report Dashboard, accessed on September 27, 2016, at https://www.sbir.gov/awards/annual-reports.

Over time, nearly 46,000 small businesses have been supported through SBIR funding. Over half of the awarded funds have gone to firms in 10 states: California, Colorado, Florida, Maryland, Massachusetts, New York, Pennsylvania, Ohio, Texas, and Virginia (https://www.sbir.gov/sbirsearch/firm/all).

Publicly available data about education-related SBIR awards

Each agency submits reports to the SBA about grant awards, which are inputted into a database that shows, for each award, the company name, award title, award start and close dates, award amount, principal investigator contact information, and a project abstract. As of late September 2016, the site included nearly 160,000 records.

Because agencies establish program goals and funding priorities addressing their own missions, we examined abstracts across all of the agencies to identify projects supporting education innovations. To extract this subset of education-related SBIR awards, we used the following filters: "education," "classroom," "student," or "teacher." This search led to the data presented in Table 2.

Table 2. Total number of SBIR awards and education-related SBIR awards, by participating federal agency

Federal agency	Total number of awards	Years examined	Number of education-related awards (relevant years)
Department of Agriculture	3,073	1983–2014	30 (1991–2014)
Department of Commerce	1,337	1985–2015	2 (1995, 2014)
Department of Defense	75,025	1991–2015	518 (1991–2015)
Department of Education	1,238	1983–2015	1,228 (1983–2015)
Department of Energy	10,933	1983–2015	30 (1993–2010)
Department of Health and Human Services	297	1983–2014	2 (1992–1993)
Department of Homeland Security	861	2004–2015	4 (2008–2010)
Department of Transportation	1,038	1983–2010	3 (1989, 2014–15)
Environmental Protection Agency	1,760	1983–2014	3 (2004, 2007)
National Aeronautics and Space Administration	14,782	1983–2014	40 (2003–2014)
National Science Foundation	11,402	1983–2015	1,175 (1993–2016)

Source: WestEd analyses of SBIR Awards Information, accessed on September 27, 2016, at https://www.sbir.gov/sbirsearch/award/all.

As shown above, the number of grants in education-related topics awarded by each respective federal agency ranges from 2 over a 20-year span (the Department of Commerce) to nearly 1,200 over a 20- or 30-year time span (the National Science Foundation and the Department of Education, respectively). Given the significantly larger number of education-related awards given by the National Science Foundation (NSF) and the Department of Education (ED) compared to all of the other federal agencies, we focused further research solely on SBIR projects funded by NSF and ED.

General Note about These Compilations

The publicly available databases compiled by the Small Business Administration from data received from agencies are limited somewhat by incompleteness (blank fields) or simple errors, such as misspellings — company name, principal investigator, and location were some of the variables we used to match awards across phase and locate Phase II grantees after their awards in order to categorize their status for the commercial viability analyses. Although the research team corrected many obvious errors by hand, some may remain and may slightly skew the tables. As possible, we checked the plausibility of our findings with knowledgeable experts with the program and elsewhere, and such confirmations are noted throughout the report.

SBIR Awards Given by the U.S. Department of Education and the National Science Foundation

As noted earlier, of the 11 federal agencies participating in the SBIR program, ED and NSF give the most education-related awards and are thus the main focus of this research. To offer a better understanding of the SBIR programs of these two federal agencies, the text boxes below present information on the solicitation process and topic areas for NSF's and ED's respective SBIR programs.

Box 1. The U.S. Department of Education SBIR Program: Solicitation Process and Topic Areas

The U.S. Department of Education's Small Business Innovation Research (SBIR) program, operates out of the agency's research arm, the Institute of Education Sciences (IES). It provides up to $1,050,000 in funding to small businesses and partners for research and development to translate their innovative ideas into commercial products that address educational problems.

ED's SBIR program accepts proposals through two tracks. Through its *education track*, the agency funds the R&D of products to improve student learning directly or indirectly (e.g., through teacher practices) in authentic education delivery settings (e.g., schools, after-school programs, distance learning).

Through its *special education track*, ED funds the R&D of products for use by infants, toddlers, or students with or at risk for disabilities, or teachers (or other instructional personnel, related service providers, or family members) in early intervention or special education.

Source: Institute of Education Sciences Small Business Innovation Research web page, accessed September 1, 2016, at http://ies.ed.gov/sbir/.

Box 2. The National Science Foundation SBIR Program: Solicitation Process and Topic Areas

The NSF's Small Business Innovation Research program encourages the submission of innovative proposals that show promise of commercial and societal impact in almost all areas of technology (except drug development). Proposals should be driven by market and societal needs and opportunities, and should identify both the end users of the proposed technology and the proposed pathway to commercialization.

The NSF recognizes that innovation often cannot be categorized. The following topic areas and subtopic areas are used internally to guide the logistics of the review process but do not affect award decisions.

Topic Areas: Advanced Materials and Instrumentation, Advanced Manufacturing and Nanotechnology, Biological Technologies, Biomedical Technologies, Chemical and Environmental Technologies, Electronic Hardware, Robotics and Wireless Technologies, Internet of Things, Information Technologies, Other Topics, Semiconductors and Photonic Devices and Materials, Smart Health, and **Educational Technologies and Applications** (from http://www.nsf.gov/eng/iip/sbir/topics.jsp, accessed 9/10/2016, emphasis added).

Subtopics for the Educational Technologies and Applications Area: pre K–12 education; global, distance, and higher education; simulations and gaming technologies; entrepreneurial, informal and maker education; and information, computer science, and engineering (from http://www.nsf.gov/eng/iip/sbir/topics/Combined.pdf, accessed 9/10/2016).

Tables 3 and 4 present data on the current and original size of the SBIR award totals.

Table 3. Size of ED's SBIR program: Budget and number of awards in 1990 and 2013

SBIR program component	1990	2013
Budget	$2,200	$303,000
Number of solicitations	1	3
Number of solicitation topics	26	8*
Phase I		
Number of proposals received/funded (success rate)	208/ 30 (14%)	253/ 24 (9%)
Phase II		
Number of proposals received/funded (success rate)	24/ 8 (33%)	22/ 6 (36%)

*ED's solicitation topics have been more focused in recent years.

Table 4. Size of NSF's SBIR program: Budget and number of awards in 1990 and 2013

SBIR/STTR program component	1990	2013
Budget	$20,008	$143,000
Number of solicitations	1	3
Number of solicitation topics	26	8*
Phase I		
Number of proposals received/funded (success rate)	1,266/ 169 (13%)	1,690/ 345 (20%)
Phase II		
Number of proposals received/funded (success rate)	193/ 49 (25%)	188/ 100 (53%)

Source: SBIR Dashboard, accessed on September 30, 2016, at https://www.sbir.gov/awards/annual-reports?program=SBIR&abbr%5B%5D=NSF&view_by=Year.
*In 2000, NSF solicitations began including fewer topics.

In both agencies, the SBIR programs have been focused and reoriented since the mid-2000s. Therefore, our analyses focused on awards from the most recent 10 years.

Table 5 shows the number of education-related awards for the past 10 years by ED and NSF in Phase I and Phase II.

Table 5. Number of Phase I and Phase II SBIR awards to support education innovation (2005–2015)

Federal agency	Phase I only	Phase II	Total
Department of Education	117	122	239
National Science Foundation	147	63	210

Using information from the 1,175 abstracts in NSF's awards database, we extracted those addressing education issues during the past 10 years, or a subset of 210. Our descriptive analyses portray characteristics of the 449 awards presented in Table 5.

How are funds distributed and what do they support?

Table 6 shows the number of companies receiving single or multiple awards from ED and NSF over the past 10 years. As the table shows, companies can compete for, and win, repeated SBIR grants; however, single awards are the norm.

Table 6. Number of companies receiving Phase I and Phase II awards to support education innovation, by number of awards (2005–2015)

Number of awards	Number of companies			
	ED		NSF	
	Phase I	Phase II	Phase I	Phase II
1	84	50	106	45
2	8	19	13	9
3	2	5	5	-
4	-	2	-	-
5	-	1	-	-
6	-	1	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	1	-	-	-

SBIR preference categories

SBIR has designated three categories as preference areas to encourage program participation for certain regions and for certain business owners.

- *Historically Underutilized Business Zones* (HUBZones) seek to encourage economic development and employment growth in distressed areas.
- *Socially and economically disadvantaged businesses* (disadvantaged) are businesses owned by individuals who can prove both social and economic disadvantage.
- *Women-owned small businesses* (WOSBs) is a category added in 2011 allowing set-asides for WOSBs in industries where women-owned small businesses are substantially underrepresented.

Of ED's 239 SBIR awards to support education innovation, 22 (9 percent) went to businesses in HUBZones, 19 (8 percent) to disadvantaged businesses, and 38 (16 percent) to WOSBs. Of the 122 ED Phase II awards, 22 (18 percent) went to businesses in HUBZones, 19 (16 percent) to disadvantaged businesses, and 28 (23 percent) to WOSBs (Table 7). Of the 210 NSF awards supporting education innovation, only 186 had data available on the three preference areas — 150 awards that only received a Phase I award and 36 awards that moved to Phase II. Of these 36 Phase II awards from NSF, 2 (6 percent) went to HUBZone businesses, 2 (6 percent) to disadvantaged businesses, and 8 (22 percent) to WOSBs (Table 7).

Table 7. ED and NSF SBIR awards to support education innovation, by SBIR preference category

		SBIR preference category					
		HUBZone		Disadvantaged		WOSB	
		Number	Percent	Number	Percent	Number	Percent
ED	*Phase I*	0	0	0	0	10	9
	Phase II	22	18	19	16	28	23
	Total	22	9	19	8	38	16
*NSF**	*Phase I*	4	3	14	9	32	21
	Phase II	2	6	2	6	8	22
	Total	6	3	16	9	40	22

*Of the 210 education-related NSF awards, 186 had available data on preference areas.

For both NSF and ED, a small business's status in one of the three preference categories does not predict its receipt of Phase II funding, an observation confirmed informally with program officers from both departments. This finding is consistent with earlier and ongoing assessments of SBIR awards government-wide (Wessner, 2008; Siegel, 2011).

Distribution of Awards Geographically

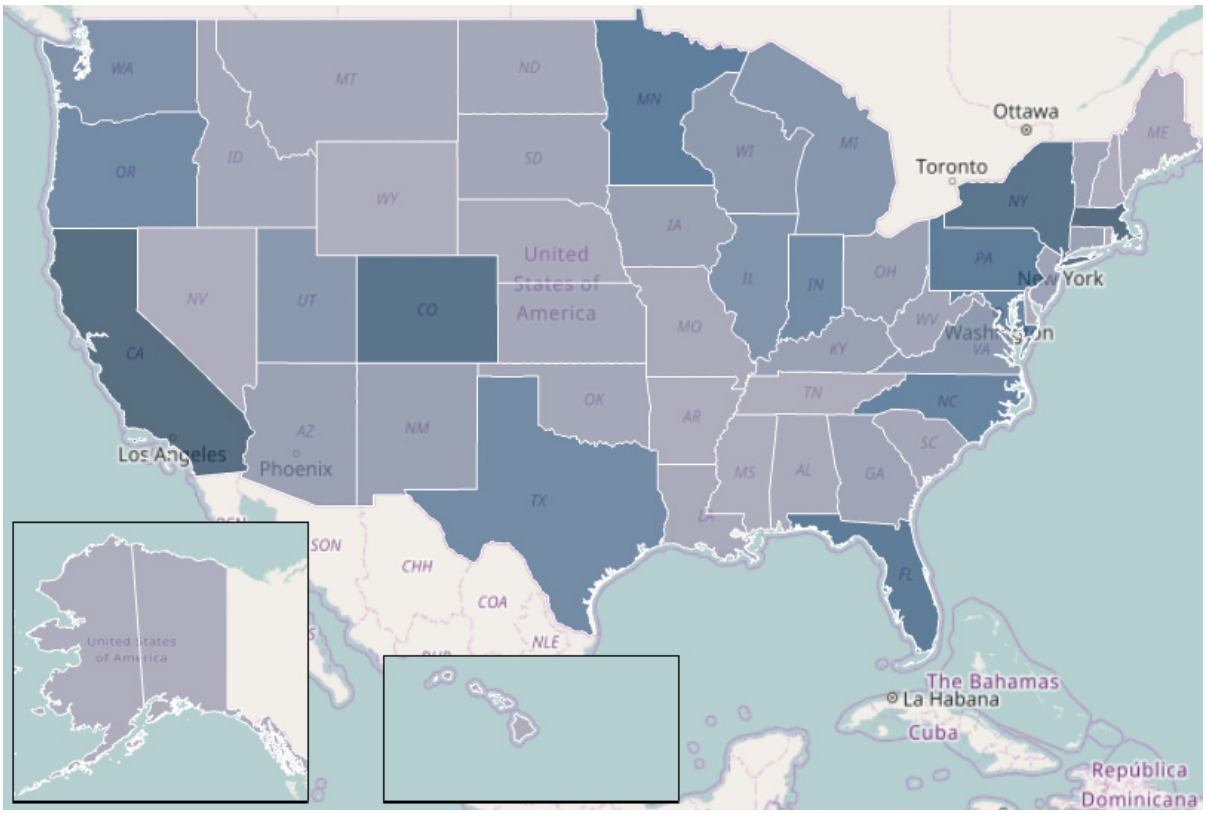
Across states

Similar to the distribution of SBIR awards from all federal agencies (https://www.sbir.gov/sbirsearch/firm/all), firms in certain states win more often than those in other locations (Table 8 and Figure 5).

Table 8. ED and NSF awards to firms across states, 2005–2015

	No. of states	States in each category and no. of awards
States receiving 20+ awards	7	MN (21), PA (23), FL (24), NY (32), CO (33), MA (44), CA (68)
States receiving 10–19 awards	8	MI (10), IL (11), WA (12), IN (15), OR (15), TX (15), MD (17), NC (18)
States receiving 5–9 awards	9	AZ, CT, IA, KY, NM, and OH (5 each); VA and WI (8 each); UT (9)
States receiving 1–4 awards	16	AL, LA, MO, and NE (1 each); DC, ID, KS, MT, ND, OK, and SC (2 each); SD and WV (3 each); GA, NJ, and VT (4 each)
States receiving no awards	11	AK, AR, DE, HI, ME, MS, NV, NH, RI, TN, and WY

Figure 5. The distribution of ED and NSF SBIR awards across states (2005–2015)



Source: WestEd analysis and http://www.openheatmap.com/.

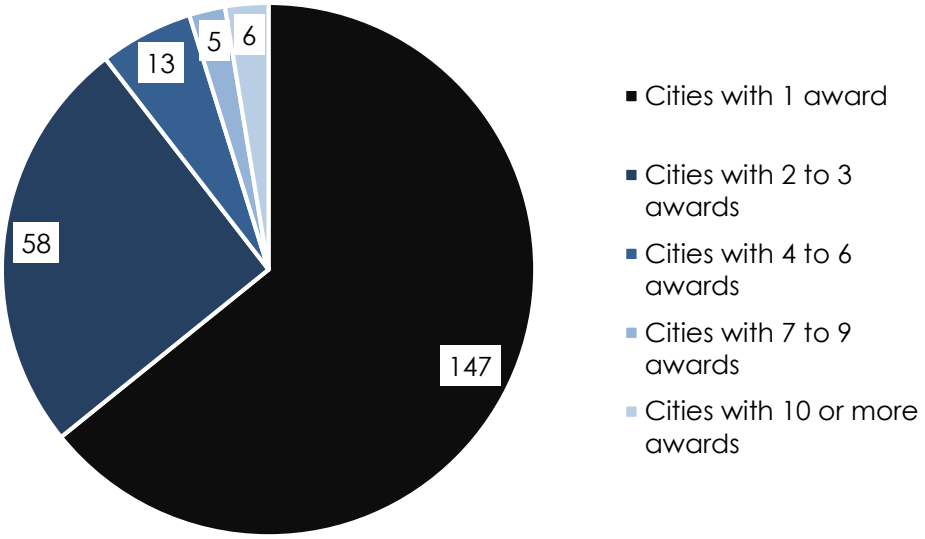
Cities with firms receiving SBIR awards

During that same 10-year period (2005–2015), awards from the two agencies clustered around a handful of cities, as shown in Table 9 (147 cities were home to firms receiving one award each).

Table 9. Numbers of awards to firms in cities

	Cities home to firms receiving multiple awards
Cities whose firms received 10 or more awards	6: Colorado Springs, CO (15 awards, all from ED); Boulder, CO (12 awards); San Francisco, CA (11 awards); Eugene, OR; Orlando, FL; and New York, NY (10 awards each)
Cities whose firms received 7–9 awards	5
Cities whose firms received 4–6 awards	13
Cities whose firms received 2–3 awards	58

Figure 6. The distribution of ED and NSF SBIR awards across cities (2005–2015)



Source: WestEd's analysis of ED and NSF SBIR Phase I award project records.

Characteristics of Projects Supported through Phase I Awards

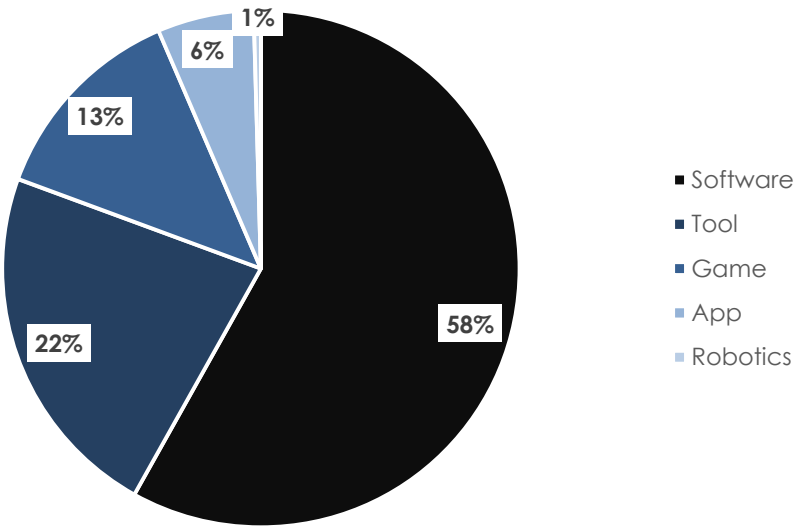
To get a better understanding of the characteristics of the projects being supported by these SBIR awards, the research team read and analyzed each abstract for the 449 education-related awards from ED and NSF and identified four main dimensions by which these awards are characterized: the type of product being developed; the education-related subject matter being addressed; the grade range being targeted; and the project's intended users.

Product type and subject matter

Figures 7 and 8 show the characteristics of ED and NSF's Phase I awards in terms of product type and education-related subject matter. The product types we found in these projects were apps (applications for smart phones or tablet devices), games, software (designed for use with computer networks), tools (physical devices or instruments to be used in the classroom), and robotics (Figure 3). The subject matter categories we identified were assessment; English language arts (ELA); special populations (students in special education, students who speak English as a second language, and/or gifted and talented students); science, technology, engineering, and math (STEM); teacher development; and miscellaneous (addressing a variety of areas, including business, civics, collaboration, health, public speaking, online learning, social skills, student collaboration, and tutoring).

From 2005 to 2015, 80 percent of the Phase I awards went to projects creating software or tools (see Figure 7).

Figure 7. Types of products developed through ED and NSF Phase I award projects (2005–2015)



Source: WestEd's analysis of ED and NSF SBIR Phase I award project abstracts.

Table 10. Types of products developed through ED Phase I projects, by year (2005–2015)

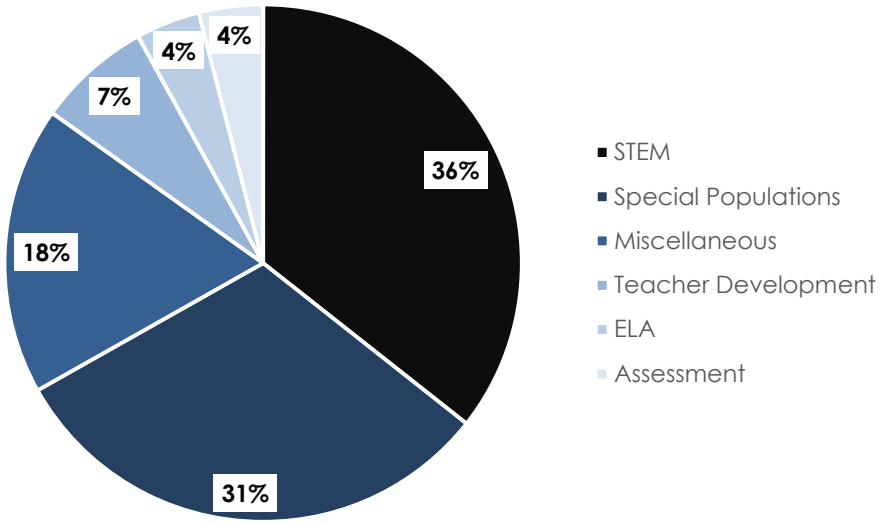
	Product type				
Year	**App**	**Game**	**Software**	**Tool**	**Total**
2005	1	0	13	10	24
2006	2	1	21	19	43
2007	1	0	15	4	20
2008	0	1	15	10	26
2009	1	3	10	6	20
2010	1	1	10	9	21
2011	1	0	10	8	19
2012	6	3	11	2	22
2013	1	8	6	1	16
2014	2	1	7	2	12
2015	3	5	7	1	16
Total	19	23	125	72	239

Table 11. Types of products developed through NSF Phase I projects, by year (2005–2015)

	Product type					
Year	App	Game	Robotics	Software	Tool	Total
2005	0	1	0	9	2	12
2006	0	0	0	5	0	5
2007	1	0	0	8	3	12
2008	0	1	0	11	0	12
2009	0	2	0	6	0	8
2010	1	3	1	24	4	33
2011	0	4	0	15	3	22
2012	1	3	0	5	2	11
2013	1	8	0	9	5	23
2014	3	8	0	17	4	32
2015	1	5	1	27	6	40
Total	8	35	2	136	29	210

From 2005 to 2015, two thirds of the ED and NSF SBIR Phase I awards went to projects focused on STEM and special populations (see Figure 8 and Tables 12–13).

Figure 8. Subject-matter focus of ED and NSF Phase I award projects (2005–2015)



Source: WestEd's analysis of ED and NSF SBIR Phase I award project abstracts.

Table 12. Subject-matter focus of ED Phase I projects, by year (2005–2015)

Subject-matter focus							
Year	Assessment	ELA	Misc.	Special pops.	STEM	Teacher dev.	Total
2005	1	2	2	18	1	0	24
2006	3	1	8	14	7	10	43
2007	2	1	4	8	4	1	20
2008	0	0	3	15	7	1	26
2009	1	2	0	11	5	1	20
2010	0	0	6	11	3	1	21
2011	0	0	2	13	3	1	19
2012	0	1	2	13	4	2	22
2013	1	1	4	6	4	0	16
2014	0	2	1	6	2	1	12
2015	0	1	4	2	8	1	16
Total	8	11	36	117	48	19	239

Table 13. Subject-matter focus of NSF Phase I projects, by year (2005–2015)

Subject-matter focus							
Year	Assessment	ELA	Misc.	Special pops.	STEM	Teacher dev.	Total
2005	0	0	2	2	7	1	12
2006	0	0	4	0	1	0	5
2007	2	0	3	3	3	1	12
2008	0	1	1	1	8	1	12
2009	0	0	2	0	6	0	8
2010	2	0	5	4	20	2	33
2011	0	0	5	2	12	3	22
2012	1	0	1	2	7	0	11
2013	1	2	3	3	12	2	23
2014	3	0	10	1	17	1	32
2015	1	4	9	5	19	2	40
Total	10	7	45	23	112	13	210

Grade level

Projects targeted a variety of grade levels, including pre-kindergarten, elementary (kindergarten through grade 5), secondary (grade 6 through grade 12), kindergarten through grade 12 (projects that sought to be of use at all grade levels), and colleges and universities (Tables 14–15).

Table 14. Grade span targeted by ED Phase I projects, by year (2005–2015)

Year	Pre-K	Elementary	Secondary	K–12	College	Total
2005	0	5	2	17	0	24
2006	2	4	10	26	1	43
2007	0	3	4	13	0	20
2008	0	1	6	19	0	26
2009	0	4	3	13	0	20
2010	0	2	4	15	0	21
2011	0	1	2	15	1	19
2012	0	6	2	13	1	22
2013	0	5	5	6	0	16
2014	0	4	2	6	0	12
2015	0	5	8	3	0	16
Total	2	40	48	146	3	239

Table 15. Grade span targeted by NSF Phase I projects, by year (2005–2015)

Year	Pre-K	Elementary	Secondary	K–12	College	Total
2005	0	1	2	6	3	12
2006	0	0	2	3	0	5
2007	0	0	6	4	2	12
2008	0	1	6	3	2	12
2009	0	0	2	3	3	8
2010	0	4	10	15	4	33
2011	0	0	5	12	5	22
2012	0	2	4	5	0	11
2013	0	8	4	8	3	23
2014	1	2	11	14	4	32
2015	0	6	14	18	2	40
Total	1	24	66	91	28	210

Intended users

Products developed through all of these education-focused SBIR awards from ED and NSF were intended for use by three main groups: students, teachers, and a group denoted as "other" (which includes administrators and researchers [Tables 16–17]).

Table 16. Intended users of products produced through ED Phase I projects, by year (2005–2015)

Year	Students	Teachers	Other	Total
2005	22	2	0	24
2006	25	12	6	43
2007	16	4	0	20
2008	22	3	1	26
2009	17	3	0	20
2010	18	2	1	21
2011	18	1	0	19
2012	19	2	1	22
2013	13	3	0	16
2014	10	2	0	12
2015	12	4	0	16
Total	192	38	9	239

Table 17. Intended users of products produced through NSF Phase I projects, by year (2005–2015)

Year	Students	Teachers	Other	Total
2005	9	3	0	12
2006	4	1	0	5
2007	9	2	1	12
2008	10	2	0	12
2009	8	0	0	8
2010	30	3	0	33
2011	17	5	0	22
2012	10	1	0	11
2013	18	4	1	23
2014	24	7	1	32
2015	37	3	0	40
Total	176	31	3	210

Characteristics of Projects That Were Awarded Phase II Grants

For the 10 years covered by our analyses, 122 (51 percent) of the Department of Education's 239 Phase I grantees advanced to win Phase II grants. For NSF, 63 of 210 advanced, or 30 percent (Table 18).

Table 18. Number of ED and NSF Phase I grantees that received Phase II funding (2005–2015)

Dept.	Phase I only	Phase II	Total	Phase II rate
ED	117	122	239	51%
NSF	147	63	210	30%

For both agencies, we probed to see if project characteristics (product type, subject matter, grade level, and intended user) were related to whether the projects advanced from Phase I to Phase II. Breakdowns by characteristic of projects receiving Phase II funding are shown in Tables 19a–d and 20a–d.

Table 19a–d. 10-year totals of ED's SBIR projects funded for Phase II, by project characteristic (2005–2015)

a. By product type					
	App	Game	Software	Tool	Total
Received Phase II funding	11	15	60	36	122
Total projects that applied for Phase II funding	19	23	125	72	239
Expected to advance (51%)	10	12	64	37	122

b. By subject matter							
	Assessment	ELA	Misc.	Special pops.	STEM	Teacher development	Total
Received Phase II funding	3	7	14	64	27	7	122
Total projects that applied for Phase II funding	8	11	36	117	48	19	239
Expected to advance (51%)	4	6	18	60	25	10	122

c. By grade level						
	Pre-K	Elementary	Secondary	K–12	College	Total
Received Phase II funding	0	21	19	81	1	122
Total projects that applied for Phase II funding	2	40	48	146	3	239
Expected to advance (51%)	1	20	25	75	2	122

d. By intended user				
	Students	Teachers	Other	Total
Received Phase II funding	101	20	1	122
Total projects that applied for Phase II funding	192	38	9	239
Expected to advance (51%)	98	19	5	122

Table 20a–d. 10-year totals of NSF's SBIR projects funded for Phase II, by project characteristic (2005–2015)

a. By product type						
	App	Game	Robotics	Software	Tool	Total
Received Phase II funding	1	8	1	46	7	63
Total projects that applied for Phase II funding	8	35	2	136	29	210
Expected to advance (30%)	2	11	1	41	9	63

b. By subject matter							
	Assessment	ELA	Misc.	Special pops.	STEM	Teacher development	Total
Received Phase II funding	2	4	10	8	36	3	63
Total projects that applied for Phase II funding	10	7	45	23	112	13	210
Expected to advance (30%)	3	2	14	7	34	4	63

c. By grade level						
	Pre-K	Elementary	Secondary	K–12	College	Total
Received Phase II funding	0	6	19	30	8	63
Total projects that applied for Phase II funding	1	24	66	91	28	210
Expected to advance (30%)	0	7	20	27	8	63

d. By intended user				
	Students	Teachers	Others	Total
Received Phase II funding	54	9	0	63
Total projects that applied for Phase II funding	176	31	3	210
Expected to advance (30%)	53	9	1	63

What distinguishes projects that receive SBIR Phase II funding from those that do not?

We used a chi-square test of independence to determine whether a project's characteristics are related to its receipt of Phase II funding. No such relationship was found except for a project's intended user for the Department of Education awards. Specifically, a statistically significant relationship was found between a project's phase and its intended user, χ^2 (2, N = 239) = 6.72, p = .04 (but the effect size for this relationship is small in terms of Cramer's V = 0.135). In short, projects targeting administrators and/or researchers were less likely to move on to Phase II than projects targeting students or teachers. No statistically significant relationship was found between the receipt of Phase II funding from the Department of Education and type of product, subject matter, or intended grade range.

For the 210 NSF Phase I and Phase II awards to education-related projects over the last 10 years, no relationship was found between a project's receipt of Phase II funding and its characteristics.

The computations for the statistical tests are shown in Table 21.

Table 21. Tests of significance of characteristics of advancers versus non-advancers

Department	Variable	χ^2	Degrees of freedom	N	p-value	Statistically significant
Department of Education	Product	2.70	3	239	0.44	No
	Topic	6.09	5	239	0.30	No
	Grade level	6.96	4	239	0.14	No
	User*	6.72	2	239	0.04*	Yes
National Science Foundation	Product	4.04	4	210	0.40	No
	Topic	4.90	5	210	0.43	No
	Grade level	1.17	4	210	0.88	No
	User	2.19	2	210	0.33	No

*Statistically significant, $p < .05$.

What happens to projects after Phase II funding has ended?

As noted above, one goal of SBIR is to increase private-sector commercialization of innovations derived from this federal R&D effort, with "commercialization" defined as "the process of developing products, processes, technologies, or services and the production and delivery (whether by the originating party or others) of the products, processes, technologies, or services for sale to or use by the Federal government or commercial markets" (SBA, 2014, p. 5). This purpose aligns with the Kauffman Foundation's mission of supporting innovations as one avenue for business and jobs creation.

Commercial viability

To explore the characteristics of SBIR-awarded ventures that achieve commercialization, we established a process for locating information about former grantees and a set of decision rules that would determine whether they had achieved commercialization.

To locate information about the former grantees, we conducted online searches for the name of the company (or a similar name), its product (or something similar), and the principal investigator's name. We tested our procedures and decision rules with a 15-percent random sample of ED Phase II grantees whose grants had ended at least three years prior to our analysis (i.e., 2013 — meaning their awards were granted in 2012). In the test run, we found information on 15 of the 28 and categorized their status:

- Exists and appears to be selling products (we labeled this "commercially viable")
- Exists, but no evidence of sales
- Products sold by others; original company does not appear to exist (in some cases it was acquired by another company)

- No evidence of either the company or the product

A logic check with program officers of both agencies confirmed the plausibility of the findings from our test. We applied the same procedures and decision rules to all ED and NSF Phase II grantees from 2005 through 2012.

Table 22 displays the results for all ED grantees, and Table 23 displays the results for all NSF grantees. Of the ED grantees who received Phase II funding, 56 percent existed and had evidence of sales, 21 percent existed but had no evidence of sales, 8 percent had products being sold by other companies, and 15 percent no longer existed.

Table 22. Number of former Phase II ED grantees found to be commercially viable three years after completion of their Phase II project (2005–2012)

Status	Number (percent)
Exists and is selling products	54 (56%)
Exists, but no evidence of sales	20 (21%)
Product(s) are sold by others but no evidence of the company in existence	8 (8%)
No evidence of either the company or the products	14 (15%)

Companies receiving NSF Phase II awards show similar commercial viability results as those within ED's portfolio (Table 23). Of the total group, 47 percent existed and had evidence of sales, 29 percent existed but had no evidence of sales, 8 percent had products being sold by other companies, and 16 percent no longer existed.

Table 23. Number of former Phase II NSF grantees found to be commercially viable three years after completion of their Phase II project (2005–2012)

Status	Number (percent)
Exists and is selling products	18 (47%)
Exists, but no evidence of sales	11 (29%)
Product(s) are sold by others but no evidence of the company in existence	3 (8%)
No evidence of either the company or the products	6 (16%)

Limitations of This Analysis

The process described above likely overrepresents the number of companies existing, as well as those existing and selling products, due to the longevity of domain names and

websites and the research team's inability to investigate data on sales and profitability. However, the results of this process align fairly closely with findings from other research, conversations with agency program officers, and conversations with experts in the field.

Summary of Findings

The Small Business Innovation Research programs in both the U.S. Department of Education and the National Science Foundation support the development of a wide variety of education products, and the array aligns well with markets predicted to be growing (Rivero, 2012).

Neither of the two agency programs grant awards disproportionately to small businesses in Historically Underutilized Business Zones, or to businesses owned by economically disadvantaged persons or by women.

Of the four project characteristics discernible from publicly available abstracts, none predict a project's receipt of Phase II funding except, for ED grantees, projects that were intended for use by administrators or researchers, which did not appear fruitful.

Three years after the receipt of Phase II funding, roughly half of the former Phase II grantees were found to be still in existence and selling products, as we could best determine from online searches of public information.

We convened an expert panel to better understand the findings of our compilations and to obtain insights into their own experiences in the arena of education innovation and entrepreneurship. Panelists read and commented on an initial draft report of methods and findings, suggested recommendations to enhance the report, suggested global recommendations for improving innovation funding, and suggested immediate recommendations that the Kauffman Foundation can consider implementing. Panelists were as follows: Glenn Larsen (Program Director at NSF), Alan Louie (Founder and former Managing Partner of ImagineK-12), Mitch Rosenberg (former NSF grantee, now Co-Founder and CEO of Kinderlab Robotics), Richard Culatta (Chief Innovation Officer in Rhode Island, Design Resident for IDEO), Charles Wessner (Research Professor at Georgetown University and author of evaluations of SBIR and STTR), Snehal Patel (former ED grantee, Founder and CEO of Sokikom), and Joe Vasquez (Founding Director of Michelson Runway).

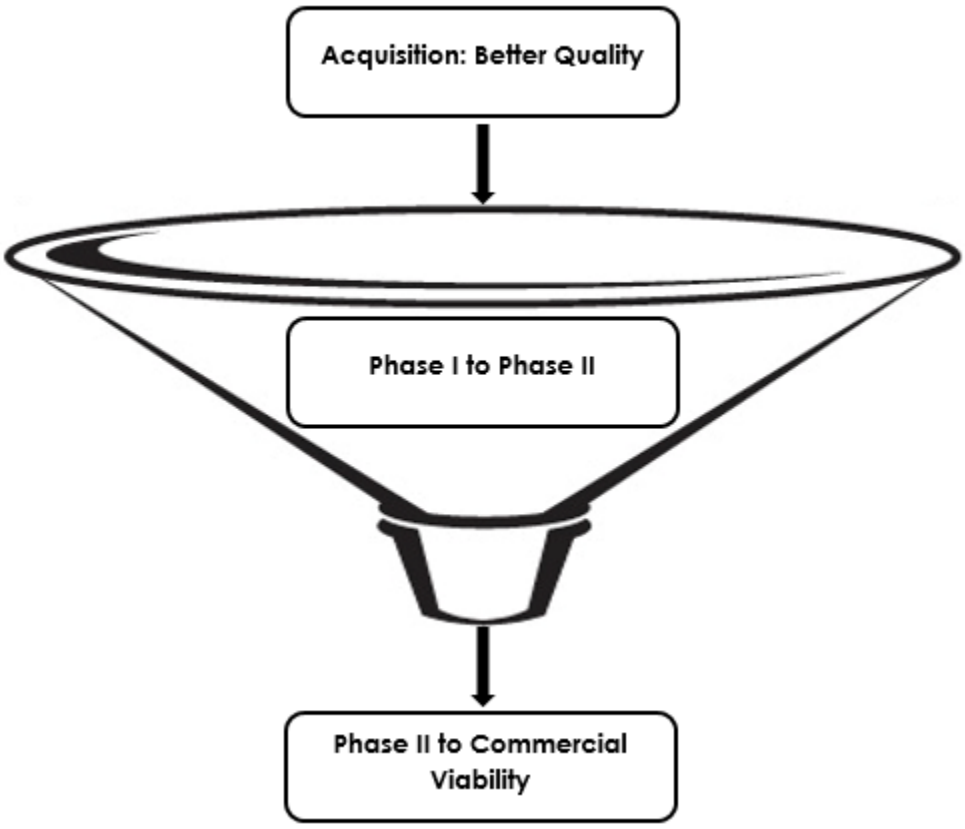
Suggestions for Increasing the Number and Success of Education Entrepreneurs

From personal experiences and observations across the arena of educational start-ups, panelists acknowledged the presence of many supports and opportunities for educational technology entrepreneurs, citing, however, a lack of information about them and how to

access them. (One panelist commented, "It is not about putting up more roads; it is about putting up better road signs.") In general, a goal should be to connect strong early entrepreneurs to existing opportunities and then support the firm through necessary funding steps.

Using a chronological framework for assistance to a promising entrepreneur, panelists offered ideas for initiatives to provide information at three general time frames: 1) as small firms are seeking supports such as SBIR, 2) as they are striving to move from Phase I to Phase II funding, and 3) as they progress from Phase II funding to securing additional supports toward commercial viability (Figure 9).

Figure 9. SBIR Supports Funnel: Three main stages of interaction opportunities



Increasing the pool of initial SBIR applicants

Panelists suggested that a larger pool of SBIR applicants needs to be identified and groomed, as a start, since firms are winnowed at every stage of the funnel, reducing the size of the pool.

NSF's framework for selecting Phase I grantees, "The Preferred Project Matrix," is shown in Table 24 as background for ways to conceptualize assistance to hopeful SBIR applicants.

As shown in the matrix, the agency is most interested in innovative, high-risk, high-reward projects (with no, or very few, competitors in their markets and which adhere to all details of the solicitation).

Table 24. NSF SBIR/STTR preferred project matrix

		Degree of Change in Technology or Application (Intellectual Merit)	
		Minimal	**Substantial**
Markets and Customers (Broad Impact)	**New**	**Evolutionary** **Minimal to no** interest in projects using existing or common technologies with few, if any, barriers to entry. There is little interest in projects that are unlikely to generate substantial revenues or jobs.	**Innovative** **High** interest in innovative, high-risk, no-competitor, high-reward projects. (Proposal is responsive to solicitation in every detail.)
	Existing	**Incremental** **No** interest in funding projects lacking innovation or in an environment where many competitors can easily gain entry to the market with little risk or minimum resources.	**Game Changing** **Moderate** interest in projects with disruptive technologies, and those impacting existing technologies and markets. (Proposal is responsive to solicitation in every detail.)

Source: National Science Foundation (2016).

Expert panelists generated a list of possible actions they thought would be helpful to SBIR applicants, as shown in Box 3.

Box 3. Specific Ideas to Increase the Pool of SBIR Applicants

- Develop and publicize the availability of a calendar of SBIR "important dates" for federal agencies that support products relevant to an organization's interests.
- Advertise the SBIR program among appropriate intermediaries (e.g., accelerators and venture capitalists) to inform them of its process, its benefits, interested applicants, and current awardees.
- Work with universities to support professors in pursuing SBIR awards, seeking to relieve them, even if temporarily, from teaching and research publication requirements that are time-consuming.
- Insist that a firm denied Phase I funding fix problems in the proposal and quickly re-apply. (Historically, these applicants have higher success rates in securing Phase I funding.)
- Share information about which markets are saturated and which need innovations. The postsecondary space has not experienced the "saturation of subject" that early education and K–12 education has experienced. For example, postsecondary products generally focus on specific and precise skills and knowledge (e.g., trigonometry), and fewer companies are in this space than are producing education innovations in grades K–12 in general areas like math.
- Identify "must-do's" for increasing SBIR applicants' success.
    - For example, they should, among other actions, contact an agency before the competition is announced for feedback on the idea.
    - They should prepare a compelling executive summary to share with the program officer in that initial inquiry.
    - They need to line up other potential support — financial or human resource such as product testers — and cite them in a proposal.
- Hold mini-competitions and then coach the winners around the "must-do's."
- Establish a university prize for business faculty and others to counsel firms about their business plan and other aspects of an SBIR application.

Advancing Phase I grantees to Phase II

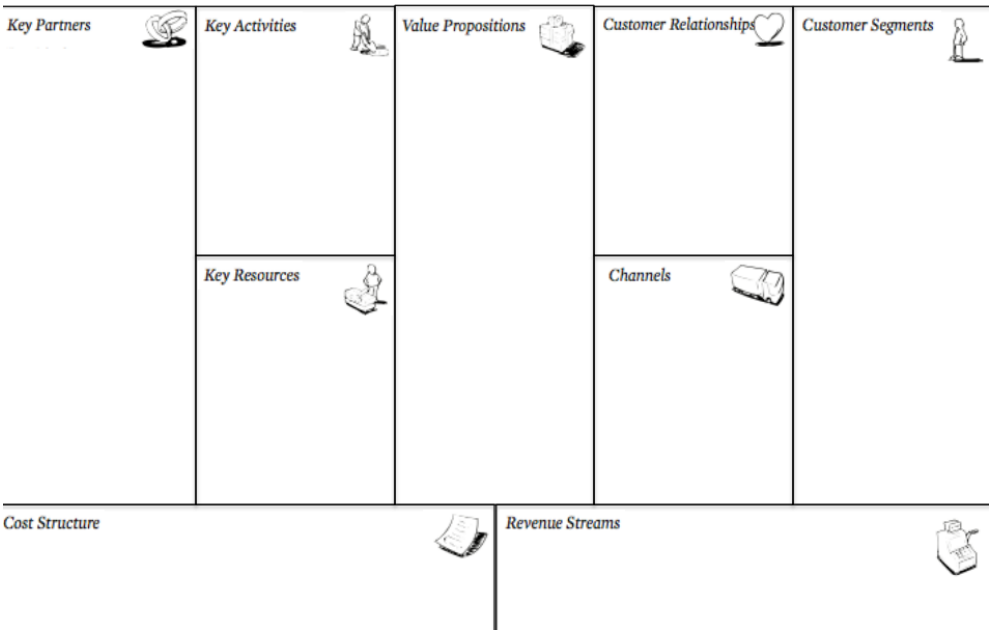
The second stage focuses on assistance to Phase I awardees seeking Phase II funding. In general, this would involve strategies to strengthen their research plans, data collections, business plans, identification of additional sources of funding, and potential client development. An example of existing agency supports is NSF's Phase I Grantee Workshop. It offers Phase I grantees the opportunity to discuss commercial and technical progress with their NSF program directors, to understand opportunities and responsibilities of all

NSF SBIR grantees, to learn about critical aspects of the SBIR Phase II program, and to receive educational information essential to high-tech small businesses. At the 2016 workshop, attendees heard from NSF program directors, successful entrepreneurs, former Phase I and II awardees, the NSF communications team, and NSF staff members critical to their work going forward. Attendees reviewed detailed itineraries for applying for Phase II funding and met with representatives from the U.S. Patent and Trademark Office and representatives from two organizations, funded by NSF, who partner with awardees to develop a commercialization plan: Dawnbreaker and Larta Inc.

An additional training opportunity for NSF Phase I grantees is the Beat-the-Odds Boot Camp (grantees must receive approval from their program director to opt out). Its goal is to provide grantees with an entrepreneurial training experience and draws on the customer discovery process attributed to serial-entrepreneur and academician Steve Blank. (See https://steveblank.com/2014/06/28/customer-discovery-the-search-for-productmarket-fit-2-minutes-to-see-why.) It focuses on developing a stronger business model, market strategy, and product. Each grantee completes Steve Blank's free "How to Build a Start Up" course online and attends three webinars hosted by NSF. In addition, participants complete a Business Model Canvas (Figure 10) to state their initial guesses and assumptions on: 1) value propositions (the customer needs/problems they are solving); 2) customer segments (the most important customers); 3) channels (how customers are reached); 4) customer relationships (attracting and retaining customers); 5) revenue streams (revenue and pricing models); 6) key resources required (financial, physical, intellectual property, etc.); 7) key partners (key partners and suppliers); 8) key activities (manufacturing, software development, etc.); and 9) cost structure (the most important costs in the business model).

After conducting at least 30 prospective customer interviews, they revise their Business Canvas Model, submit a report of their findings to NSF facilitators, and present findings for the facilitators and fellow attendees for comment.

Figure 10. Business Model Canvas used by NSF to prepare Phase I awardees for the transition to Phase II



Source: NSF Beat-the-Odds Boot Camp conference website, accessed on September 19, 2016, at http://www.nsfiipconf.com/2016fallsbirp1/boot-camp/.

A member of the research team interviewed select conference attendees to gauge their levels of satisfaction with their experience. Several had previously participated in similar development opportunities, including small business incubator programs run by nonprofit organizations, universities, and chambers of commerce. Two interviewed attendees have received SBIR funding from both ED and NSF and were able to compare and contrast their experiences. ED has neither the capacity nor the funding to provide a training program similar to what NSF provides. In focusing on the institutional support provided by each agency, attendees commented that NSF has a focus on building the capacity of the company to be successful. That is, the company should have the capacity to produce a product that makes revenue so that the company can succeed long term; whereas, ED's emphasis, as perceived by the attendees, is to have grantees build a product that can quickly get into schools, without the same focus on revenue.

Advancing Phase II grantees to commercialism

Expert panelists suggested several ways to supplement assistance offered by individual agencies (see Box 4).

Box 4. Illustrative Concrete Ways to Position Phase I Grantees for Success in Attaining Phase II Funding

- Keep them focused and on a fast-track for meeting the terms of their grant and submitting the Phase II application on schedule. (Any lag in time between phases allows competitors to enter the market, often making their product less unique or innovative.)
- Establish agreements ahead of time with organizations likely to be useful for data collection. For example, Michelson Runway, founded by panelist Joe Vasquez, recruits "pilot partners," such as the schools in the California State University system that agree to test and use products under development and report on their experiences. Establishing a database of organizations that are open to testing innovations will help companies improve their products and write better proposals.
- Help them recruit and use a balanced team (i.e., a product developer, a manager, an evaluator, a sales and marketing team) to facilitate their progress from their development phase to the sales phase.
- Help them begin soliciting outside funds immediately to at least develop a support.

The panel also generated a list of possible ways organizations could help former grantees become commercially viable, as shown in Box 5.

Box 5. Help for Phase II Grantees to Prepare for Commercial Viability

- Partner with current SBIR awardees and assist them financially and logistically in attending meetings and conferences to demonstrate their work and products and connect with potential customers and funders.
- Assist awardees in their marketing and sales efforts.
  - For example, compile a list of "top 20 factors that help make a sale."
  - Emphasize the importance and build the capacity for awardees to make repeated sales.
  - Increase awardees' connections with purchasing agents.
  - Provide guidance on how to price products and how to match their company's sales processes and procedures to those of schools and districts.
- Help them begin soliciting outside funds immediately to maximize eligibility for agencies' own follow-on funding. For example, as a 2-to-1 match for funds Phase II firms raise, NSF's Phase IIB Supplement Funding Opportunity provides an additional $100,000–$500,000 in research and development funds. Firms that have secured Phase IIB grants are substantially more likely to become commercially viable, not only because of the additional influx of funding but also because of the outgrowths of the process to secure matching funds (making connections, identifying support, better refining their message, etc.). Both NIH and DoD provide similar continuation awards after Phase II funding.

Further Research Needed

The panel offered the following recommendations for additional research:

- Conduct case studies of successful innovators in education (as well as some who have failed, for contrast) to draw conclusions from what was instrumental to success and what contributed to failure. For example, the Tibbetts Award, named after Roland Tibbetts who was instrumental in founding the SBIR program, recognizes those individuals, organizations, firms, or projects that made a visible technological impact on the socio-economic front. Award winners are selected based on the economic impact of their technological innovation and the extent to which that innovation served federal research and development needs, encouraged diverse participation, and increased the commercialization of federal research. A future study can select certain winners from past awardees and conduct case studies of their success.
- Using the SBIR supports funnel (Figure 9), document what happens to individuals, organizations, firms, or projects at each level of the process and establish what goes right to advance them and what goes wrong to hinder them.
- Document the arguments and evidence that grantees would benefit from additional marketing and commercialization support versus grantees needing more capacity to conduct research into their innovation and into scaling that innovation.

Tibbetts Award winners that were innovators in education:

1996 winner: Academic Software Inc. from Lexington, KY, produced software to assist individuals with learning, intellectual, or physical disabilities.

2014 winner: Tactus Technologies from Akron, NY, developed a virtual environment for training, education, and product development.

2014 winner: IRIS Media, from Eugene, OR, produced a web application to improve study skills for middle school students.

2015 winner: Behavior Imaging Solutions from Boise, ID, created technology to more cheaply conduct autism diagnostic assessments, which have been used by school districts and health services.

2016 winner: Agile Mind, Inc. from Grapevine, TX, developed web-based visualizations to embed in its high school biology program.

2016 winner: Sokikom, from San Jose, CA, created a collaborative math program where elementary students help one another learn through a team-based approach.

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