**Final Report for the**
**National Center for Intermodal Transportation for Economic Competitiveness**

**Project Title:** ***Student Technology Exchange Program (STEP) for Engineering/Robotics in Middle School Students***

**Principal Investigator (PI) Name, Title and Contact Information:** Victor Branch, CAVS-Extension, Mississippi State University; 601-407-2712; Vbranch@cavse.msstate.edu

**Submission Date:** May 5, 2015

**Project Period (Start Date, End Date):** January 1, 2015 – April 30, 2015

**Reporting Period End Date:** April 30, 2015

**Report Term or Frequency:** Semi-annually

## 1. Project Description

**STEP Engineering/Robotics in Middle School** – This project objective is to deliver a yearlong project (July 1, 2013 – April 30, 2015) that includes a 3 day professional development for teachers and 5 day workshop for 25 students from 4 schools. It also includes approximately 40 hours of teacher mentoring over the 9 month school year to implement activities and concepts that will help to improve math and engineering principles with test scores. This program interacts with children on robotics, basic engineering principles, transportation logistics, teamwork and critical thinking skills, in order to heighten their interest in math and science while providing teachers with professional development and mentoring to bolster confidence. The targeted focus will be on engineering and robotics application related to intermodal transportation. This project targeted economically disadvantaged underserved populations in the central Mississippi area.

### 1.1. What are the major goals of the project?

1. Professional Development workshop 3 days for 8 teachers (Engineering and Robotics) representing 4 schools to teach engineering and robotics principles
2. Engineering/Robotics workshop 5 days for 25 middle school students to perform activities and programming exercises
3. Intermodal tour for workshop participants to view first hand activities of technologies in operation
4. Mentoring teachers at classroom to implement the engineering/robotics curriculum developed for their school for math and science on by-monthly visits by MSU CAVS-E staff (total mentoring hours not to exceed 40 hours per school year) for lesson plan development and implementation
5. This is a 1 year proposal that will influence teachers and students in central Mississippi
6. This workshop will impact the 5$^{th}$, 6th and 7th grade students in the central Mississippi with the most urgent need for improvement of math and science scores

### 1.2. What was accomplished under these goals?

The purpose of the project has 6 main goals:
(1) To recruit “Low Performing” or “Academic Watch In Danger of Failing” schools to integrate with “High Performing” school teachers at the same academic level
(2) To provide a challenging environment for both teacher and students to excel in STEM related activities
(3) To provide project based activities that can be used to measure concept knowledge as demonstrated by students
(4) To provide classroom manipulatives with classroom mentoring for classroom implementation strategies that encourage projected outcomes in science and math
(5) Increase opportunities for student access to success
(6) Develop instructional models that promote technology career cluster.

1) Major Summer Camp activities –

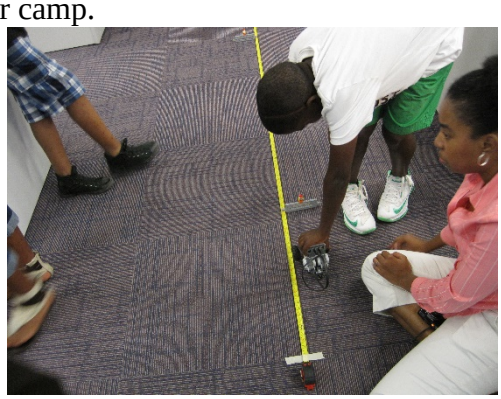
| NCITEC Summer Intermodal Transportation/Robotics Summer Camp 2014 | | | | | |
|---|---|---|---|---|---|
| | 7/21/2014 | 7/22/2014 | 7/23/2014 | 7/24/2014 | 7/25/2014 |
| | Monday | Tuesday | Wednesday | Thursday | Friday |
| 8:00 AM | Student Check-In | Student Check-In | Student Check-In | Student Check-In | Student Check-In |
| 8:30 AM | Pre-Assessment | | | | |
| 9:00 AM | What Do Engineers Do? Engineering Bingo | Stretching The Truth Lab (Elasticity Test) | Railroad Terminal Tour | LEGO Robotics Simulation Lab 3 | Spaghetti Bridges |
| 9:30 AM | | | | | |
| 10:00 AM | | | Intermodal Transportation Simulation 3 | Rootbeer Lab Taste-Testing | |
| 10:30 AM | | | | | LEGO Challenge |
| 11:00 AM | Rootbeer Brewing Lab | Bubble Gum Creation Lab | Southern Railroad Presentation & Activities | Strawkets & Homopolar Motors | Intermodal Transportation Challenge |
| 11:30 AM | Towers & Cantilevers | Life-Saver Racers Lab | | | |
| 12:00 PM | | | | | |
| 12:30 PM | Lunch and Outside Time (Gliders) | Lunch and Outside Time (Gliders) | Lunch and Outside Time (Gliders) | Lunch and Outside Time (Gliders | Lunch Time |
| 1:00 PM | | | | | |
| 1:30 PM | Intermodal Transportation Simulation 1 | Intermodal Transportation Simulation 2 | Nissan Tour | Solar S'mores Lab Part 1 | Set Up for Exhibition |
| 2:00 PM | | | | | |
| 2:30 PM | | | | | Post-Assessment |
| 3:00 PM | | | | | |
| 3:30 PM | Lego Robotics Simulation 1 | Rescue Cargo Drop Lab | Lego Robotics Simulation 2 | Solar S'mores Lab Part 2 | |
| 4:00 PM | | | | | Parent Exhibition |
| 4:30 PM | Check- Out | Check- Out | Check- Out | Check- Out | Student Check- Out |

2) Specific objectives – STEP Engineering/Robotics for Middle School introduced students to the career concepts of transportation with activities related the construction of bridges that are designed to transport payloads and clearance depending on construction materials and infrastructure(spaghetti bridges - understand weight distribution and be able to combine their understanding of shape strength with bridge design) – these activities demonstrated the effects of auto, trucks and heavy equipment impact the longevity of roads and bridges; motor design (homopolar motors - build a simple motor) – these activities included the design and effectiveness of simple motors; engineering concepts (engineering process design - identify 5 the 5 parts of the Engineering Design Process) – this and other activities practice and performed these engineering concepts when constructing devices: Design – Measure – Analyze – Improve – Control (DMAIC); circuit design (spider circuits - understand complete and incomplete circuits); process flow (Supply Chain - understand how problem solving can streamline the process) – shows relationships between major and minor components as thru put is manipulated for distribution and planning as well as workflow; and other activities that identify safety techniques as well as economic competitiveness and environmental sustainability.

| | NCITEC Professional Development Teacher Workshop | | |
|---|---|---|---|
| Teacher Pay = $125.00/Day for 5 day summer camp… 2.4 CEU Credits for 3-Day Professional Development | | | |
| | 7/15/2014 | 7/16/2014 | 7/17/2014 |
| | LEGO | Intermodal | Engineering |
| 8:00 AM | | | Activity Inventory |
| 8:30 AM | | | |
| 9:00 AM | | Intermodal Transportation Simulation 1 | Perform Experiments on Game and Activities |
| 9:30 AM | | | |
| 10:00 AM | LEGO Professional Development workshop: Configuration; Teaching Theory; Connections; Sequencing; Infrared; Voice Control; Inventory Control; Concepts & Ideas; Common Core Integration | Break | Break |
| 10:30 AM | | | Realign (Common Core) Activity Schedule |
| 11:00 AM | | | |
| 11:30 AM | | Intermodal Transportation Simulation 2; Common Core Integration | Redesign (Common Core) Activity Room |
| 12:00 PM | | | |
| 12:30 PM | | | Working Lunch |
| 1:00 PM | Working Lunch | Working Lunch | |
| 1:30 PM | | | Identify Team Leadership & Teacher Partnerships |
| 2:00 PM | | Intermodal Transportation Simulation 3; Common Core Integration | |
| 2:30 PM | | | Review Expected Outcomes |
| 3:00 PM | Configurations; Programming; Computer Interface; Build Model; Configure; Common Core Integration | Break | Break |
| 3:30 PM | | | Wrap Up & Complete Paperwork |
| 4:00 PM | | Intermodal Transportation Simulation Data Analysis | |
| 4:30 PM | | | |
| 5:00 PM | Questions & Plans | Questions & Plans | Questions & Plans |

3) Significant results, including major findings, developments, or conclusions -

1. **K-12 Workshop -** The immediate impact is 5 day workshop of summer training for 25 middle school students. The broader impact will happen back at the classroom where there are 200-250 students at 4 schools.
2. **Workforce Metrics –** The number of workshops conducted is 1. The number of students to be trained is 25. The number of schools is 4 Middle Schools. The number of follow up teacher mentoring sessions is 5 visits for 4 schools (40 hours/school).
3. **Economic Benefit -** $51,102 in annual economic impact (e.g., investment in education of students to fill needed jobs in the future). Continuing Education Units (CEU) being provided to teachers to enhance their teaching credentials and skills.
4. **Technology Transfer –** One Refereed Conference Presentation to highlight the research outcomes to the broader audience at the NCITEC Conference. This technology that will be implemented into each classroom every year that these teachers are performing their trade.
5. **Classroom Mentoring –** Provided 40 hours of classroom mentoring to help teachers implements activities and develop lessons around the summer camp activities. Teachers were encouraged to use the students that participated to help lead classroom activities that were conducted during summer camp.

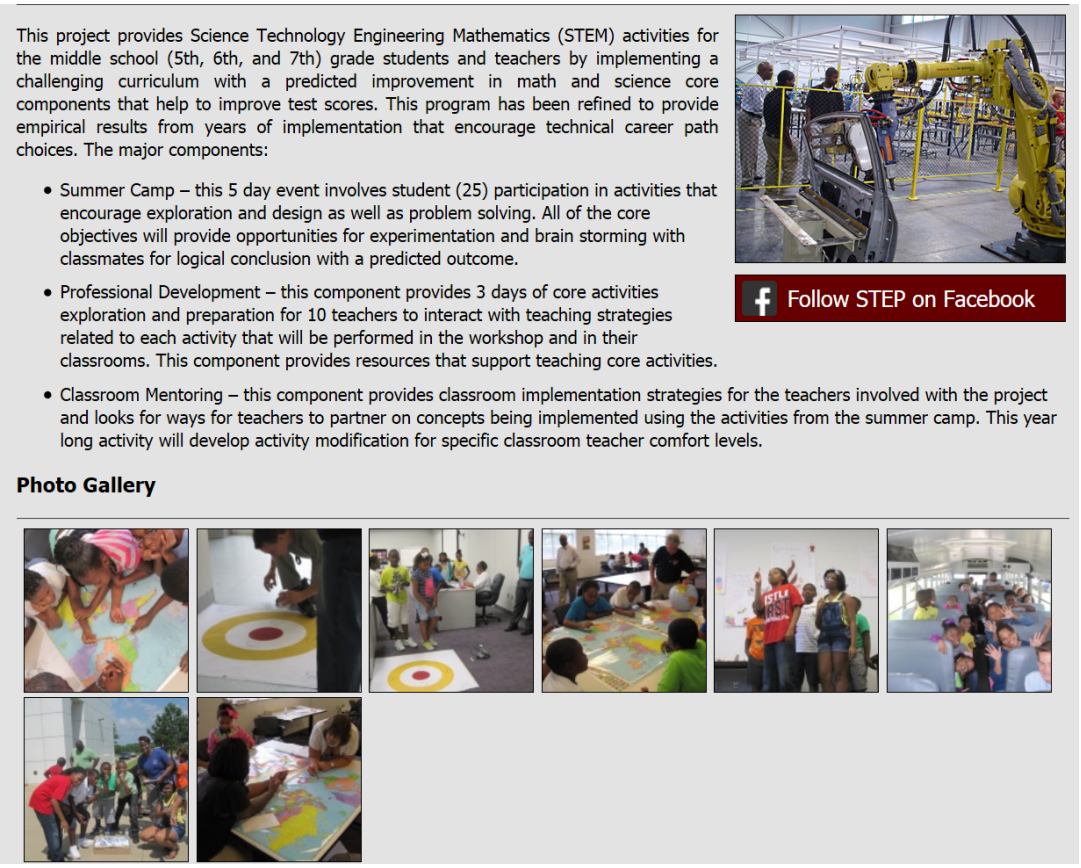



4) **Key outcomes or other achievements -** This project highlighted the importance of math and science concepts within three of the six STEM-related career clusters as defined by the Mississippi Department of Education: Agriculture, Food and Natural Resources; Health Science; Information Technology; **Manufacturing**; **Transportation**; and **Science, Technology, Engineering, and Mathematics (STEM).** STEP defined transportation as the movement of people, animals and goods from one location to another. Modes of transport include air, rail, road, water and pipeline. The field can be divided into infrastructure, vehicles, and operations. Transport is important since it enables trade between people, which in turn establishes civilizations.

Students were able to experience transportation by car, rail, truck, plane and ship. These calculated experiences allowed them to use their imagination to add the cost of travel and supplies necessary to complete the journey on a budget. The excitement in understanding how to calculate the distance/cost factors using the formulas given provided a foundation to understand the science, technology, engineering and mathematics (STEM) involved to complete the tasks. Students were able to calculate the cost, distance and time requirements by rail, ship, truck and air.

## 1.3.How have the results been disseminated?

Webpage posting: [www.cavse.msstate.edu/outreach/K12/](www.cavse.msstate.edu/outreach/K12/)



This project provides Science Technology Engineering Mathematics (STEM) activities for the middle school (5th, 6th, and 7th) grade students and teachers by implementing a challenging curriculum with a predicted improvement in math and science core components that help to improve test scores. This program has been refined to provide empirical results from years of implementation that encourage technical career path choices. The major components:

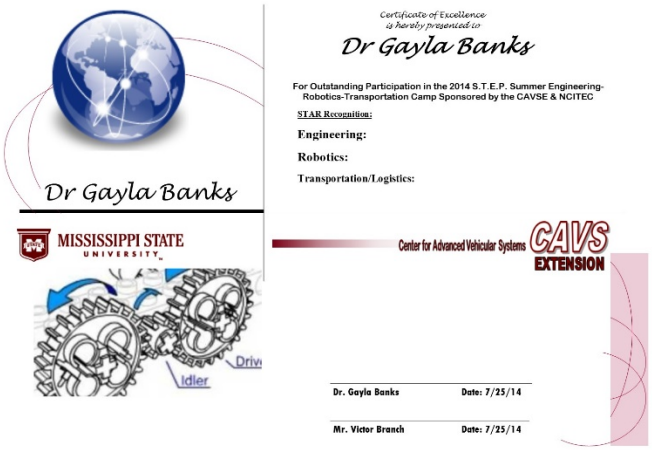


- Summer Camp – this 5 day event involves student (25) participation in activities that encourage exploration and design as well as problem solving. All of the core objectives will provide opportunities for experimentation and brain storming with classmates for logical conclusion with a predicted outcome.
- Professional Development – this component provides 3 days of core activities exploration and preparation for 10 teachers to interact with teaching strategies related to each activity that will be performed in the workshop and in their classrooms. This component provides resources that support teaching core activities.
- Classroom Mentoring – this component provides classroom implementation strategies for the teachers involved with the project and looks for ways for teachers to partner on concepts being implemented using the activities from the summer camp. This year long activity will develop activity modification for specific classroom teacher comfort levels.

**Photo Gallery**

## 1.4.What do you plan to do during the next reporting period to accomplish the goals?

- Project Completed Certificates



Dr Gayla Banks

MISSISSIPPI STATE UNIVERSITY

Certificate of Excellence
is hereby presented to
Dr Gayla Banks

For Outstanding Participation in the 2014 S.T.E.P. Summer Engineering-Robotics-Transportation Camp Sponsored by the CAVSE & NCITEC

STAR Recognition:

Engineering:

Robotics:

Transportation/Logistics:

Center for Advanced Vehicular Systems CAVS EXTENSION

Dr. Gayla Banks Date: 7/25/14

Mr. Victor Branch Date: 7/25/14

## 2. Products

- **Teacher Support identified**
- **25 potential students for workshop**



## 3. Participants & Other Collaborating Organizations

(Who has been involved? NCITEC needs to know who has worked on the project to gauge and report performance in promoting partnerships and collaborations.)

- **School Districts: Brookhaven, Madison County & Canton Public**
- **Schools involved: East Flora, Goodloe, Camden & Huey Porter**
- **LEGO Education**


### 3.1. What organizations have been involved as partners?

- **Madison County Schools**
- **Canton Public Schools**
- **Brookhaven High School**

Provide the following information for each partnership: Lead Teacher
Organization Name: Brookhaven High School
Location of Organization: Brookhaven, MS
Partner's contribution to the project: Facilities, Collaborative research and Personnel exchanges

Provide the following information for each partnership: 2 Teachers & 6 student participants
Organization Name: East Flora
Location of Organization: East Flora, MS
Partner's contribution to the project: Facilities, Collaborative research and Personnel exchanges

Provide the following information for each partnership: 2 Teachers & 4 student participants
Organization Name: Goodloe Elementary
Location of Organization: Canton, MS
Partner's contribution to the project:  Facilities, Collaborative research and Personnel exchanges

Provide the following information for each partnership: 2 Teachers & 7 student participants
Organization Name: Camden Elementary
Location of Organization: Camden, MS
Partner's contribution to the project: Facilities, Collaborative research and Personnel exchanges

Provide the following information for each partnership: 2 Teachers & 5 student participants
Organization Name: Huey Porter
Location of Organization: Canton, MS
Partner's contribution to the project: Facilities, Collaborative research and Personnel exchanges

**3.2.Have other collaborators or contacts been involved?**

- CN Railroad – John Knight – Regional Logistics Manager

- Nissan Canton

## 4. Impact

### 4.1.What is the impact on the development of the principal discipline(s)?

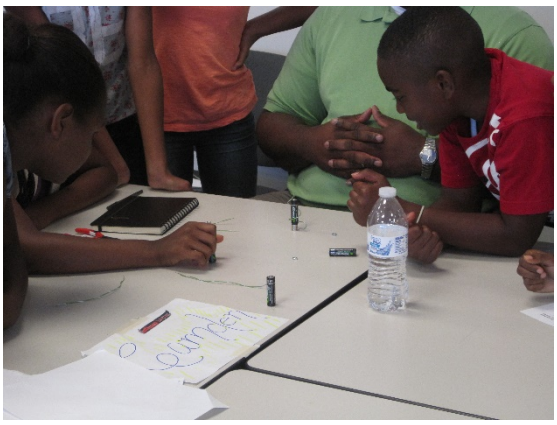
The short term goals were addressed through 3 day professional development for teachers, followed by 5 day summer camps for students and teachers. The teaching strategies focused on 3 major concepts: Engineering, Technology (Robotics) and Logistics (Inter-modal Transportation Games) that are designed to help implement role playing. Teachers were engaged in content and pedagogical knowledge building and development of inquiry based engineering activities with industry partners. This professional development workshop is designed to assist teachers in understanding the goals and expectations for student participants as they prepare them to replicate these activities for their own classrooms. Student activities provided opportunities for students to understand how science, math and logistics concepts support engineering principles and processes. Students were challenged with complex, critical decision-making activities that could occur in industry environments. Teachers facilitated instruction during the camp engaging students in career exploration activities; return to their classrooms with increased awareness and knowledge of working with their local industries in preparing inquiry based lessons; participate in follow-up professional mentoring activities during the school year. Teachers and students implemented the fact finding model:

1. **Design** -students will be able to engage in the design of a robot, parachute, catapult, and other devices that will require imagination and planning.
2. **Build** -students will be involved with building their design with minimal guidance from support personnel to encourage problem solving and new ideas.
3. **Test** -students will perform written test and compliance checks for their design to verify the performance and guidelines for the models are within specification.
4. **Competition** -students will compete in design and time trials to identify the best design for performance and each winning design will be recognized at the certificate ceremony.


### 4.2. What is the impact on other disciplines?

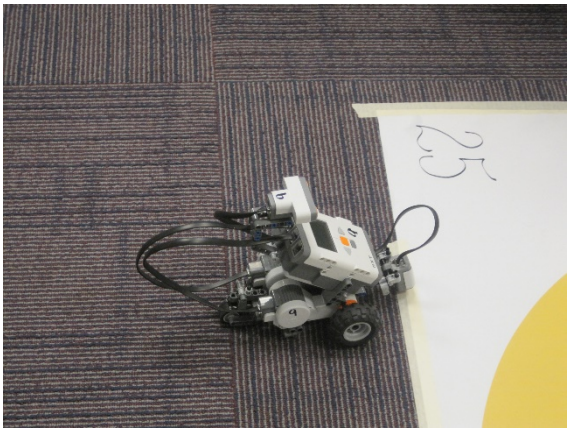
Chemical Engineering activities included: Making Bubble Gum and Root Beer

Mechanical Engineering Activities included: Homopolar Motors; Gliders;



Civil Engineering Activities included: Spaghetti Bridges; Towers; Cargo Drop;

Industrial Engineering Activities included: Robotics; Cargo Drop; Solar S'mores



Intermodal Transportation Activities included: Intermodal Transportation Model 1A, 2A, 3A





**4.3.What is the impact on the development of transportation workforce development?**

This intense professional development session in engineering, robotics, transportation logistics were designed to introduce the teachers to the activities that were practiced in the summer camp. Teachers were introduced to the concepts, activities and expected outcomes that each students will be exposed. All activities were evaluated using these guidelines:

- Objectivity - having or showing a mind receptive to new ideas or arguments.
- Integrity - adherence to moral and ethical principles; soundness of moral character; honesty.
- Transparency - clearness or lucidity as to perception or understanding; freedom from indistinctness or ambiguity.
- Reproducibility - to make a copy, representation, duplicate, or close imitation.

| NCITEC Intermodal Transportation Simulation |
|---|
| Phase 1: Create Travel Plan + Cost of Trip |
| 1. Identify Start Point and Destination |
| 2. Determine Transportation MODE: Truck; Train; Air; Ship |
| 3. Map out Travel Rout |
| 4. Identify Commodities: Ice; Candy; Peanuts |
| 5. Move Payload from Start Point to Destination |
| 6. Record: Mileage; Destination Time; Handling Fee; Wait Time; Gallons of Fuel; Trip costs |
| Draws Trip Route on Map |
| |
| Phase 2: Change Mode of Transportation + Cost of Trip |
| 1. Identify Start Point and Destination |
| 2. Determine Transportation MODE: Truck; Train; Air; Ship |
| 3. Map out Travel Rout |
| 4. Identify Commodities: Ice; Candy; Peanuts |
| 5. Move Payload from Start Point to Destination |
| 6. Record: Mileage; Destination Time; Handling Fee; Wait Time; Gallons of Fuel; Trip costs |
| Draws Trip Route on Map |
| |
| Phase 3: International Transportation + 2 Modes + Cost of Trip |
| 1. Identify Start Point and Destination |
| 2. Determine Transportation MODE: Truck; Train; Air; Ship |
| 3. Map out Travel Rout |
| 4. Identify Commodities: Ice; Candy; Peanuts |
| 5. Move Payload from Start Point to Destination |
| 6. Record: Mileage; Destination Time; Handling Fee; Wait Time; Gallons of Fuel; Trip costs |
| Draws Trip Route on Map |

## NCITEC Intermodal Transportation Simulation 1A

1. Start: _San Francisco, CA_____ End: __New York, NY___
2. Mode of Transportation: **Truck** Rail Air Ship
3. Distance: _____
4. # Of States Crossed: _____
5. Name States:

## NCITEC Intermodal Transportation Simulation 1B

1. Start: ___Jackson, MS_____ End: __Jackson, MS_____
2. Modes (2) of Transportation: **CAR** **Rail** Air Ship

**Destinations:** Jackson, MS => Nashville, TN => Louisville, KY => Cincinnati, OH => Cleveland, OH => Detroit, MI => Belleville, MI => Chicago, IL => St Louis, MO => Memphis, TN => Jackson, MS

3. Distance: _____
4. # Of States Crossed: _____
5. Total Time To Destination: _____
6. Total Cost Of Fuel: _____
7. Total Miles Per Gallon: _____ (25 miles/gal)
8. Name States:

| Activities | STEM Principles Taught | Relationship to Intermodal Transportation |
|---|---|---|
| **Intermodal Challenge** | Cost Analysis; Evaluation of Competing Options; Global Positioning data; | Transportation Mode Analysis & selection; |
| **Spaghetti Bridges** | • Understand weight distribution<br>• Be able to combine their understanding of shape strength with bridge design. | Bridges are critical infrastructure for all modes of transportation |
| **Strawket Launch** | • Understand the concept of center of gravity<br>• Be able to design a balanced rocket<br>• Determine the effect of force and angle of launch in effecting change as variables | General principles of engineering design |
| **Engineering Design Process** | • Be able to identify the 5 parts of the Engineering Design Process.<br>• Be able to identify the EDP in examples | General principles of engineering design |

| | | |
|---|---|---|
| **Supply Chain** | Understand how problem solving can streamline the process of production which is a major component of Industrial Systems Engineering. | Product flows across different modes and geographies |
| **Life Saver Racers** | • Explain the steps of the engineering design process.<br>• Identify dependent and independent variables.<br>• Identify control variables. | designing transportation vehicles to navigate different terrains |
| **Homopolar motors** | • be able to build a simple motor to sustain different payloads | motors are key technology related to the intermodal transportation industry |
| **Towers and Cantilevers** | • the student will be able to identify which designs can withstand the self-weight of the newspaper tower as well as a lateral wind load and which do not.<br>• be able to explain how their towers worked to withstand the lateral wind load using terms learned in other lessons within this curricular unit if applicable or general engineering terms. | cranes are critical resources at intermodal yards |
| **Solar S'mores** | • Describe how engineers help develop solar cooking technology to benefit people in developing countries<br>• Describe the important properties of a solar cooker and their purposes.<br>• Describe the transformation of energy that takes place in a solar cooker. | General engineering and design as applied to alternative energy sources |

### 4.4. What is the impact on physical, institutional, and information resources at the university or other partner institutions?

**"Nothing to Report"**

### 4.5. What is the impact on technology transfer?

Participants were introduced to STEM concepts and Engineering methodologies that are focused on careers related to Intermodal Transportation. The transportation component will develop scenarios for moving people/product across several modes of transportation including, Rail, Interstate highways and shipping. Students will calculate the cost of moving and efficiency of delivery schedules models outlined. The introduction, planning, implementation and development of ideas and principles of the transportation industry were utilized as a major outcome from "The Student Technology Exchange Program Engineering/Robotics for Middle School" to implement programming techniques for robotics, engineering principles as well as experiments related to chemical, civil, mechanical and computer engineering. Students were tasks with math principles, measurements, gear ratio, design relationships, etc.


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

This workshop will focus on real problems and allow teachers and students to experiment on possible solutions that must adapt to changing variables:

(1) Increased teachers' ability to develop and integrate STEM inquiry-based projects embedded in their curriculum

(2) Increased teachers' pedagogical content knowledge of Robotics/ Engineering/ Science/ Intermodal Transportation Logistics principles embedded in engineering

(3) Improved students' disposition toward science and mathematics learning in ways which eliminate barriers to the pursuit of engineering-related careers

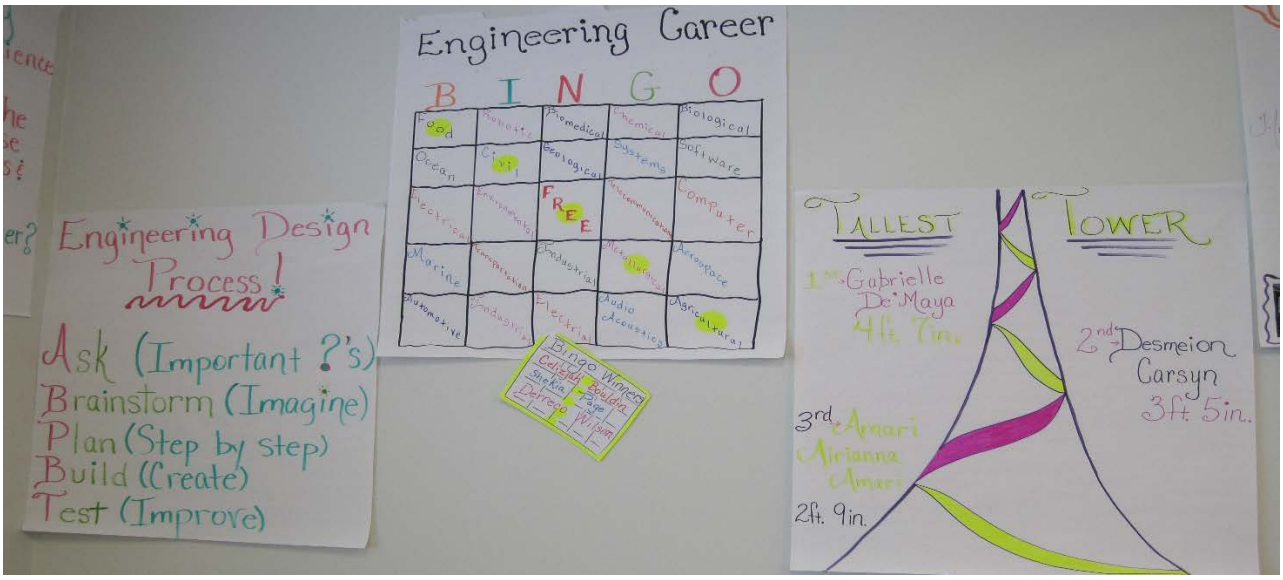
(4) Encouraged students to pursue educational opportunities in STEM careers

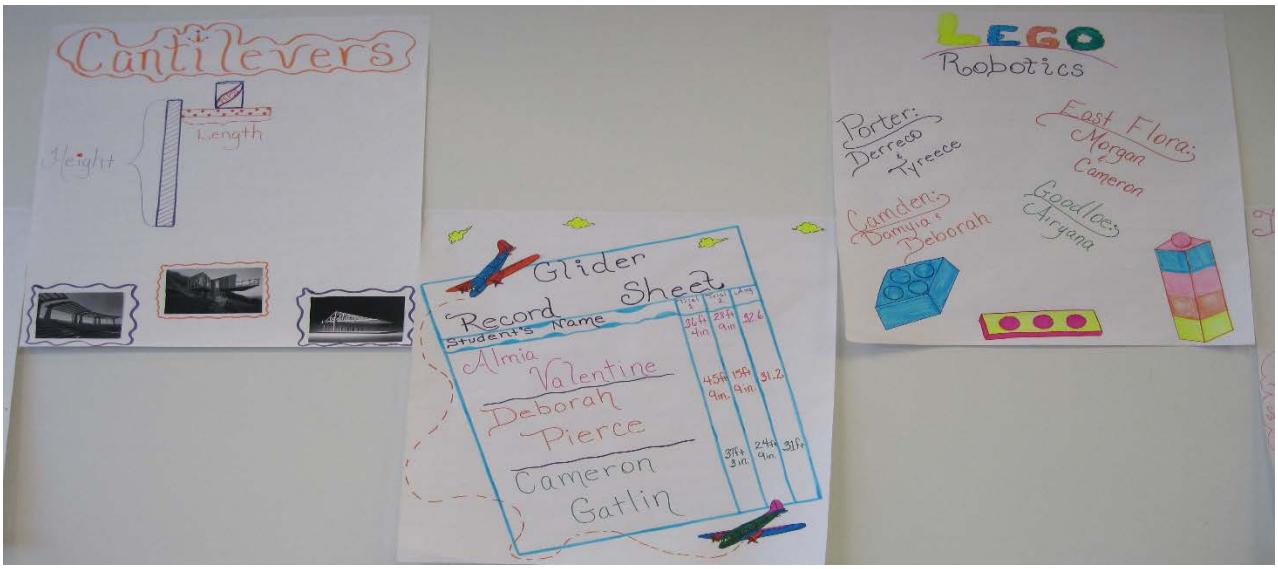




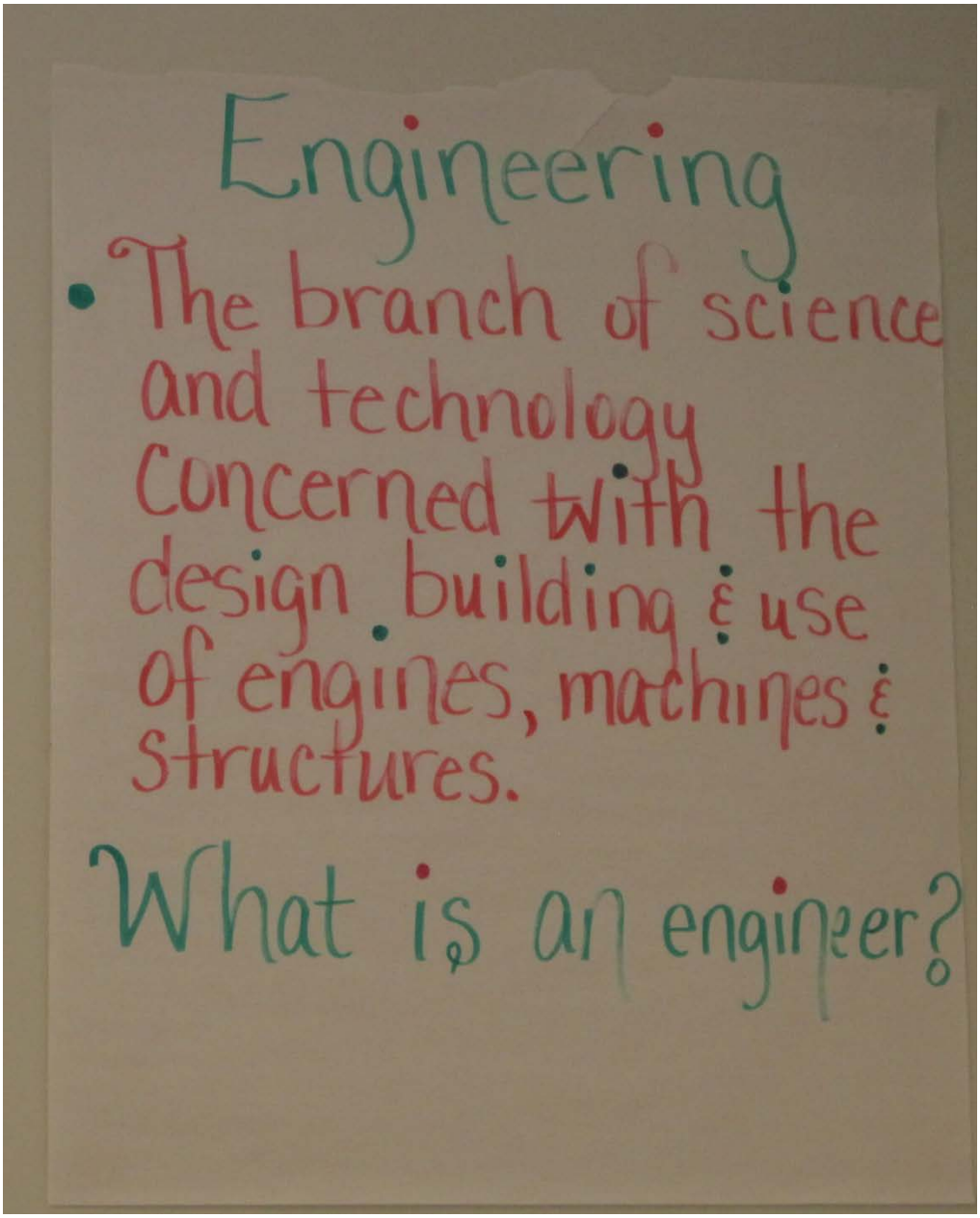

**POSTERS:**


Rootbeer
Stretching
the
TRUTH
Rescue
Cargo
Drop
East
Flora
Straw Rocket
Homopolar
Motors


Engineering Career
B I N G O
Engineering Design
Process!
Ask (Important ?'s)
Brainstorm (Imagine)
Plan (Step by step)
Build (Create)
Test (Improve)
TALLEST
TOWER
1st Gabrielle
De'Maya
4ft. 7in.
2nd Desmeion
Carsyn
3ft. 5in.
3rd Amari
Arianna
Amari
2ft. 9in.


Cantilevers
Height
Length
Glider
Record Sheet
Student's Name
Almia Valentine
Deborah Pierce
Cameron Gatlin
LEGO
Robotics
Porter:
Derreco & Tyreece
East Flora:
Morgan & Cameron
Camden:
Domyia & Deborah
Goodlow:
Aryana


Intermodal Transportation Simulation
What mode of transportation will you choose?
Rootbeer
Brewing
Rootbeer
SUGAR CUBES
YEAST
Stretching
the
TRUTH
Gum Brand
Average Length
Student Name


Engineering
• The branch of science and technology concerned with the design building & use of engines, machines & structures.
What is an engineer?

## 5. Changes/Problems

**5.1. Changes in approach and reasons for change:**

"**Nothing to Report**"

**5.2. Actual or anticipated problems or delays and actions or plans to resolve them:**

"**Nothing to Report**"

**5.3. Changes that have a significant impact on expenditures:**

"**Nothing to Report**"

**5.4. Significant changes in use or care of animals, human subjects, and/or biohazards:**

"**Nothing to Report**"

## 6. Special Reporting Requirements

**6.1. Information on matching funds:**

| Federal Budget 364802 | | | Cost Share Budget 864802 | | |
|---|---|---|---|---|---|
| **Description** | **Budgeted** | **Expenditures** | **Description** | **Budgeted** | **Expenditures** |
| Salary | $22,987 | $23,776 | Salary | $20,987 | $20,941.40 |
| Fringe | $6,427 | $6,645.84 | Fringe | $5,944 | $5,345.10 |
| Travel | $441 | $502.92 | Travel | $510 | $447.77 |
| Contractual | $2,000 | $2,037.50 | Contractual | $427 | $396.37 |
| Commodities | $3,510 | $1,615.35 | Commodities | $7,497 | $7,428.18 |
| Indirect | $15,737 | $15,245.78 | Waived | $15,737.43 | 15,236.09 |
| Total | $51,102 | $49,505.96 | Total | $51,102.43 | $49,474.09 |

**6.2. RITA Performance Indicators:**

1. Students participating in transportation research projects funded by this grant
    - Undergraduate student: Austin Heath (ajh524@msstate.edu )- Computer Engineering
    - Undergraduate student: Brian Sprow (bts134@msstate.edu) – Mechanical Engineering