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**Final Project Report NSF Award 1744490: NSF INCLUDES DDLP:  
Leadership and iSTEAM for Females in Elementary school (LiFE):  
An Integrated Approach to Increase the Number of Women  
Pursuing Careers in STEM**

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## Preview of Award 1744490 - Final Project Report

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### Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
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Project Title:	NSF INCLUDES DDLP: Leadership and iSTEAM for Females in Elementary school (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM
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Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

### Accomplishments

#### \* What are the major goals of the project?

**Note: This is taken from the original proposal and so is written in the future tense.**

**LiFE** will increase the number of women and minorities interested in, and pursuing STEM pathways by engaging them early and training their teachers to effectively leverage research-based best practices and educational materials. LiFE's collective impact approach engages our partners as the project works toward the shared goal of providing hands-on experiences and strong community support to ensure that girls sustain their interest in STEM. LiFE is a comprehensive program bringing together iSTEAM, holistic student growth, and modern technologies to sustain girls' interests in STEM in the face of strong, often subtle social pressure.

We will engage and encourage girls in grades 3-6 to follow STEM pathways for life by offering problem-based design challenges

with community-focused outcomes and participation by volunteers from higher grades, college students, and community members with support from government and corporate experts.

**LiFE** will directly impact over 200 girls, many of them from underrepresented minority groups. **LiFE** will build connections among various groups and organizations from the US Army and NJIT faculty and students, to corporations such as Apple, to K-12 educators and young students in addition to New Jersey based governmental organizations.

**\* What was accomplished under these goals and objectives (you must provide information for at least one of the 4 categories below)?**

**Major Activities:**

The LiFE project started preparatory activities began before the official grant start date of 4/1/2018, so some activities took place before that date. More detail is provided in Annual Reports due to the space limitations here.

- **Prelude to Pi Day 12/19/2017** – brought 110 elementary school students from 2 LiFE districts to work together on hands-on, minds on STEAM activities with a STEAM Tank focus. We had Professional Development (PD) around the US Army STEAM Tank Challenge, while students participated in small group hands-on STEAM events. (STEAM Tank student teams present projects in which they have invented something or modified a product to solve a real world problem). All participants engaged in a “mini-STEAM Tank” experience.
- **INCLUDES Annual meeting 12/2018** - LiFE presented a poster and delivered an oral presentation. LiFE made connections and learned about other INCLUDES projects.
- **Pi Day 3/14/2018** Nearly 200 students from LiFE schools rotated among stations staffed by NJIT faculty, staff and students. Students engaged in hands-on and collaborative activities. Our partners from Apple led a Virtual Reality PD session with the teachers and all participants implemented what was learned.
- **3 day Summer Institute for LiFE teachers 6/27-29/2018** – Administrators, representatives of our partner organizations, the evaluation team and presenters also participated. The workshop included introductory information about LiFE and about stereotypical differences between boys and girls, presentations from NJIT scientists, hands-on activities, time for discussion among the teachers who have run such clubs and those who are new to the process and more.
- **Club meetings** – 2018-9. LiFE ran after school clubs in 4 schools in our 3 partner districts during the first year of the project (the proposal called for clubs in 3 schools in year 1). Clubs began meeting approximately every second week in Oct. 2018, for girls in 3rd and 4th grade in Hillside’s Hurden Looker School and in Morris Plains’ Borough School, and for girls in 5th and 6th grade in Hillside’s Washington School and for boys and girls in Weehawken’s Roosevelt School. Each club had 1-2 dozen students. Students engaged hands-on and exploratory activities, including using materials and activities presented during the Summer Institute.
- **Communication and collaboration** – The LiFE team regularly conducted conference calls with the administrative teams from the partner schools and districts and with the teachers. The PI team actively encouraged communication, continually seeking input and planning together, including planning visits to the schools, supplies that LiFE provided and obtaining feedback the teachers shared. This led to supporting our teachers’ participation in a PD event on K-5 Engineering at Liberty Science Center (2/28/2019).
- **Role model visits** - NJIT female undergraduate STEM majors visited the clubs, describing their path toward a STEM degree and worked with and gave encouragement to students. These visits continued and increased in frequency until the pandemic shut live visits down.
- **Technology support** from Apple helped NJIT’s technology group set up the iPads and provided PD on iPads and education resources.
- **Supplies** – The project supplied materials for STEAM exploration activities for the clubs ranging from iPads and accessories, snap circuits electronics kits and batteries to craft sticks, paper, glue, and more.
- **Pi Day 3/14/2019** – Based on partner input, and lessons from Pi Day 2018, rather than only have students engage in hands-on activities, club members presented to their peers from both LiFE schools and students from other interested districts. Partners from Apple (technology) and US Army (leadership) participated. Nearly 200 girls from 5 clubs attended.

- **Kid's Summit 5/29/2019** was held at Liberty Science Center for all club participants. For this year-end student recognition event, LiFE arranged a private screening of "Dream Big: Engineering our World" which "inspires kids of diverse backgrounds to become innovators". There was a session with NJIT Prof. Saikat Pal's biomedical engineering research team about innovative medical devices and pharmaceuticals, and time for students to explore the museum. NJIT faculty and students female role models facilitated.
- **Summer Institute 6/26-28/2019:** Having added new schools and districts (a new school from Hillside, a charter school from Newark and the Long Branch district), this 3-day event was attended by 20 teachers. Several teachers from non-LiFE schools, administrators, the evaluation team and presenters also participated. The workshop reviewed the first year and lessons learned, had presentations concerning technology from Apple, a visit by US Army Captain Adrienne Smith, presentations from NJIT scientists, hands-on activities, and discussion and planning time for teachers.
- **Club meetings and visits by role models/mentors** - The project supported clubs in all our original schools plus added a Hillside school, a Newark charter school and the Long Branch school district. Each school met according to a schedule that works best for them, every second week. Clubs were provided supplies desired by their teachers to engage students in hands-on, exploratory activities.
- **STEM Month 2020** - Based LiFE teacher input, rather than hold a single large Pi Day event in 2020, LiFE supported each school in a STEM Month (March) activity for their "community". Each school submitted an application for funds to support their local event, to be run by their LiFE club and include people beyond the club members to promote STEM in the community. Two of these events were held before the pandemic closings. (Planned visits to NJIT's Makerspace by the clubs were also cancelled).
- **NJ STEM Showcase at the NJ Statehouse** – LiFE was chosen by the NJ STEM Pathways Network (NJSPN) to showcase our work for the NJ State government 3/26/2020 at the state STEM Month event. (The event was cancelled but a digital magazine showcasing LiFE was produced).
- **STEAM Tank** – With partner US Army, we supported LiFE schools' participation in the US Army and NJ School Boards Association STEAM Tank challenge. Several student teams presented their efforts at Pi Day 2019. Two LiFE teams from Weehawken were top performers at the Northern NJ Regional competition, (held 3/2019 at NJIT) and were selected to present at the statewide competition in Atlantic City in 10/2019. During Summer Institute 2019 and our PD events, US Army / STEAM Tank continued to participate.
- **Activities during COVID-** LiFE was set to conclude in Spring 2020, when COVID hit. We adjusted our efforts to continue serving students in 2 ways. First, we repurposed funds from STEM Month plans to purchase supplies for STEM Starter Kits to be used by students to engage in STEM activities at home with adult supervision, assembling 500 kits. Next, rather than visiting schools, our role models crafted hands-on STEM videos with activity plan write-ups. LiFE ran a series of "STEM in Your Home" online events, available on our youtube channel and at our [www.stemforsuccess.org](http://www.stemforsuccess.org) website. (LiFE transitioned to STEM for Success to provide a larger umbrella for our expanded activities.) LiFE also created a video tour of NJIT's Makerspace facility. We also worked with Princeton Day School Girl Scouts.
- **Leveraging funds from Howmet Aerospace Foundation** LiFE held several online PD events / focus groups for LiFE teachers. We held two events for LiFE project teachers (1/12/2021 and 2/16/2021). At these events teachers discussed the transition to online learning, what worked, what was challenging and discussed resources available for STEM education through remote learning. We arranged for similar events for our partner school districts reaching over 50 teachers. A Tools for Teachers Guide was produced based on these events.
- **NJSPN STEM Month 2021** - LiFE was again selected for the now Virtual Showcase and online magazine.
- As a culmination of the project, LiFE produced a Hands-on STEM guide.

Specific Objectives:

From the proposal: **Goals and Metrics: Vision--LiFE** will increase the numbers of women and minorities interested in and pursuing STEM pathways by engaging them early and training their teachers to effectively leverage research-based best practices and educational

materials. **Mission**--We will engage and encourage girls in grades 3-6 to follow STEM pathways for life by offering problem-based design challenges with community-focused outcomes and participation by volunteers from higher grades, college students, and community members with support from government and corporate experts

**In the grant proposal, we listed the following objectives:**

**Objectives:**

**1) Understand the current state of the Girls Rock Science club**

While this issue is somewhat covered in the first year evaluation report, some of the main takeaways are that the teachers who lead the clubs are generally motivated by a personal commitment to supporting girls in STEM and that the teachers were looking forward to professional development to help them succeed in leading the STEAM projects and facilitating the club girls rock science. They want to identify and understand engaging activities for the clubs to conduct and confidence building activities for females in science or related fields. They hoped to prepare girls for STEM/STEAM career in the future and how as an educator they might influence future female leaders. They were concerned about having enough preparation time, the stress of guiding the clubs and the need for financial support for the clubs.

Based on the growth of the project and the interest we have seen from those who connect with us from outside the project, there is great interest and activity in promoting STEM participation among students at all levels of K-12.

**2) Determine from students the types of projects and activities in STEM that interest them**

*LIFE promoted through project actions connecting creativity, design and arts with STEM to helps broaden student interest and engagement. LIFE supported participants' interests rather than imposing a top-down one-size fits all program. This has been evidenced by the variety of activities our clubs have chosen to do and artifacts generated at club meetings and events:*

- Diversity of topics showcased at events such as Pi Day by club members
- Participation in STEAM Tank Challenge
- Club driven agenda items such as the end-of-year event for club members, choices of PD opportunities, individual selection of supplies and ways to demonstrate club work, requests for role models and experts to come to clubs, etc.
- Choice to develop their own community event for NJ STEM month and the variety of events they chose to have. Their applications demonstrate the variety of events they planned.

Once COVID struck, for the 2020-2021 year, we continued this philosophy by incorporating the suggestions of our audience to decide the topics about which to make STEM in Your Home videos – for example, it turns out that cooking related ones are a big hit. We also developed the STEM kits in conjunction with the desires of our partner schools.

**3) Determine from teachers the specific STEM projects to be offered and the resources that are needed to accomplish effective STEM projects suited to their specific community and situation**

Teachers had the freedom to develop and organize club meetings as they desired, how often, whether during the school day or after school, number of participants accepted, whether to have the same girls all year or bring in new girls twice a year. Our foundational club at Hurden-Looker had the girls join for half a year to accommodate more demand to be in the club, but opted not to have them join for one-third of the year in order to accommodate longer projects. Another teacher made a list of supplies that teachers at other schools revised to their desires. Teachers reported activities worked on at club meetings. Variety of

activities and interests are evidence by the projects presented at Pi Day, STEM Month proposals and activities worked on as reported in teacher logs. This was also evidenced by the range of supplies requested by the teachers ranging from paper, markers, pencils, glue, dish soap, flour etc. to bins, electronics, books and more.

In addition, at our PD event held Feb 27, 2020, we solicited feedback from the teachers concerning (i) their experiences establishing a club, recruiting and retaining students and sustaining the club, (ii) activities that worked well and what to avoid going forward, (iii) how they used technology and supplies provided by the project, (iv) what the clubs do to foster skill development, such as collaboration, leadership, communication, creativity, problem solving, critical thinking, and confidence and other skills (v) how the clubs foster connections for students (vi) the messages the clubs provide for girls (vii) the challenges they have faced. Information from this event appear in the project playbook (Hands on STEM Guide) available at the project's [stemforsuccess.org](http://stemforsuccess.org) website.

Because of such teacher input, we were in a good position to know what to include in the STEM Starter Kits we developed once the pandemic hit. We fine-tuned the list of items in conjunction with our partners. The kits include: Snap Circuits, batteries, colored pencils, construction paper, craft sticks, graph paper, index cards, scotch tape markers, paper clips, pipe cleaners, post-it notes, resealable bags, rubber bands, ruler/protractor set, and scissors.

#### Significant Results:

- **Clubs and events** - LiFE Girls Clubs started at four schools with over 70 participating girls in Fall 2018. Two of the clubs were for 3rd and 4th girls while the other two included girls in 5th and 6th grade. One school had a parallel boys club for 5th and 6th grade boys. Some schools had two half-year clubs due to overwhelming demand in order to accommodate more girls. This number girls served regularly by the clubs in the first year was about 135.

In its second year, LiFE grew from 4 clubs in 3 districts to 9 clubs in 5 districts. (We consider the club in Long Branch to be 3 clubs since 3 elementary schools were involved although they met together). Thus, activities and project in which club members participated served 300 elementary school children on a regular basis with events connecting with a much larger number overall. The project has also developed a cadre of undergraduates to serve as role models and help at PD events of the project. These role models continued and expanded the number of visits to the schools. The project has also developed collaborations that involve a group of middle school girls in robotics (First Tech Challenge) related activities and the hosting of hundreds more in an event with Newark Public Schools and Girls who Code. Pi day 2019 brought about 200 elementary school club members and children from Long Branch, which became a LiFE partner district together to showcase work. The Dec. 12, 2019 Newark Public Schools / Girls who Code showcase brought 400 middle school students to NJIT to showcase their program work. The events planned for STEM Month 2020 were expected to reach a wider group of stakeholders, including other students at club members' schools, faculty, families and community members. However, most of these had to be cancelled due to COVID. By the end of the second year of LiFE, the project far surpassed the project goal of having impact on a total of 200 girls over the course of the project.

**PD** - Teachers were supported in the first year through PD activities provided at the NJIT LiFE Summer Institute (with partners Apple and US Army), one at Liberty Science Center in Jersey City, NJ mentioned earlier and one with Classcraft (who developed a game-based approach to teaching that encourages participation, good behavior, and 21st-century skills and involves Positive Behavioral Intervention and Supports (2/8/2019). Apple provided PD and brought to our attention free resources to share with our teachers. In its second year, LiFE continued supporting the teachers and the clubs with supplies and with bringing the teachers together several times to share their ideas with the others and with the project leadership.

**Collaborations** - The LiFE project has built collaborations with other organizations with overlapping interest. The LiFE team has connected with a number of people and

organizations that have an interest in promoting positive STEAM experiences for various populations. We have been strong participants in the NJ Stem Pathways Network and the Newark STEAM Coalition (and hosted events and meetings for them). LiFE worked to have PD from Classcraft but our teachers didn't feel this was worth pursuing further). We developed a close relationship with the Long Branch school district and co-PI Lipuma has received a 21st century skills grant from the district to involve the district with LiFE. Long Branch sent staff to the Classcraft event and to our Pi Day 2019 event. Later Long Branch schools joined the LiFE project. NJIT hosted the Northern New Jersey Regionals for the US Army NJ School Boards Association's STEAM Tank challenge March 9, 2019. We collaborated with the Newark Public School and Union City school districts with respect to Pi Day. We worked with two FIRST Tech Challenge robotics teams, including an all girls team. LiFE connected with Liberty Science Center (LSC) and held a Kids Summit event to celebrate the conclusion of LiFE's first year at LSC in May, 2019. By the end of the second year of LiFE, our efforts raised the awareness of other groups to our work and led to connections and collaboration opportunities. Several independent schools like Princeton day school and Stuart Country Day School have engaged with us to participate in events and support their programs. We have engaged with Girl Scouts and other service groups to work on aligning efforts and developing partnerships.

Once the **pandemic** hit, the project shifted to creating and distributing the STEM Starter Kits, producing the STEM in Your Home events and videos, and the PD events to gather educator insights in online STEM learning, we continued to grow STEM for Success. We also worked to develop our digital commons presence, a repository that will house many of the products produced through the grant and that promises to serve as a vehicle through which students can disseminate their STEM creative work. Thus, we were able to continue serving the clubs in a modified way during the pandemic.

Key outcomes or Other achievements:

Our clubs, starting with 4 at the start of the project and growing to 9 clubs in 5 districts in the second year, have been developed and continue to operate even though funding has concluded. In addition, we have expanded collaborations with other organizations and are building a network extending from elementary school (through LiFE) to middle school (with First Robotics, for example) and to the Junior Science and Humanities Symposium challenge (at the high school level) as well as working with several high school interns to undergraduate role models at NJIT along with faculty.

Thus, we have transitioned LiFE to STEM for Success [www.stemforsuccess.org](http://www.stemforsuccess.org) . This provides a larger umbrella for our expanded activities and helps disseminate information to interested stakeholders and supporters.

LiFE provided many worthwhile PD experiences for project teachers and to other teachers. Having Apple and US Army as partners extended the expertise and skills offered. The PD events are listed in the relevant section of this report.

Feedback from our partners and growth of interest (making the logistics of events with all participants more complicated) led to a transition of the support for a Pi Day event to a set of events, one in each community, for NJ STEM month, March 2020. The only parameters we required were that the events be centered on their LiFE club and that it extend and promote STEM to a community beyond those already involved in LiFE. We developed an application process and allocated funds from the project to support these 7 events (one event for Long Branch's 3 participating elementary schools) rather than one large event. The transition from a single Pi Day event to a set of community events for STEM month is a significant result in that the participating LiFE club students played a key role in developing the events with a mission to promote STEAM beyond their clubs, to the community. It also served to build the communication and leadership skills of the girls, a key aspect of the LiFE proposal. Two of the events occurred before the closings due to the pandemic.

The LiFE team has been actively involved with the NJ STEM Pathways Network. Our work was showcased in their 2020 and 2021 virtual STEM Month publications. STEM for Success is playing an important role with NJSPN in their STEM Month plans going forward.

The Arconic Foundation (later Howmet Aerospace Foundation) learned of the LiFE project

and has provided two grants totaling \$55,000 to supplement NSF's support for LiFE. Arconic representatives participated in our Feb. 27, 2020 PD event. They supported purchase of supplies and efforts to understand and create content for online STEM education.

The project produced two key documents, the Hands-On STEM Guide and the Tools for Teacher Guide, found at [stemforsuccess.org](http://stemforsuccess.org). A listing of media coverage and products produced by LiFE is provided in an attached file. These include LiFE being featured in the inaugural issue of the INCLUDES Network blog.

We have added to our team, this year, two high school students. These students have made videos presenting STEM topics for our online events. Thus, our project now includes elementary school, middle school, high school and undergraduate students making our evolving network truly K-20.

We conclude this section with a listing of many of the lessons learned from working on the LiFE grant.

*Insight I: It is important to be intentional and persistent in fostering a sense of partnership with all stakeholders. Some of the best ideas arise in this manner.*

*Insight II: It is important not to overly impose structures on project partners. It is beneficial to allow for flexibility so that communities can develop what works for them.*

*Insight III: In the safe, supportive environment of exploration fostered by the clubs, girls were enthusiastic about participation (in some cases clubs were oversubscribed) and girls were not afraid to have their designs fail, they simply "failed forward".*

*Insight IV: While teachers applauded many aspects the project's PD, they most appreciated the opportunity to bond with other teachers. Generally, teachers have few opportunities to interact and discuss ideas and plans with teachers at other schools and even within their own schools. Thus, the more time that PD provides for educators to discuss activities, desired supplies and to collaborate with one another, the better.*

*Insight V: The PD activities as structured by the project helped teachers feel confident in their abilities to implement and run the program.*

*Insight VI: Teachers appreciated having a program that wasn't overly structured that allowed for common planning, sharing time and communication along with hands-on aspects.*

*Insight VII: If events are held where teachers are separated from students, one needs to plan for enough supervision.*

*Insight VIII: Students were engaged by having multiple hands-on activities with opportunities to choose which one(s) to participate in.*

*Insight IX: Club participants gained experience with communication and leadership when provided with opportunities to showcase their efforts for a friendly audience. Allowing for various avenues of involvement and engagement by K-12 students in STEAM was "extremely effective" (according to the evaluator) at sustaining STEAM interest. The project's many activities and events cultivated a sense of community among students and staff across participating schools.*

*Insight X: Many teachers are concerned about lack of preparation time, stress, lack of financial support, or school mandates. It is important to keep this in mind when developing PD experiences.*

*Insight XI: Prepare for changes in district leadership and teacher turnover. Regular and open communication as well as support from project leadership and other teachers is important working to deal with such situations.*

***Insight VII: If events are held where teachers are separated from students, one needs to plan for enough supervision.***

***Pandemic Insight I: Sending materials/supplies home whether by the schools or through our***



*STEM Starter Kits was worthwhile since different students may have different access to hands-on activity materials, some even needed paper.*

*Pandemic Insight II: The participants in the online teacher fora indicated that there is a need for tutorials for educators and for parents in order to make STEM learning at home more effective. Thus, we produced the Tools for Teachers Guide.*

#### \* What opportunities for training and professional development has the project provided?

- **Prelude to Pi Day 12/19/2017** – As noted above, even before the official start of the project, we held this event which included PD around the US Army STEAM Tank Challenge, while students participated in small group hands-on STEAM events. (STEAM Tank student teams present projects in which they have invented something or modified a product to solve a real world problem). All participants engaged in a “mini-STEAM Tank” experience in the afternoon where the teachers led the activities based on what they learned during the morning session.
- **Summer Institute June 27-29, 2018** – The event, described above, was designed specifically for our LiFE district teachers and also, in part, for the administrative teams. The event featured PD from Apple and participation from Army. There was hands-on training with technology and group work and exploration with science resources with guests from the American Chemical Society. Presentations/workshops about various topics relating to iSTEAM took place. A special guest speaker at the Institute was New Zealand Primary School principal Chris Murphy who was awarded a prestigious Woolf Fisher Fellowship, which had him travel overseas around the world to examine different teaching practises during 2018.
- **2018 Champions for Change** – Here the PIs engaged in the PD by attending this workshop to increase their understanding of collective impacts and to learn how various organizations are applying these concepts on a scale that is making a difference in diverse areas such as crime prevention, urban planning, and more. We met several people involved with and knowledgeable about INCLUDES Alliance projects and gleaned ideas for moving forward toward such a project.
- **NJ School Boards Association Workshop Oct. 22-24, 2018**– The PIs and several NJIT faculty, students and a LiFE teacher attended this conference to witness the US Army STEAM Tank finals in preparation for participation of LiFE in the STEAM Tank Challenge. Our group also promoted the project, engaged in leadership activities, attended PD presentations and developed role model/mentorship skills and networked with education professionals.
- **Classcraft PD event Feb 8** - Classcraft is a new, game-based approach to teaching. It is designed to encourage participation, good behavior, and 21st-century skills like collaboration as well as to increase student engagement with their lessons. Everything students learn in class stays the same, but they get to have a little fun each day. A significant part of this is its Positive Behavioral Intervention and Supports (PBIS). Classcraft leverages machine learning to offer real-time insights into behavior trends and educational outcomes around PBIS and SEL (Social and Emotional Learning). A professional development event was held at NJIT on Feb 8, 2019 for LiFE districts and other potential LiFE districts. Classcraft offered to create a custom “experience” for the LiFE clubs. The project participants chose not to pursue this opportunity further.
- **Liberty Science Center Workshop (Feb 28, 2019)** Engineering is Elementary (K–5) works to enhance teacher understanding of STEM units that focus on engineering practices. Teachers were exposed to a curriculum unit and other topics that can help them help students pursue proficiency in Next Generation Science Standards based engineering practices. LiFE provided funding for all our teachers to attend.
- **Summer Institute – June 26-28, 2019:** This 3 day workshop included ice breakers to bring in all the new participants and a review of the first year and the lessons learned. There were presentations concerning technology from our partners at Apple and a visit by US Army Captain Adrienne Smith. There were presentations from NJIT scientists, hands-on activities, time for discussion among the teachers who have run such clubs and those who are new to the process and more. Positive impacts included bonding among the project’s teachers, collecting information about the supplies teachers found useful and ones that they felt would be helpful going forward.
- **Oct. 30, 2019 and Feb. 27, 2020 PD events at NJIT** - LiFE’s teachers identified a need to have common planning time and a way to communicate with one another and their colleagues in a professional learning community. Thus, we intentionally planned at each of these PD days to include both content (hands-on activities, a visit to NJIT’s makerspace) and sharing time as requested by teachers. Teachers also were among the presenters as they shared successful activities used in their clubs as well as their experiences starting, maintaining and managing their clubs. At the Feb 27 event, the success of the makerspace tour led to requests for visits by 4 of our districts that were scheduled for mid-late March. Unfortunately, these had to be canceled due to the pandemic.
- **iSTEAM 2020 Conference:** LiFE supported 2 teachers’ attendance at the iSTEAM 2020 Conference: Full STEAM Ahead workshop at Ramapo College, NJ on January 14, 2020. Those teachers reported about their experience to the other teachers at the Feb. 27 PD event.
  - **2021- Professional Development Events:** By leveraging funds from Howmet Aerospace Foundation we held several online professional development events / focus groups for LiFE teachers. We held two events for LiFE project teachers Jan 12, 2021 and Feb. 16, 2021. At these events we discussed the transition to online learning, discussed what worked and what was challenging and discussed resources available for STEM education through remote learning. We offered our partner school districts the opportunity to have similar events (funded by the Howmet funds) and reached over 50 educators, including in

Morris Plains, Long Branch and Newark.

These PD sessions were helpful in garnering feedback from participants about the STEM in Your Home events as well. These events have been well received and we have been told that there are parents who adjust schedules to attend. Some have taken and sent us pictures of their children doing the activities at home. All teachers agreed that hands-on STEM was difficult in an online environment. The main support provided was via virtual tools which is not particularly hands-on. Superintendents reported much lower performance ratings for STEM by parents. All educators felt that the cost of digital tools both in real costs of money and the cost in time needed to learn and master them caused STEM teaching to be less effective. All expressed a high interest in virtual visits to classrooms by our role models and a desire for more and more diverse hands-on experiences to be recorded and shared. Based on the input we held an Earth Day STEM in Your Home livestream event.

**\* Have the results been disseminated to communities of interest? If so, please provide details.**

In this section we detail the media coverage, NSF INCLUDES blogposts, publications and other forms of dissemination of LiFE.

Some of our early work appears on the original project website [njit.edu/lifegrant](http://njit.edu/lifegrant). Once the project transitioned to the more expansive STEM for Success project, we connect our material to the [stemforsuccess.org](http://stemforsuccess.org) website. Our efforts have been disseminated as well through the Future Ready Schools – NJ which reaches over 4000 education professional in NJ and through the NJ STEM Pathways Network which is a hub for the 8 NJ STEM Ecosystems.

Major dissemination efforts included the Hands-on STEM Guide and the Tool for Teachers guide, available at [stemforsuccess.org](http://stemforsuccess.org). Our events have also been publicized our social media @STEMforSuccess and on our youtube channel.

A chronological listing of project dissemination follows:

**Publications/Conferences and Showcases related to the project:**

James Lipuma. (2017, March 13). *Creating Strong Broader Impacts for NSF Proposals: Role of Evaluation & Broader Participation*. Panel discussion at NJIT featuring Bernice Anderson, Melvin Hall and Jennifer Slimowitz Pearl <https://www.youtube.com/watch?v=7rUa9WiBIIA&feature=youtu.be>

Bukiet, B., Lipuma, J. & Steffen-Fluhr, N. (2018, Jan. 10-12). *Leadership and iSTEAM for Females in Elementary Schools (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*, poster presentation at INCLUDES Annual Meeting 2018, Alexandria, Va.

Bukiet, B., Lipuma, J. & Steffen-Fluhr, N. (2019, May 29-30). *Leadership and iSTEAM for Females in Elementary Schools (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*, poster presentation at NSF INCLUDES National Network Convening 2019, Alexandria, Va.

Bukiet, B., & Lipuma, J. (2019). *Building 21st Century Skills among Elementary Schools Students – The LiFE Project*. In S. Carliner (Ed.), *Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 1031-1038). New Orleans, Louisiana, United States: Association for the Advancement of Computing in Education (AACE). <https://www.learntechlib.org/primary/p/211184/>.

Lipuma, J., & León, C. (2019). LiFE: Collaboration Potentials and Partnerships. *Bringing ERCs into the INCLUDES National Network*, 37. [https://www.washington.edu/doit/sites/default/files/atoms/files/ERC-INCLUDES\\_CBI\\_Accessible\\_PDF.pdf](https://www.washington.edu/doit/sites/default/files/atoms/files/ERC-INCLUDES_CBI_Accessible_PDF.pdf)

Bukiet, B., & Lipuma, J. (2021, July 30). *STEM in Your Home at the NSF INCLUDES National Network* [Video]. NSF INCLUDES Virtual Convening 2021: Multimedia Showcase, online. <https://www.includesnetwork.org/viewdocument/stem-in-your-home>

same as: NSF. (2021, May 11). *2021 STEM For All Video Showcase*. 2021 STEM For All Video Showcase. <https://stemforall2021.videohall.com/>

Lipuma, J., & León, C. (2021, July 15). Collaborative co-design for community change. *Collaborative Change Models*. 2021 NSF INCLUDES National Network Virtual Convening: Mobilizing to Transform Systems, USA. <https://www.includesnetwork.org/viewdocument/collaborative-change-initiatives-c?CommunityKey=c80fae58-3392-4f6f-a2e7-3e42a729c456&tab=librarydocuments>

Bukiet, B, Lipuma, J. & Steffen-Fluhr, N., (2021, 11/18) Project Outcomes Report for LiFE: [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1744490&HistoricalAwards=false](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1744490&HistoricalAwards=false)

**Press releases and media coverage:**

September 2017 NSF press release: 27 new NSF INCLUDES awards aim to enhance U.S. science and engineering enterprise

- [https://www.nsf.gov/news/news\\_summ.jsp?cntn\\_id=243055&WT.mc\\_id=USNSF\\_51&WT.mc\\_ev=click](https://www.nsf.gov/news/news_summ.jsp?cntn_id=243055&WT.mc_id=USNSF_51&WT.mc_ev=click)

NSF Announcement of the Award:

- Bukiet, B., Lipuma, J. M., & Steffen-Fluhr, N. (2017, September 8). *NSF Award Search: Award#1744490—NSF INCLUDES DDLP: Leadership and iSTEAM for Females in Elementary school (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*. [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1744490](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1744490)

September 2017: NJIT press release: Learning Strategies to Encourage Girls to Embrace STEM

- <https://news.njit.edu/learning-strategies-encourage-girls-embrace-stem>

Fall 2017: Inside Hillside article: Hillside program to serve as model: Girls Rock Science will be foundation of NJIT program to encourage girls in STEAM

- <http://www.district.hillsidek12.org/userfiles/380/my%20files/inside%20hillside%20fall%202017.pdf?id=4560>

Pi day 2018 NJIT 1 UP video

- <https://www.youtube.com/watch?v=8Ohf73VsLLE> March 19, 2019

2018 April FRS-NJ newsletter article about Pi Day

- [https://drive.google.com/file/d/1we-MK61W6\\_gDXXQ7PSrDPwznj0Va7Svr/view?usp=sharing](https://drive.google.com/file/d/1we-MK61W6_gDXXQ7PSrDPwznj0Va7Svr/view?usp=sharing)

LiFE project discussed in: National Science Foundation. (2018). *NSF INCLUDES Report to the Nation I* (Report No. 1; NSF INCLUDES). National Science Foundation.

- [https://www.nsf.gov/news/special\\_reports/nsfincludes/pdfs/INCLUDES\\_report\\_to\\_the\\_Nation.pdf](https://www.nsf.gov/news/special_reports/nsfincludes/pdfs/INCLUDES_report_to_the_Nation.pdf)

US Army and SBA's Joseph Wittmer gave a STEAM Tank presentation at Weehawken 12-12-2018. Here is a link to a video of one group's presentation

- [https://www.icloud.com/attachment/?u=https%3A%2F%2Fcvws.icloud-content.com%2FB%2FAenM2TdBhcT8kvV95ZecseplIOeuAZ5Uc2Nd-O4W0Sok6yqjl-32a7LD%2F%24%7Bf%7D%3Fo%3DA55OBTUAA3eGA8DM-9z7A9eU0Dz5vXe8o2UPqTT4sh72%26v%3D1%26x%3D3%26a%3DB8sdORQLySIN\\_0qVr3c2TvHvyDJQAx3SAEACAHIAP9-SPxqA1zORw%26e%3D1547249002%26k%3D%24%7Buk%7D%26fl%3D%26r%3DE51A3281-3FBB-46BD-9933-6167E6E68972-1%26ckc%3Dcom.apple.largeattachment%26ckz%3D02AE9CB2-E413-4F30-999E-DA1F205F17E7%26p%3D25%26s%3D5T\\_mYPTOo2f0lv5a7\\_xsfW7-3s&uk=-U2DTIGF\\_6RILaJtzUSayQ&f=IMG\\_2222.MOV&sz=105154168](https://www.icloud.com/attachment/?u=https%3A%2F%2Fcvws.icloud-content.com%2FB%2FAenM2TdBhcT8kvV95ZecseplIOeuAZ5Uc2Nd-O4W0Sok6yqjl-32a7LD%2F%24%7Bf%7D%3Fo%3DA55OBTUAA3eGA8DM-9z7A9eU0Dz5vXe8o2UPqTT4sh72%26v%3D1%26x%3D3%26a%3DB8sdORQLySIN_0qVr3c2TvHvyDJQAx3SAEACAHIAP9-SPxqA1zORw%26e%3D1547249002%26k%3D%24%7Buk%7D%26fl%3D%26r%3DE51A3281-3FBB-46BD-9933-6167E6E68972-1%26ckc%3Dcom.apple.largeattachment%26ckz%3D02AE9CB2-E413-4F30-999E-DA1F205F17E7%26p%3D25%26s%3D5T_mYPTOo2f0lv5a7_xsfW7-3s&uk=-U2DTIGF_6RILaJtzUSayQ&f=IMG_2222.MOV&sz=105154168)

2/15/2019 Press release about the Classcraft event:

- <https://news.njit.edu/njit-workshop-introduces-new-jersey-teachers-world-fantasy-rpg-education>  
National Pi Day 2019: NJIT Welcomes New Jersey's Elementary School Girls to STEM LiFE

[Tuesday, March 19, 2019 CSLA February Alumni Newsletter \(2019\)](https://www.csla.njit.edu/news?page=20)

- <https://csla.njit.edu/news?page=20>

Pi Day 2019 stories:

- From NJIT: <https://news.njit.edu/national-pi-day-2019-njit-welcomes-new-jerseys-elementary-school-girls-stem-life> 3/21/2019
- Pi Day 2019 report on News 12  
<https://drive.google.com/file/d/1wUvl28TO40TjXoGFxZtst7nrxLEs4p3D/view?usp=sharing>

NJIT Pi Day in March 2019 FRS-NJ Newsletter had a story but is not online

LiFE / STEM for Success Featured in NJSPN STEM Month 2020 Showcase p. 22

- <https://online.flippingbook.com/view/750069/22/>

INCLUDES Network blogpost 2/2021

- <https://www.includesnetwork.org/blogs/nsf-includes-coordination-hub1/2021/02/04/looking-back-at-2020-as-a-year-of-challenge-and-in>

LiFE / STEM for Success Featured in NJSPN STEM Month 2021 Showcase p. 14 (DCS) and p. 27

- <https://njstempathways.org/stemmonthrecap-2021/>

11/10/2021 update of INCLUDES network blogpost

- <https://www.includesnetwork.org/blogs/nsf-includes-coordination-hub1/2019/10/10/network-spotlight-leadership-and-isteam-for-female>

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## Products

### Books

### Book Chapters

### Inventions

### Journals or Juried Conference Papers

View all journal publications currently available in the [NSF Public Access Repository](#) for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

Lipuma, J., Bukiet, B. & Leon, C., Cultivating Interest in STEM among Elementary School Females: An exploratory study for NSF INCLUDES, Paper In preparation.. Status = OTHER.

### Licenses

### Other Conference Presentations / Papers

Bukiet, B., & Lipuma, J. (2019). *Building 21st Century Skills among Elementary Schools Students – The LiFE Project*. Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 1031-1038). Association for the Advancement of Computing in Education (AACE).. New Orleans, Louisiana. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Bukiet, B., Lipuma, J. & Steffen-Fluhr, N. (2018). *Leadership and iSTEAM for Females in Elementary Schools (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*. INCLUDES Annual Meeting 2018 (poster presentation). Alexandria, Va.. Status = OTHER; Acknowledgement of Federal Support = Yes

Bukiet, B., Lipuma, J. & Steffen-Fluhr, N. (2019). *Leadership and iSTEAM for Females in Elementary Schools (LiFE): An Integrated Approach to Increase the Number of Women Pursuing Careers in STEM*. NSF INCLUDES National Network Convening (poster presentation). Alexandria, Va.. Status = OTHER; Acknowledgement of Federal Support = Yes

Lipuma, J., & León, C. (2019). *LiFE: Collaboration Potentials and Partnerships*. Bringing ERCs into the INCLUDES National Network. Seattle, WA. Status = OTHER; Acknowledgement of Federal Support = Yes

### Other Products

*Audio or Video Products.*

Video for the STEM for All Video Showcase and for the NSF INCLUDES Virtual Convening 2021: Multimedia Showcase

<https://www.includesnetwork.org/viewdocument/stem-in-your-home>

and <https://stemforall2021.videohall.com/>

*Educational aids or Curricula.*

Hands-On Developmental Playbook for STEM Clubs in Elementary School. [https://drive.google.com/file/d/1FOCfiviJOIzZmluZjfAdE\\_3D4Q0pvHyL/view](https://drive.google.com/file/d/1FOCfiviJOIzZmluZjfAdE_3D4Q0pvHyL/view)

*Educational aids or Curricula.*

Tools for Teachers Guide [https://a4e0a079-e668-44e4-9ac6-83b90c08abdd.filesusr.com/ugd/335889\\_4bee1d3a5d6b4d15926a29bd3b222629.pdf](https://a4e0a079-e668-44e4-9ac6-83b90c08abdd.filesusr.com/ugd/335889_4bee1d3a5d6b4d15926a29bd3b222629.pdf)

*Project Outcomes Report for this Grant.*

This is the Project Report submitted for this grant: [https://www.nsf.gov/awardsearch/showAward?AWD\\_ID=1744490&HistoricalAwards=false](https://www.nsf.gov/awardsearch/showAward?AWD_ID=1744490&HistoricalAwards=false)

## Other Publications

## Patent Applications

## Technologies or Techniques

## Thesis/Dissertations

## Websites or Other Internet Sites

*LiFE Project original website*  
<https://www.njit.edu/lifegrant/>

This is the first website for the project. As the project expanded into the STEM for Success initiative, all later material is incorporated there.

*STEM for Success website*  
<https://www.stemforsuccess.org/>

This is the website for the STEM for Success project and contains links in particular to the Hands-on STEM guide and the Tools for Teachers guide.

## Participants/Organizations

### What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Bukiet, Bruce	PD/PI	9
Lipuma, James	Co PD/PI	9
Steffen-Fluhr, Nancy	Co PD/PI	3

**Full details of individuals who have worked on the project:**

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**Bruce G Bukiet****Email:** bukiet@njit.edu**Most Senior Project Role:** PD/PI**Nearest Person Month Worked:** 9

**Contribution to the Project:** Dr. Bruce Bukiet (PI) led the LiFE project, overseeing daily responsibilities for management and communication with all partners and participants. These responsibilities included: maintaining the budget, ordering items, arranging visits to schools and coordinating all events and meetings. Prof. Bukiet took part in all interactions, calls, and meetings with partner schools, government, and industry collaborations. He worked with students and role models and with Prof. James Lipuma in building collaborations with other educational, non-profit and other organizations and in the planning and running of project events and activities. He played a large part along with Dr. Lipuma in developing and executing strategy for the project.

**Funding Support:** partial support from NSF #1744490

**Change in active other support:** No

**International Collaboration:** No

**International Travel:** No

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**James Lipuma****Email:** lipuma@njit.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 9

**Contribution to the Project:** Dr. James Lipuma (CoPI) led the development and maintenance of our Collaborative and event logistics for the backbone of our collective impact efforts. As director of NJIT's Collaborative for Leadership Education and Assessment Research (CLEAR) and STEM for Success, he continued our partner recruitment activities as the project expanded. He supported the day-to-day operations of the project while managing the mid and long-range planning and scheduling in support of the project. He continually consulted with Dr. Bukiet, all levels of NJIT administration, members of the partner districts, our corporate partners, and potential new collaborators and volunteers. He played an essential role in connecting with industrial and governmental organizations as well as other non-profits, working to grow the network of involved organizations and individuals. He played a large part along with Dr. Bukiet in developing and executing strategy for the project.

**Funding Support:** partial support from NSF #1744490

**Change in active other support:** No

**International Collaboration:** No

**International Travel:** No

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**Nancy Steffen-Fluhr****Email:** steffen@njit.edu**Most Senior Project Role:** Co PD/PI**Nearest Person Month Worked:** 3

**Contribution to the Project:** Dr. Nancy Steffen-Fluhr, Director of NJIT's Murray Center for Women in Technology, took the lead in planning the Summer Institute workshops for 2018 and 2019. She arranged for speakers, hands-on activities and discussion around Climate Change and helping to design demos and hands-on activities for the teachers. Faculty, mostly female, from Chemistry, Forensic Science, Biology, Architecture and Informatics delivered presentations and led hands-on activities. During the school year, D. Steffen-Fluhr, an Associate Professor in the NJIT Humanities Department's Science, Technology and Society Program, has helped to engage NJIT women faculty and students in LiFE activities as mentors, and role models. She is the driving force behind NJIT's annual Women Designing the Future Conference.

**Funding Support:** partial support from NSF #1744490**Change in active other support:** No**International Collaboration:** No**International Travel:** No**What other organizations have been involved as partners?**

Name	Type of Partner Organization	Location
Apple Corporation	Industrial or Commercial Firms	Cupertino, California
Arconic / Howmet Aerospace Foundation	Other Nonprofits	Dover, NJ
US Army	Other Organizations (foreign or domestic)	NJ

**Full details of organizations that have been involved as partners:****Apple Corporation****Organization Type:** Industrial or Commercial Firms**Organization Location:** Cupertino, California**Partner's Contribution to the Project:**

In-Kind Support

Personnel Exchanges

**More Detail on Partner and Contribution:** Apple Corporation has provided technology expertise and advice for the project. Apple personnel have participated in numerous meetings and professional development over the course of the project.

**Arconic / Howmet Aerospace Foundation****Organization Type:** Other Nonprofits**Organization Location:** Dover, NJ**Partner's Contribution to the Project:**

Financial support

**More Detail on Partner and Contribution:** Provided support for supplies and role model visits to schools. Provided support for PD events concerning STEM education in online environments once the pandemic struck.

**US Army****Organization Type:** Other Organizations (foreign or domestic)

**Organization Location:** NJ**Partner's Contribution to the Project:**

Personnel Exchanges

**More Detail on Partner and Contribution:** US Army – NJ School Boards Association – We have worked with US Army personnel embedded with NJ School Boards Association to incorporate LiFE participation in their STEAM Tank challenge process. Toward this effort, Staff Sergeant Joseph Wittmer visited several LiFE schools during the year and John Henry presented at our professional development events. Several of our role models went to the STEAM Tank finals in Atlantic City and served as judges and in other capacities at the STEAM Tank regionals Capt. Adrienne Smith presented as a role model at several LiFE professional development events and joined LiFE and Girl Scouts at an event. One of our undergraduate role models participated in a parachute jump with the US Army Golden Knights. Video from this jump was part of a STEM in Your Home event <https://www.youtube.com/watch?v=AXHw0dMoUrU> We also ran a Facebook live event with NJSBA in August 2020.

**Were other collaborators or contacts involved? If so, please provide details.**

Due to space limitation, we do not include individual names here as we did in the annual reports, but rather summaries of organizations/categories involved.

School administrative teams –

Hillside Public School District - Superintendents; Principals, Science Supervisor

Morris Plains School District - Superintendent; Director of Technology & Innovation; Principal,

Weehawken – Principal, – Assistant Superintendent, Academic Affairs & Innovation; IT and Digital Information Officer;

Long Branch School District- Coord Grants & Innovative Programs

Discovery Charter School, Newark - School Leader,

Teachers from each of the districts/schools noted above

Princeton Day School Girl Scouts Leadership

Evaluation team at Center for Effective School Practice

NJIT Undergraduate Student Role Models and Graduate student role models etc.

High School Interns

Outside organizations: JerseySTEM, American Chemical Society, elb global, Girls who Code / Newark Public Schools, NJ STEM Pathways Network, Newark STEAM Coalition, Joya Clark of the NJIT Center for Pre-College Programs/Science Teacher at Sojour High School at the Essex County Juvenile *Detention Center* in Newark

NJIT faculty and staff and organizations: Murray Center for Women in Technology, Summer Institute, Off Institutional Effectiveness, Director of Research, College of Science and Liberal Arts

**Impacts****What is the impact on the development of the principal discipline(s) of the project?**

Nothing to report.

**What is the impact on other disciplines?**

Nothing to report.

**What is the impact on the development of human resources?**

LiFE supported STEAM clubs with role models and utilized research based best practices in co-design and community involvement. Educators were supported with relevant professional development for hands-on STEM, and 21st century skills, including leadership and communication. We begin this section by summarizing the number of schools, districts, educators, students etc., i.e. the reach



of the LiFE project.

LiFE's goal was to impact 200 girls in grades 3-6 from four schools in 3 NJ districts. Interest in participation in the project was greater than we expected which enabled the project to expand. Table 1 below presents data about the program components while Table 2 provides data on participants and impact.

	total
NJ schools / districts	9 / 5
Partners and collaborators	56
NJIT STEM role models	15
High school STEM interns	4
Backbone & support staff	50

Table 2: NSF INCLUDES Shared Metrics Reported in Aggregate

Shared Measure	Overall Interactions	Unique participants
Student participants	8480	1470
Collaborators	53	15
Unique Educators	770	300
Total Participant Interactions	9,303	
Indirect impact (estimated)	3,830	
Total Impacts	13,133	

LiFE club participants benefited from the ongoing positive STEAM activities as well as from interactions with role models and US Army's STEAM Tank personnel who have visited partner schools. Club members also developed their own explorations and projects and presented them at events held at NJIT and for their communities. The various events and activities of the project have been detailed earlier in this report. Club participants also gained from the leadership, communication, presentation and technology skills that LiFE and its partners (US Army and Apple) brought to the project. Evidence of student growth includes presentations at NJIT and community events and at the statewide STEAM Tank challenge. We discuss benefits to education professionals in the following subsection.

During the pandemic, the project's transition to STEM for Success has enabled a wider range of participants to be impacted as the project created videos and learning objects which are persistent and may be viewed on the users' schedule. The feedback about the STEM in Your Home events has been quite positive, with some people following and performing the experiment/activity at home and some rearranging their schedules so they can participate in the live event. Because of the production of these resources in addition to the ability to make them available through our youtube channel, our digital commons repository and our stemforsuccess.org website. The impact of our efforts can scale to reach a wider audience. Through our DDLP, it became clear that to expand and reach sustainable scale, club creation would not work in an affordable way. STEM for Success can help support the formation of local organizations both in school and outside of school time as well as the continued functioning of clubs. In addition, with the STEM in Your Home events and the Hands-on STEM Guide playbook, offers the opportunity for others to benefit from our efforts at the time and place convenient to them going forward.

### What was the impact on teaching and educational experiences?

More than 20 teachers benefited from the professional learning community developed through the project's activities and through the collaborations fostered through the professional development events and the hands-on activities at these events. Teachers who were apprehensive at first gained confidence and became mentors and partners to the other members of the team. By breaking down barriers and fostering an environment of mutual respect, sharing of ideas among teachers, administrators and university faculty became the norm and the impact of each of LiFE's efforts was greatly enhanced. By interacting with and getting support from female role models who are pursuing STEM degrees and careers, elementary school girls could see continuing on in STEM as a natural path forward. The playbook that the project developed can bring the benefits of our LiFE clubs to other schools and communities. The Tools for Teachers guide, based on input from focus groups with over 50 teachers, can be used by educators to develop and/or enhance STEM education in an online or remote environment. Our experience with LiFE paves the way to expand our efforts by developing the STEM for Success initiative on our journey toward creating a cradle to career mechanism for girls to pursue their own pathways to success in STEM.

#### **What is the impact on physical resources that form infrastructure?**

Nothing to report.

#### **What is the impact on institutional resources that form infrastructure?**

Nothing to report.

#### **What is the impact on information resources that form infrastructure?**

The persistent learning objects developed through LiFE and STEM for Success and available through our [stemforsuccess.org](http://stemforsuccess.org) website, youtube channel and digital commons repository make available to all information and activities that build STEM knowledge among students and educators.

#### **What is the impact on technology transfer?**

Nothing to report.

#### **What is the impact on society beyond science and technology?**

A more scientifically educated workforce with stronger 21st century skills such as those promoted by LiFE (leadership, communication, collaboration, etc.) will strengthen the ability of our citizenry to perform positive civic engagement and contribute to our society.

#### **What percentage of the award's budget was spent in a foreign country?**

0

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## **Changes/Problems**

### **Changes in approach and reason for change**

During the course of LiFE there were several programmatic changes made based on input from our stakeholders, based on certain realizations discovered as the project progressed and, of course due to the COVID pandemic. We describe these in this section.

- The content of the PD events for teachers was revised based on the input of the teachers. In particular, we held some extra events and revamped the agendas mostly to allow for teachers to have more time to collaborate with one another and have unstructured time to share their knowledge.
- Another change was to go from having a large annual Pi Day event for the club members to having an event in each participating school or district. This would expand the circle of impact to include parents and community members. Unfortunately, the pandemic cut this effort short and only two of the events materialized. We repurposed the funds for the large event to funding of smaller events and when the funding wasn't needed due to COVID, we used the funds to purchase materials for 500 STEM starter kits that students could use at home.
- Probably the biggest change in approach is the realization that as interest in our work grew, we recognized that we would not have the bandwidth to scale up our efforts after the conclusion of the grant with the same plan of having role models visit schools, providing supplies to schools. COVID hastened our move to STEM in Your Home livestreams and development of digital resources. (The Hands on Guide was always intended to be available electronically; the Tools for Teachers guide was inspired by the move to online instruction). This continued our engagement with the teachers and students involved in LiFE, though with a very different dynamic.

Going forward we also plan to work with other organizations working to address the underrepresentation of females in STEM. We look forward to building on the impact LiFE and STEM for Success have had and expanding our efforts to wider audiences in terms of grades and groups. We look forward to the day when a girl in elementary school who participates in a STEAM club will be able to seamlessly move on to participation in middle school and high school efforts to continue involvement in positive STEAM experiences and pursuits.

## **Actual or Anticipated problems or delays and actions or plans to resolve them**

There were several issues that we didn't anticipate and needed to overcome during the project. None of these (except COVID) caused significant delay of the work or significant change in the project.

- **Software and purchasing issues:** We purchased iPads for our teachers and for club participants to use but needed to purchase software to sync the machines in different locations to contain and be update with the same software. While this took four months to resolve, we had started the process in June (2018) so it was resolved around the time the clubs started operating in the Fall. The clubs had activities that didn't require the iPads in the meantime. We also had delays in ordering desired materials for clubs when NJIT changed its purchasing system. All vendors had to be entered anew and there was a long backlog at the university. Thus, we experienced many delays in get things ordered, delivered and brought to our clubs. While it led to some frustration that items did not get to the clubs in a timely manner, our LiFE teachers were true professionals and dealt with it in stride. One thing we learned is that when you provide even a little support (some supplies, funding, and connection and collaboration experiences) to those who are so dedicated and working so hard, you end up getting so much appreciation and excellent results. In the long run, the new purchasing system is much smoother than the old one.
- **Personnel turnover at our participating districts:** Two of our partner districts each had 3 superintendents during the project. Some individuals were let go and others took leaves, yet our clubs did not miss a beat. Our teachers rolled with the punches and administrative changes barely cause a ripple. When teachers could not continue, new teachers were supported by the other teachers and by the project's leadership and quickly were able to start running excellent clubs. By having open and positive communication, all stakeholders knew the team was always available to help and problems that might fester were avoided.
- **The pandemic led to cancellation of the community events for STEM Month and our ability to present our work at the NJ Statehouse.** We adapted as noted earlier with creation of STEM starter kits sent to our schools for distribution to students and our incorporation of online activities. The NJ State STEM Month event was cancelled but an online showcase booklet was produced which included our project.

## **Changes that have a significant impact on expenditures**

Originally, we categorized certain budget items incorrectly in that some funds going toward participant support, which does not incur overhead charges, were placed in the "regular" budget. Similarly, we had anticipated having 4 teachers at each school, but the different schools had different number of teachers – none more than 4. This led to having fewer than the number of planned teachers (but more districts, schools and clubs than in the proposal). This led to more funds being available for technology (iPads), professional development and travel for the teachers and non-PIs and adding schools.

When we received support from Arconic Foundation (later called Howmet Aerospace Foundation) – two grants totaling \$55K, we were able to continue providing supplies to all our schools, hire more undergraduate student role models, afford media support, pay our role models to develop videos and complete the project playbook, and fund STEM starter kits for students to use for STEM projects at home. One teacher remarked that whatever she asked for we found a way to help with. We also held focus groups with teachers during the pandemic and developed a Tools for Teachers guide for educators to use to help them succeed in delivering STEM instruction in an online environment.

## **Significant changes in use or care of human subjects**

Nothing to report.

## **Significant changes in use or care of vertebrate animals**

Nothing to report.

## **Significant changes in use or care of biohazards**

Nothing to report.

## **Change in primary performance site location**

Since the COVID pandemic struck our efforts have been online. Our participating schools have continued running the STEAM clubs online at times and later back in person.