Future Trajectories for STEM Education at Virginia Air and Space Center By John H. Falk and Robert R. Griesmer

What exactly is the future role for science and technology-related free-choice learning centers in fostering student engagement, critical thinking, lifelong learning, and workforce development? Do we have a responsibility to address long-term issues pertaining to the United States' competitive advantage such that no child is left behind? Isn't it true that every country needs to have a science literate public and that no country can afford to leave anyone behind?

Students get to experiment with liquid nitrogen in a Virginia Air and Space Center (VASC) STEM 360 program called "Space Freeze." Photo courtesy VASC





A student discovers static electricity using a Van de Graaff generator during a VASC STEM 360 program called "Electricity." Photo courtesy VASC

The Virginia Air and Space Center (VASC) in Hampton (one of seven cities that make up the Hampton Roads metropolitan area) asked these questions when it concluded that its own fundamental relevancy needed to be addressed if it were to face the strategic necessity of long-term sustainability.

Similar to some other areas of the United States, the Hampton Roads area has numerous free-choice learning institutions, in which hundreds of millions of dollars have been invested, and whose assets have only been peripherally used by formal educational institutions. The most typical uses are one-off school field trips in the spring or the occasional school program. These experiences have positive benefits for students, but few believe they significantly change most students' STEM learning trajectories.

VASC, led by executive director and chief executive officer Bob Griesmer, felt it could do better. In collaboration with the Institute for Learning Innovation's director, John Falk, VASC met with the superintendents of each of the neighboring school districts and proposed a whole new way to approach



the challenge of enhancing STEM learning in the Hampton Roads area. In September 2016, the STEM 360 research-practice partnership was formed, and over the next two years it would follow 1,800 4th grade students through the completion of their 5th grade academic year. The STEM 360 Program was conceived to put into practice, as well as holistically assess, years of research findings showing that STEM learning derives not from a single source (e.g., schools or visits to science centers), but rather from multiple sources (school, out-of-school free-choice

HELPFUL DEFINITION Free-choice learning: the learning that occurs when people have significant choice and control over what, where, and when they learn

experiences, parental support, and mentoring-type support from other key adults). The STEM 360 Program was designed as a multi-modal, ecosystem approach to enhancing STEM learning.

THE FOUR STRATEGIES

The STEM 360 Program explored how STEM engagement influenced children's STEM career awareness, academic achievement, engagement, and attitudes. Four strategies were used to enrich the existing STEM learning ecosystem: (1) In-School "Educational Outreaches"; (2) "Field Experiences": Trips to VASC and other local informal STEM institutions; (3) "Family Engagement" through STEM ambassadorships; and (4) "STEM Coach Engagement and Support." These four strategies were tested at three levels of engagement over two years: Level 1, the highest intensity; Level 2, an intermediate level of engagement; and Level 3, the control group, the level of least exposure.

- 1. "In-School Education Outreaches" were onehour programs conducted by VASC educators who had been identified as STEM coaches. For example, one program provided fascinating details about Earth environments and the comparatively harsh environments on the moon and the necessary design constraints needed to keep humans alive in such conditions. Students were then asked to build model lunar colonies using what they'd learned.
- 2. "Field Experiences" provided additional opportunities to engage students in more immersive STEM learning opportunities. Participants experienced the *MathAlive!* exhibition at VASC, went indoor sky-diving at iFLY,

and visited the Norfolk Botanical Garden and Virginia Zoo where they engaged in team-based, hands-on learning activities; educational IMAX movies; and guided educational experiences. Career awareness partners included Virginia Tech Cooperative Extension, which conducts agricultural research in hydroponics and aquaponics, as well as East Coast Polytechnic Institute (ECPI), which provided experiences related to STEM careers in the health sciences and technology.

- 3. "Family Engagement" included STEM ambassadorships where students and one adult were provided free unlimited entry to the VASC. Monthly STEM Saturday programs at VASC were structured around a theme and featured various STEM activities such as guest speakers. The most popular of these events was a visit and presentation by astronauts Fred Haise and Walt Cunningham, who shared inspiring stories and interacted with visitors.
- 4. "STEM Coach Engagement and Support" provided engagement and support for all participating schools. These VASC educators served as mentors to the students, conducted most of in-school education programs, attended field experiences with the students, greeted students and families at STEM Saturday events, and communicated with classroom teachers and parents about STEM opportunities in the community that might be of interest to students.

RESULTS

After two years and reams of data collected, results from the STEM 360 Program found that relative to Level 3 controls, Level 1 students and even some Level 2 students showed significant increases in:

- 1. STEM career awareness
- 2. STEM achievement as measured by Virginia standardized test scores
- 3. Engagement with STEM
- 4. Attitudes toward STEM





Student participates in a STEM 360 field experience at iFly in Virginia Beach, Virginia. Photo courtesy VASC

For example, at the conclusion of the STEM 360 Program, Level 1 students were significantly more interested in pursuing a career in STEM than were Level 3 students. In addition, while all students increased their interest in pursuing a career using STEM skills from the beginning of the program to the end of the program, this increase was significant only for Level 1 students, which as previously stated, was the highest level of STEM engagement.

THE FUTURE

So what does all of this mean for the future of science centers? After two years of exposure to field experiences, outreach efforts, STEM coaching and mentoring, STEM Saturdays, and STEM career activities, project results confirmed that this new, multi-modal, ecosystem approach successfully enhanced the STEM interest, learning, and engagement of participating children.



A student discharges the Van de Graaff generator during a STEM 360 program at VASC. Photo courtesy VASC

The STEM 360 team has been able to identify new and ever better ways to support student needs, build synergies, and coordinate across the four-pronged support of STEM learning—classroom experiences, informal setting experiences, adult mentors, and family engagement—and to develop student STEM experiences that complement, enhance, and extend the students' standard classroom instruction.

Equally important, VASC's board and supporters are beginning to see VASC in a new light. Rather than merely being perceived as a nice attraction and place to take children on field trips or weekends, VASC is increasingly seen as a regional and statewide leader in STEM education—an organization helping to address and solve the area's critical issues.

We wanted to share our story with other science centers because this successful direction for VASC's future may be useful to others as well. We do believe, however, new leadership opportunities for science centers may very well reside in the bundling of the components considered in this research. We are achieving a more profound relationship with school divisions and our sister institutions due to the partnership developed and the outcomes being achieved. In the final analysis, all our successes will be determined by how we manage and optimize the resources in our respective communities.

The STEM 360 Program was funded through the legislature of the Commonwealth of Virginia and now, with an additional two years of funding, VASC and the Institute for Learning Innovation have initiated a second round of programming and assessment to determine if the findings can be replicated and validated with a new cohort of students. For more details, visit *www.VASC.org/STEM360*. The final report will be available at that site after March 1.

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