STEM ED HANDBOOK

BUILDING STRONG® STEM STUDENTS

A Basic Guide to the U.S. Army Corps of Engineers

STEM ED Program

In coordination with the Department of Defense Education Activity

OCTOBER 2014

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Message from Lieutenant General Bostick

The U.S. Army Corps of Engineers depends on a diverse, dedicated and competent team of science, technology, engineering and mathematics professionals. In the 1980s, the U.S. led the world in the percentage of college graduates with STEM degrees. Today, we rank among the lowest in the world. As technical professionals, we must invest in the profession's future and encourage the next generation to obtain STEM diplomas. To that end, we have initiated a partnership with the Department of Defense Education Activity to expose students to real-life examples of STEM projects in DoDEA classrooms around the world. This is a tremendous opportunity for our engineers and scientists to pay it forward as mentors and inspire young students to pursue STEM careers. Through this partnership, we are leveraging the strengths of two major organizations with a mutual goal: to increase STEM awareness and exposure among young people. This is a win-win situation. USACE professionals are giving back to the profession and students are seeing the applicability of a STEM degree. Making an investment now will pay dividends in the future—for the nation, the U.S. military and USACE.

Thank you for your participation in this program and your work to further STEM education and awareness.

Essayons. Army Strong. Building Strong.

Thomas P. Bostick
Lieutenant General
Commander
U.S. Army Corps of Engineers

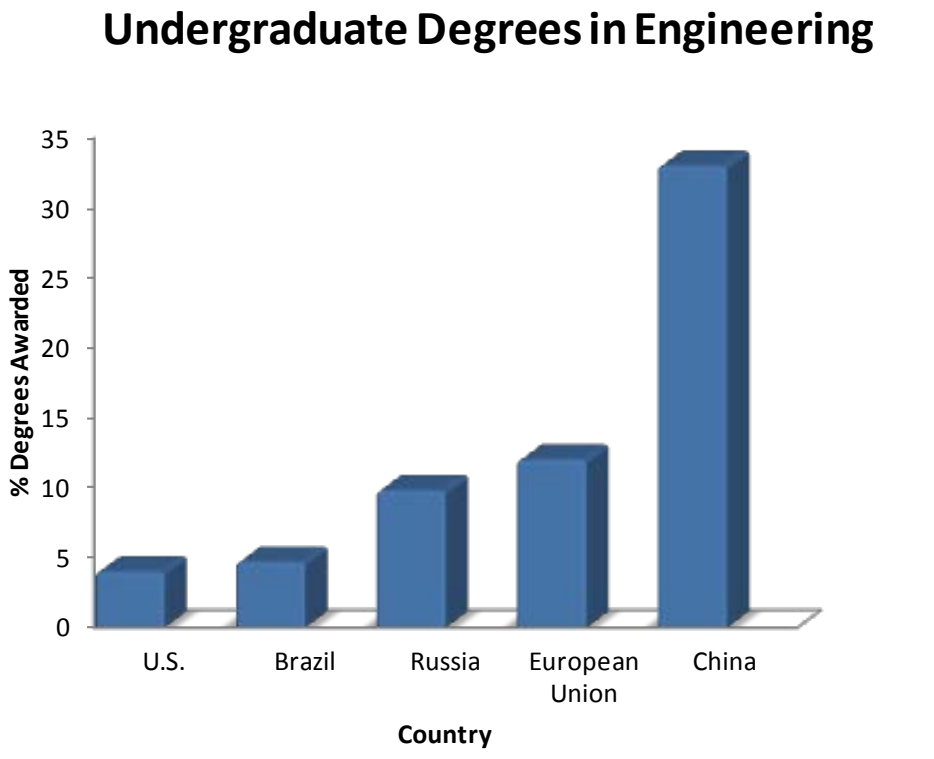
Message from Thomas Brady

Science and technology have long been the primary driving force behind America's economic strength and competitive workforce. The future of our nation depends on its ability to increase student performance in science, technology, engineering and mathematics (STEM). Partnering with the U.S. Army Corps of Engineers is an exciting education initiative with enormous potential to positively influence students' impression of science and math at a critical point in their academic careers. Having USACE scientists and engineers work with teachers in classrooms and mentor students is extremely valuable and provides tremendous benefit to the learning experience. This partnership takes full advantage of the mutual interests and commitments of DoDEA and USACE, cultivating collaborative synergies that provide the high-quality STEM educational opportunities essential for preparing a diverse and highly educated workforce. We look forward to working with the U.S. Army Corps of Engineers to advance STEM education for military-connected students.

Mr. Thomas M. Brady
Director, Department of Defense Education Activity

INTRODUCTION

Science, Technology, Engineering and Mathematics (STEM) form the basis of the nation's current and next generation workforce. Jobs in STEM fields are the fastest-growing employment sectors, but the number of students graduating with degrees in those areas is declining. Engineering accounts for only 4 percent of U.S. bachelor's degrees, compared with about 33 percent in China and 19 percent in the rest of Asia (National Science Board, 2012). More importantly, with the demographic composition of the nation changing, a workforce with diverse backgrounds and experiences is needed to foster different, more innovative, systems-oriented ways of thinking about the complex problems which we face as a society. Crucial segments of the U.S. population are underrepresented in the STEM (and the nation's) technical workforce. Women now represent the majority of the U.S. postsecondary population and account for only 27 percent of the U.S. STEM workforce. Likewise, underrepresented minorities make up 24 percent of the U.S. population, but only comprise approximately 10 percent of the U.S. STEM workforce (NSB, 2012). It is imperative that DODEA seeks out and enables partnerships with STEM organizations to tap into the rich resources offered by specialists and practitioners in STEM-specific fields.



National Science Foundation, 2012

PARTNERSHIP

At nearly 35,000 strong, the U.S. Army Corps of Engineers (USACE) has the capacity to make a tremendous difference in STEM education. The USACE team is a diverse group of men and women with a vast array of knowledge and skills who recognize the potential of pairing its engineers with students and teachers in DoDEA's classrooms. The USACE/DoDEA partnership allows for engineers and scientists to be paired with specific middle schools (grades 6 – 8) where DoDEA and USACE activities are co-located. USACE civilian and military professionals are committed to establishing a long-term sustainable partnership with DoDEA.

The program is different from others because it is embedded in the classroom and tied to the curriculum, conceptual understanding is built in and the program provides the face-to-face, hands-on, long-term interaction with the teachers and students. The partnership values the flexibility needed to set priorities, choose partners, and select projects that represent the best fit between USACE and DoDEA resources. At the same time, each site benefits from the collective knowledge provided by DoDEA and USACE Headquarters which facilitates a more personalized and focused approach rather than a mix of unrelated STEM outreach initiatives.

PROGRAM

GOALS OF THE PROGRAM*

1. Connect and leverage USACE STEM professionals to establish a focused and sustainable long-term STEM partnership in communities where DoDEA and USACE activities are co-located.
2. Increase student interest in and knowledge of STEM careers; increase student exposure to professional role models and mentors who represent gender and ethnic diversity.
3. Inform students of USACE missions and the nation's STEM needs in the future.

*See Appendix B for more details re: goals and objectives

CO-LOCATIONS

USACE has personnel located throughout the United States, in the Pacific and Europe and DoDEA operates approximately 175 schools throughout the United States, the Pacific and Europe. This provides many opportunities for collaboration at co-locations (not every DoDEA location will provide an opportunity for program participation). For a complete map of DoDEA and USACE locations, please see www.usace.army.mil/stem).

CURRICULUM

- Standards-driven instruction
- Introduction to the engineering design process (teachers and students)
- Real world applications of the scientific method
- Problem-based learning

EVALUATION

Success of the program will be measured using several tools. USACE will gather data and administer a program evaluation to STEM professionals (Appendix C). HQ DoDEA will develop and administer a program evaluation to teachers (Appendix D). DoDEA will also administer a student pre and post assessment to students (Appendix E). The assessment will serve as data to drive the program's improvement cycle.

CAPSTONE EVENT

A capstone experience is a multi-facted assigment that serves as a culminating academic intellecutal experience for students that occurs at the end of the school year. The capstone experience encourages students to connect what they learned in the classroom to extend their learning outside the school setting. A capstone experience can take many forms, the following are some examples:

Research paper	Video
Poster board presentation	Project
Brochure	Marketing STEM careers
Field trip to local engineering project site	Booklet

ROLES AND RESPONSIBILITIES

The following outlines the roles and responsibilities of the stakeholders implementing the program. Effective STEM partnerships and outreach develops out of a culture of community engagement that cannot occur without high-level leadership. DoDEA/USACE Headquarters leaders are committed to providing support on multiple fronts. In order to facilitate strong partnerships and open and effective communication, DoDEA and USACE will identify liaisons.

STEM PROFESSIONALS

The participation of USACE STEM professionals is the underpinning of the STEM partnership. STEM professionals bring relevance to potential STEM careers by serving as role models and revealing what these careers entail. STEM professionals volunteering are an in-classroom resource that will help link the classroom curriculum to the application of STEM in the real world. They will be key in creating parent- and peer-friendly messages about STEM careers and pathways for career choices.

All STEM professionals are self-selected from their unit/command. Effective recruitment taps the curiosity, enthusiasm, and professionalism of STEM professionals whose personal return on investment contributes to inspiring current and future generations of young people to pursue careers in these fields. Local decision making provides the flexibility to match the professionals' interests and availability with outreach opportunities.

Considerations/Advantages for STEM Professionals

- Interest in investing in mentoring the future generation of engineers and scientists
- A desire to contribute to a community of peers and co-workers offering an innovative learning environment to DoDEA students
- Work closely with teachers to develop hands-on, rigorous, age appropriate, technology rich, standard based projects
- Provide feedback on program
- Supervisory/Commander approval to participate
- Consideration of the commitment of time and energy to the program
- Connect with the USACE District Liaison for connection with the school
- Provide updates to supervisor(s) on program progress, time requirements, etc.
- Compliance with school requirements including a background/security check (initiated by the school)
- Possible claiming of Professional Development Hours

Logistical Requirements

- Approximately 1-2 hours per week, per classroom, over a 4-6 week period (includes classroom and preparation time)
- Additional time may be required to travel to and from the local school
- Additional time may be required for after school activities/competition preparation and awards ceremony

Responsibilities for STEM Professionals During a School Visit

- Model the design process by asking questions to guide students toward solutions (see additional suggestions and characteristics of middle school learners in Appendix F)
- Support lesson plan objectives by demonstrating how STEM careers are tied to math and science concepts
- Identify required resources
- Coordinate with your teacher-partner early in the school year to establish a schedule and a focus for lessons

- Present a professional image and attitude at all times
- Schedule time to prepare for the classroom session; commit to participating in all scheduled sessions
- Become familiar with school safety/security protocol; adhere to parking, entry/exit & check-in procedures; understand evacuation/take shelter procedures
- Notify teacher/volunteer team in advance of absence
  Note: some of this preparation may need to be done outside of the work day

USACE LIAISON

Commanders will identify a (division, district, and/or field office) liaison to support this initiative; a person exhibiting passion for the STEM initiative (may be either a civilian or military member). The USACE liaison will connect with the DoDEA liaison to help organize and develop the partnership with the local DoDEA schools. The USACE liaison shall:

- Support the Commander's intent
- Identify and energize USACE volunteers
- Connect with local professional societies, like the Society of American Military Engineers (SAME) and private industry partners, to supplement volunteers.
- Establish and maintain communication with the school liaison
- Assist volunteers in complying with visitor protocol
- Connect volunteers with the DoDEA school liaison
- Arrange volunteer meetings as necessary
- Familiarize new employees with the opportunity to volunteer
- Provide information to liaison for the preparation of reports
- Provide Commander feedback on program improvements resulting from volunteer efforts
- Connect with Public Affairs to communicate program events and successes

SCHOOL LIAISON

Participating DoDEA schools will establish a school liaison that will make the connection with the local USACE office. The liaison can be a school staff member, administrator, teacher or parent volunteer. The liaison will help organize and develop the partnership with the local USACE office(s) and support the team members in carrying out their responsibilities. The school liaison shall:

- Contact the local USACE office to discuss potential partnership opportunities
- Arrange partnership team meetings
- Collaborate with the teacher(s) to explain and communicate program goals and expectations
- Establish and maintain communication with partnership team members
- Familiarize new USACE members with their roles and responsibilities, and acquaint them with visitor protocol at the school
- Communicate with parents and local community
- Prepare and submit reports

- Organize events such as student presentations, competitions, award ceremonies, and open houses
- Invite parents/community to attend events such as student presentations, competitions, award ceremonies, and open houses
- Provide feedback on program improvements resulting from team efforts
- Utilize local and social media to communicate program events and successes
- Recognize partnership team members for their support

TEACHERS

The vision of the project is to connect teacher professionals with STEM career professionals in order to have them share collective expertise around teaching and STEM careers to benefit DODEA students. To this end, teachers should plan on:

- Collaborating to plan effective lessons (model lessons supplied by DODEA) with volunteer STEM professional that link USACE functions with the curricular content standards
- Utilize the STEM Professional to bring real-world relevance to the lesson
- Being responsible for classroom management
- Communicating openly with the STEM professional
- Working with student teams in advance of each classroom visit to ensure the students are prepared
- Evaluating student learning, recognizing participation and providing feedback on the program and how it can be improved
- Providing necessary materials and supplies for the projects

LEADERSHIP

- Engage DoDEA/USACE leadership (Headquarters level)
- Establish and support sustainable partnerships at the local level (Command and School level)
- Recruit volunteers (Command level: USACE STEM professionals, local professional organizations, private industry partners, parents)
- Supply model lessons and a rubric to review lesson plans that emphasize inclusion of the design process, an inquiry-based approach, addressing STEM careers; addressing equity; a focus on a real world, local problem; requiring students to design/create/explain solutions (Headquarters level)
- Measure impact (Headquarters level)
- Analyze program and make adjustments to assure sustainability and effectiveness (HQ, Command and Local level)

**This document is a living document and will be updated regularly as changes are necessary. For the most up-to-date version or to recommend changes, please see https://www.usace.army.mil/stem.*

APPENDIX A

FREQUENTLY ASKED QUESTIONS

Q1. How do I sign up to be a STEM professional volunteer?
A1. Check with your supervisory chain to determine whether or not your organization is co-located with a participating school.

Q2. Do I have to obtain my supervisor's permission to volunteer?
A2. Yes, supervisory approval is required.

Q3. How is this STEM initiative different than others?
A3. This is a program built in conceptual understanding; it is imbedded in the classroom and tied to the curriculum; it provides the face-to-face, hands-on consistent interaction w/ the teachers and students.

Q4. What age children will I be working with?
A4. The program will be based in DODEA middle schools, grades 6-8. The students will range in age from 11-14 years of age.

Q5. May I invite others to volunteer with me?
A5. Absolutely! Encourage other USACE STEM professionals to volunteer. USACE will also be partnering with professional societies, like the Society of American Military Engineers (SAME), and our private industry partners to provide volunteers in the classrooms.

Q6. Why should I get involved with DoDEA schools?
A6. DoDEA schools provide us with a focused and special opportunity to contribute to military families.

Q7. Why is USACE interested in STEM?
A7. USACE is interested in STEM as a way to leverage our engineers and scientists to contribute to the Nation's STEM challenge.

Q8. How can I contribute if I am not located near a DoDEA school?
A8. You may consider contacting USACE colleagues who are located near and volunteering at a DoDEA school and offer your assistance via the internet (e.g., providing project ideas, review of projects, etc.)

Q9. How many times per week and per school year will I be required to interact with the students?
A9. Typically, volunteers should expect to be in the classroom for about 1-2 hours per week for a 4-6 week period.

Q10. Will I be working one-on-one with a student?
A10. The classroom project will be based on a team concept with each team member having an individual responsibility; however, there may be times when volunteers will work with students one-on-one in the classroom.

Q11. I do not have teaching experience. Will I still be able to contribute to the initiative?
A11. Yes. Volunteers need not have experience teaching – only a passion for furthering STEM education.

APPENDIX B

GOALS-METRICS

Goal 1: Connect and leverage USACE STEM professionals to establish a focused and sustainable long-term STEM partnership in communities where DoDEA and USACE activities are co-located.

Objective 1.1 USACE will provide engineering and scientific resources, within funding constraints, to help execute mutually agreed upon STEM programs within DoDEA schools.
Objective 1.2 USACE STEM professionals will partner with teachers in DoDEA classrooms to enhance STEM curricula for middle grades.
Objectives 1.3 USACE will increase the number of interested and available STEM professionals for participation in STEM outreach activities by leveraging Commander support and commitment.

Goal 2: Increase student interest in and knowledge of STEM careers; increase student exposure to professional role models and mentors who represent gender and ethnic diversity.

Objective 2.1 USACE STEM professionals will collaborate with DoDEA in the development of STEM curriculum enhanced by a classroom project related to the USACE mission and connect classroom content to career paths, while increasing awareness of how the content students are learning is applied by individuals in STEM careers.
Objective 2.2 USACE will recruit a diverse group of STEM professionals to volunteer in the classroom, so that students are exposed to role models representing gender and ethnic diversity.

Goal 3: Inform students of USACE missions and the nation's STEM needs in the future.

Objective 3.1 USACE will strengthen and broaden its STEM partnerships in communities where DoDEA and USACE activities are co-located,
Objective 3.2 USACE will increase community support for making STEM a key part of "Career Awareness and Preparation."

APPENDIX C

STEM PROFESSIONALS' PROGRAM EVALUATION

1. How did you hear about the opportunity to participate in the DoDEA program?
   a. Commander
   b. Colleague
   c. USACE website
   d. Other? Please add:_____

2. How much time did you spend preparing for class?
   a. Less than 1 hour/week
   b. 1-2 hours/week
   c. 2-4 hours/week
   d. More than 4 hours/week

3. How much time did you spend in the classroom?
   a. 1-2 hours/week
   b. 2-4 hours/week
   c. More than 4 hours/week

4. How much time did you spend traveling to class?
   a. Less than 1 hour/week
   b. 1-2 hours/week
   c. 2-4 hours/week
   d. More than 4 hours/week

5. Did you see a measureable difference in students' knowledge in the areas of the program between the beginning of the program and the end?
   a. Yes
   b. No

   If yes:
   - Small increase
   - Medium increase
   - Great increase

6. Through interaction with students, teachers and parents have you noticed an increase in your own professional development in the following areas?
   a. Gained valuable presentation and organizational skills and experience?
      - Yes
      - No
   b. Enhanced leadership and communication skills?
      - Yes
      - No
   c. Experienced pride and a sense of community in joining with peers and co-workers to offer an innovative learning environment to DoDEA students?
      - Yes
      - No

7. Do you plan to participate in the USACE-DoDEA program next year?
   a. Yes
   b. No

8. If you do not plan to participate again, why?
   a. My workload does not allow me to make the time commitment required.
   b. Personal matters does not allow me to make the time commitment required.
   c. Working with school children is not my interest/talent.
   d. I do not have the full support of my chain of command.
   e. Other_____

9. Would you recommend volunteering to your colleagues?
   a. Yes
   b. No

10. Do you consider the program to be successful?
    a. Yes (skip to question 12)
    b. No

11. If not, what improvements would you suggest?

    _____
    _____
    _____

12. Did the classroom provide adequate supplies for the project?
    a. Yes
    b. No

    If not, what is needed for future lessons?

    _____

13. Additional comments:

_____
_____
_____
_____

APPENDIX D

STEM TEACHERS' EVALUATION SURVEY

1. **I saw an increase in students' knowledge about STEM careers as a result of this STEM experience.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

2. **I saw an increase in students' interest in STEM careers as a result of this STEM experience**.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

3. **I saw an increase in students' knowledge in science as a result of this STEM experience.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

4. **I saw an increase in students' knowledge in engineering as a result of this STEM experience.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

5. **Through my involvement with the STEM volunteer, I gained STEM content knowledge that I will use in my instruction.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

6. **Through my involvement with the STEM volunteer, I gained knowledge about STEM careers that I will use in my instruction.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

7. **Through my involvement with the STEM volunteer, I gained STEM content knowledge that I will be able to use in my instruction.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

8. **What did you see as strengths of the program?**

9. **What would you change about the program to improve it?**

STEM LEARNING STUDENT SURVEY

Please circle the response that best describes your experiences with engineering.

1. I am able to do well in activities that involve engineering.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

2. I plan to use engineering in my future career.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

3. I will work hard on activities at school that involve engineering.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

4. If I learn a lot about engineering, I will be able to do lots of different types of careers.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

5. **My parents would like it if I choose an engineering career.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

6. **I am interested in careers that involve engineering.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

7. **I like activities that involve engineering.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

8. **I have a role model in an engineering career.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

9. **I feel comfortable talking to people who are engineers.**

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree

Adapted from *The Development of the STEM Career Interest Survey* (Kier, Blanchard, Osborne & Albert, 2013)

APPENDIX F

TIPS for WORKING with MIDDLE SCHOOL STUDENTS

Understanding more about the developmental traits of the middle school student will help STEM mentors ensure students are provided with positive STEM experiences.

MIDDLE SCHOOL AGE STUDENT		
Cognitive Characteristics	**Social Characteristics**	**Emotional Characteristics**
Transitioning from concrete thinking to abstract thinking.	Demonstrate a desire for increased autonomy	Tend to be self-conscious and may over-react to embarrassment or ridicule.
Like new challenges, but reasoning and decision-making skills are still developing.	May demonstrate immature behavior or act out as social skills catch up with physical and intellectual development.	Need frequent affirmation and recognition for their efforts.
Prefer active to passive learning experiences.	Exhibit heightened awareness of how they compare with their peers.	Often unpredictable.
Intellectually curious about the world and themselves.	Desire to be “in” and not “out.”	Often exhibit sudden bursts of activity to release energy.
MIDDLE SCHOOL MOTIVATORS		
Cognitive	**Social**	**Emotional**
Intellectual challenges	Autonomy/choice	Acceptance/safety
Responsibilities	Peer acceptance	Reduced anxiety
Decision-making	Positive recognition	Fear of failure
Imagination / curiosity	Fun and use of humor	Positive feedback