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Mobile STEMship Discovery Center: K-12 Aerospace-Based Science, Technology, Engineering, and Mathematics (STEM) Mobile Teaching Vehicle

Linda McNeil
Federation Of Galaxy Explorers

08/03/2015
Final Report

Air Force Research Laboratory
AF Office Of Scientific Research (AFOSR)/ CL
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Contents

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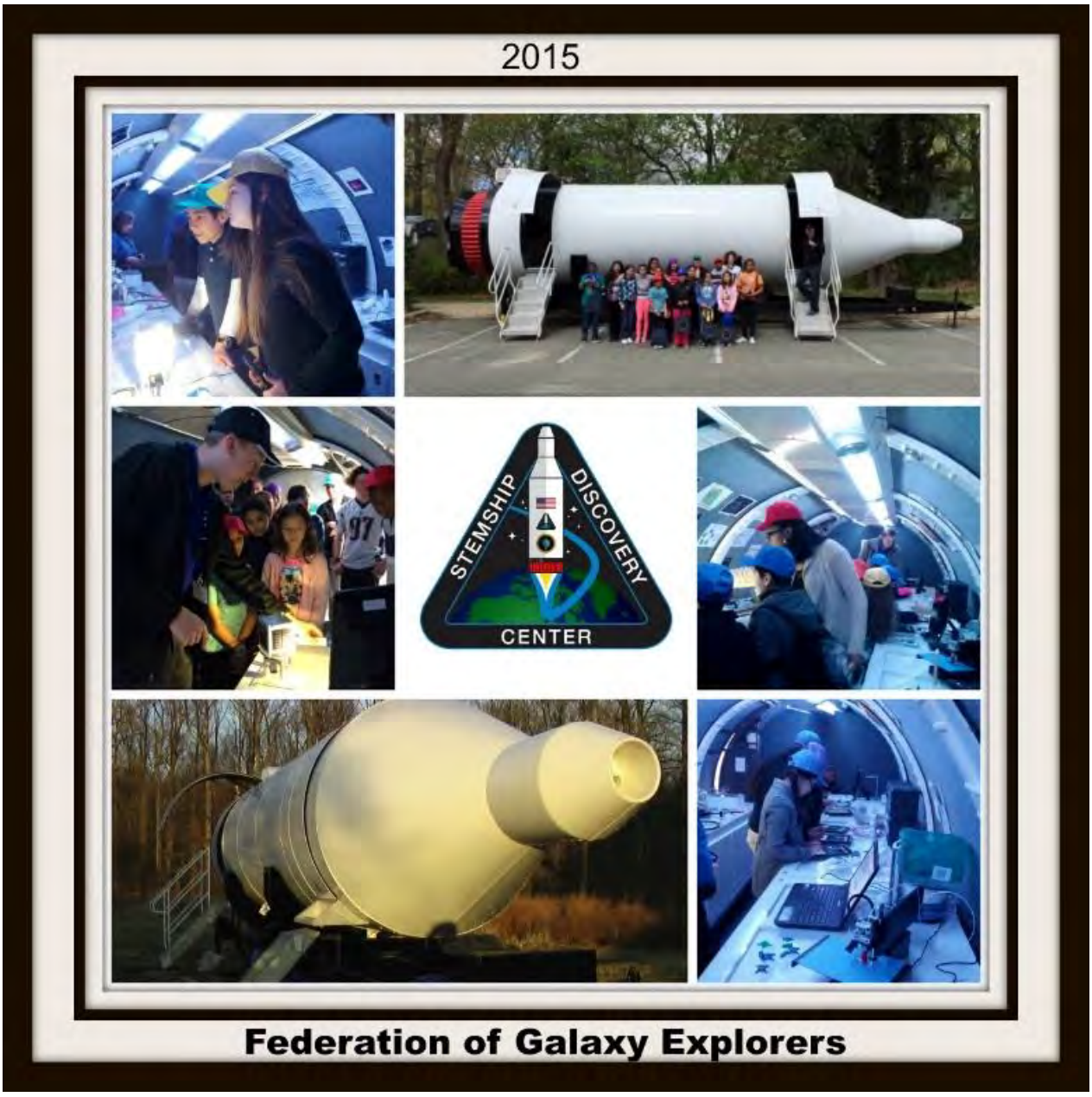
Executive Summary

The Federation of Galaxy Explorers (FOGE) is a 501(c)3 non-profit organization that inspires youth in the fields of science and engineering. Certified by the Space Foundation educational program, FOGE has afterschool programs, summer camps and special focused events that target five primary themes: space science, engineering, earth science, rocketry and space development. With the assistance of the Air Force Office of Scientific Research Cooperative Agreement Award FA9550 for 2014-2015, FOGE was able to develop a d STEMShip Discovery Center program to be able to expose Science Technology, Engineering and Mathematics (STEM) space-inspired science centers for DC Metro beltway schools and children.

In 2010, FOGE purchased a 42-foot mobile Astroliner in the shape of a rocket for conversion into a hands-on STEM training platform. Development consists of five primary tasks: engineering, systems, software, documentation and operations. The goal was to use the mobile STEMShip Discovery Center to present the FOGE educational program to underprivileged DC Metro region schools, including government and non-government organizations with other related organizations in 2014 and future years. The aim within the curriculum program was to present Geology, Geography, Life Sciences, and Engineering in a fun and dynamic manner without gender or racial bias. Our philosophy is to deliver strong introduction to the concepts and methods of Science and Engineering in a modality of application and exploration.

The STEMShip met and exceeded our phase 1 goals of producing curriculum and science centers. The refurbishment process was completed for presenting our STEMShip to the schools and to other programs. We contacted over 100 Title 1 schools in the area and dialoged with over 30 schools who looked at our programs. Additionally, we directly served over 700 children in 7 schools.



BAA-AFOSR-FA9550
FOGE Grant Final Report

The Federation of Galaxy Explorers (FOGE) seeks to be a part of a STEM solution to both the declining proficiencies and the lack of interest in STEM careers is to inspire and engage the students at a younger age in dynamic and fun STEM activities. Enrichment programs seek not just the brightest students, but all students to engage in dynamic activities that promote STEM careers, science understand, and math correlation. To battle the trend of decline, a combination of educational, industrial, government and societal effort is needed.

FOGE integrates with commercial, government and educational programs in a manner that facilitates STEM learning. For the Commercial and Government entities, it allows employees and volunteers to integrate with students, directly influencing career choice without the overhead of creating a program. In addition, sponsors allow FOGE to go into the school with enrichment programs after school in the form of Mission Teams. Here, Galaxy Explorers acts as a liaison to foster positive STEM growth. Many Mission Team leaders are either corporate or government workers who are building a succession plan of the future STEM workforce.

Through the assistance of the grants and cooperative agreements, Galaxy Explorers is able to fund activities and programs that directly inspire STEM education and careers. The STEMShip Discovery Center, funded by Air Force Office of Scientific Research emboldened our STEM outreach capabilities in outstanding ways. With this funding we were able to refurbish our rocket ship, build out curriculum and directly engage with children around our beltway. This first year brought an immense amount of increase dialog about space STEM careers and interest. We had both positive outcomes from the schools and the students themselves. We are looking forward to doing more with our STEMShip as we move forward in

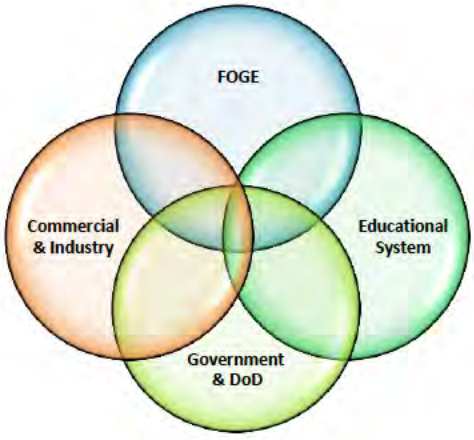


Figure 1 – Galaxy Explorers Relationships

our future of Galaxy Explorers.

Our other programs not inclusive, but integrated with the STEMShip The elementary and middle school Mission Teams build strong engineering concepts in students using curriculum certified by the Space Foundation. Hands on activities reinforce learning on multiple levels and encourage interest. The high school Mission Team has been in a pilot program and is being duplicated this year. Taught after school by Naval Research Laboratory (NRL) personnel and using FOGE curriculum focusing on engineering concepts such as rockets with robotic payloads, three volunteers instruct one after school program and two summer camps. The programs promote science, engineering and naval interests to high school students. This last few years, students from the pilot project have converted to NRL interns and Mission Team volunteers during their time in college. Three students have gone through the NRL internships and now are full time employees at NRL. This pattern of direct corporate, government and FOGE integration builds a full pipeline of success to the next STEM career force.

Building the Dream

In addition to partnership integration, dreams combat the STEM crisis in the areas math proficiencies, a lack of desire to participate STEM curriculum and careers as well as racial and gender participation gaps. One thread in common with the most successful astronauts, engineers, and scientists is they dreamed and desired to become their chosen profession as a child. Inspiration came in many forms, from large rocket launches their parents took them too, model rockets, a science show, a significant historical event. These dreams were powerful enough to overcome some educational deficits and lack of proficiencies to build a strong and stable career in a STEM field. For those that have the strong proficiencies, a strong inspiration of career choice gives satisfaction and allows one to thrive. Dreaming a dream makes a difference. It is the inspiration behind success.

In 2014, Galaxy Explorers engaged over 5,900 children in programs and outreach activities utilizing Mission Teams, the Moon, Mars, Rocketry and Robotics summer camps, Battle of the Rockets competition and we completed the STEMShip Discovery Center refurbishment project. Steven Tomaszeski, Wista Rector, Victor King and the curriculum team are poised and ready to further refine already existing programs for growth in use, quality and new development. FOGE desires to target growth areas in existing and future programs to expand educational content nationally and enable STEM education solutions with a space themed emphasis. This last year, FOGE succeeded in strong programmatic outreach with the help of collaboration with Naval Research Labs and funding from the Air Force Office of Scientific Research, multiple corporate sponsors, and foundation grants.

The STEMShip Mobile Science Center has with fun educational content that enhances summer camp content and is also a stand-alone learning tool. The phase 1 target was: grades 3-6. We had 7 schools engaged around beltway – emphasis on Title 1 schools. We have had many more request visits for next year and currently have 25 schools on our waitlist. We are looking forward to future funding for schools visits in the near future as we investigate our options.

Full activity book to accompany and given to students. The hard copy of this coloring book has been distributed to all the children who have participated in our STEMShip program and additional handouts have been for our summer camp students grades 3-6.

Teacher lesson plans were created and provided for ancillary lessons for teachers and educational providers. All instructors received this in their teacher's gift bag.

Types of schools we reached out to:

We were in contact via mail, email, phone and face-2-face meeting with over 100 Title 1 schools in the beltway region. Out the 100 we contacted, 12 schools wanted to have us visit in the 2014-2015 school year. 4 schools wanted to meet during a time frame outside the scope of the contract and 1 cancelled their meeting due to lack of communication with the school officials. 25 additional schools have contacted us for future program use for the 2015-2016 school year.

Satisfaction of Educational Content Survey

An exit survey online was distributed to all schools after the STEMShip visited. The responses were open for participating schools. The link was provided to the point-of-contact of the school and asked to be distributed to the teachers who had students participate.

- 100% or all 10 responses from 7 schools indicated they were content with the STEMShip's educational content.
- 90% of the responses stated they felt the educational content extremely well exceeded expectations, where as 10% stated it met the expectations moderately well.
- 80% of the participating educators enjoyed the science center learning extremely well and 20% stated they enjoyed the science centers quite well.
- 90% of the participants felt extremely satisfied about the science inspiration presented within the STEMShip. 10% felt quite satisfied and inspired.
- 70% of the educators felt the curriculum was extremely useful to use within the classroom where as 30% that it was quite useful.
- 70% of the educators thought the science centers made a great deal of impact (highest ranking) in STEM inspiration; 20% felt is made a lot of impact (second highest ranking) and 10% stated is made a moderate amount of impact in science inspiration.
- 100% of the past schools have asked for us to come back next year and make this an annual event.

The Title 1 Schools we brought the STEMShip:

- 2015 – Bladensburg Elementary – TAG gr 3,4,5 -- 45 engaged
- 2015 – Sugarland - 85 engaged
- 2015 – Beech Tree – 93 engaged
- 2015 – Pine Spring – 81 engaged

- 2015 - Port Towns Grade 3 - 126 engaged
- 2015 - Mt Vernon – 102 engaged
- 2015 - Kemp – 72 engaged

The Work Effort

Objective

The Objective was to "develop, establish and maintain the STEMShip Discovery Center designed to improve the enthusiasm of STEM space based imagination and future career fields within the United States by reaching the beginning of the STEM pipeline through the K-12 grade levels. Galaxy Explorers focus on this grant is on the Greater Washington DC Metro area with an emphasis on Title 1 schools, to equalize gender and racial participation and grow the next STEM workforce."

This objective was met for the 2014-2015 school year. We met and touched the lives in a high impact space-inspired science manner over 700 children in the spring of 2015. We would have loved to have impacted more, but the time due to the delay onset of the grant and the winter weather did not permit more meetings. It is preferred that we are able to schedule meetings in the fall or early winter and not present during the precarious months of December – March.

Scope

The original scope was to "develop, refurbish and deploy the STEMShip Discovery Center to a minimum of six educational visits delivering interactive science curriculum." This was completed with reaching to 7 school and 8 school visits (one school had two days).

Outcomes

Upon completion of the program, expected outcomes were realized as:

1) A Mobile STEMShip equipped to create a dynamic, interactive learning environment.
2) An enrichment program for a minimum of six schools, with a target of Title 1 school systems
3) An enriched relationship between school systems, corporations, government and FOGE.
4) A curriculum program designed for in science enrichment with take home materials.

Impact

Over the lifetime of the STEMShip Discovery Center, the vehicle will provide an array of curricular presentations presented in a fun and inspiring manner to support continuity and promotion of STEM careers which will assist the classroom understanding and real life application. We are seeking funding to continue outreach with the STEMShip and it's involvement.

Work Break Down

The work breakdown (WBS) of the STEMShip program is broken into tasks to make the program affordable and feasible to do with primarily a volunteer workforce. Contracting is left to crafting the interior cabinetry, electrical wiring, driving, curriculum art work and inspections. All these tasks are highly integrated and require coordination from the program manager to make the program a success.

There are five primary tasks: engineering, systems, software, documentation and operations. These tasks are discussed by task to fully describe the program.

Implementation

The implementation of the engineering has been successfully completed, but did was not implemented as originally planned. Funding delays caused our volunteer work windows to be lost – which caused us to have to reschedule and hire for some of the work needed to be done. This meant that some of our expenses had to be trimmed to stay within the cost constraints. Additionally, it also meant that our school visits would be delay into the unreliable days of winter.

Task I Engineering

The construction and build-out of mounted tables are designed to hold computer displays within the ship. The ability to quickly build and tear down the equipment is preplanned into the procurement of equipment and build-out of the Discovery Center. We hired our heavy equipment operator to remove all seating within the STEMShip. Our exterior contractor was unable to perform the new painting job as originally planned due to the delay in funding. By the time we received the final approvals on our contract, the bid proposals and work time windows were past. We were now in the busy season of our program. Our volunteer engineers and primarily planning force dedicated their time would put them working in the middle of the harsh winter with primitive conditions and extreme weather constraints.

Engineering Work Effort completed by:

- Dr. Don Faxon, Original Concept
- Jellian Stantn, Engineering Consulting
- Adrian Rector, Engineering Consulting
- Marty Rothwell, Engineering Consulting
- Exterior Auto Body – Livengood Auto Body
- Nick's Cabinets rebuilt cabinets and flooring
- FloorMax carpeted floor and walls
- Daniel Belfils installed cabinet tops, electrical wiring,
- Heidi Kohrs designed cabinet tops

- Stan Dillard – oversight, School Organization
- Engineering and Lighting design work by STENSat (Engineers: Ivan Galysh, Jim McGuire, Kevin Dohtery)
- Warren McNeil – engineering planning and implementation

Figure 2 -- exterior completions

Figure 3 -- exterior work on "booster"

Figure 4 – Modifications in the interior

Documentation

Documentation consists of development of Curriculum, Operations manual and a Maintenance manual. Curriculum development consists of four stages: 1) Teacher training and information, 2) Student Curriculum, 3) Parent take home material and 4) a coloring book for student reinforcement. The literature and curriculum is a continuation of education based on the Summer Camp curriculum and real life application of space sciences and engineering. A focus on closing the gender gap and profiling multiple racial perspectives will be included within the curriculum. The curriculum will be followed up with a line art coloring book for the lower elementary aged children. This coloring book will be based off of the curriculum and add one more tactile dynamic with a lasting impact for the participants. These coloring books are designed to be take home material to reinforce learning.

The Operations and Maintenance manuals are designed to assist the instructor and other volunteers when they use the STEMShip for public outreach and educational enrichment. These documents are meant to be living documents that will grow and modify as needed as the program grows.

- **Written Curriculum** (Student/Parent/Teacher)

    - Linda McNeil
    - Miriam Pipes
    - Dr. Don Faxon
    - Bill Kemp
    - Victor King
    - Dr. Kate Cage
    - Juli Lawless
    - Caitlin Marsh
    - Jill Mohammad
    - Wista Rector
    - Adie Rector
    - Dr. J. P. Berends
- **Art** for Student Workbooks & Curriculum
    - Joanna King
    - Victor King
- **Operations Manual – done** Stan Dillard
- **Maintenance Manual – done** Stan Dillard

STEMShip Learning Concept

The learning concept is two-fold: first, to instill solid science foundational curriculum in a dynamic environment; second, to provide inspiration to build dreams and desires to becoming the next scientist or engineer. The educational topics covered are presented in a fun filled way that will peak learning and participation.

Educational Topics/Skills Matrix

Space Citizenship	Geography Geology	Rocketry	Robotics	Life Science	Physics Systems & Power
Critical Thinking Skills	Critical Thinking Skills	Critical Thinking Skills	Critical Thinking Skills	Critical Thinking Skills	Critical Thinking Skills
Collaboration with others	Collaboration with others	Collaboration with others	Collaboration with others	Collaboration with others	Collaboration with others
Cross Cultural Skills	Cross Cultural Skills	Cross Cultural Skills	Cross Cultural Skills	Cross Cultural Skills	Cross Cultural Skills
Ethics and Science	Weather & Climate	Engineering Design	Engineering Design	Nutrition	Engineering Design
Space Careers	Rocks & Minerals	Forces and Motion	History of Space Robots	Basic Needs Hierarchy	Electricity
Science and Math Correlations	Mapping Skills	Vector Forces	Software Life Cycle Development	Food Sources in Space	System Dynamics
Understanding Teamwork	Planetary Bodies	Trajectory Design	Intro to Programming	Biospheres	Green Energy
Famous People in Space/Science	Gravity	Orbit Mechanics (orbit tuner)	Commands and objects	Physical Fitness in Space	Intro to Power Systems
Lunar Missions	Solar Radiation	Orbit types	Sensors and cameras	History of Hydroponics	Problem Solving
Mars Missions	Scientific Method	The solar system	Problem Solving	Water systems	
Career Knowledge	Interpreting Data	Flight Fundamentals	Logical sequencing	Clean Air	

Figure 5. Educational Topics and Skills Matrix

Task V Operations

Operations consists of outreach, events, scheduling and maintenance. Deployment of the STEMShip will require preliminary relationship development with the schools, public outreach to build awareness, creating a schedule to bring the STEMShip to the school, driving the STEMShip to the school for the day and setting up the systems to allow student interaction.

- **Deployment Task**
  Galaxy Explorers will schedule with the participating schools, with a goal of a minimum of 6, to bring the mobile STEMShip to the premise and allow engagement with the

interactive program. FOGE will contract the driving to a low cost professional driver for each event.

- Build Relationships
  - Linda McNeil
  - Stan Dillard
  - Steve Tomazweski
  - Marta Stoveski
  - Ivan Galysh
- Driving the STEMShip to schools
  - Fritz Duval – licensed and professional driver
  - Morton's Towing

Build Relationships and inspire STEM -- Outcome

FOGE desires to build bridges and relationships with the school systems, commercial, industry, and the government to promote STEM education. To accomplish this, a true integration of combined effort is warranted. Galaxy Explorers' strategy is to be an integral solution to the STEM problem by creating partnerships. By being present at outreaches, visiting schools, engaging with the PTA and administrators FOGE will foster a relationship that would benefit the schools and the students, as well as inspire them. A minimum of four methods of building bridges will be used, including outreach, school Parent-Teacher Associations (PTA), direct mail and media.

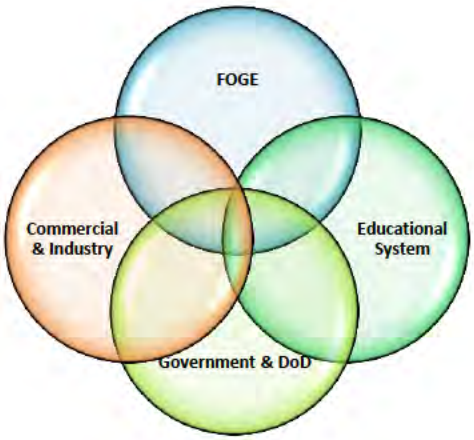


Figure 6. Integration and Functionality Venn Diagram of a STEM crisis solution.

Financial:

Year-to-Date STEMShip Accumulatives Summary Sheet

DESCRIPTION		MarInvoice6	JanInvoice5	DecInvoice(4)	SeptInvoice 3	MayJuneInvoice 1	JulyInvoice 2	YTD Accumlative	YTD Paid	Balance Owed
Categories A & B (Salaries)	Salaries/fringe	938.48	-	$ 10,389.35	$ 5,041.26	$ 18,577.77	$ 2,360.84	$ 70,649.06	$ 69,710.58	$ 938.48
Categories C, D, E	other		1,704.56	$ 4,659.50	$ 674.49	$ 13,616.55	$ 693.56	$ 30,372.37	$ 30,372.37	$ -
Categories F (Engineering)	Engineering	6,684.42	25,079.30	$ 21,570.52	$ 26,547.81	$ 5,725.60	$ 1,334.92	$ 98,978.57	$ 92,294.15	$ 6,684.42
Advance Salaries -- cat A & B	Salaries	-	-	$ 12,503.01	$ 12,503.01		$ 8,335.34		$ -	$ -
Advance Equipment -- C, D, E	other	-	-				$ 9,023.71		$ -	$ -
Advance Engineering -- Cat F	Engineering	-	-				$ 12,036.00		$ -	$ -
YtD Total Spent on Grant		$ 7,622.90	$ 26,783.86	$ 49,122.38	$ 44,766.57	$ 37,919.92	$ 33,784.37	$ 200,000.00	$ 192,377.10	$ 7,622.90

Conclusion:

AFOSR funding has made a tremendous difference in Galaxy Explorers STEMShip Discovery Center programs and the children, teachers and educators we sought to inspire. With dynamic effect, the STEMShip Discovery Center also influenced the partition of our Prince George County, in the State of Maryland's summer camps participation. Every day we strive to reach lives and inspire STEM careers and influences to the world around us. This grant gave us the ability to increase our participation and STEM exposure immensely.

In the future, we plan on reaching more schools with our STEMShip. We are currently waiting for the College Park Air Port to open up a housing area for our STEMShip and more collaboration for Mission Teams and other special events. Additionally, we would like to go mobile and visit more schools across our area to service the greater DC Beltway region. Again, thank you for your assistance with this, we look forward to collaborating more in the future.

1.

1. Report Type

F na Report

Primary Contact E-mail

Contact email if there is a problem with the report.

L nda@foge.org

Primary Contact Phone Number

Contact phone number if there is a problem with the report

610-981-8511

Organization / Institution name

Federat on of Ga axy Exp orers

Grant/Contract Title

The full title of the funded effort.

Mob e STEMSh p D scover Center

Grant/Contract Number

AFOSR assigned control number. It must begin with "FA9550" or "F49620" or "FA2386".

FA9550-14-2-0002

Principal Investigator Name

The full name of the principal investigator on the grant or contract.

L nda McNe

Program Manager

The AFOSR Program Manager currently assigned to the award

L nda McNe

Reporting Period Start Date

04/30/2014

Reporting Period End Date

07/29/2015

Abstract

Outcomes: Over 700 ch dren were engaged. Over 7 schoo s were reached.

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• 100% of the past schoo s have asked for us to come back next year and make th s an annua event.

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Archival Publications (published) during reporting period:

Changes in research objectives (if any):

Change in AFOSR Program Manager, if any:

Extensions granted or milestones slipped, if any:

AFOSR LRIR Number

LRIR Title

Reporting Period

Laboratory Task Manager

Program Officer

Research Objectives

Technical Summary

Funding Summary by Cost Category (by FY, $K)

	Start ng FY	FY+1	FY+2
Sa ary			
Equ pment/Fac t es			
Supp es			
Tota			

Report Document

Report Document - Text Analysis

Report Document - Text Analysis

Appendix Documents

2. Thank You

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