North-Central Florida High School Students have a Blast at STEMTank™

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STEMTank™ is an annual summer college access program coordinated by Educational Talent Search (ETS) and funded by the U.S. Department of Education. The STEMTank™ program introduces high school students to engineering by immersing them in a college-like environment and engaging them in design thinking to complete an open-ended, hands-on project. Now in its third year, STEMTank™ is an award-winning collaboration between the University of Florida (UF) MERGE Laboratory and the Santa Fe College (SF) TRIO Office. UF and SF engineering students serve as near-peer mentors for high school participants, providing support and guidance throughout the 10-day hybrid program. Mentors portray successful STEM student attitudes and behaviors and serve as inspirational role models for participants. The majority of STEMTank™ participants are considered low-income and potential first-generation college students.

The STEMTank™ theme and project change annually, allowing participants to return each summer to take on a new challenge. This year's theme was Rocket Engineering, which challenged students to design, build, fly, and analyze solid propellant rockets under realistic constraints to achieve a participant-defined mission (e.g., reaching a particular altitude or testing the viability of an experimental component). Participants first built Estes Alpha III kits to learn about rockets, and they launched them with Featherweight Raven-4 altimeter payloads to collect flight data for analysis. Next, participants created Alpha III simulations in Open Rocket using rulers, protractors, and calipers to measure and digitize each rocket component. They then compared simulated rocket performance with actual flight data. Next, students harnessed Open Rocket's flight simulation capability to test modifications by iterating designs through simulated flight to achieve their self-defined rocket mission. Once rockets met performed specifications in simulation, students modified Estes Alpha kits to match the custom configuration developed in Open Rocket. In all cases, student designs required the fabrication of custom components such as nosecones, payload bays, fins, and couplers. Students performed detailed CAD design of custom components in Fusion 360 by Autodesk. They digitized these designs into G-code via Prusa Slicer, and they 3D printed components from PETG filament using Prusa i3 MK3S+ printers. Assembled custom rockets were painted, loaded with Raven-4 altimeters, and launched by students. The STEMTank™ culminating event was a reveal of students' custom rocket designs and quantitative evaluation of flight performance and mission achievement through analysis of altimeter data with comparison against Open Rocket simulations and Alpha III baseline flights. Students delivered these presentations to a panel of "Sharks", subject matter experts from industry and academia who provided insight and feedback on student presentations.

STEMTank™ is delivered in a hybrid format with 3 in-person and 7 online sessions to keep program cost low, enabling all participants to attend tuition-free. In addition to interaction with UF and SF faculty, staff, and student mentors, STEMTank™ participants also interact with and shadow mechanical & aerospace engineering senior college students enrolled in UF's Capstone senior design course. These interactions provide opportunities to experience the format and feel of college-level engineering classes. The program builds a pipeline from North-Central Florida high schools into STEM majors at SF and UF. Through pre/post self-efficiency surveys, STEMTank™ has demonstrated statistically significant improvement in one or more measured

self-efficacy metrics during each program iteration. STEMTank™ participants are tracked for five years to evaluate STEMTank's longitudinal effectiveness as an intervention that promotes long-term student engagement in STEM majors and careers. The program's curriculum is designed around a new pedagogical framework, low-stakes intentional failure technique (LIFT), which builds "intentional failure opportunities" into the curriculum while scaffolding tasks by increasing support proportional to the level of difficulty. Collected pedagogical evidence shows this practice leads to higher levels of student persistence and success in project-critical milestones.

Figure 1. STEMTank™ students with their rockets and STEMTank™ staff.

Figure 2. STEMTank™ students learning about rockets at the University of Florida campus.

Figure 3. STEMTank™ students launching their rockets.

Figure 4. STEMTank™ students using computer-aided design (CAD) to design their rocket nosecone.