Annual Summary of leaderSTATE 2018

M. Cade Smith, Caleb Carlton, Renee Clary, Stephen Williams

Program Overview

LeaderSTATE-STEM consists of a summer residential Science, Technology, Engineering, and Mathematics (STEM) training camp and fall-semester STEM outreach/education program. LeaderSTATE-STEM was made possible by a partnership between the U.S. Army, the Department of Geosciences at Mississippi State University (MSU), and the Office of Student Leadership and Community Engagement (SLCE) at MSU. During the summer of 2018, a total of 336 high school Junior ROTC (JROTC) cadets from Mississippi, Louisiana, and Alabama participated in leaderSTATE. Collectively, about 26,880 hours of STEM education and outreach were delivered through leaderSTATE-STEM.

Program Goals

The desired leaderSTATE-STEM learning outcomes include: 1) a greater understanding of self; 2) a greater appreciation for the preferences of others; 3) increased collaborative/teamwork skills; 4) increased written and verbal communication skills; 5) a greater understanding of application of STEM in colleges/university research units; 6) a greater understanding of application of STEM in high tech industries; 7) a greater understanding of educational and STEM opportunities afforded through Army, Navy, and Air Force ROTC units in Mississippi Schools; 8) a greater understanding of higher education opportunities offered by community colleges and 4-year institutions; 9) a greater understanding of how to prepare for and navigate college enrollment, admission, and graduation; 10) learning fundamental STEM principles; 11) learning how to synergistically apply STEM principles through concept, design, build, and perform segments of a student-led, hands-on aerospace engineering challenge; and 12) increasing the future orientation of JROTC cadets so that they can understand how it looks and feels to be a successful college student.

Summer Residential LeaderSTATE-STEM Training Program

Enrollment Data

Prior to the six week-long summer residential STEM training camps, cadre pre-enrolled 392 cadets in leaderSTATE, of which, 336 ultimately participated/completed the camp (47 in cycle 1, 58 in cycle 2, 56 in cycle 3, 58 in cycle 4, 58 in cycle 5, and 59 in cycle 6). The majority of participating cadets were from

Mississippi (47 percent). Thirty-five (35) percent of the cadets were from Louisiana and 18 percent were from Alabama. Females comprised fifty-three (53) percent of the participants. The racial demographics were sixty (60) percent African-American, twenty-seven (27) percent Caucasian, and thirteen (13) percent Other.

Program Structure

During the summer STEM training program, cadets learned leadership, STEM, and fitness skills, and ultimately applied those skills during student-led, team-based challenges. The typical day at leaderSTATE included a 4:45 AM wakeup and 9:45 PM lights-out. Throughout the day, cadets participated in about 1.5 hours of physical training, 3.0 hours of engaged learning activities, 1.5 hours of cadet-led presentations, 2.0 hours of tours, 2.0 hours of interactive lectures, and 1.0 hour of discussion/reflection. Meals and personal time totaled about 4.0 hours per day, and transitional/transport time was about 2.0 hours per day.

Mr. Caleb Carlton (Graduate Student in Geosciences) and Dr. Renee Clary (Professor of Geosciences) collaborated to create and deliver the STEM curriculum that was imbedded within all aspects of the training camp from teambuilding challenges through Geoscience-related projects and final team presentations. Additionally, cadets learned from MSU scientists/engineers, students, administrators, admissions counselors, coaches, ROTC personnel, and student/career development professionals. To supplement on-campus learning, cadets participated in tours of STEM applications in industry (Nissan Manufacturing, Canton, MS; Mercedes Manufacturing, Birmingham, AL) and research facilities (High Voltage Lab, Starkville, MS; Archaeology Museum and Excavation, Starkville, MS).

Assessment of STEM Training Camp Effectiveness

Two complementary pre-camp assessments and post-camp assessments were administered on the first and last day of camp, respectively, to determine the effectiveness of leaderSTATE-STEM. The first Pre/Post assessment was an internationally validated Test of Science-Related Attitudes (TOSRA), which focuses on measuring the attitudes of respondents toward science and science-related items. Designed to measure seven distinct science-related attitudes among secondary school students, TOSRA results were first published in 1978 by Barry J. Fraser[1]. During its development, the assessment was extensively

[1]*TOSRA: Test of Science-Related Attitudes*, The Australian Council for Educational Research Limited, Radford House, Frederick Street, Hawthorn, Victoria 3122, p 1.
(http://www.ecu.edu/ncspacegrant/docs/RESTEPdocs/TOSRA_BJF_paper.pdf)

field-tested and, after being internationally cross-validated, shown to be highly reliable. The seven scales included in TOSRA are: 1) Social Implications of Science (S), which measures the manifestation of favorable attitudes towards science; 2) Normality of Scientists (N), which measures the manifestation of favorable attitudes toward scientists; 3) Attitude to Scientific Inquiry (I), which measures acceptance of scientific inquiry as a way of thought; 4) Adoption of Scientific Attitudes (A), which measures adoption of 'scientific attitudes' such as open-mindedness and willingness to revise opinions; 5) Enjoyment of Science Lessons (E), which measures the enjoyment of science learning experiences; 6) Leisure Interest in Science (L), which measures the development of interest in science and science-related activities; and 7) Career Interest in Science (C), which measures the development of interest in pursuing a career in science.

The second Pre/Post assessment was created by SLCE staff to determine changes in cadets as they relate to the stated leaderSTATE-STEM learning outcomes. Assessments consisted of Likert-type items addressing various desired learning outcomes with "5" equaling a very positive response and "1" equaling a very negative response.

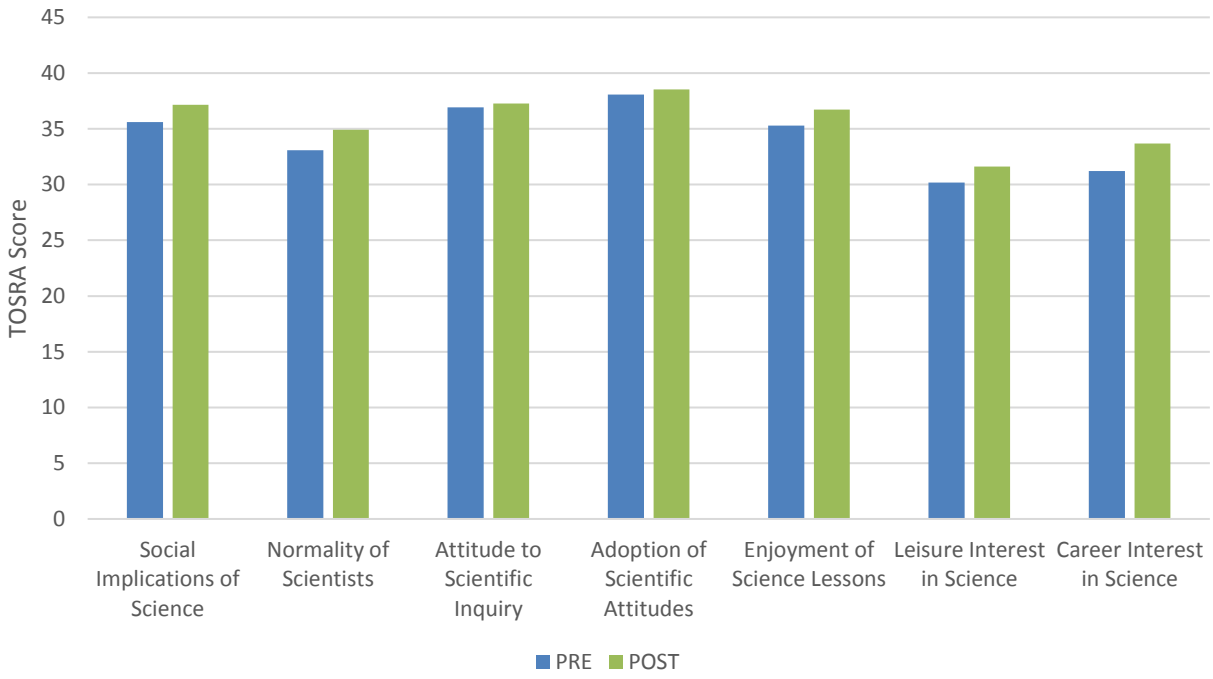
The effect of leaderSTATE-STEM on cadets attitudes toward STEM and STEM-related issues and regarding the stated learning outcomes were determined by changes in the average cadet response from the Pre-camp the Post-camp assessments. Cadet's responses were analyzed using Student's T-test, and statistical significance was classified as **not significant** (ns, p-value $\geq$ 0.10), **significant** (+, p-value < 0.10 but $\geq$ 0.05) and **highly significant** (++, p-value < 0.05).

Results of the Test of Science-Related Attitudes (TORSA) – Figure 1.

Three hundred thirty-eight (338) cadets took the Pre-camp TORSA, and 336 cadets took the Post-camp TORSA. The difference between the Pre- and Post-camp assessments for the seven scales and their statistical significance are presented in Figure 1. When compared to the Pre-camp scores, the

leaderSTATE-STEM experience improved the cadets' scale scores. The largest increases came in the Normality of Scientist and Career Interest in Science. The smallest increases were in Attitudes to Scientific Inquiry and Adoption of Scientific Attitudes.

Figure 1. Pre-camp and Post-camp Scores of Cadets taking the Test of Science-Related Attitudes (TOSRA)



Results of the leaderSTATE-STEM Learning Outcomes Assessment – Table 1.

Three hundred thirty-eight (338) cadets took the Pre-camp learning outcomes assessment, and 336 cadets completed the Post-camp learning outcomes assessment.

The results of the camp assessment analysis are featured in Table 1. The cadet responses increased from pre-assessment to post-assessment on average 0.88 points on a 5-point scale when asked about their understanding of types of STEM jobs available in university research units, understanding of how STEM is used in high tech industries, understanding of types of STEM jobs available in high tech industries, and their understanding of how STEM is used in university research units.

Cadet responses increased, on average 0.66 points on a 5-point scale when asked about their understanding of STEM opportunities available through Senior ROTC program, understanding of types of STEM educational opportunities available to them in college, understanding of the educational opportunities available in community colleges, and understanding of how to prepare for college enrollment.

Cadet responses increased on average 0.35 points from pre-assessment to post-assessment when asked about their understanding of college educational opportunities available through Senior ROTC

program, the likelihood of them pursuing at degree in a STEM-related field, and their understanding of educational opportunities available at 4-year colleges/universities.

Upon completion of camp, cadets expressed more confidence in their ability to address a STEM related challenge by creating a plan to address the challenge, identifying individuals or groups who could help them solve the challenge, be interviewed about the challenge, get other people to understand the challenge, and calling someone on the phone that they had never met before to get their help with the challenge (increased on average 0.24 points from pre- to post-assessment).

Furthermore, after the completion of leaderSTATE, cadets expressed more confidence in their ability to communicate ideas using written words, to work on a collaborative team, and to express their views and solutions to problems in front of a group of people, increasing on average 0.28 points from pre- to post-assessment.

Three assessment items did not statically change from the pre-assessment to the post-assessment. These items focused on the cadets' appreciation of other people having a different solution to a common problem, understanding of why they make the choices they do, and valuing different ideas from other people. Each of these items had an average Pre-camp response above 4.42.

Table 1. leaderSTATE STEM 2018 Assessment of Program Effectiveness.

Learning Outcomes	Assessment Statement	Pre-camp[1] (N=338)	Post-camp[2] (N=336)	Change in Response (Post - Pre)	Level of Statistical Significance[3]
Scale for the Following Items:					
1 = Strongly Disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree, 5 = Strongly Agree					
LO[4]: 5	I understand what types of STEM jobs are available in university research units.	3.33	4.34	1.01	++
LO: 6	I understand how STEM is used in high tech industries.	3.62	4.36	0.74	++
LO: 6	I understand what types of STEM jobs are available in high tech industries.	3.47	4.33	0.86	++
LO: 5	I understand how STEM is used in university research units.	3.47	4.36	0.89	++
LO: 7	I have a good understanding of STEM opportunities available through Senior ROTC programs.	3.61	4.35	0.74	++
LO: 8	I understand what type of STEM educational opportunities are available to me in college.	3.78	4.39	0.61	++
LO: 8	I have a good understanding of what educational opportunities are available at community colleges (2 year colleges).	3.54	4.21	0.67	++
LO: 9	I have a good understanding of how to prepare for college enrollment.	3.46	4.09	0.63	++
LO: 7	I have a good understanding of college educational opportunities available through Senior ROTC programs.	4.00	4.43	0.43	++

Learning Outcomes	Assessment Statement	Pre-camp[1] (N=338)	Post-camp[2] (N=336)	Change in Response (Post - Pre)	Level of Statistical Significance[3]
LO: 12	I will pursue a degree in a STEM-related field.	3.33	3.62	0.29	++
LO: 12	I have a good understanding of what educational opportunities are available at 4-year colleges/universities.	4.01	4.34	0.33	++
LO: 1,4	I am good at communicating ideas using written words.	3.69	3.97	0.28	++
LO: 1,3	I am skilled at working on a collaborative team.	4.04	4.20	0.16	++
LO: 1,3,4	I would be comfortable with my ability to express my views and solutions in front of a group of people.	3.86	4.27	0.41	++
LO: 1,3,4	I am good at speaking in front of people.	3.26	3.69	0.43	++
LO: 1,2,3	I think it is good that other people solve challenges differently than how I solve them.	4.47	4.43	-0.04	ns
LO: 1,3	I understand why I make the choices that I do.	4.33	4.42	0.09	ns
LO: 1,2,3	I value that other people have ideas that are different than mine.	4.46	4.43	-0.03	ns
LO: 1,2,3	I am skilled at working with other people to solve a common challenge.	4.10	4.21	0.11	+
LO: 1,2,3	The more people you have working to solve a challenge, the more likely you are to achieve success.	3.80	3.95	0.15	+

Learning Outcomes	Assessment Statement	Pre-camp[1] (N=338)	Post-camp[2] (N=336)	Change in Response (Post - Pre)	Level of Statistical Significance[3]
Scale for the Following Items: **1 = Definitely Can't, 2 = Probably Can't, 3 = Not Sure, 4 = Probably Can, 5 = Definitely Can**					
LO: 11	Faced with a STEM challenge, I would be comfortable with my ability to create a plan to address the challenge.	4.06	4.41	0.35	++
LO: 11	Faced with a STEM challenge, I would be comfortable with my ability to identify individuals or groups who could help me solve the challenge.	4.20	4.33	0.13	++
LO: 11	Faced with a STEM challenge, I would be comfortable with my ability to be interviewed about the challenge.	3.85	4.05	0.20	++
LO: 11	Faced with a STEM challenge, I would be comfortable with my ability to get other people to understand the challenge.	3.98	4.35	0.37	++

LO: 11	Faced with a STEM challenge, I would be comfortable with my ability to call someone on the phone that I had never met before to get their help with the challenge.	3.72	3.88	0.17	+
LO: 1	Faced with a STEM challenge, I would be comfortable pursuing a degree in Science, Technology, Engineering, or Math.	3.95	4.15	0.20	++

[1]Pre-camp assessments given upon arrival.

[2]Post-camp assessments given prior to departure.

[3]Determined by Student's T-test, two-tails with unequal variance. ++ = (P-value < 0.05), + = (P-value < 0.10), ns = (P-value $\geq$ 0.10)

[4]LO = Learning Outcomes:

1) a greater understanding of self;

2) a greater appreciation for the preferences of others;

3) increased collaborative/teamwork skills;

4) increased written and verbal communication skills;

5) a greater understanding of application of STEM in colleges/university research units;

6) a greater understanding of application of STEM in high tech industries;

7) a greater understanding of educational and STEM opportunities afforded through Army, Navy, and Air Force ROTC units in Mississippi Schools;

8) a greater understanding of higher education opportunities offered by community colleges and 4-year institutions;

9) a greater understanding of how to prepare for and navigate college enrollment, admission, and graduation;

10) learning fundamental STEM principles;

11) learning how to synergistically apply STEM principles through concept, design, build, and perform segments of a student-led, hands-on aerospace engineering challenge;

12) increasing the future orientation of JROTC cadets so that they can understand how it looks and feels to be a successful college student.